Impacts of Railroad Costs on Kansas Wheat Basis

by

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Abstract: *Numerous studies and their results have maintained a general consensus that variation in transportation costs between a central futures market and a local delivery market is a main determinant of basis. However, surprisingly few empirical estimates exist to quantify the relationship between variation in transportation costs and basis. Our work is the first to directly model elevator-level grain pricing behavior (i.e., basis) and the transportation costs that those elevators face. We link elevator-specific basis data with actual rail costs incurred by those elevators, and then add elevator-level characteristics to control for numerous factors that can impact pricing behavior. These data are then use to empirically estimate and quantify the degree to which transportation costs affect elevators' pricing behaviors. We find that, as predicted by theory, increases in elevators' transportation costs results in weakening basis at those elevators, and that this is exacerbated in periods of higher expected rail costs and higher expected rail cost variability. However, our results also indicate that change in transportation costs are far from passed through to producers on a one-to-one basis and that variation in local spot market conditions and futures prices contribute more to elevators' price-setting behaviors than changes in rail costs.*

Keywords: basis, marketing, ownership structure, cost pass-through, rail, transportation costs

Introduction

Basis—the difference between cash and futures prices—is one of the primary and most used concepts in grain marketing. Basis modeling and prediction has also been the topic of considerable research. This fairly extensive literature has identified numerous factors that, on the margin, impact basis values, including futures market conditions, local supply and demand dynamics, spatial competition, and entry of alternative users of grain (e.g., ethanol plants, feedlots, and mills), among others. However, despite these numerous studies and their results, there has always remained a general consensus that variation in transportation costs between a central futures market and a local delivery market is the main determinant of basis.

While the widely-accepted theoretical underpinning of basis remains unchanged, surprisingly few empirical estimates exist to quantify the relationship between variation in transportation costs and basis. Wilson and Dahl (2011) used regional, aggregated rail and barge rates for corn and soybeans to investigate how changes in shipping costs, among other factors, explained basis volatility. An older study by Garcia and Good (1983) found that basis is seasonally affected by production and stocks relative to capacity during harvest, while transportation costs were more significant in later months for Illinois corn. Several other studies developed spatial-based proxies to account for transportation costs, but we are not aware of any research that has directly linked variation in basis to transportation costs faced by shippers.

Our work is the first to directly model elevator-level grain pricing behavior (i.e., basis) and the transportation costs that those elevators face. Specifically, we combine daily wheat basis information from 267 grain elevators in Kansas—the largest wheat producing state—between 2005 and 2013 with restricted-access, location-specific rail cost information (including rail car charges, fuel, and other costs associated with shipment) from the Surface Transportation Board's (STB's)

Waybill Samples from the same period. Wheat shippers in the Great Plains primarily use railroads for grain transportation because they are too distant from barge shippers, and truck transportation is not typically price competitive. The rail landscape in Kansas is dominated by two railroads—BNSF and UP—which each control about half of the track mileage in the state. As such, rail shipment costs are likely to drive wheat basis levels for most Kansas elevators.

The specificity and location-specific linkage between transportation and basis information, length of the data sample, spatial dispersion of grain elevators in the state, information about elevator-level characteristics (e.g., capacity, ownership structure, grain loading technology), and spatial competition dynamics provides an opportunity to empirically estimate and quantify the degree to which transportation costs affect elevators' pricing behaviors. After controlling for these factors, our preliminary results consistently indicate that, as predicted by theory, increases in elevators' transportation costs results in weakening basis at those elevators. However, our results also indicate that there are important dynamics in this pricing behavior.

First, we find that variation in rail costs is, on average, not the largest contributor to changes in basis values. That is, changes in transportation costs are estimated to be less influential in explaining basis variation than variation in local marketing conditions and in futures prices. Second, we examine how elevators respond to rail cost variation in different transportation cost regimes. The data suggest that elevators exhibit asymmetric cost pass-through behaviors. Specifically, in periods when elevators expect rail costs to be higher or uncertainty about transportation costs to be higher, they tend to pass through a larger portion of their rail costs to producers in the form of weaker basis. In calmer, lower-cost transportation markets, elevators' pass-through of their transportation costs is less aggressive. These insights may be particularly useful for grain producers for whom storage and the timing of grain sales is a key marketing strategy.

The Grain Industry in Kansas

Kansas has the largest wheat production and handling industry in the United States. As such, the grain handling infrastructure is well-developed for large grain throughput and shipping. Furthermore, because of the high production capacity of Kansas producers, most of the grain holding and storage occurs at grain elevators rather than in on-farm storage. These conditions have led to a grain marketing landscape characterized by a high spatial density of grain elevators that varies significantly in loading technologies, storage and handling capacities, and ownership structure.

Figure 1 shows the Kansas grain handling infrastructure and provides descriptive statistics of the Kansas wheat marketing industry. The figure shows that the high density of elevators, is strongly related to the overall crop production capacity across the state. The figure also makes evident that the majority of elevators are structured as farmer cooperatives (blue circles). However, the majority of elevators that have shuttle train loading capabilities (red circles) and have the largest storage and handling capacity (larger circles) are owned by private firms. Only three of the elevators in the sample are both cooperatively owned and are shuttle-loaders. Bekkerman and Taylor (2018 w.p.) show that the ownership structure impact elevators' basis bid behavior.

Figure 1 also provides insights about the potential effects that spatial competition may have on basis bidding and how price shocks are likely to transfer geographically. The figure shows that while many of the elevators are located on main rail lines, a substantial number of facilities are either located on a rail line spur or do not have access to rail transportation services. Additionally, there are discernible differences in elevator density across the state, with higher concentration in the central and southwestern portion of Kansas and lower concentration in the northwest. These factors have been shown to impact basis bidding behavior and the spatio-temporal transmission speed of price shocks (Bekkerman et al., 2014; McNew and Griffith, 2005).

In addition to the spatial competition and ownership structure of Kansas elevators, it is also important to capture the production and consumption demand of the state's grain output. Data from the USDA National Agricultural Statistics Service show that during 2004–2013, corn constituted 40–50% of Kansas' overall crop production. Wheat was the second most produced crop, representing approximately 20–30% of total output. However, despite the fact that corn is the largest crop produced in Kansas, wheat is the most exported crop from the state. Between 2004 and 2013, there were 4–8 times more wheat rail shipments than any of the other crop-related commodities. In addition, Figure 2 shows that most of the wheat shipments (97.8%) were delivered to locations outside of Kansas.

The marketing dynamics of Kansas wheat—which primarily flows to locations outside the state—imply that rail transportation plays a critical role in the profitability of grain elevators. This marketing landscape also substantially reduces the likelihood that elevators can compete on the costs of alternative modes of transportation, such as trucking (which would be prohibitively expensive due to long distance of shipments) or barge (due to an absence of accessible waterways for the majority of the state). As such, price setting behavior is also likely to be significantly and directly influenced by variability in rail costs, which provides a unique opportunity to more cleanly identify the dynamics of elevators' pricing behaviors associated with changes in transportation costs.

Data Description and Location Matching Methodology

A common challenge in many industrial organization and production economics studies is the limited information about firms' variable costs. Empirical work within the context of this challenge requires making assumptions about the cost structure, estimating variable costs using observed variation in pricing and/or production behaviors, or both. Our work is the first to directly overcome this challenge by combining elevator-specific wheat price information with data about payments that an elevator made to railcar owners to ship a carload of wheat.

Specifically, we combine several datasets that link information about Kansas wheat elevators' price bidding behavior (i.e., prices that are reported to have been offered by elevators to farmers); elevator-level characteristics such as handling capacity, technological capability, and business structure; and information about rail shipment origins, volume, costs, and destination. The original price data for winter wheat is a pooled cross-section of weekly cash and futures prices for 267 locations in Kansas (essentially a census of facilities in the state) over the 2004 to 2013 period. Cash prices were obtained from a historical database of posted bids reported to DTN. Futures prices for the nearby (closest contract to expiration at a given point in time) hard red winter wheat contracts traded on the Kansas City Board of Trade (KCBT) were collected from Bloomberg.[1]

[1] The rollover date for the nearby contract was defined as the first day of the month that the nearby contract was due to expire.

Using the cash and futures prices, the nearby basis levels are calculated by subtracting the futures price from the cash price.[2]

Additional information about the elevators in the dataset was gathered from a variety of sources. The ability of an elevator to load shuttle trains was determined by directly contacting individual elevators and from state and federal elevator licensing records, railroad websites, news releases, and the Kansas Grain and Feed Association's Annual Directory. Other elevator characteristics were similarly collected and include information about rail line access, business structure (cooperative or investor-owned firm), and licensed grain holding capacity.

Information about shipment activity is from the 2004–2013 Carload Waybill Sample datasets, maintained by the U.S. Department of Transportation's Surface Transportation Board (STB). A rail waybill is a required document filed by an elevator or railway line that transports some cargo. This document typically includes information about the originating shipper, the contents of a shipment and its volume, the destination and any rail switching points, payments obtained by the owner of a railway line for the shipment, and many other informational items. Data provided by the STB is a stratified sample of these waybills. A sample is available for each state and includes information for railcars that passes through the state (regardless of whether it originates or terminates in that state). There are two types of carload waybill sample data available: public use and restricted-access. The public use data aggregates waybills into a few regions within each state. However, the restricted-access data provides full information about each specific waybill that appears in an annual sample.

Elevator-level rail expenses are obtained from the restricted-level carload waybill sample data for Kansas. The original data contain information about all products shipped through Kansas during the sample period, but we limit the sample to only wheat using the Standard Transportation Commodity Code (STCC) 1137. We then remove data associated with carloads that originated at elevators outside of Kansas. Lastly, we use the reported total shipment cost of a sampled carload to compute a cost per bushel of wheat. This provides a similar measure to that used in many industry reports and popular press publications, thus allowing us to provide insightful assessments to industry stakeholders.

Lastly, while the data containing elevator-level prices and facility characteristics contain specific geolocation information (i.e., city, state, latitude, and longitude), the STB waybill sample does not. Instead, the STB data identify elevators' freight station accounting code (FSAC), which can be geocoded to a specific city and state. This provides sufficient geographic specificity to merge all of the elevator-level data. In the vast majority of cases, there is only one elevator in a particular city, which results in a perfect match between the price and rail cost data sources. In cases when multiple elevators were located in the same city, rail cost information was assumed to be identical for all facilities in that city.

[2] It should be noted that cash bids collected in this manner represent offer prices to buy grain and do not necessarily imply that grain was transacted at these prices for every elevator on every day. While a significant proportion of winter wheat produced in Kansas and Montana is shipped west to export terminals in the Pacific Northwest, KCBT hard red winter wheat futures contracts—for which delivery locations are not on the west coast—represent the only consistently reported instrument for evaluating future price expectations. Furthermore, significant convergence problems that occurred in KCBT winter wheat futures markets (for example, see Garcia, Irwin, and Smith, 2015) would similarly affect basis values in all winter wheat production locations.

The final data includes a large proportion but not all of the 267 facilities that are in the original Kansas price dataset because of two reasons. First, there are 83 facilities that operate exclusively by loading and unloading trucks and, thus, do not have access to a rail line. By definition, there would be no waybill samples for those elevators. Second, some facilities were not sampled by the STB during the sample period. This would also result in those elevators not appearing in the final dataset, because no associated rail costs or other transportation information are available.

Table 1 shows descriptive statistics for the final, combined price and rail cost data for Kansas elevators between 2004 and 2013.[3] The data show that, on average, basis was negative during the sample period, as expected for a state from which wheat is primarily exported. The cost to ship a bushel of wheat is, on average, \$1.05. This is very much in line with costs that we have found in industry publications, providing confidence in the data. Somewhat surprisingly, even though the top 1% of the rail cost data was removed from the sample, the variable still exhibits significant positive skewness, possibly suggesting that some elevators may have paid substantial premiums on the secondary market to fulfill their orders.

The descriptive statistics also show that the most common grain haul occurs on a 48–52 car train, although there is some skewness toward a longer, unit-train setup. The average mileage to a terminal location is 916 miles, which is approximately the distance from Kansas to the two major ports in Texas—Houston and Corpus Christi. Additionally, it is not surprising that over 40% of the elevators in the sample have shuttle-train loading capabilities and are relatively large, with an average grain capacity of 4.5 million bushels. These facilities are much more likely to move grain longer distances using rail. Conversely, elevators structured as farmer-owned co-operatives, which are typically smaller facilities and often fulfill more local demand using truck transport, represent only 13% of the final sample.

Model of Basis

We define a base case model of nearby basis, which largely reflects basis model specifications from the expansive literature on agricultural basis. Specifically, we model nearby basis for location i at time t as follows,

$$\ln b_{i,t} = \beta_0 + \beta_1 \ln C_{i,t} + \boldsymbol{\delta P_{i,t}} + \boldsymbol{\phi R_{i,t}} + \boldsymbol{\theta E_i} + \boldsymbol{\sigma_t} + \varepsilon_{i,t} \tag{1}$$

The term $\ln b_{i,t}$ represents the log-modulus transformation of the nearby basis and $\ln C_{i,t}$ is the log-transformed cost per bushel observed at location i at time t. The log transformation of both the basis and cost data are performed to attenuate issues associated with positively skewed data. However, because basis data can be positive or negative, the log-modulus function is used to apply a log transformation without affecting the original sign of an observation (John and Draper, 1980).

The term $\boldsymbol{P_{i,t}}$ in equation (1) is a vector of additional market information variables, including the logged nearby hard red winter wheat futures price and one-year lagged basis (i.e., the basis value observed on the same week of the preceding year at location i). Additional rail transportation variables are characterized by the vector $\boldsymbol{R_{i,t}}$, including the logged total number of cars being

[3] The rail cost per mile per bushel was highly skewed due to a small number of outliers. Therefore, we remove the data that correspond to the largest 1% of the rail cost data.

shipped on the train from which a waybill sample was reported, total distance traveled by the car, categorical variables that account for shorter or longer haul transport, and whether the train's final destination is a port facility or an inland market.

The vector $\boldsymbol{E_i}$ contains additional information about grain elevators, including the elevator's logged grain handling capacity, whether the elevator is privately owned or structured as a farmer-owned co-operative, whether the elevator has shuttle-train loading technology, and whether the facility has a federal or state grain operation license. Lastly, $\boldsymbol{\sigma_t}$ represents a vector of seasonality fixed effects (i.e., week and year) and $\varepsilon_{i,t}$ is the error term. We cluster the standard errors at the county level to account for potential spatial autocorrelation of basis within localized geographic areas.

Table 2 presents the estimation results of the base case nearby basis model. The parameter associated with the rail cost variable is statistically significant and negative, indicating the expected relationship between elevators' variable costs and their pricing behavior. That is, increases in rail costs are associated with a weakening of basis. Moreover, because we control for the nearby futures price in the model, a weakened basis is, therefore, an indicator of lower spot price bids in local markets.

Other statistically significant market information variables also exhibit expected relationships with the dependent variable. Lagged basis values are positively correlated (indicating elevators' use of historical information in current pricing decisions) and futures prices are inversely related (indicating that local spot prices may be stickier and respond to futures markets rather than the reverse). Estimates of the additional rail transport variables suggest that basis values are weaker when the destination of the grain is nearby (e.g., a short-line) and farther than the median, and when the terminal location is a port (which are typically the farthest shipping locations). Because we control for the distance a shipment travels, the regression results suggest that elevators incur additional costs for shipping to farther terminals and/or elevators that ship farther distances or to ports systematically offer lower price bids for wheat as a result of additional opportunity costs associated with these shipments.

Lastly, parameter estimates for the elevator level characteristics indicate that basis is higher at locations that have a higher grain handling capacity and a federal license. Larger capacity elevators are also those that are most likely to exhibit higher demand for grain to fulfill orders and minimize fixed costs; as such, they are more likely to make higher bids. Facilities with a federal license are certified under the national grain handling standards. Unsurprisingly, because the vast majority of Kansas wheat is exported out of the state, federally-licensed elevators are likely to have lower opportunity costs for identifying buyers. Perhaps somewhat unexpectedly, neither the business structure nor grain loading technology appear to affect basis bids. However, this may be due to the fact that so few co-operatives ship wheat using rail (only 13% of elevators in the final sample are co-operatives) and that most elevators that ship via rail are relatively large and have already implemented efficient loading technologies, even if they are not specific to loading shuttle trains.

Magnitudes of the estimated coefficients can be interpreted as elasticities for continuous variables and semi-elasticities for discrete ones. Changes in lagged basis and futures prices are associated with the largest impacts on current nearby basis—a 0.28% and –0.31% change associated with a 1% change in lagged basis and nearby futures price, respectively. This is expected because these factors directly affect cash bids. The estimate associated with the rail cost—a 1% change in per mile per bushel rail cost is associated with a –0.09% change in basis—appears to be rather small. This magnitude is similar to estimates associated with the other variables for which the estimated parameters are statistically significant. However, it is important to note that the average rail cost has a relatively small standard deviation. As such, directly comparing magnitudes of the estimated coefficients may be misleading.

Instead, it may be more useful to consider a comparison of standardized parameter estimates, which measure changes in terms of standard deviations. There are two advantages of assessing the regression results in this manner. For example, for a one standard deviation change in the per bushel cost of shipping wheat (i.e., approximately \$0.93 per bushel), the associated change in basis is, on average, approximately –0.16 standard deviations (i.e., approximately 6.5 cents per bushel). During periods of particular transportation constraints and large increases in railcar costs—such as those that occurred in 2014 and 2015, when prices for a single railcar on the secondary market ranged between \$2,000 and \$4,000 (USDA Agricultural Marketing Service)—elevators can observe significantly higher increases in rail costs than \$0.93 per mile per bushel. Our results provide a direct estimate of the extent to which these market changes can affect elevators' pricing behavior and basis bids observed by farmers.

A second advantage of assessing standardized coefficient values is that it is possible to rank variables in the order of relative importance in explaining basis by comparing the absolute values of the standardized parameters. For example, it is unsurprising that the current nearby futures price and the lagged basis rank as the most influential predictors of basis. However, despite its relatively small elasticity estimate, the rail cost variable is the third most influential factor, followed by the other transport-related variables. While the intuition behind this result may not be revelatory, we are the first study to directly estimate the degree to which rail costs affect basis. Specifically, the results indicate that changes in rail costs lead to approximately 50% less change in basis than variation in market-related information.

Asymmetric Rail Cost Pass-through

Asymmetric cost pass-through has been repeatedly noted and empirically identified in many industries. These studies also cite numerous reasons for asymmetric pass-through, including changes in their perceptions about input markets (i.e., the market for rail services), may be possible reasons that grain elevators could differentially pass through their rail costs to farmers. We consider and empirically test these possibilities.

Basis Model in Rising and Falling Rail Cost Regimes

We first consider the extent to which grain elevators alter their basis setting behaviors when they perceive different input cost landscapes for rail services. Specifically, we use the base case model of basis in equation (1) to specify a regime-switching model

$$\ln b_{i,t} = \begin{cases} \beta_0' + \beta_1' \ln C_{i,t} + \boldsymbol{\delta}'\boldsymbol{P}_{i,t} + \boldsymbol{\phi}'\boldsymbol{R}_{i,t} + \boldsymbol{\theta}'\boldsymbol{E}_i + \boldsymbol{\sigma}_t + \varepsilon_{i,t}', & \text{if } E[C_t] \text{ rising} \\ \beta_0'' + \beta_1'' \ln C_{i,t} + \boldsymbol{\delta}''\boldsymbol{P}_{i,t} + \boldsymbol{\phi}''\boldsymbol{R}_{i,t} + \boldsymbol{\theta}''\boldsymbol{E}_i + \boldsymbol{\sigma}_t + \varepsilon_{i,t}'', & \text{if } E[C_t] \text{ falling} \end{cases} \tag{2}$$

Equation (2) describes an elevator that could exhibit different pricing behaviors depending on their expectations of rail costs that the elevator could incur. Additionally, we consider how expected rail cost variability may affect pricing behavior. We can empirically test this hypothesis by estimating basis models that are dependent on the rail cost level or variability expectation regime during which a basis is observed, and then statistically test whether $\beta_1' = \beta_1''$.

We define grain elevators' rail cost expectations as the ratio of average rail costs in the period preceding time t relative to the average rail costs in the period that occurred immediately prior. That is,

$$E[C_t] = \frac{\frac{1}{N}\sum_1^n c_{t-1-n}}{\frac{1}{M}\sum_1^M c_{t-1-N-m}} \tag{3}$$

For example, if $N = 2$ and $M = 2$, then $E[C_t]$ would represent the ratio of the average rail costs that occurred one and two weeks before time t relative to the average rail costs that occurred three and four weeks before time t. If $E[C_t] > 0$, then we define the expected rail cost regime in time t to be cost-increasing (i.e., grain elevators expect rail costs to be, on average, above those that occurred in the past), and if $E[C_t] < 0$, then the expected rail cost regime is cost-decreasing. We estimate the regime-switching basis model under four alternative assumptions about the period lengths; that is, $N = M = \{1,2,3,4\}$.

Similarly, we calculate expected volatility measures as the coefficient of variation of rail costs in preceding periods. The increasing and decreasing volatility regimes are defined similarly to cost regimes presented in equation (3). We estimate these alternative regimes with period lengths of four, eight, and twelve weeks. The longer period lengths (relative to the expected cost level models) are used to ensure there are sufficient data to calculate within-period variability.

It would be ideal to define elevator-specific rail cost expectation regimes (i.e., determine $E[C_{i,t}]$); however, we are not aware of any publicly-available longitudinal weekly rail cost data for Kansas grain handling facilities. Therefore, we use the grain transportation rail cost index from the USDA Agricultural Marketing Service. These data provide a national rail cost estimate for shipping grain in the United States. While this measure may be perceived as being too geographically broad, we believe that it is appropriate for characterizing our rail cost regime variable for two reasons.

First, the rail cost index is specific to grain shipments. Because Kansas is one of the largest grain producers and shippers in the United States, the national grain rail cost shipment index would arguably take into sizeable consideration the grain transportation conditions occurring in this state. Second, because the secondary rail market provides an opportunity for grain elevators to openly bid and compete for rail cars across large geographic markets, rail costs in one region are likely to be highly correlated with rail costs in other locations. As such, expectations about rail costs for any specific grain elevator are also likely to be highly correlated with expectations about rail costs for another facility, implying that a generic index would be sufficient to determine the broad rail cost regime at time t.

Table 3 shows the pertinent results of the regime-switching basis model under the alternative period length assumptions. The table only shows the parameter estimates for the rail cost variable in each model as well as the results of the statistical tests that compare those parameter estimates across models. Across all rail cost expectation period lengths and regimes, the parameter associated with rail costs is statistically significant with expected signs. Within each period length assumption, we assess whether these estimated parameters are statistically different in the cost variability increasing and cost decreasing regimes. We follow Paternoster et al. (2003) to calculate the z-statistic for parameter pairs within period length assumptions.

For models that measure elevators' responses to rail cost trends within one or two weeks, parameter estimate comparisons indicate that there is no statistical evidence that firms do not price wheat differently in regimes of increasing or decreasing rail cost expectations. When longer periods are considered (i.e., expectations based on three- and four-week rail cost trends), differential pricing strategies begin to be observed.

Table 3 shows that in regimes when the most recent three- and four-week rail costs are higher than during the preceding weeks, grain facilities tend to pass through the same amount of those costs (in terms of weaker basis) as the estimate in the base case model; that is, the elasticity between rail cost and basis is approximately –0.07%. However, in regimes when rail costs decrease, the degree of pass-through is approximately one-third as large. These results indicate that grain handling facilities may behave and bid for wheat dynamically in response to observed market trends and expectations about rail markets.

The table also shows pass-through differences under alternative rail cost variability regimes. The results indicate that for all estimated regime lengths, elevators tend to alter their pass-through strategies. Specifically, in periods when elevators expected higher rail cost variability, they tend to pass-through a higher portion of the rail costs to farmers in the form of lower basis. In higher cost variability periods, the elasticity between rail costs and basis is –0.10% to –0.11%, while in lower-variability periods the elasticity is approximately –0.07%. This result is similar to findings in Taylor, Tonsor, and Dhuyvetter (2014), which indicate that in periods of higher market uncertainty, elevators tend to pass-through that risk to farmers in the form of weaker basis.

Concluding Remarks

As the first study that directly links elevator-specific basis data with elevator-specific grain transportation information, we are able to provide detailed estimates of elevator pricing behaviors in response to changes in their variable costs for transportation. The findings are consistent with economic theory that higher costs are passed through to farmers in the form of weaker basis, a result that is highly robust to changes in empirical specifications and underlying assumptions. The analysis is also the first to provide insights about the relative role of transportation costs in elevators' pricing decisions, indicating that only changes in local and futures prices plays a larger part in affecting these decisions.

We also show that elevators behavior is dependent on their observations of market conditions and expectations about future outcomes. Specifically, when markets signal increases in either the level of transportation costs or the uncertainty about future costs, elevators tend to pass through a larger portion of their transportation costs to farmers in the form of weaker basis. This is particularly important information for grain producers who use storage as a marketing strategy for selling their crops. By having an improved understanding of when basis is expected to be weaker as a result of higher cost pass-through, these producers can develop more optimal strategies for timing grain sales to nearby elevators.

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Table 1. Descriptive Statistics, Kansas Elevators, 2004–2013

	Mean	Std Dev	Minimum	Maximum
Dependent variable				
Nearby basis	-0.530	0.405	-1.660	0.164
Rail cost measure				
Rail cost, dollars per bushel	1.051	0.925	0.212	8.303
Market information				
Nearby basis, one-year lag	-0.507	0.381	-1.916	0.550
Nearby KCBT futures contract price	6.525	1.920	3.156	12.705
Rail transport information				
Number of carloads in sampled train	55.441	45.460	1.000	120.000
Distance traveled by train (miles)	916.594	499.242	40.400	5,113.300
Ocean port as final destination of train	0.306			
Elevator characteristics				
Has shuttle-loading technology	0.409			
Structured as a co-operative	0.131			
Grain handling capacity, million bushels	4.538	5.167	0.246	42.543
Has federal grain handling license	0.452			
Has state grain handling license	0.548			
Elevator facilities in combined sample		134		
Total observations		2,757		

Notes: Standard errors are presented only for continuous variables.

Table 2. Estimation Results for the Base Case Logged Nearby Basis Model

	Estimate	Std error	Std estimate
Rail cost measure			
Rail cost, dollars per mile per bushel, log	**-0.085**	0.012	-0.158
Market information			
Nearby basis, one-year lag, log	**0.281**	0.055	0.265
Nearby KCBT futures contract price, log	**-0.307**	0.023	-0.381
Rail transport information			
Number of carloads in sampled train, log	**0.011**	0.006	0.068
Total distance traveled, log	-0.008	0.011	-0.013
Distance traveled by train, lowest quintile	**-0.064**	0.016	-0.088
Distance traveled by train, second quintile	-0.016	0.017	-0.023
Distance traveled by train, fourth quintile	**-0.046**	0.013	-0.077
Distance traveled by train, top quintile	**-0.024**	0.014	-0.034
Ocean port as final destination of train	**-0.035**	0.013	-0.062
Elevator characteristics			
Grain handling capacity, million bushels, log	**0.026**	0.013	0.086
Structured as a co-operative	-0.015	0.020	-0.009
Has shuttle-loading technology	0.006	0.030	0.015
Has federal grain handling license	**0.049**	0.026	0.091
Intercept	**0.516**	0.075	--
Fixed effects, joint F-test			
Weekly seasonality		**62.580**	
Yearly		**271.820**	
R-squared		0.770	

Notes: Bolded values represent those that are statistically significant at least at the 10% level. Standard errors are clustered at the county level. "Std. error" represents standard errors and "Std. parameter" represents the standardized value of the parameter estimate.

Table 3. Estimated Log Nearby Basis Models and Cross-Model Comparison Test Statistics Across Cost Regimes

	Estimate (Std Err)	Comparison Z-score	Estimate (Std Err)	Comparison Z-score
One-week trends				
Increasing costs	-0.070 (0.012)	0.013		
Decreasing costs	-0.070 (0.012)			
Two-week trends				
Increasing costs	-0.063 (0.012)	1.225		
Decreasing costs	-0.084 (0.012)			
Three-week trends				
Increasing costs	-0.064 (0.010)	**1.700**		
Decreasing costs	**-0.090 (0.011)**			
Four-week trends				
Increasing costs	-0.065 (0.010)	**1.783**		
Decreasing costs	**-0.092 (0.011)**			
Four-week trends				
Increasing cost variability			**-0.095 (0.011)**	**-1.873**
Decreasing cost variability			-0.065 (0.012)	
Eight-week trends				
Increasing cost variability			**-0.106 (0.013)**	**-2.089**
Decreasing cost variability			-0.070 (0.011)	
Twelve-week trends				
Increasing cost variability			**-0.107 (0.013)**	**-2.339**
Decreasing cost variability			-0.067 (0.012)	

Notes: All models are estimated using the full specification, but only the parameter estimate associated with the rail cost variable is shown to conserve space. Full results are available on request. Regimes with increasing (decreasing) costs are those in which the average cost for a specified time period (i.e., one, two, three, or four weeks) is higher than the average cost of the preceding time period (i.e., one, two, three, or four weeks, respectively). Regimes with increasing (decreasing) cost variabilities are those in which the cost coefficient of variation for a specified time period (i.e., four, eight, and twelve weeks) is higher than the cost coefficient of variation of the preceding time period (i.e., four, eight, and twelve weeks, respectively). Z-scores are calculated following Paternoster et al. (1998). Values in bold are those that are at least statistically significant at a 10% level.

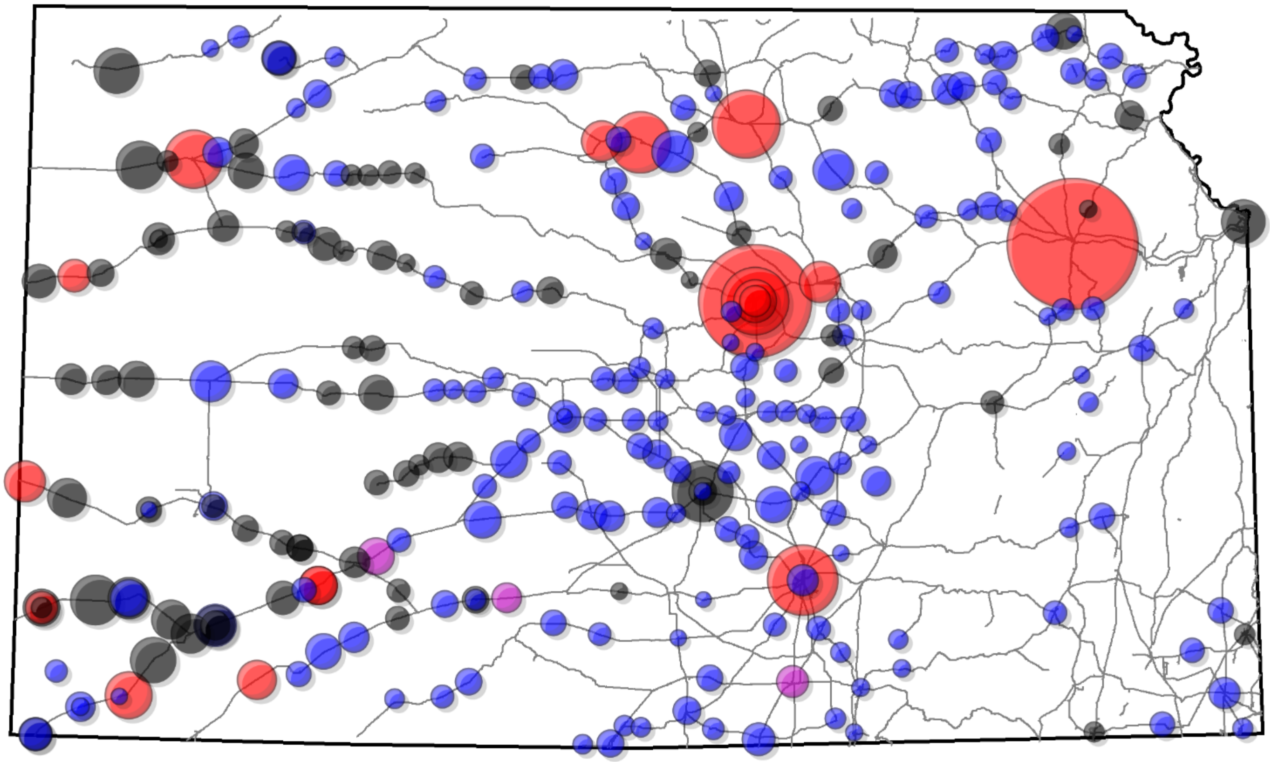

Figure 1. Location, Ownership Type, and Relative Capacity of Kansas Grain Elevators

Notes: Circles represent the location of a grain handling facility. Gray circles represent conventional, privately owned elevators. Red circles represent privately owned facilities with shuttle train-loading capabilities. Blue circles represent conventional elevators that are cooperatively owned. Purple circles represent cooperatively owned facilities with shuttle train loading capabilities. The size of each circle represents the total storage capacity at the location relative to other elevators across the two states. Black lines characterize rail lines.

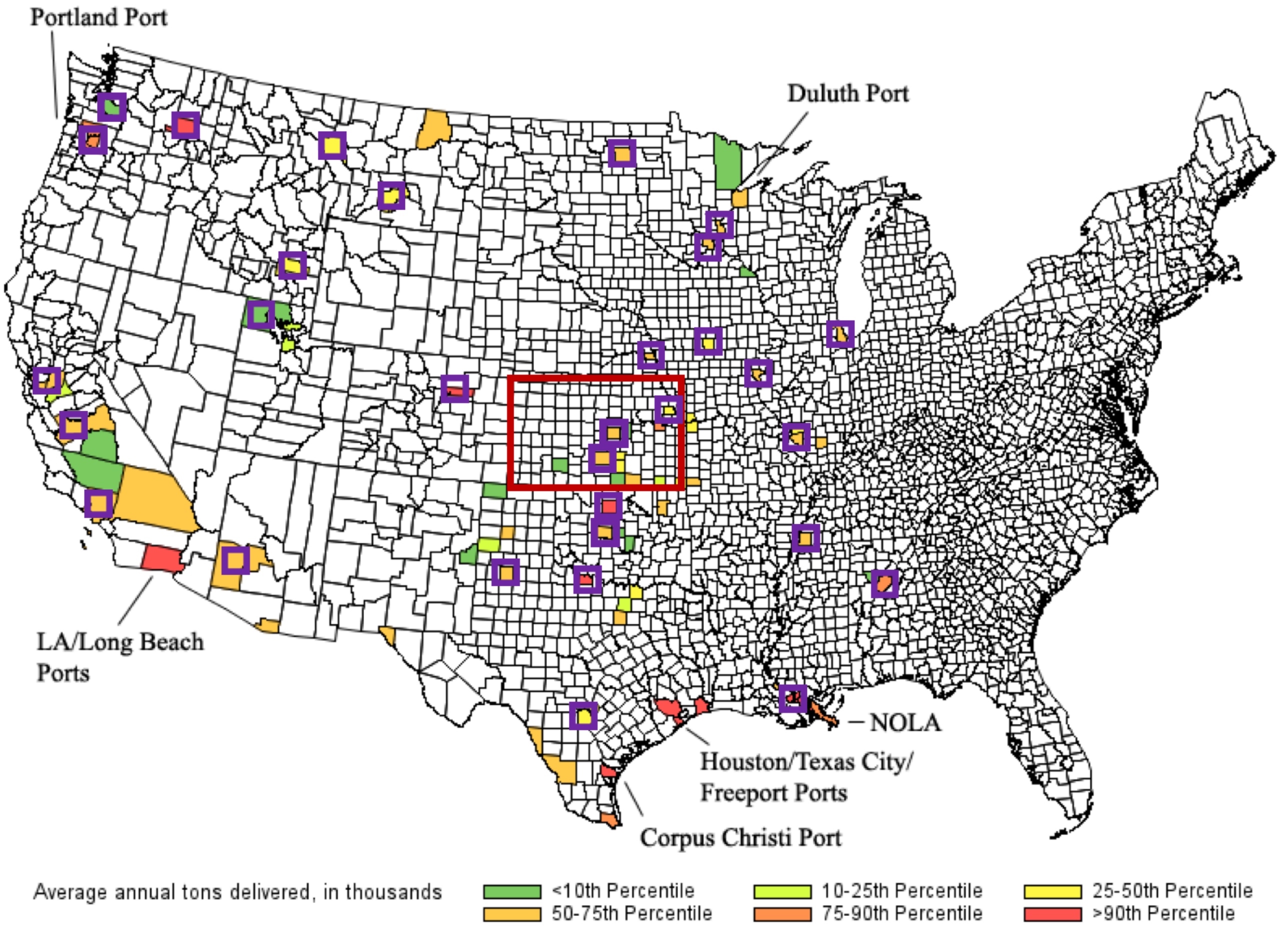

Figure 2. Delivery Locations of Kansas-Originated Wheat, by County

Notes: Major ocean export facilities are indicated on the map. Counties with large flour mills are outlined by squares. Kansas is outlined by the large rectangle.