Rail Rates for Grain Shipments over Time[1]

by

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EXECUTIVE SUMMARY

Transportation rates are a key determinant of traffic flows and affect whether a flow occurs, the level of the flow, which origins and destinations are involved, and, ultimately, the economic well-being of shippers. This is particularly true in agricultural markets where trades are quite sensitive to transportation rates and are made under small margins.

For 20 years after passage of the Staggers Rail Act of 1980, railroad rates declined significantly. However, beginning in 2003, rates began to increase sharply until 2014 but fell some in 2015 and 2016. This paper examines the sources of changes in rail rates over the period of 2000 to 2016 for the transportation of U.S. corn, wheat, and soybeans.

There are several steps in the process of examining the sources of change in rail rates to specify the model, estimate the model, and report the econometric results.

First, the relevant literature was identified and used to identify key variables that explain rail rates. This literature basically points to cost and markup variables (measures of competition) which are included and improved upon.

Second, the dataset for the empirical analysis was developed. The primary data are the Surface Transportation Board's (STB) confidential Carload Waybill Samples (CWS), which give information on rates and shipment characteristics. These data were supplemented by information from the Centralized Station Master (CSM), which provides latitudes and longitudes for the CWS origins and destinations, as well as information about railroads that provide service at the origin and destination locations. From these data, measures of intramodal competition were developed and incorporated in the model. The data were then combined with U.S. Army Corps of Engineers (USACE) data on the locations of docks that can handle grain commodities. This provides a measure of the distance to the nearest waterway port to both the origin and destination of the rail shipment. The combined data provide information on rail shipments from origin to destination from 2000-2016, along with measures of intra- and inter-modal competition.

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Third, these data were heavily scrutinized, and the results were presented descriptively prior to the estimation of the empirical model.

Fourth, the model was estimated by year and commodity to assess whether the coefficients vary across commodities and whether they vary over time. The results point to differences across time and across commodities with the result that the model was estimated for each year and each commodity. Generally, the results are consistent with the previous literature, as well as expectations. However, unlike most of the previous literature, the results are summarized not just by commodity, but also through time. The model also uses a novel approach of measuring the effects from competition, both intra- and inter-modal sources.

Fifth, the empirical results enable a comparison of coefficient estimates over time. The results point to significant changes in railroad pricing over time and across commodities. There are significant changes in coefficients over time suggesting that railroad pricing rules change over time, but also from the descriptive analysis, there are also significant changes in the variables (shipment distance, shipment size, etc.), suggesting the price changes have resulted not only from changes in railroad pricing but also from changes in the shipments themselves.

Sixth, a Blinder-Oaxaca decomposition was used to identify the major sources of change in rates between parameters and variables.[2] The results across all commodities (corn, wheat, and soybeans) are consistent in the sense that in each case *changes in the variables* as a group point to lower rates through time as shipment distances, cars, etc., have generally increased and have a negative effect on rates, while *changes in the coefficients*, which reflect railroad pricing rules, explain sizable increases in rates through time.

Seventh, commodity specific changes in the intercept (unidentified sources of change through time) point to dramatic increases in rail rates through time, especially from 2003-2015. A final analysis runs weighted regressions by commodity of the intercepts over time. The weights are the standard errors of the intercept coefficients. As explanatory variables, the time variation of rates is explained in terms of prices received for each commodity and a measure of fuel prices over time. The results provide strong evidence that increases in fuel prices have had a strong positive influence on rates for corn and wheat.

The general findings of the research are that rail rates changed little in the early years of analysis (2000-2003), but beginning in 2003-4, rates began to rise and rose sharply until 2013-2015, and then fell. An econometric model is used to capture these changes in terms of traditional explanations (i.e., changes in traffic characteristics such as distance, shipment size, etc. as well as measures of intra- and inter-modal competition). From a Blinder-Oaxaca decomposition, it appears that changes in the variables point to rate decreases not rate increases. However, the coefficients attached to the shipment and competition variables have pointed to sizable changes in rates, which point to changes in railroad pricing behavior. A key change is with respect to time (i.e., the intercepts of the pricing equation generally increased over time). These are changes due to variables not in the model that are correlated with time. Two possibilities were examined—fuel prices and commodity prices. The results provide strong evidence that rail rates increased due to increases in fuel prices and that commodity prices for corn, wheat and soybeans had no effect.

[2] Wikipedia defines the Blinder-Oaxaca decomposition as a statistical method that explains the difference in the means of a dependent variable between two groups by decomposing the gap into that part that is due to differences in the mean values of the independent variable within the groups, on the one hand, and group differences in the effects of the independent variable, on the other hand.

1. INTRODUCTION

Transportation rates are a key determinant of traffic flows. Transportation rates affect whether a flow occurs, the level of the flow, and the origin/destination of the flows as well as the economic well-being of shippers. This is particularly true in agricultural markets where trades are quite sensitive to transportation rates and are made under small margins.

Following partial deregulation in 1980, there were large declines in rates fueled by the growth of contracts and associated volume shipments, pricing flexibility of railroads, and consolidation of the industry (Burton (1993), Wilson (1994), Wilson and Wilson (2001), and National Academies (2015)). But, over the last several years, except for the last few, the price of shipping grain as well as other commodities by rail has increased dramatically. Over the same span, rail costs have generally fallen, which would theoretically point to falling transport prices. Most models of rail pricing to date are incapable of explaining this puzzle. This research attempts to understand the sources of change in rail rates since 2000, focusing on corn, soybeans, and wheat.

Modeling rail prices is quite difficult owing to the dimensionality and heterogeneity of railroad outputs as well as differences in shippers in terms of capacity, market options, line characteristics, and spatial locations of the origins and the destinations. Railroads serve multitudes of different origins and destinations as well as commodities. They also use a variety of different pricing mechanisms. In a general theoretic model, the prices of specific movements (origin-destination-commodity) are determined by interactions between shippers and railroads. It will generally depend on other flows over the network, the pricing mechanism (contract versus tariff) used, the degree of competition over the network, and, of course, shipment characteristics.

Over the last few years, there has been a major change in the traffic mix as coal shipments are down sharply, and railroads have been forced to realign pricing of commodities to reflect the revenue shortfall from coal. Agricultural shipments (especially to distant export markets) are a commodity group that is heavily dependent on rail, and there is limited competition from other modes especially for longer hauled shipments. Wheat tends to be produced in areas that are generally distant from the waterway, while corn and soybeans tend to be produced in areas for which there are either local markets (e.g., ethanol and feed) or for which truck to barge (truck-barge) is a realistic competitive alternative. Hence, one could expect that the pricing strategies are different across the different commodities over geographic space.

This research provides an econometric model of rail rates for wheat, soybeans, and corn from 2000 to 2016. The model includes various shipment characteristics (e.g., distance, shipment size, number of interchanges) as well as measures of intra- and inter-modal competition, and other characteristics of the shipment relating to ownership of cars and whether the shipment occurs under a contract. Although similar to previous studies, the model does introduce new measures of competition. It is estimated for each commodity and each year of the data. Finally, a Blinder-Oaxaca decomposition is used to explain the sources of change in rail prices.

The next section provides a synopsis of the existing literature on rail rates over time. This is followed by a brief examination of rail rates and commodity prices. Section 3 describes the data and variable construction. Section 4 provides the econometric results, while section 5 reports the results of the Blinder-Oaxaca decomposition. Section 6 summarizes the findings and conclusions.

2. PREVIOUS LITERATURE

There have been a number of studies of railroad rates, which were used to identify possible sources of rate variations over time. The industry was partially regulated in 1980 with the passage of the Staggers Rail Act. This legislation made significant changes in how railroads were regulated. In terms of this project, the primary changes relate to the notion of market dominance and the introduction of contract pricing. As discussed in Eaton and Center (1985) and Wilson (1996), the reasonableness of a rate could be considered by the regulator[3] only if the revenue to variable cost ratio exceeds 180 percent and if the regulator finds the traffic in question to be market dominant.[4] The Act also clarified the legality of confidential contracts. Contracts allow for service provisions, and often lower rates. Through time, contracts have become widely used for many commodities, such as coal, chemicals, and petroleum.

Several studies have examined the effects of partial deregulation on rail rates. These include Boyer (1987), Barnekov and Kliet (1990), Wilson (1994), Dennis (2000) Wilson and Wilson (2001), McFarland (1989), and others. Each examine rates before and after partial deregulation, and they generally find that rates fell between regulated and partially deregulated regimes. A series of papers by MacDonald (1987, 1989), Burton (1995), MacDonald and Cavalluzzo (1996) and, more recently, the National Academy of Sciences (2015)[5] are particularly germane to the present study. These studies point to the role of distance traveled, shipment size, the number of railroad interchanges, proximity to water competition, and various measures on rail competition as explanatory variables in a model of rates. In all cases, the authors use the Interstate Commerce Commission's annual rail Waybill data set.[6] In similar fashion, this paper uses the Surface Transportation Board's (STB) confidential carload waybill sample, along with other datasets, to uncover the determinants behind rail rates for grain. This paper uses distance, shipment

[3] Until the end of 1995, the regulatory authority was the Interstate Commerce Commission. It was abolished by the Interstate Commerce Commission Sunset Act in 1995. The Act created the Surface Transportation Board (STB) which now is the regulatory authority over economic matters for railroads.

[4] The criteria for assessing market dominance has changed through time. Initially, it included an assessment of intramodal, intermodal, product, and geographic competition. In 1999, the criteria were reduced to intramodal and intermodal competition.

[5] Note that Wilson, Wilson and Koo (1988) look at the pricing of railroads with market power in the presence of the truck market as a competitive pressure.

[6] MacDonald (1987, 1989) and the National Academies report use the confidential Carload Waybill Sample while Burton (1993) uses the public Waybill file.

size, the number of railroads involved in the shipment, whether the railroad owns the equipment or not, whether the movement is a contract or a tariff rate, measures of intra- and inter- competition, and a variety of fixed effects to capture differences across railroads.

3. BACKGROUND

This section provides a brief overview of changes in the rail market and then focuses on the behavior of rail rates, fuel surcharges, and commodity prices over time.

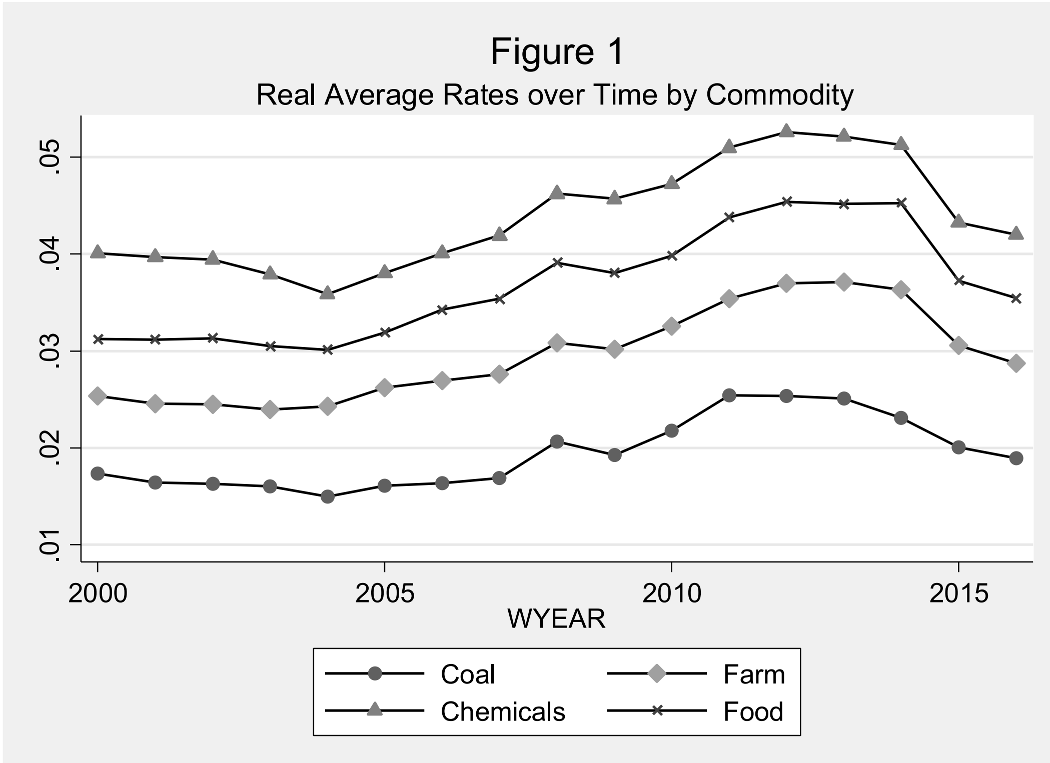
Over the entire time period (2000-2016), there are seven class 1 railroads and a total of 189 other railroads (regional and short lines) that appear in the Surface Transportation Board's carload waybill statistics.[7] They haul a wide range of commodities.

In the data, there are 38 different standard commodity transportation two-digit codes (STCC-2), which has up to seven-digit distinctions in the commodity carried. For the present purpose, Table 1 provides the total volume (tonnages), revenue, and ton-miles shipped from 2000 to 2016 for major two-digit groupings (top ten in at least one category). For all groupings in Table 1, coal is the largest commodity group by any measure and dominates all categories, accounting for 39, 19, and 36 percent of total tons, revenue, and ton-miles, respectively, across the sample period. These percentages are significantly larger than for the other commodity classifications. Farm Products ranks 3, 5, and 4 by tonnage, revenue, and ton-miles with shares of the total equaling 8, 8, and 10 percent, respectively.

[7] The number are unique numeric railroad codes. There is also a script variable, but sometimes the scripts are different for the same railroad numeric code.

Table 1: Major Commodity Groups Shipped by Railroads – 2000-2016							
STCC2	Description	Tons (million)	Rank	Revenue (million)	Rank	Tonmiles (billion)	Rank
1	Farm Products	2,821	3	82,902	5	2,855	4
10	Metallic Ores	1,140	7	10,000	16	283	15
11	Coal Products	14,100	1	203,412	1	10,739	1
14	Nonmetallic Minerals	2,659	4	36,971	10	911	7
20	Food Products	2,090	6	78,109	6	2,136	5
24	Wood Products	956	11	38,209	8	1,073	6
26	Pulp & Paper Products	849	13	41,990	7	895	8
28	Chemical Products	3,624	2	135,887	3	3,140	2
29	Petroleum or Coal Products	1,001	9	35,450	11	749	11
32	Stone & Glass Products	958	10	28,345	12	617	12
33	Metal Products	1,068	8	37,416	9	788	9
37	Transportation Equipment	872	12	83,930	4	773	10
46	Misc Mixed Shipments Exc	2,094	5	135,963	2	3,117	3
	Other	1,626		82,398		1,578	
	Total	35,858		1,030,982		29,654	

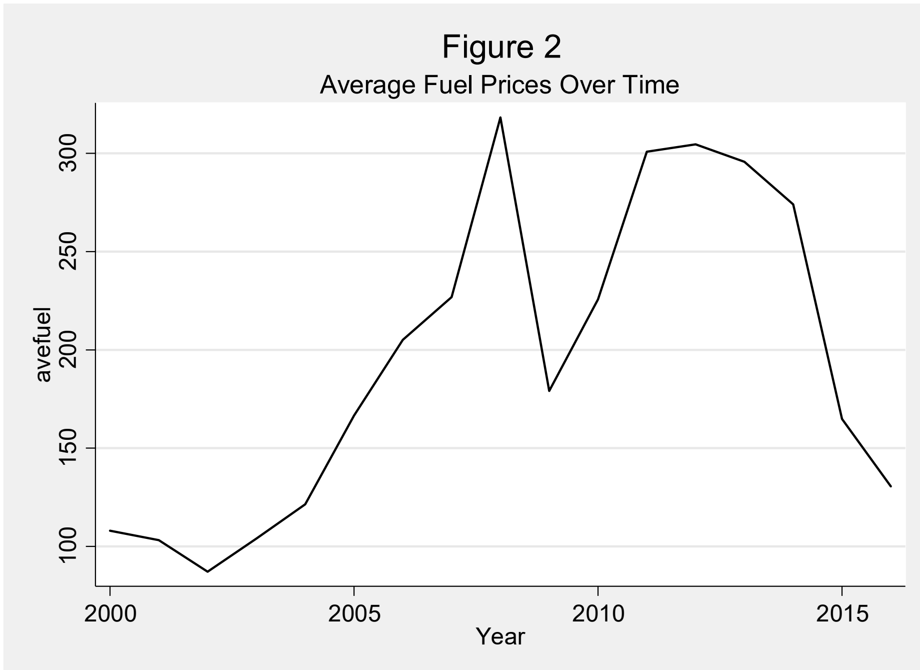
This research focuses on the behavior of rates over time. Figure 1 provides a comparison of real rail rates (measured as revenue per ton-mile, while accounting for inflation) for coal, farm products, chemicals, and food products over time. There are differences across commodity groups (as expected), with the average chemical rates being the highest, and coal and farm products relatively lower. Over time, the changes in rates are remarkably similar across commodities, with rates being relatively constant from 2000 to 2005, and increasing until 2012 or 2013 (depending on the commodity) and then falling thereafter. These point to a common factor driving the changes in rates over time and that they are not due to commodity specific factors.

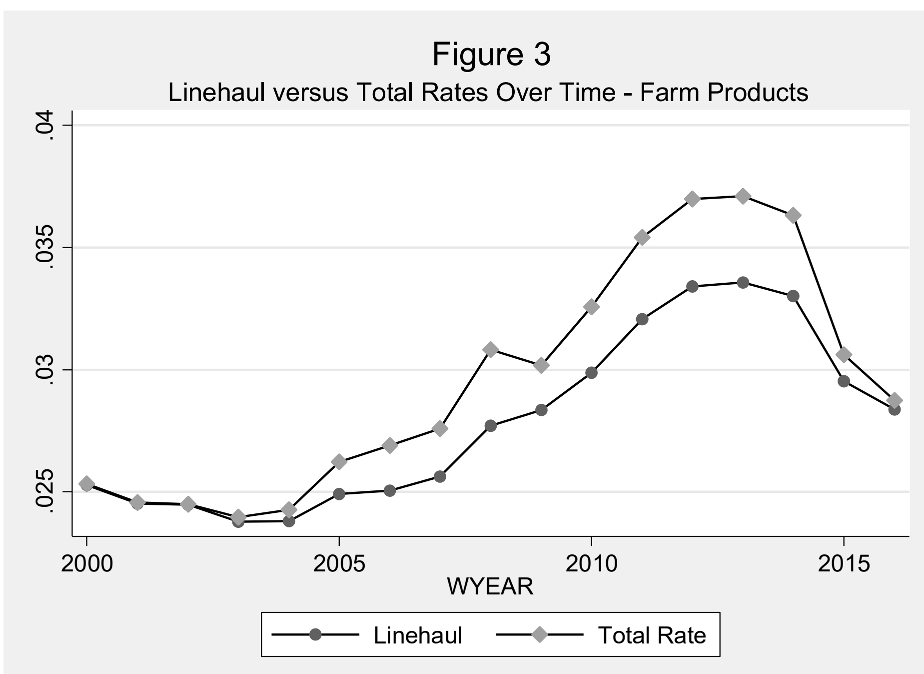


One possibility is changes in fuel prices over time. Figure 2 presents the real average fuel price per gallon.[8] Fuel prices increased dramatically from 2002 through 2008, falling sharply in 2009, but rebounding in 2010-2013, and then falling dramatically in 2014 and 2015. To combat increases in fuel prices, the railroads introduced fuel surcharges in 2003. These were reported either in linehaul revenue or miscellaneous charges until 2009 when the STB introduced a separate field for reporting fuel surcharges. Figure 3 presents the linehaul rate (the transit charges) and the total rate (which includes any transit charges, miscellaneous charges, and fuel surcharges) for farm products over time. (Again note, from 2000 to 2008, the linehaul rate may be overstated, because fuel surcharges were then not explicitly separated.) Nevertheless, it is clear that rates for farm

[8] The underlying data were taken from Railroad Facts which is an annual publication of the Association of American Railroads (AAR). It was deflated by the gross domestic product price deflator available from the FRED database managed by the St. Louis Federal Reserve Bank. The figures presented are in 2010 dollars.

products did indeed begin to rise about 2004 and continued until 2013, and then fell. The difference between the total and the linehaul rate also grew, but has fallen dramatically in the last two years of the study period (2015 and 2016) as have fuel prices (Figure 2).

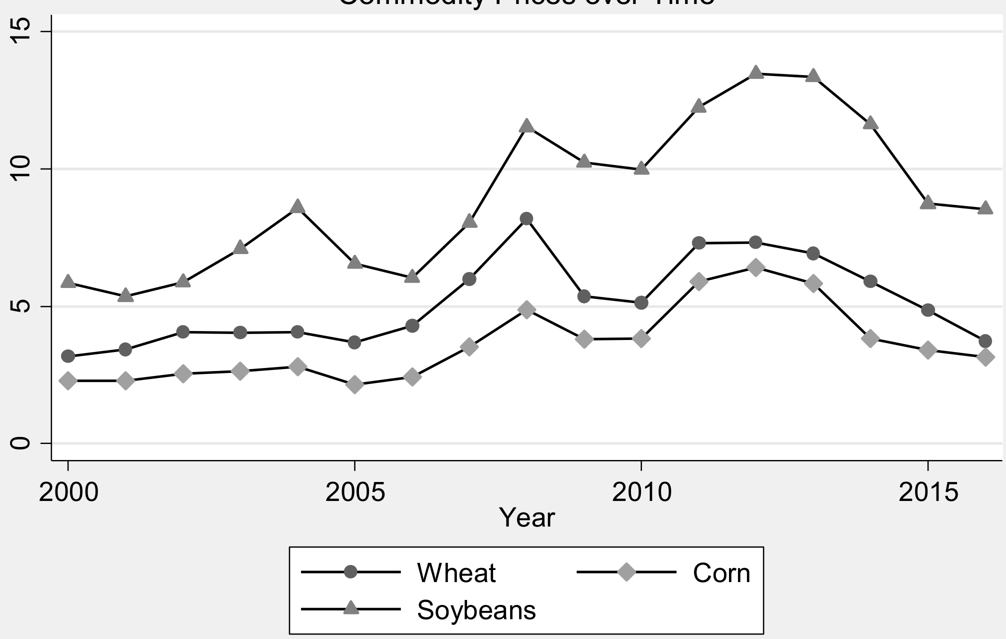




Next, for further context, prices received from farmers are examined for corn, wheat, and soybeans. Price data are from the National Agricultural Statistics Service and are converted to real terms using the gross domestic product price deflator noted above. National prices are plotted over time in Figure 4. All commodities had modest price increases over the years, with a dip in 2009 and 2010, reaching a peak in 2011 (wheat) and in 2012 (soybeans and corn) with decreases thereafter.

Figure 4

Commodity Prices over Time



The overriding takeaways from this brief overview are that agricultural products are collectively one of the top commodities handled by railroads and railroads are central to distributing these products. Rates associated with farm products generally began to rise about 2004 or so and increased to a peak in 2014. Generally, the prices follow a pattern similar to that of fuel prices and, to a lesser extent, grain prices. In the ensuing sections, multiple models are developed and estimated that enable the sources behind rate changes to be better identified. In the next section, the data are described with a description of changes over time by commodity which is then followed by the empirical application.

4. DATA AND VARIABLES

The primary data used for the analysis are the Surface Transportation Board's Carload Waybill Samples (CWS). These data are the result of a stratified sample of freight bills for individual shipments, which together yield an underlying sample rate of about 1 percent of all rail shipments. Each record contains a weighting factor to retrieve characteristics of the entire population of rail movements.

There are three different versions of the waybill. These are the public use waybill, the masked waybill, and the unmasked waybill.[9] In the unmasked waybill, the data include the revenues, tonnage, distance, interchanges, commodity, origin, destination, waybill date, car ownership (private versus railroad), originating station, terminating station, whether the shipment revenue reflects a contract or a tariff rate, and a wide variety of other shipment characteristics for each shipment in the sample. The masked data are identical, with only the revenue field for contract movements "masked." The public use data eliminates station and carrier information, and includes tonnage and other variable information where confidentiality is not affected. Origin and termination points are at the Business Economic Area level and junction points are at the state or province level.[10]

The CWS records also contain a location code (the Standard Point Location Code) that can be linked to supplemental data (e.g. the Centralized Station Master, Oak Ridge National Laboratory rail network files, various individual railroad files), which allow shipper and receiver

[9] The public use waybill is available on-line at https://www.stb.gov/stb/industry/econ_waybill.html.
[10] Access to the unmasked and masked data are restricted. In this case, we have the unmasked waybill data under a confidentiality agreement through USDA with the Surface Transportation Board.

locations to be identified by the Standard Point Location Codes. These data, along with railroad network geographic information system data,[11] were combined to identify locations of stations and shipment origins and destinations and to develop measures of railroad competition. The data were also used in conjunction with the Port Series[12] data produced by the U.S. Army Corps of Engineers to measure the presence of water competition. The Port Series data indicate the location of ports on U.S. waterways along with the commodities handled by each port. Finally, all monetary variables are adjusted to constant 2010-dollar values using the gross domestic product price deflator available from Federal Reserve economic data.[13]

The analysis covers waybill shipments from 2000 to 2016 for wheat, corn, and soybean shipments. The analysis estimates several models to gauge the changes in rates from changes in the variables as well as changes in the coefficients over time. The dependent variable is the average revenue per ton-mile deflated by the gross domestic product price deflator. In this regard, total revenues were used to calculate the average rate per ton-mile. As discussed earlier, the railroads introduced fuel surcharges in 2003 in response to higher fuel prices. Reporting differences across railroads requires the use of the total rate (i.e., inclusive of the linehaul charges, miscellaneous charges, and fuel surcharges).

The righthand side variables cover shipment characteristics, including distance shipped, shipment size (measured by the number of cars), the number of interchanges, whether or not the shipment was a contract rate, and whether a car was owned by the railroad or not. Also included are various measures of competition to capture railroad competition as well as barge competition.

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[11] http://www-cta.ornl.gov/transnet/RailRoads.html.
[12] http://www.navigationdatacenter.us/ports/ports.htm.
[13] These data comes from the St. Louis Federal Reserve, http://research.stlouisfed.org/fred2/.

Railroad competition is measured by the product of the number of Class I railroads located within 50 miles of the origin and within 50 miles of the destination.[14]

Summary statistics are provided in Table 2 by commodity for 2000, 2005, 2010, and 2015. It is noted that rates (measured as revenue per ton-mile) for corn and soybeans have remained relatively stable, but for wheat have increased over time. Explanatory variables in the table include distance (average shipment miles), shipment size (average number of cars), the number of interchanges (in the average shipment), ownership of equipment (as a percent), and the use of contract rates (as a percent). Distance has increased substantially for all commodities over time. Shipment size has increased for corn and wheat, but fallen for soybeans. The number of interchanges has stayed about the same for corn over time, but increased slightly for wheat and soybeans. For all commodities, the use of privately-owned cars has increased, and for soybeans has grown markedly. Finally, for all commodities, the use of contract rates has increased, but particularly, for corn and soybeans. It is expected that the increases in distance, shipment sizes, contracts, and the use of private equipment should reduce rates, while the increases in the number of interchanges should increase rates.

[14] The number of Class I railroads for distances that range from 0 to 200 from the origin and destination were calculated, and various distances were considered. Results across different distances are qualitatively similar. In the reported results, 50 miles was used.

Table 2: Summary Statistics by Commodity over Time						
Corn						
	Rate	Distance	Size	Interchanges	Private	Contract
2000	0.033	773	12.72	1.14	0.521	0.261
2005	0.033	854	16.29	1.13	0.519	0.327
2010	0.034	1242	15.54	1.11	0.642	0.542
2015	0.034	1266	17.44	1.13	0.631	0.493
Wheat						
2000	0.037	716	9.99	1.00	0.357	0.317
2005	0.037	742	12.30	1.18	0.324	0.373
2010	0.043	838	10.88	1.13	0.247	0.411
2015	0.042	1005	12.35	1.13	0.558	0.348
Soybeans						
2000	0.034	652	16.68	1.07	0.405	0.404
2005	0.035	768	15.58	1.12	0.556	0.556
2010	0.030	1454	16.52	1.10	0.744	0.744
2015	0.030	1469	14.85	1.11	0.827	0.827

Note: All statistics are for values between the 5^{th} and 95^{th} percentile and are weighted by the expansion factor to reflect the population rather than the stratified sample.

Summary statistics for selected intramodal competitive factors are presented in Table 3. The measure presented is the number of Class I railroads that served an origin or terminal within 0, 20, 50, and 100 miles in 2013.[15] For corn, there are 543 and 344 stations that originate and terminate shipments, respectively. For wheat, there are 470 originating and 193 terminating stations. And, for soybeans, there are 412 originating and 76 terminating stations. For all commodities, the bulk of shippers received direct service from a single Class 1 railroad. For example, for corn, wheat and soybeans, there are 439 originating stations out of 543 (81 percent), 385 out of 470 (82 percent), and 312 out of 412 (76 percent), respectively, that receive service from a single Class 1 railroad. But, there are a number of origins that receive direct service from two or more Class 1 railroads. In all cases, as the distance band increases, the frequency of stations receiving direct service falls, and the frequency of stations receiving service from two or more increases. Indeed, for example, for wheat, there are 349 shippers that are within 100 miles of three

[15] Inspection of the data suggests little if any change through time.

or more Class 1 railroads. As noted earlier, there are fewer terminal locations, but the general patterns mirror that of originating stations. That is, most stations receive service from at least one Class 1 carrier, and stations have more options as the distance band increases.

Table 3: Intramodal Competition at Origin and Terminal Locations - 2015											
Corn	**ORIGINS**						**TERMINAL**				
Miles	0	1	2	3 +	Total		0	1	2	3+	Total
0	60	439	38	6	543		15	269	51	9	344
10	51	379	96	17	543		13	231	86	14	344
20	30	262	177	74	543		11	192	122	19	344
50	5	63	257	218	543		3	106	193	42	344
100	0	10	184	349	543		2	40	187	115	344
Wheat											
Miles	0	1	2	3+	Total		0	1	2	3+	Total
0	34	385	42	9	470		0	119	56	18	193
10	26	365	66	13	470		0	101	68	24	193
20	18	314	122	16	470		0	78	83	32	193
50	7	168	255	40	470		0	37	100	56	193
100	4	72	270	124	470		0	17	82	94	193
Soybeans											
Miles	0	1	2	3+	Total		0	1	2	3+	Total
0	55	312	40	5	412		3	38	25	10	76
10	46	277	76	13	412		2	19	40	15	76
20	29	201	148	34	412		2	16	39	19	76
50	5	62	228	117	412		0	10	41	25	76
100	0	10	164	238	412		0	1	33	42	76

Note: All statistics are based on values between the 5th and 95th percentile and are weighted by the expansion factor to reflect the population rather than the stratified sample.

Intermodal competition is measured by the distances of the originating station and terminating station to the nearest waterway ports for each and an interaction between the two.[16] Table 4 provides calculations of the total tonnage by commodity and bands of distance to the nearest port. It is evident from this table that corn tends to originate from locations nearer water than wheat or soybeans. For corn, 31 percent of the rail tonnage originates within 100 miles of the

[16] The interaction is simply the product of the distance to origin and the distance to destination. It is included to allow for differences between the origin and destination differences e.g., a origin 1 mile from the dock and a destination 99 miles from the dock might be priced differently than an an origin 50 miles from the dock and a destination 50 miles from the destination.

nearest waterway port. For wheat and soybeans, in contrast, only about 18 percent originate within 100 miles. In contrast, 25 percent of corn, 44 percent of wheat, and 71 percent of soybeans terminate at locations within 10 miles of the waterway.

Table 4: Percentages of Tonnages Originated and Received by Distance from the Waterway

Commodity	Miles	Origins	Terminals
Corn	10	1.70	24.99
	25	3.48	5.49
	50	7.67	3.31
	100	18.64	20.74
	Over 100	68.51	45.47
	Total	100.00	100.00
Wheat	10	2.86	43.93
	25	10.55	29.10
	50	1.15	1.94
	100	3.59	8.27
	Over 100	81.84	16.77
	Total	100.00	100.00
Soybeans	10	1.80	71.11
	25	3.13	6.87
	50	2.79	1.76
	100	11.99	3.43
	Over 100	80.29	16.83
	Total	100.00	100.00

5. PANEL REGRESSION

Estimation

The model has the natural log of average revenue ton-miles as the dependent variable. This variable is explained by shipment distance, shipment size, the number of interchanges in the movement, a measure of railroad competition, measures of waterway competition, whether the shipment is made under contract or not, whether privately owned cars are used, and firm dummies for the railroad in the case of single line service or the dominant railroad in the movement.[17] For each commodity, the model is estimated year by year to identify major changes over time.

The results for corn, wheat, and soybeans are presented in tables 5, 6, and 7, respectively, for the primary variables. Only the coefficient estimates are provided in these tables to facilitate interpretation. The complete set of estimates and standard errors is provided in the Appendix (Tables A-1, A-2 and A-3 for corn, wheat and soybeans, respectively). Firm effects are numerous, and to conserve space, these are suppressed from the output. Generally, the models tend to fit the data well with R-Squares that range from 61 to 75 for corn, 62 to 73 for wheat, and 57 to 83 for soybeans. The number of observations varies both across commodities, but also across time for each commodity. There are a total of 67,553 observations for corn in all years, and the number ranges from 2,980 in 2013 to 5,274 in 2006. For wheat, there are a total of 54,277 observations, and the number of observations range from 2,713 in 2013 to 3,844 in 2005. For soybeans, there are a total of 20,823 observations, and the number of observations range from 894 in 2004 to 1,491 in 2016. The number of observations may reflect differences in market conditions across the different commodities and are consistent with the tonnages observed in the data by commodity.

[17] The dominant railroad is the railroad that handles the most miles in the shipment.

Table 5: Coefficient Summary Corn

Year	Distance	Cars	Number of RR	RR-Comp	Miles to Barge-Origin	Miles to Barge-Ter	Miles to Barge Inter	Origin on Water	Dest on Water	Private Cars	Contract	Constant	N	R^2
2000	-0.440**	-0.0459**	0.110**	-0.0132**	0.0772**	0.0835**	-0.0124**	0.0248	0.0498**	-0.0893**	-0.0292**	-1.059**	4,471	0.646
2001	-0.439**	-0.0480**	0.0243	-0.00977**	0.0741**	0.0806**	-0.0130**	0.102	0.0678**	-0.0751**	-0.0744**	-0.989**	4,400	0.612
2002	-0.453**	-0.0482**	0.114**	-0.00673**	0.154**	0.135**	-0.0254**	0.0965**	0.0700**	-0.106**	-0.0848**	-1.339**	4,313	0.607
2003	-0.469**	-0.0500**	0.0365*	-0.00680**	0.158**	0.132**	-0.0248**	0.159**	0.0652**	-0.0866**	-0.0923**	-1.220**	3,845	0.618
2004	-0.439**	-0.0661**	0.0845**	-0.00681**	0.0771**	0.0394**	-0.00736**	0.272**	-0.00402	-0.109**	-0.138**	-1.013**	4,081	0.683
2005	-0.468**	-0.0573**	0.0524**	-0.00401**	0.0329**	-0.00754	0.000696	0.073	-0.014	-0.106**	-0.139**	-0.540**	4,755	0.664
2006	-0.470**	-0.0609**	0.133**	-0.00645**	-0.00558	-0.0569**	0.0119**	0.0994**	0.00689	-0.108**	-0.145**	-0.274**	5,274	0.738
2007	-0.477**	-0.0689**	0.173**	-0.00478**	-0.00889	-0.0486**	0.0102**	0.169**	0.0163	-0.112**	-0.130**	-0.144**	4,555	0.759
2008	-0.458**	-0.0753**	0.205**	-0.00202**	0.000817	-0.0494**	0.0114**	0.267**	0.0201	-0.0868**	-0.151**	-0.201**	4,100	0.769
2009	-0.451**	-0.0764**	0.0858**	-0.00206**	0.0226*	0.00055	0.00189	0.159**	0.0732**	-0.0858**	-0.149**	-0.389**	3,775	0.696
2010	-0.428**	-0.0848**	0.144**	-0.00564**	0.00532	-0.0193	0.00259	0.0718	0.0218	-0.0981**	-0.106**	-0.307**	3,879	0.726
2011	-0.432**	-0.0797**	0.111**	-0.00523**	0.0127	-0.0187*	0.0024	0.143**	0.0269*	-0.0745**	-0.0916**	-0.307**	3,634	0.723
2012	-0.422**	-0.0734**	0.0754**	-0.00344**	0.000661	-0.0386**	0.00721**	0.156**	0.0547**	-0.0746**	-0.0869**	-0.341**	3,269	0.712
2013	-0.441**	-0.0870**	0.116**	-0.00718**	0.00987	-0.0075	0.00269	0.0838**	0.129**	-0.0514**	-0.0944**	-0.190**	2,980	0.754
2014	-0.428**	-0.0847**	0.159**	-0.00533**	0.0324**	0.00787	0.000429	0.211**	0.110**	-0.0651**	-0.134**	-0.397**	3,446	0.75
2015	-0.420**	-0.0740**	0.114**	-0.00464**	0.000495	-0.0164	0.0026	0.0168	0.0708**	-0.0424**	-0.160**	-0.294**	3,414	0.628
2016	-0.448**	-0.0660**	0.107**	-0.00464**	-0.0056	-0.00859	0.00113	-0.028	0.0168	-0.0232**	-0.120**	-0.183**	3,362	0.692

A *, and a ** indicate statistical significance at the .1 and .05 levels.

Table 6: Coefficient Summary Wheat

Year	Distance	Cars	Number of RR	RR-Comp	Miles to Barge-Origin	Miles to Barge-Ter	Miles to Barge Inter	Origin on Water	Dest on Water	Private Cars	Contract	Constant	N	R^2
2000	-0.477***	-0.0348**	0.0998**	-0.0124**	0.200**	0.164**	-0.0306**	0.292**	0.0241*	-0.0285**	0.0143	-1.190**	3,278	0.675
2001	-0.478***	-0.0374**	0.0441**	-0.0203**	0.165**	0.148**	-0.0292**	0.0881*	0.0197	-0.0401**	-0.00185	-1.037**	3,097	0.675
2002	-0.475***	-0.0296**	0.121**	-0.00378**	0.162**	0.125**	-0.0249**	0.103**	0.0339**	-0.0311**	-0.0235**	-1.257**	2,886	0.641
2003	-0.435***	-0.0219**	0.103**	-0.00303**	0.124**	0.0653**	-0.0134**	0.150**	-0.00097	-0.0386**	-0.0159	-1.324**	3,070	0.62
2004	-0.447***	-0.0287**	0.0529**	-0.00508**	0.145**	0.0989**	-0.0178**	-0.0254	0.0117	-0.0526**	-0.0350**	-1.258**	3,066	0.638
2005	-0.478***	-0.0184**	0.0422**	-0.00590**	0.134**	0.101**	-0.0171**	0.100**	0.00328	-0.0428**	-0.0211**	-0.845**	3,844	0.673
2006	-0.457***	-0.0246**	0.106**	-0.00494**	0.128**	0.127**	-0.0207**	0.0990**	0.0131	-0.0384**	-0.0407**	-0.886**	3,431	0.667
2007	-0.467***	-0.0326**	0.134**	-0.00399**	0.125**	0.144**	-0.0245**	-0.0309	-0.013	-0.0103	-0.0426**	-0.815**	3,834	0.664
2008	-0.473***	-0.0334**	0.157**	-0.00223**	0.0777**	0.0735**	-0.0105**	0.0566*	-0.0149	-0.0188**	-0.0697**	-0.453**	3,684	0.683
2009	-0.476***	-0.0408**	0.0918**	-0.00384**	0.0729**	0.0556**	-0.0104**	-0.0756**	-0.0443**	-0.0461**	-0.0822**	-0.293**	3,421	0.683
2010	-0.470***	-0.0388**	0.0728**	-0.00191**	0.0706**	0.0632**	-0.00983**	-0.00646	-0.0453**	-0.0445**	-0.100**	-0.314**	3,635	0.729
2011	-0.431***	-0.0418**	0.0665**	-0.0011	0.0648**	0.0413**	-0.00859**	0.0569**	-0.0521**	-0.0236**	-0.129**	-0.563**	3,542	0.672
2012	-0.425***	-0.0390**	0.0837**	-0.00358**	0.0764**	0.0519**	-0.0126**	0.0303	-0.132**	-0.0368**	-0.132**	-0.611**	2,800	0.66
2013	-0.419***	-0.0391**	0.0820**	-0.00558**	0.0792**	0.0729**	-0.0158**	0.0261	-0.0898**	-0.0413**	-0.0812**	-0.602**	2,713	0.641
2014	-0.427***	-0.0409**	0.0814**	-0.00104	0.0639**	0.0846**	-0.0142**	0.0356	-0.0329**	-0.0425**	-0.0864**	-0.556**	2,714	0.66
2015	-0.503***	-0.0458**	0.0228	0.000836	0.110**	0.0990**	-0.0200**	0.0369	-0.0689**	-0.00876	-0.0935**	-0.149	2,672	0.69
2016	-0.474***	-0.0309**	-0.0147	-0.00098	0.0841**	0.0842**	-0.0175**	-0.218***	-0.114**	-0.00652	-0.135**	-0.756**	2,590	0.713

A *, and a ** indicate statistical significance at the .1 and .05 levels.

Table 7: Coefficient Summary Soybeans														
Year	Distance	Cars	Number of RR	RR-Comp	Miles to Barge-Origin	Miles to Barge-Ter	Miles to Barge Inter	Origin on Water	Dest on Water	Private Cars	Contract	Constant	N	R^2
2000	-0.414**	-0.044**	0.068	-0.012**	0.0307*	0.023	-0.001	0.301**	0.066**	-0.084**	-0.032	-0.994**	1,209	0.659
2001	-0.403**	-0.049**	0.089**	-0.006**	0.053**	0.032	-0.001	0.265**	0.099**	-0.101**	-0.064**	-1.300**	1,336	0.679
2002	-0.395**	-0.048**	-0.001	1.59E-06	0.018	0.044**	-0.004	-0.146	0.106**	-0.128**	-0.048**	-1.262**	1,171	0.682
2003	-0.421**	-0.062**	0.112**	-0.004**	0.105**	0.132**	-0.023**	0.099	-0.005	-0.126**	-0.137**	-1.313**	938	0.753
2004	-0.413**	-0.066**	0.044	0.002	0.017	0.027	-0.005	-0.075	0.010	-0.092**	-0.066**	-1.033**	894	0.752
2005	-0.377**	-0.047**	0.048	0.002	-0.060**	-0.092**	0.014**	0.322*	-0.021	-0.108**	-0.062**	-0.783**	1,123	0.571
2006	-0.430**	-0.057**	0.097**	-0.002	0.001	-0.062**	0.013**	-0.09	0.070**	-0.086**	-0.071**	-0.660**	1,234	0.768
2007	-0.403**	-0.069**	0.044*	-0.001	0.014	-0.055**	0.010**	0.348**	0.101**	-0.058**	-0.010**	-0.855**	1,111	0.796
2008	-0.445**	-0.0746**	0.163**	0.001	0.001	-0.040**	0.004	0.096	0.001	-0.063**	-0.017	-0.199**	1,216	0.827
2009	-0.476**	-0.072**	0.080**	-0.007**	0.009	-0.013	-0.005	-0.082	-0.024	-0.043**	-0.048**	0.077	1,514	0.811
2010	-0.445**	-0.0589**	0.086**	-0.006**	-0.019*	-0.026**	0.000	-0.179**	-0.005	-0.061**	-0.056**	0.022	1,380	0.832
2011	-0.449**	-0.041**	0.066**	-0.005**	-0.023**	-0.001	-0.000	-0.152*	0.041**	-0.075**	0.007	-0.090	1,088	0.825
2012	-0.426**	-0.054**	0.043**	-0.001	0.004	-0.032**	0.002	-0.053	-0.011	-0.053**	-0.011	-0.219**	1,253	0.801
2013	-0.439**	-0.050**	0.057**	-0.002**	0.034**	0.040**	-0.010**	-0.120**	0.020	-0.110**	-0.021	-0.297**	1,192	0.792
2014	-0.460**	-0.057**	0.067**	-0.003**	0.021**	-0.008	-0.002	-0.066	0.024*	-0.071**	0.057**	-0.047	1,338	0.817
2015	-0.477**	-0.041**	0.053**	-0.005**	-0.000	-0.001	-0.007**	-0.120*	-0.013	-0.026**	0.008	0.0398	1,335	0.756
2016	-0.452**	-0.043**	0.0909**	-0.006**	0.002	0.017	-0.006	-0.202**	0.044**	-0.020**	-0.010	-0.254**	1,491	0.748
A *, and a ** indicate statistical significance at the .1 and .05 levels.														

Overall, the models not only fit well, but generally are consistent with prior expectations in terms of signs.[18] Notably, for all commodities, there are large changes in some of the coefficients over time. The results for each commodity are summarized below.

Corn

The effects of shipment distance are negative for all years (as expected). There are some differences over time, where the effect is somewhat dampened in the later years. For example, all else equal, a one percent increase in shipment distance in 2006 and 2015 is estimated to reduce RPTM by .47 and .42 percent, respectively. The effects of shipment size over time are all negative (as expected), but generally increasing in magnitude with time. These effects range from -.046 in 2000 to -.087 in 2013. The effect of interchanges is captured in the number of railroads. It is positive (as expected) in all years but appears to be growing over time. The effects range from .024 in 2001 to .205 in 2008 (which appears to be an outlier, but the trend is upward). The results are consistent with two notions: cost savings associated with greater shipment distances are smaller than in the early years, and cost savings associated with larger shipment sizes are larger than in the early years. And, finally, the costs of interlined movements have become more important over time.

Competition from both rail and barge are present in the model. The effects of railroad competition are negative (as expected) in all years, but the effect dissipates over time to the extent that railroad competition is lessening over time. The effects of barge competition are similar. The effect of distance to water from the origin and to the destination (from water), are positive in the early years (as expected), but fall sharply around 2005, and thereafter are very close to zero (no

[18] There are a few anomalies in some years for some commodities and variables, but these generally are not statistically different from zero.

effect). As with rail competition, this suggests that barge competition has become less important over time, and points to higher rail rates beginning around 2005.

The remaining coefficients include those on private ownership of rail cars, contract rates, and the intercept. In all three cases, there are marked trends in the effects, most of which change in 2005 or 2006. Shipments occurring in private cars have a negative effect in all years, but the savings from private cars fall in magnitude from -.09 to -.11 in the early 2000s but become much smaller from then until 2016. By 2016, the effect is only -.02. The savings from contract rates, however, have become much stronger. In the early 2000s, it was -.04 to -.1 but increased in magnitude to -.16 in 2015 and to -.12 in 2016. Finally, the intercept, which captures the mean value of effects not in the model, was about -1 or lower in the early years, but increased dramatically from 2004 to 2007 and has remained relatively constant since then with values that range from -.2 to .39. These results suggest that rates are increasing over time as a result of unobserved effects (e.g., market prices, fuel prices, and/or other effects).

Wheat

The effects of shipment distance are negative for all years (as expected). There is no discernible trend in the effect, and the range is from -.50 to -.42. The effects of shipment size over time are all negative (as expected), but generally become larger in magnitude over time, beginning about 2005. These effects range from -.018 in 2005 to -.046 in 2015. The effect of interchanges is positive (as expected) in all years (except 2016), and in 2015 and 2016 there are not statistical differences from single-line service. But, in the later part of the data, the effect has fallen dramatically. The effects range from .16 in 2008 to .023 in 2015 and -.015 in 2016. The results are consistent with a notion that cost savings associated with greater shipment distances are about the same over time, and that cost savings associated with larger shipment sizes are larger than in the early years. Finally, the costs of interlined movements has become less important, at least in recent years.

Competition from both rail and barge are present in the model. The effects of railroad competition are negative (as expected) in all years (except 2015), but the effect dissipates over time to the extent that railroad competition is lessening over time. The effects of barge competition are similar. The effect of distance to water from the origin and to the destination (from water), are positive in all years (as expected), but the effects dissipate over time. As with rail competition, this suggests that barge competition has become less important over time, and points to higher rail rates between the beginning and the end of the data.

The remaining coefficients include those on private ownership of rail cars, contract rates, and the intercept. In all three cases, there are marked trends in the effects, most of which change in 2005 or 2006. Shipments that occur in private cars have a negative effect in all years, but, while noisy, the effects do appear to be dissipating over time. The effect was strongest in 2004 with a value of -.052 and weakest in 2016 with a value of -.006. The effect of the use of contracts is generally negative (with the exception of 2000), and generally falls through time. This means that the savings from contracts has become much stronger over time. In the early 2000s, it is close to zero, but by 2016 it is -.135 (i.e., 13.5 percent lower if a contract rate). Finally, the intercept, which captures the mean value of effects not in the model, was about -1.2 to -1.32 in the early years, but increased dramatically from 2004 to 2010 and has remained constant but noisy since then.

Soybeans

The effects of shipment distance are negative for all years (as expected), and there is a downward trend over time. The range of values is -.377 in 2005 to -.48 in 2016. The effects of shipment size over time are all negative (as expected), but there is no consistent trend in the data.

The effects range from -.07 in 2008 to -.041 in 2015. The effect of interchanges is positive (as expected) in all years and has a small upward trend, ranging from .053 in 2015 to .163 in 2008. This implies cost savings associated with greater shipment distances are larger over time, and cost savings associated with larger shipment sizes have remained constant (but noisy) over time. And, finally, the costs of interlined movements have increased over time.

In terms of rail and barge competition, the effects of railroad competition are negative (as expected) in most years (except 2008). However, the effect (in magnitude) dissipates over time suggesting the effects of railroad competition are lessening over time. The effects of barge competition are similar. The effects of distance to water, from the origin and to the destination (from water), are positive in most years (as expected). This suggests that, as distance to water increases, rail rates are higher. However, these results are strongest in the earlier years. The effect of distance from the origin is positive for the first five years of data, and then fell dramatically in 2005 (turning negative) but then rebounded and has been close to zero since then. A very similar pattern is observed with distance from water, where the effect is positive for the first four years in the data, falling sharply in 2005, rebounding slightly over time and is relatively small in the latter part of the data. Together, there is a marked change in pricing with respect to the waterway taking place about 2005. As with rail competition, this suggests that barge competition has become less important over time, and points to higher rail rates between the beginning and the end of the data.

The remaining coefficients include those on private ownership of rail cars, contract rates, and the intercept. In all three cases, there are marked trends in the effects. Shipments that occur in private cars has a negative effect in all years, but the effect does appear to get smaller with time. The effect was strongest in 2002 with a value of -.128 and weakest in 2016 with a value of -.020. The effect of the use of contracts is generally negative (with the exception of 2011, 2014, and

2015). The largest value was -.128 in 2003, meaning contract rates were 12.8 percent lower than tariff rates. However, over time, the coefficient became smaller in magnitude and was quite small by 2016. This means that the savings from contracts has become much less over time. Finally, the intercept, which captures the mean value of effects not in the model, was about -1 to -1.31 in the early years, but became much larger from 2004 to 2010, with values of -.30 to .02 since then.

Summary

Generally, the results point, in some cases, to considerable differences in coefficient estimates through time and across commodities. Figure 5 provides a comparison of coefficient estimates over time for each variable across commodities. For shipment distances, there are modest differences across commodities and through time. For shipment sizes, corn has experienced significant increases in the magnitude of the coefficients, the wheat coefficients have increased in magnitude only marginally, and changes for soybeans pointed to increases in magnitude until about 2008-9 but have fallen since then. The coefficients on the number of railroads in the movement have no perceptible pattern. Rail competition had a negative effect early in the sample, but generally disappears for most of the sample and for all commodities. The coefficients on distance to water is smallest for wheat and essentially zero for corn and soybeans, except for the early time periods. Rail movements occur with both rail owned cars and privately owned cars. For wheat, the change in rates from using private cars is remarkably stable over time and is about -1 to -3 percent with some modest increases in the last few years of the data. But, for corn and soybeans, the magnitude is much larger (-.09) in the early years, but becomes much smaller (in magnitude) over time, and in the last year of the data is about the same as for wheat. The coefficient estimates on contract carriage are striking. For wheat and corn, the coefficients generally decline through time, pointing to great differences between tariff and contract rates. For wheat, the effect begins at about zero and becomes more important in magnitude over time, reaching about a 15 percent difference between contract and tariff rates by 2016. For corn, the effect begins at about 3 percent and ends at about a 12 percent difference by the end of the sample. The effects for soybeans are considerably different. Early in the sample, the effect is similar to that of corn (about 3 percent), becoming larger for a few years, and then generally becomes smaller in magnitude over time to essentially zero. A striking finding from Figure 5 relates to changes in the constant over time. The patterns point to dramatic price increases for all commodities beginning in 2003-4. The intercept reflects the effects of variables not in the model. As discussed earlier, there are (at least) two sources that could explain the differences. These include the effects of the commodity markets themselves (Figure 4) and also the increase in rail fuel costs (Figure 2). The effects of these on the change in the intercept is taken up in Section 7.

Figure 5
Coefficients Through Time

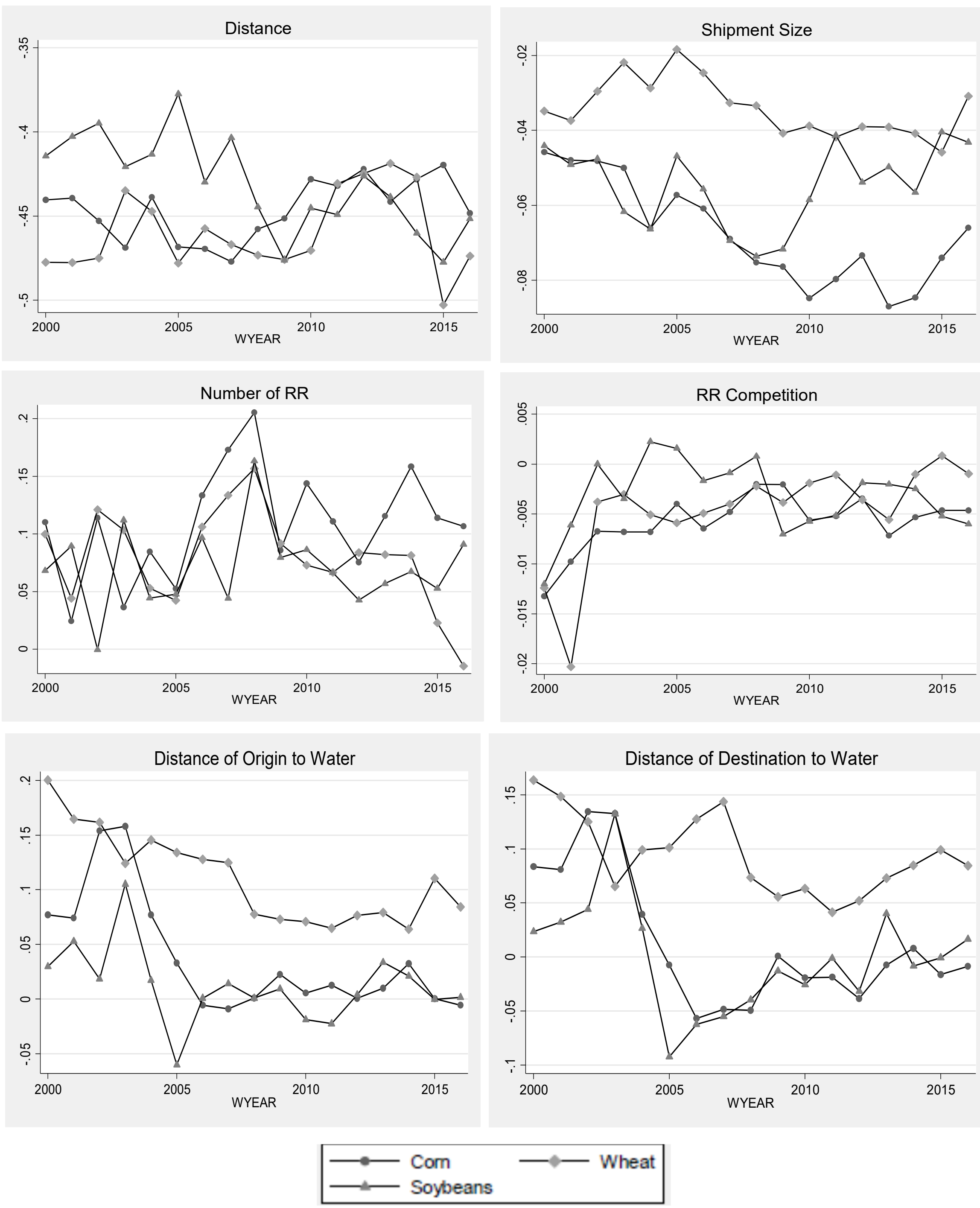
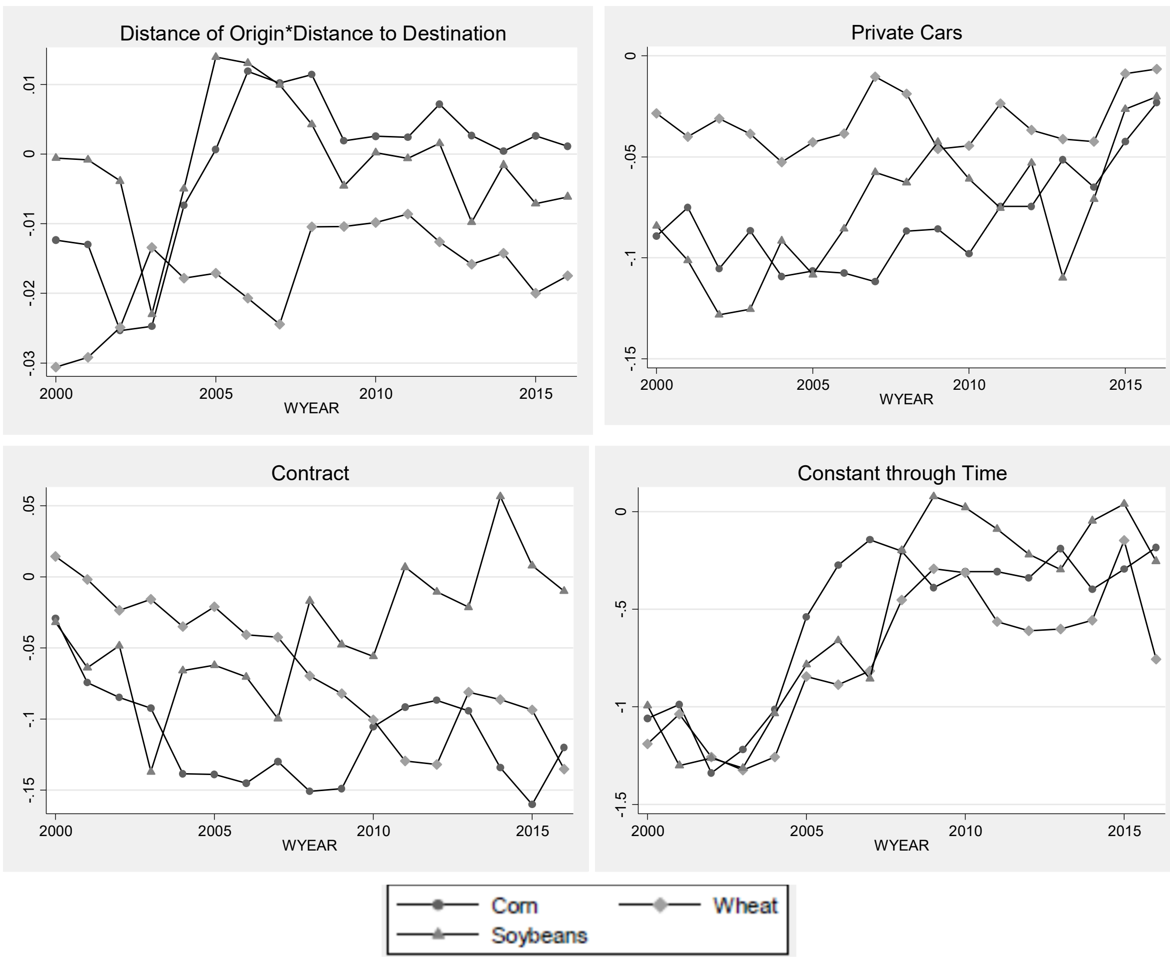


Figure 5

Coefficients through Time - Continued



6. CHANGES IN RATES OVER TIME

The results across commodities indicate some similarities as well as some differences through time. These were discussed in the previous section. This section focuses on changes in rates over time using a Blinder-Oaxaca decomposition (Blinder (1973) and Oaxaca (1973)) to identify sources of change in rates between 2000 and 2014 (which is approximately the largest change in rates). This decomposition takes the econometric results in 2000 and in 2014 and attributes the differences to (1) changes in the parameters, (2) changes in the variables (also called the endowment effect), and (3) an interaction term which accounts for the fact that differences in the variables and differences in the coefficients exist simultaneously between the two periods of time.

The basic model is written as:

$$Y^{Late} - Y^{Early} = \Delta X * \beta^{Early} + \Delta\beta * X^{Early} + \Delta X \Delta\beta \qquad (1)$$

where the first term is the endowment effect i.e., the effect of changes in the variables (e.g., distance, shipment size, competition etc.) on rates. The second term refers to changes in the coefficients on rates, and the third term represents the interaction effect. To calculate the endowment effect, the coefficients (e.g., the discount on longer shipments) are held constant at the 2000 level and multiplied by the change in variables (e.g., the change in average shipment length between 2000 and 2014). This shows, for example, how much higher or lower rates would have been in 2000, if the average shipment in 2000 was as long as it was in 2014. To calculate the effect of changing coefficients, the variables are held constant at the 2000 level and multiplied by the change in coefficients between 2000 and 2014. This shows, for example, how much higher or lower rates would have been if shipments in 2000, at their average length in 2000, had been given the 2014 discount. The interaction effect makes up the remainder of the difference in rates, accounting for the fact that, for example, the difference between 2000 and 2014 rates involved simultaneously longer shipments and greater discounts to long shipments.

The results are summarized in Table 8 for each commodity in terms of the endowment (changes in variables), changes in coefficients, and the interaction. From this table, changes in variables point to decreases in rates over time (i.e., there is no change if the value is 1, and values less than 1 point to lower rates) for all commodities. Changes in coefficients, which reflect railroad pricing rules, point to dramatic increases in rates for all commodities.

Table 8: Blinder-Oaxaca Decomposition Summary

Source	Corn	Wheat	Soybeans
Endowment (changes in variables)	0.911	0.851	0.838
Coefficients (changes)	1.499	1.475	1.702
Interaction	0.961	1.037	0.914
Total	1.312	1.301	1.303

In the Appendix, tables A-4, A-5, and A-6 provide the detailed results for each commodity where the results are summarized in exponentiated form. In all cases, there are four columns of information. Column 1 provides the total effects, including the log of the average rate in the early period (group_1) and in the late period (group_2) along with their difference. It also includes the variable, coefficient, and interaction affects from Table 8.

In the case of corn (Table A-4), the average rate in the early period is .0305 and .0400 in the late period—a total increase of about .0094, which represents about a 31 percent difference in the early period relative to the later period. The 31 percent change can be assessed by looking at the sources of change. Changes in the variables (i.e. the endowments) account for about an 8.9 percent reduction in rates.[19] Changes in the coefficients, which reflect rail pricing rules, account

[19] This is calculated as one minus the endowment effect. In this case, 1-.911=.089. The coefficient effect and the interactive effect follow similarly.

for a 49.9 percent increase in rates, while the interaction accounts for a 3.9 percent reduction. The total difference is the product of the three sources (.911*1.499*.961=1.311). From the relative weights, it appears that the endowment or variable effect and the simultaneous effect reduce the change in rates, while the change in coefficients was substantial and dominated the others, resulting in the estimated 31 percent change in rates.

The other commodities are reported in tables A-5 and A-6 and can be interpreted similarly. As with corn movements, changes in the endowments (the variables) reduce the change in rates, while changes in the coefficient effects have a strong positive effect Each of the three commodities have sizable increases in prices from 2000 to 2014. The overriding conclusion then is that primary explanation for the differences emanates from changes in the coefficients, while the differences are muted somewhat by the changes emanating from variables.

The remaining columns in tables A-4 – A-6 break down the decomposition to the individual independent variable level. Because the overall change increase in rates appears to be primarily the result of changes in coefficients, column (3) is helpful in analyzing that effect further. Some variables show substantial endowment and coefficient effects on rate changes. For example, in Table A-4, the increases in distance reduce rates by nearly 10 percent (1-.904), while the change in the coefficient points to about a 47 percent decrease for corn. The other estimates can be interpreted similarly. However, by and large, for each commodity, the change in coefficient effect attributed the differences in the intercept (labeled as the constant) in tables A-4, A-5, and A-6. Changes in the intercept capture differences in variables not in the model, sometimes called, "unobserved factors." In the models reported, there is no representation of commodity prices and fuel prices, which changed over time. The effects of these variables are reflected in the intercepts, and in the next section, an attempt is made to identify their effects.

7. EXPLAINING THE ANNUAL EFFECTS

As a final exploration, the analysis provides the annual effects for corn, wheat, and soybeans along with their standard errors. This allows weighted regressions (Saxonhouse (1976)) of possible explanations behind the unexplained variation. In this regard, neither fuel prices nor commodity prices can be included in the year-by-year models due to perfect collinearity of these prices with the annual variables.[20] In the regressions, the annual effects are themselves estimated values, and weighted least squares (with the standard errors of the annual effects as weights) are used to gauge the effects of fuel and annual commodity prices on rates.

The results are reported in table 9 for a pooled (across commodities) regression as well as for each commodity separately. While there are only 17 observations for each commodity, the fit is strong with R-squares .84, .93, and .68 for the commodity specific regressions and .805 for the pooled regressions. Fuel prices has the anticipated sign in all regressions, and it is statistically significant for corn and wheat, but not for soybeans. Grain prices were not statistically significant.

[20] This is because regressions are run for each year. Since grain and fuel prices are annual values, there is no variation within a particular year's regression.

Table 9: Explaining the Time Fixed Effects

VARIABLES	(1) Pooled	(2) Corn	(3) Wheat	(4) Soybean
fuel	0.00307***	0.00503***	0.00404*	0.000282
	(0.000682)	(0.00150)	(0.00210)	(0.00219)
Price of Commod	0.0226	-0.101	-0.0454	0.109
	(0.0175)	(0.0824)	(0.105)	(0.0658)
one	-1.335***	-1.149***	-1.366***	-1.510***
	(0.131)	(0.185)	(0.234)	(0.360)
Observations	51	17	17	17
R-squared	0.805	0.851	0.928	0.679

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

8. CONCLUSIONS

Rail rates have a dramatic effect on the flows of agricultural commodities both in terms of where the goods flow and how much flows. The primary findings suggest all three commodities (corn, wheat, and soybeans) follow a similar pattern. Rail rates are relatively constant in the early 2000s. But in the mid-2000s, they begin to rise sharply until 2013-2014 and have fallen since. The empirical model is specified on the basis of the bulk of the literature and includes controls for shipment characteristics such as distance, shipment size, and number of interchanges as well as whether the movement occurred under a contract and whether privately owned cars were used. There are a number of controls for competition based on characteristics of the origin and the destination and, in the case of barge competition, the measures only take a nonzero value if the rail movement is feasible by barge.

The empirical results are very strong and generally consistent across commodities for the shipment characteristics (distance, shipment size, interchanges, private ownership of cars, and whether a contract rate). In virtually all cases, the presence of intramodal competition is negative.

The treatment of water is somewhat novel. In this case, barge competition enters only if the railroad movement occurs between regions where waterway movements are feasible.

The paper concludes with a decomposition of sources of changes in rates from 2000 and 2014. In this regard, rates did increase for each commodity. The increases in each are the result of changes in the coefficients over time rather than changes in the variables (which would have reduced rates). This finding is consistent with changes in railroad pricing over time. As a final exercise, a Saxonhouse regression was used to evaluate the sources of change in the unobserved effects over time. In this regard, a weighted regression by commodity suggested that for corn and wheat, increases in fuel prices had a strong and significant effect on rates.

There are a number of extensions to the work. First and foremost, while "statistically" significant results are found for competition variables, they do appear generally to be relatively small in magnitude. The implications are that competition is not present in the establishment of railroad pricing. But, such a conclusion, may be premature. Future research might consider alternative measurements of the competitiveness variables and/or alternative estimation procedures which let the coefficients for competition vary across geography. Second, there are sizable changes in the coefficients on contracts, which are not fully understood, especially the differences across commodities. Finally, there are considerable differences over the geography in terms of alternative outlets for the commodities (e.g., ethanol plants, milling, feed lots, etc.). Finding a way to empirically examine such outlets may be a fruitful area of further inquiry.

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APPENDIX

Table A-1: Coefficient Estimates for Corn

VARIABLES	Pooled	2000	2001	2002	2003	2004
Distance	-0.429***	-0.440***	-0.439***	-0.453***	-0.469***	-0.439***
	(0.00182)	(0.00635)	(0.00686)	(0.00720)	(0.00741)	(0.00633)
Cars	-0.0575***	-0.0459***	-0.0480***	-0.0482***	-0.0500***	-0.0661***
	(0.000659)	(0.00243)	(0.00244)	(0.00247)	(0.00264)	(0.00229)
Number of RR	0.103***	0.110***	0.0243	0.114***	0.0365*	0.0845***
	(0.00433)	(0.0171)	(0.0194)	(0.0186)	(0.0201)	(0.0160)
RR-Comp	-0.00608***	-0.0132***	-0.00977***	-0.00673***	-0.00680***	-0.00681***
	(0.000244)	(0.00108)	(0.00117)	(0.000724)	(0.000968)	(0.000879)
Miles to Barge-Origin	0.0441***	0.0772***	0.0741***	0.154***	0.158***	0.0771***
	(0.00321)	(0.0123)	(0.0150)	(0.0150)	(0.0149)	(0.0130)
Miles to Barge-Ter	0.0203***	0.0835***	0.0806***	0.135***	0.132***	0.0394***
	(0.00353)	(0.0139)	(0.0169)	(0.0167)	(0.0163)	(0.0143)
Miles to Barge Inter	-0.00324***	-0.0124***	-0.0130***	-0.0254***	-0.0248***	-0.00736***
	(0.000658)	(0.00256)	(0.00310)	(0.00313)	(0.00308)	(0.00265)
Origin on Water	0.166***	0.0248	0.102	0.0965**	0.159***	0.272***
	(0.0133)	(0.0482)	(0.0925)	(0.0462)	(0.0458)	(0.0488)
Dest on Water	0.0274***	0.0498***	0.0678***	0.0700***	0.0652***	-0.00402
	(0.00491)	(0.0190)	(0.0214)	(0.0222)	(0.0235)	(0.0196)
Private Cars	-0.0808***	-0.0893***	-0.0751***	-0.106***	-0.0866***	-0.109***
	(0.00205)	(0.00681)	(0.00716)	(0.00717)	(0.00772)	(0.00696)
Contract	-0.105***	-0.0292***	-0.0744***	-0.0848***	-0.0923***	-0.138***
	(0.00246)	(0.0104)	(0.00916)	(0.00828)	(0.00942)	(0.00780)
Constant	-0.706***	-1.059***	-0.989***	-1.339***	-1.220***	-1.013***
	(0.0192)	(0.0735)	(0.0898)	(0.0839)	(0.0847)	(0.0728)
Observations	67,553	4,471	4,400	4,313	3,845	4,081
R-squared	0.581	0.646	0.612	0.607	0.618	0.683

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-1: Coefficient Estimates for Corn-Continued

VARIABLES	2005	2006	2007	2008	2009	2010
Distance	-0.468***	-0.470***	-0.477***	-0.458***	-0.451***	-0.428***
	(0.00670)	(0.00554)	(0.00603)	(0.00663)	(0.00700)	(0.00614)
Cars	-0.0573***	-0.0609***	-0.0689***	-0.0753***	-0.0764***	-0.0848***
	(0.00242)	(0.00194)	(0.00212)	(0.00228)	(0.00239)	(0.00220)
Number of RR	0.0524***	0.133***	0.173***	0.205***	0.0858***	0.144***
	(0.0148)	(0.0126)	(0.0139)	(0.0169)	(0.0158)	(0.0136)
RR-Comp	-0.00401***	-0.00645***	-0.00478***	-0.00202**	-0.00206**	-0.00564***
	(0.000829)	(0.000655)	(0.000756)	(0.000802)	(0.000974)	(0.000788)
Miles to Barge-Origin	0.0329***	-0.00558	-0.00889	0.000817	0.0226*	0.00532
	(0.0105)	(0.00815)	(0.00970)	(0.00901)	(0.0121)	(0.0109)
Miles to Barge-Termi	-0.00754	-0.0569***	-0.0486***	-0.0494***	0.000550	-0.0193
	(0.0120)	(0.00884)	(0.0104)	(0.00992)	(0.0132)	(0.0122)
Miles to Barge Inter	0.000696	0.0119***	0.0102***	0.0114***	0.00189	0.00259
	(0.00219)	(0.00169)	(0.00201)	(0.00192)	(0.00248)	(0.00228)
Origin on Water	0.0730	0.0994**	0.169***	0.267***	0.159***	0.0718
	(0.0589)	(0.0397)	(0.0437)	(0.0413)	(0.0583)	(0.0675)
Dest on Water	-0.0140	0.00689	0.0163	0.0201	0.0732***	0.0218
	(0.0166)	(0.0118)	(0.0137)	(0.0140)	(0.0157)	(0.0143)
Private Cars	-0.106***	-0.108***	-0.112***	-0.0868***	-0.0858***	-0.0981***
	(0.00742)	(0.00587)	(0.00655)	(0.00730)	(0.00766)	(0.00737)
Contract	-0.139***	-0.145***	-0.130***	-0.151***	-0.149***	-0.106***
	(0.00894)	(0.00744)	(0.00768)	(0.00899)	(0.00956)	(0.00847)
Constant	-0.540***	-0.274***	-0.144**	-0.201***	-0.389***	-0.307***
	(0.0682)	(0.0541)	(0.0608)	(0.0606)	(0.0740)	(0.0675)
Observations	4,755	5,274	4,555	4,100	3,775	3,879
R-squared	0.664	0.738	0.759	0.769	0.696	0.726

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-1: Coefficient Estimates for Corn-Continued

VARIABLES	2011	2012	2013	2014	2015	2016
Distance	-0.432***	-0.422***	-0.441***	-0.428***	-0.420***	-0.448***
	(0.00607)	(0.00622)	(0.00618)	(0.00638)	(0.00774)	(0.00724)
Cars	-0.0797***	-0.0734***	-0.0870***	-0.0847***	-0.0740***	-0.0660***
	(0.00220)	(0.00230)	(0.00233)	(0.00195)	(0.00237)	(0.00241)
Number of RR	0.111***	0.0754***	0.116***	0.159***	0.114***	0.107***
	(0.0127)	(0.0155)	(0.0143)	(0.0132)	(0.0173)	(0.0191)
RR-Comp	-0.00523***	-0.00344***	-0.00718***	-0.00533***	-0.00464***	-0.00464***
	(0.000789)	(0.000860)	(0.000853)	(0.000822)	(0.00127)	(0.00129)
Miles to Barge-Origin	0.0127	0.000661	0.00987	0.0324***	0.000495	-0.00560
	(0.00902)	(0.0112)	(0.00981)	(0.0110)	(0.0147)	(0.0122)
Miles to Barge-Term	-0.0187*	-0.0386***	-0.00750	0.00787	-0.0164	-0.00859
	(0.0100)	(0.0120)	(0.0103)	(0.0120)	(0.0157)	(0.0142)
Miles to Barge Inter	0.00240	0.00721***	0.00269	0.000429	0.00260	0.00113
	(0.00188)	(0.00224)	(0.00190)	(0.00220)	(0.00287)	(0.00255)
Origin on Water	0.143***	0.156***	0.0838***	0.211***	0.0168	-0.0280
	(0.0418)	(0.0369)	(0.0274)	(0.0389)	(0.0592)	(0.0753)
Dest on Water	0.0269*	0.0547***	0.129***	0.110***	0.0708***	0.0168
	(0.0158)	(0.0192)	(0.0200)	(0.0155)	(0.0208)	(0.0183)
Private Cars	-0.0745***	-0.0746***	-0.0514***	-0.0651***	-0.0424***	-0.0232***
	(0.00741)	(0.00851)	(0.00860)	(0.00715)	(0.00784)	(0.00775)
Contract	-0.0916***	-0.0869***	-0.0944***	-0.134***	-0.160***	-0.120***
	(0.00848)	(0.00962)	(0.00911)	(0.00769)	(0.00982)	(0.0103)
Constant	-0.307***	-0.341***	-0.190***	-0.397***	-0.294***	-0.183**
	(0.0583)	(0.0666)	(0.0594)	(0.0694)	(0.0868)	(0.0785)
Observations	3,634	3,269	2,980	3,446	3,414	3,362
R-squared	0.723	0.712	0.754	0.750	0.628	0.692

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-2: Coefficient Estimates for Wheat

VARIABLES	Pooled	2000	2001	2002	2003	2004
Distance	-0.404***	-0.477***	-0.478***	-0.475***	-0.435***	-0.447***
	(0.00203)	(0.00667)	(0.00708)	(0.00757)	(0.00706)	(0.00722)
Cars	-0.0320***	-0.0348***	-0.0374***	-0.0296***	-0.0219***	-0.0287***
	(0.000782)	(0.00266)	(0.00285)	(0.00303)	(0.00293)	(0.00285)
Number of RR	0.0574***	0.0998***	0.0441**	0.121***	0.103***	0.0529***
	(0.00495)	(0.0215)	(0.0195)	(0.0193)	(0.0179)	(0.0170)
RR-Comp	-0.00240***	-0.0124***	-0.0203***	-0.00378***	-0.00303***	-0.00508***
	(0.000253)	(0.00140)	(0.00152)	(0.000654)	(0.000754)	(0.000882)
Miles to Barge-Origin	0.0991***	0.200***	0.165***	0.162***	0.124***	0.145***
	(0.00203)	(0.00766)	(0.00785)	(0.00821)	(0.00745)	(0.00718)
Miles to Barge-Ter	0.0726***	0.164***	0.148***	0.125***	0.0653***	0.0989***
	(0.00278)	(0.0112)	(0.0111)	(0.0112)	(0.0106)	(0.0104)
Miles to Barge Inter	-0.0134***	-0.0306***	-0.0292***	-0.0249***	-0.0134***	-0.0178***
	(0.000473)	(0.00193)	(0.00194)	(0.00197)	(0.00182)	(0.00179)
Origin on Water	0.0611***	0.292***	0.0881*	0.103**	0.150***	-0.0254
	(0.0107)	(0.0470)	(0.0476)	(0.0401)	(0.0334)	(0.0362)
Dest on Water	-0.00786**	0.0241*	0.0197	0.0339**	-0.000968	0.0117
	(0.00372)	(0.0124)	(0.0128)	(0.0139)	(0.0131)	(0.0128)
Private Cars	-0.0358***	-0.0285***	-0.0401***	-0.0311***	-0.0386***	-0.0526***
	(0.00238)	(0.00747)	(0.00803)	(0.00875)	(0.00840)	(0.00824)
Contract	-0.0484***	0.0143	-0.00185	-0.0235**	-0.0159	-0.0350***
	(0.00328)	(0.0122)	(0.0106)	(0.0105)	(0.0119)	(0.0109)
Constant	-1.104***	-1.190***	-1.037***	-1.257***	-1.324***	-1.258***
	(0.0214)	(0.0545)	(0.204)	(0.0649)	(0.0666)	(0.0740)
Observations	54,277	3,278	3,097	2,886	3,070	3,066
R-squared	0.480	0.675	0.675	0.641	0.620	0.638

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-2: Coefficient Estimates for Wheat-Continued

VARIABLES	2005	2006	2007	2008	2009	2010
Distance	-0.478***	-0.457***	-0.467***	-0.473***	-0.476***	-0.470***
	(0.00623)	(0.00646)	(0.00622)	(0.00635)	(0.00632)	(0.00545)
Cars	-0.0184***	-0.0246***	-0.0326***	-0.0334***	-0.0408***	-0.0388***
	(0.00246)	(0.00234)	(0.00229)	(0.00237)	(0.00233)	(0.00194)
Number of RR	0.0422***	0.106***	0.134***	0.157***	0.0918***	0.0728***
	(0.0137)	(0.0149)	(0.0147)	(0.0162)	(0.0155)	(0.0115)
RR-Comp	-0.00590***	-0.00494***	-0.00399***	-0.00223***	-0.00384***	-0.00191***
	(0.000692)	(0.000787)	(0.000772)	(0.000856)	(0.000874)	(0.000715)
Miles to Barge-Origin	0.134***	0.128***	0.125***	0.0777***	0.0729***	0.0706***
	(0.00653)	(0.00641)	(0.00659)	(0.00630)	(0.00612)	(0.00521)
Miles to Barge-Termi	0.101***	0.127***	0.144***	0.0735***	0.0556***	0.0632***
	(0.00963)	(0.00910)	(0.00942)	(0.00805)	(0.00781)	(0.00720)
Miles to Barge Inter	-0.0171***	-0.0207***	-0.0245***	-0.0105***	-0.0104***	-0.00983***
	(0.00161)	(0.00152)	(0.00158)	(0.00136)	(0.00130)	(0.00120)
Origin on Water	0.100***	0.0990***	-0.0309	0.0566*	-0.0756**	-0.00646
	(0.0320)	(0.0332)	(0.0321)	(0.0291)	(0.0316)	(0.0289)
Dest on Water	0.00328	0.0131	-0.0130	-0.0149	-0.0443***	-0.0453***
	(0.0108)	(0.0109)	(0.0104)	(0.0112)	(0.0118)	(0.00987)
Private Cars	-0.0428***	-0.0384***	-0.0103	-0.0188**	-0.0461***	-0.0445***
	(0.00726)	(0.00727)	(0.00726)	(0.00759)	(0.00822)	(0.00746)
Contract	-0.0211**	-0.0407***	-0.0426***	-0.0697***	-0.0822***	-0.100***
	(0.00980)	(0.0107)	(0.0102)	(0.0107)	(0.00992)	(0.00882)
Constant	-0.845***	-0.886***	-0.815***	-0.453***	-0.293***	-0.314***
	(0.0590)	(0.0687)	(0.0564)	(0.0592)	(0.0863)	(0.0701)
Observations	3,844	3,431	3,834	3,684	3,421	3,635
R-squared	0.673	0.667	0.664	0.683	0.683	0.729

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-2: Coefficient Estimates for Wheat-Continued

VARIABLES	2011	2012	2013	2014	2015	2016
Distance	-0.431***	-0.425***	-0.419***	-0.427***	-0.503***	-0.474***
	(0.00596)	(0.00691)	(0.00699)	(0.00696)	(0.00726)	(0.00668)
Cars	-0.0418***	-0.0390***	-0.0391***	-0.0409***	-0.0458***	-0.0309***
	(0.00204)	(0.00236)	(0.00247)	(0.00244)	(0.00278)	(0.00261)
Number of RR	0.0665***	0.0837***	0.0820***	0.0814***	0.0228	-0.0147
	(0.0129)	(0.0152)	(0.0172)	(0.0161)	(0.0171)	(0.0153)
RR-Comp	-0.00110	-0.00358***	-0.00558***	-0.00104	0.000836	-0.000984
	(0.000740)	(0.000841)	(0.000883)	(0.000893)	(0.000929)	(0.000931)
Miles to Barge-Origin	0.0648***	0.0764***	0.0792***	0.0639***	0.110***	0.0841***
	(0.00516)	(0.00566)	(0.00618)	(0.00652)	(0.00657)	(0.00640)
Miles to Barge-Term	0.0413***	0.0519***	0.0729***	0.0846***	0.0990***	0.0842***
	(0.00706)	(0.00827)	(0.00801)	(0.00824)	(0.00860)	(0.00854)
Miles to Barge Inter	-0.00859***	-0.0126***	-0.0158***	-0.0142***	-0.0200***	-0.0175***
	(0.00119)	(0.00139)	(0.00137)	(0.00141)	(0.00142)	(0.00144)
Origin on Water	0.0569**	0.0303	0.0261	0.0356	0.0369	-0.218***
	(0.0261)	(0.0392)	(0.0380)	(0.0415)	(0.0341)	(0.0323)
Dest on Water	-0.0521***	-0.132***	-0.0898***	-0.0329***	-0.0689***	-0.114***
	(0.0106)	(0.0128)	(0.0125)	(0.0123)	(0.0136)	(0.0127)
Private Cars	-0.0236***	-0.0368***	-0.0413***	-0.0425***	-0.00876	-0.00652
	(0.00728)	(0.00919)	(0.00963)	(0.00879)	(0.00735)	(0.00674)
Contract	-0.129***	-0.132***	-0.0812***	-0.0864***	-0.0935***	-0.135***
	(0.00960)	(0.0120)	(0.0133)	(0.0144)	(0.0148)	(0.0116)
Constant	-0.563***	-0.611***	-0.602***	-0.556***	-0.149	-0.756***
	(0.0744)	(0.0815)	(0.0644)	(0.0908)	(0.0969)	(0.104)
Observations	3,542	2,800	2,713	2,714	2,672	2,590
R-squared	0.672	0.660	0.641	0.660	0.690	0.713

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-3: Coefficient Estimates for Soybeans

VARIABLES	Pooled	2000	2001	2002	2003	2004
Distance	-0.412***	-0.414***	-0.403***	-0.395***	-0.421***	-0.413***
	(0.00322)	(0.0110)	(0.0101)	(0.0110)	(0.0106)	(0.0109)
Cars	-0.0313***	-0.0441***	-0.0491***	-0.0476***	-0.0617***	-0.0663***
	(0.00160)	(0.00690)	(0.00593)	(0.00655)	(0.00578)	(0.00572)
Number of RR	0.0995***	0.0682	0.0894**	-0.000468	0.112***	0.0444
	(0.00722)	(0.0442)	(0.0381)	(0.0335)	(0.0273)	(0.0350)
RR-Comp	-0.00487***	-0.0120***	-0.00613***	1.59e-06	-0.00346***	0.00225
	(0.000405)	(0.00220)	(0.00177)	(0.00122)	(0.00131)	(0.00159)
Miles to Barge-Origin	0.0132***	0.0297*	0.0528***	0.0184	0.105***	0.0172
	(0.00434)	(0.0163)	(0.0148)	(0.0176)	(0.0154)	(0.0170)
Miles to Barge-Ter	-0.0135**	0.0234	0.0323	0.0441**	0.132***	0.0265
	(0.00548)	(0.0205)	(0.0197)	(0.0224)	(0.0182)	(0.0200)
Miles to Barge Inter	-0.000367	-0.000550	-0.000796	-0.00385	-0.0230***	-0.00497
	(0.00107)	(0.00393)	(0.00375)	(0.00425)	(0.00362)	(0.00398)
Origin on Water	0.136***	0.301**	0.265***	-0.146	0.0989	-0.0750
	(0.0263)	(0.149)	(0.0953)	(0.234)	(0.0757)	(0.0816)
Dest on Water	0.0536***	0.0664**	0.0985***	0.106***	-0.00529	0.00981
	(0.00652)	(0.0276)	(0.0239)	(0.0280)	(0.0261)	(0.0272)
Private Cars	-0.0468***	-0.0842***	-0.101***	-0.128***	-0.126***	-0.0916***
	(0.00412)	(0.0168)	(0.0152)	(0.0163)	(0.0160)	(0.0158)
Contract	-0.0609***	-0.0321	-0.0639***	-0.0484***	-0.137***	-0.0660***
	(0.00529)	(0.0235)	(0.0166)	(0.0170)	(0.0179)	(0.0182)
Constant	-0.739***	-0.994***	-1.300***	-1.262***	-1.313***	-1.033***
	(0.0276)	(0.103)	(0.169)	(0.104)	(0.0993)	(0.0991)
Observations	20,823	1,209	1,336	1,171	938	894
R-squared	0.559	0.659	0.679	0.682	0.753	0.752

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-3: Coefficient Estimates for Soybeans-Continued

VARIABLES	2005	2006	2007	2008	2009	2010
Distance	-0.377***	-0.430***	-0.403***	-0.445***	-0.476***	-0.445***
	(0.0159)	(0.00969)	(0.0105)	(0.0102)	(0.00942)	(0.00795)
Cars	-0.0469***	-0.0557***	-0.0694***	-0.0736***	-0.0717***	-0.0585***
	(0.00709)	(0.00457)	(0.00476)	(0.00483)	(0.00429)	(0.00403)
Number of RR	0.0477	0.0967***	0.0442*	0.163***	0.0795***	0.0863***
	(0.0398)	(0.0222)	(0.0253)	(0.0249)	(0.0185)	(0.0158)
RR-Comp	0.00158	-0.00166	-0.000871	0.000774	-0.00703***	-0.00573***
	(0.00205)	(0.00118)	(0.00122)	(0.00121)	(0.00113)	(0.000995)
Miles to Barge-Origin	-0.0602***	0.000751	0.0140	0.000832	0.00930	-0.0188*
	(0.0202)	(0.0128)	(0.0151)	(0.0111)	(0.0116)	(0.0103)
Miles to Barge-Termi	-0.0924***	-0.0623***	-0.0550***	-0.0397***	-0.0129	-0.0257**
	(0.0261)	(0.0162)	(0.0195)	(0.0139)	(0.0153)	(0.0129)
Miles to Barge Inter	0.0140***	0.0131***	0.00994**	0.00426	-0.00453	0.000201
	(0.00521)	(0.00320)	(0.00387)	(0.00274)	(0.00298)	(0.00256)
Origin on Water	0.322*	-0.0900	0.348***	0.0961	-0.0816	-0.179***
	(0.172)	(0.105)	(0.0910)	(0.0624)	(0.0675)	(0.0513)
Dest on Water	-0.0205	0.0697***	0.101***	0.000941	-0.0237	-0.00452
	(0.0323)	(0.0188)	(0.0198)	(0.0179)	(0.0151)	(0.0146)
Private Cars	-0.108***	-0.0857***	-0.0577***	-0.0628***	-0.0426***	-0.0609***
	(0.0207)	(0.0121)	(0.0133)	(0.0120)	(0.0106)	(0.0109)
Contract	-0.0622**	-0.0705***	-0.0997***	-0.0170	-0.0476***	-0.0559***
	(0.0259)	(0.0172)	(0.0195)	(0.0180)	(0.0165)	(0.0130)
Constant	-0.783***	-0.660***	-0.855***	-0.199***	0.0774	0.0221
	(0.133)	(0.0818)	(0.0936)	(0.0748)	(0.0736)	(0.0650)
Observations	1,123	1,234	1,111	1,216	1,514	1,380
R-squared	0.571	0.768	0.796	0.827	0.811	0.832

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-3: Coefficient Estimates for Soybeans-Continued

VARIABLES	2011	2012	2013	2014	2015	2016
Distance	-0.449***	-0.426***	-0.439***	-0.460***	-0.477***	-0.452***
	(0.00888)	(0.00846)	(0.00894)	(0.00824)	(0.00949)	(0.00914)
Cars	-0.0413***	-0.0539***	-0.0498***	-0.0566***	-0.0405***	-0.0432***
	(0.00402)	(0.00420)	(0.00386)	(0.00372)	(0.00403)	(0.00418)
Number of RR	0.0663***	0.0426***	0.0569***	0.0674***	0.0526***	0.0909***
	(0.0162)	(0.0163)	(0.0152)	(0.0149)	(0.0178)	(0.0201)
RR-Comp	-0.00515***	-0.00186	-0.00201**	-0.00249**	-0.00523***	-0.00600***
	(0.00108)	(0.00114)	(0.000887)	(0.00101)	(0.00122)	(0.00126)
Miles to Barge-Origin	-0.0225**	0.00385	0.0336***	0.0211**	-0.000203	0.00149
	(0.0113)	(0.0106)	(0.0101)	(0.0101)	(0.0117)	(0.0125)
Miles to Barge-Term	-0.00114	-0.0318**	0.0402***	-0.00841	-0.000730	0.0165
	(0.0131)	(0.0142)	(0.0117)	(0.0128)	(0.0158)	(0.0204)
Miles to Barge Inter	-0.000595	0.00155	-0.00977***	-0.00156	-0.00713**	-0.00612
	(0.00259)	(0.00279)	(0.00236)	(0.00253)	(0.00302)	(0.00397)
Origin on Water	-0.152*	-0.0531	-0.120**	-0.0663	-0.120*	-0.202**
	(0.0900)	(0.108)	(0.0545)	(0.0546)	(0.0641)	(0.0844)
Dest on Water	0.0412**	-0.0105	0.0197	0.0239*	-0.0130	0.0429***
	(0.0181)	(0.0176)	(0.0185)	(0.0140)	(0.0154)	(0.0149)
Private Cars	-0.0754***	-0.0530***	-0.110***	-0.0709***	-0.0264***	-0.0202**
	(0.0121)	(0.0123)	(0.0114)	(0.0100)	(0.00967)	(0.00957)
Contract	0.00678	-0.0106	-0.0214	0.0565***	0.00785	-0.0101
	(0.0153)	(0.0149)	(0.0137)	(0.0155)	(0.0161)	(0.0165)
Constant	-0.0901	-0.219***	-0.297***	-0.0470	0.0398	-0.254***
	(0.0698)	(0.0723)	(0.0714)	(0.0708)	(0.0820)	(0.0780)
Observations	1,088	1,253	1,192	1,338	1,335	1,491
R-squared	0.825	0.801	0.792	0.817	0.756	0.748

Note: A *, **, *** indicated statistical significance at the .1, .05 and .01 level. Firm fixed effects are included but suppressed.

Table A-4: Oaxaca Decomposition Corn

VARIABLES	(1) overall	(2) endowments	(3) coefficients	(4) interaction
Distance		0.904***	0.533***	0.977***
		(0.00931)	(0.0582)	(0.00455)
Cars		0.996**	0.945***	0.995**
		(0.00171)	(0.00562)	(0.00214)
Number RR		0.999	1.008*	1.000
		(0.00178)	(0.00439)	(0.000860)
RR-Comp		0.985***	1.054***	1.016***
		(0.00276)	(0.0111)	(0.00365)
Water Dist-OR		1.022***	0.927	0.996
		(0.00632)	(0.149)	(0.00899)
Water Dist-Dest		1.014**	0.915	0.997
		(0.00595)	(0.146)	(0.00489)
Water O-D Inter		0.972***	1.093	1.008
		(0.00851)	(0.147)	(0.0121)
Private		1.003	1.040***	0.998
		(0.00262)	(0.00834)	(0.00145)
Contract		0.995**	0.981***	0.991***
		(0.00211)	(0.00541)	(0.00282)
OR - ONWATER		1.000	1.001	0.999
		(0.000461)	(0.00202)	(0.00119)
DEST-ONWATER		0.998*	1.004	0.999
		(0.000825)	(0.00371)	(0.000827)
Constant			2.941***	
			(0.592)	
		–		
Overall				
2014	0.0400***			
	(0.000366)			
2000	0.0305***			
	(0.000251)			
difference	1.312***			
	(0.0161)			
endowments	0.911***			
	(0.00920)			
coefficients	1.499***			
	(0.0155)			
interaction	0.961***			
	(0.00868)			
Observations	7,917	7,917	7,917	7,917

Robust see form in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A-5: Oaxaca Decomposition Wheat

VARIABLES	(1) overall	(2) endowments	(3) coefficients	(4) interaction
Distance		0.889***	1.676***	1.020***
		(0.0109)	(0.291)	(0.00715)
Cars		0.995***	1.015**	1.002*
		(0.00134)	(0.00696)	(0.00115)
Number RR		1.000	1.008**	1.000
		(0.000683)	(0.00353)	(0.000995)
RR-Comp		0.965***	1.060***	1.034***
		(0.00620)	(0.0157)	(0.00889)
Water Dist-OR		0.978**	0.503***	1.017*
		(0.0107)	(0.0512)	(0.00906)
Water Dist-Dest		0.973***	0.712***	1.018**
		(0.0103)	(0.0588)	(0.00804)
Water O-D Inter		1.036***	1.318***	0.979**
		(0.0121)	(0.0884)	(0.00809)
Private		1.009***	1.013*	0.996
		(0.00189)	(0.00784)	(0.00273)
Contract		0.999	0.973***	0.995*
		(0.00105)	(0.00982)	(0.00236)
OR - ONWATER		1.000	0.996***	1.000
		(0.00164)	(0.00148)	(0.00164)
DEST-ONWATER		1.000	0.979***	1.001
		(0.000499)	(0.00556)	(0.00168)
Constant			1.692**	
			(0.382)	
Overall				
2014	0.0448***			
	(0.000425)			
2000	0.0344***			
	(0.000319)			
difference	1.301***			
	(0.0173)			
endowments	0.855***			
	(0.0114)			
coefficients	1.477***			
	(0.0237)			
interaction	1.031**			
	(0.0144)			
Observations	5,992	5,992	5,992	5,992

Robust see form in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A-6: Oaxaca Decomposition Soybeans

VARIABLES	(1) overall	(2) endowments	(3) coefficients	(4) interaction
Distance		0.828***	0.742**	0.980**
		(0.0205)	(0.0927)	(0.00852)
Cars		1.000	0.953**	1.000
		(0.00284)	(0.0179)	(0.00298)
Number RR		1.006*	1.000	1.001
		(0.00296)	(0.00226)	(0.00406)
RR-Comp		0.988***	1.056***	1.009**
		(0.00444)	(0.0172)	(0.00392)
Water Dist-OR		0.996	1.013	1.000
		(0.00338)	(0.126)	(0.00303)
Water Dist-Dest		1.000	0.930	1.000
		(0.00411)	(0.0809)	(0.00375)
Water O-D Inter		1.002	0.997	1.000
		(0.00369)	(0.0781)	(0.00487)
Private		0.981***	1.007	1.003
		(0.00519)	(0.0125)	(0.00571)
Contract		0.988*	1.038	1.016
		(0.00620)	(0.0257)	(0.0113)
OR - ONWATER		1.009	1.000	0.992
		(0.0105)	(0.000559)	(0.0109)
DEST-ONWATER		0.998	0.996	1.000
		(0.00252)	(0.0167)	(0.00168)
Constant			2.643***	
			(0.995)	
Overall				
2014	0.0406***			
	(0.000787)			
2000	0.0312***			
	(0.000579)			
difference	1.303***			
	(0.0350)			
endowments	0.816***			
	(0.0437)			
coefficients	1.700***			
	(0.0379)			
interaction	0.940			
	(0.0490)			
Observations	2,547	2,547	2,547	2,547

Robust see form in parentheses
*** p<0.01, ** p<0.05, * p<0.1