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Structural Change in Forward Contracting Costs for Kansas Wheat

Mykel Taylor, Glynn Tonsor, and Kevin Dhuyvetter

Farmers use forward contracts to eliminate adverse price and basis movements prior to harvest. Since late 2007, the local basis for Kansas wheat has changed dramatically relative to historic levels, causing greater risk exposure for elevators offering forward contracts. The result has been an increase in the cost of forward contracting paid by farmers from $0.086 per bushel to $0.327 per bushel. The factors driving this increase in costs are basis volatility, wheat futures harvest price, the information available in the market as harvest approaches, and realized returns to the elevator from forward contracting in previous years.

Key words: basis, convergence, forward contract, Kansas wheat, risk, volatility

Introduction

Farmers looking to eliminate preharvest price risk may choose between using the futures market and forward contracting. Their choice is likely to be influenced by the relative cost of these two methods. The transaction costs of hedging are typically considered to be measured by opportunity cost of margins, liquidity costs, brokerage fees, and added paperwork. The cost of forward contracting is not as easily measured, but is typically defined as wider implied basis relative to expected or historical harvest basis.

A farmer using the futures market to hedge risk of grain price movements will eliminate downside futures price risk, but will remain exposed to basis risk. A short hedge only offers full coverage of a cash position if the expected value of the basis when the hedge is lifted equals the actual basis. Basis risk in this case implies either a wider harvest basis (net loss to the farmer) or a narrower harvest basis (net gain to the farmer).

Entering into a forward contract offered by a local elevator allows farmers to transfer both futures price risk and local basis risk. Their risk is reduced to production risk (having a crop to deliver) and any difference between the forward contract price and the price paid by crop insurance in the event of crop loss.[1] Elevators commonly deal with this transfer of risk by taking an offsetting short position in the futures market for the bushels they have agreed to purchase. Transferring risk (and the costs associated with hedging) from the farmer to the elevator does not occur without some intended charge to the farmer on the part of the grain elevator.

The volatility of basis for wheat in Kansas has dramatically increased in the past five years relative to historic levels. Figure 1 shows the average nearby basis for wheat at four Kansas locations: Topeka, Hutchinson, Beloit, and Garden City. Visual inspection of the chart suggests that

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[1] If a farmer does not have a sufficient harvest to cover contracted bushels, in most cases they will purchase grain on the open market to fill the contract or pay the elevator the difference owed between contracted bushels and current cash market. If the market price for grain is higher than the price on which their crop insurance indemnity is based, they will incur a loss of the price difference.

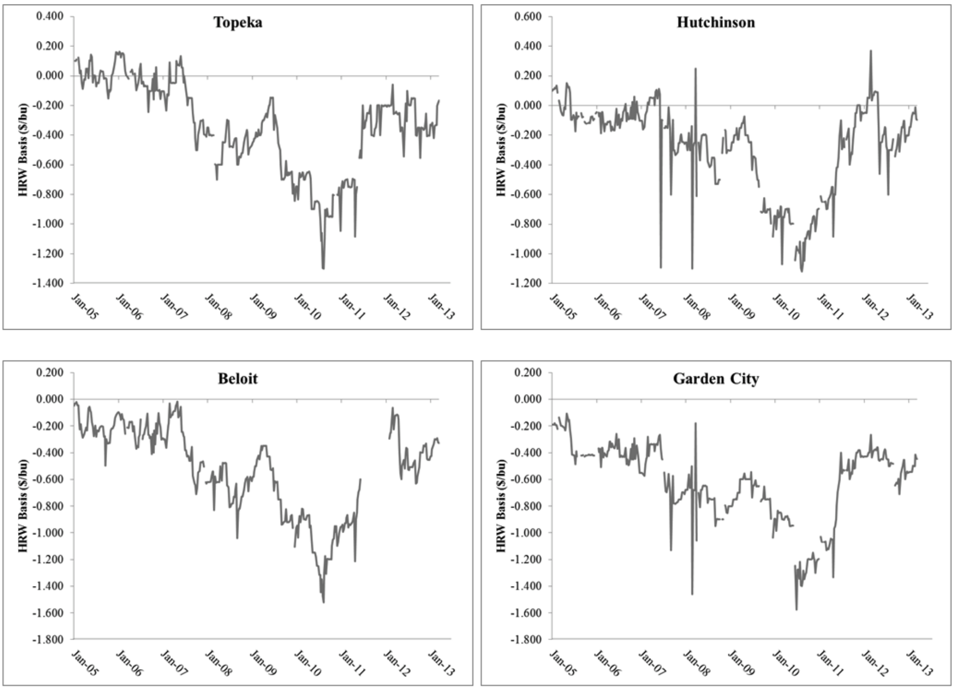

Figure 1. Nearby Wheat Basis at Four Kansas Locations (Jan. 2005–Mar. 2013)

from January 2005 to the fall of 2007, basis generally followed a seasonal pattern with an average basis across all four locations of −$0.240/bushel. The standard deviation of the basis across the four locations during this time period was $0.203/bushel. In the fall of 2007, the pattern shifted noticeably, with less well-defined seasonal patterns and an average basis of −$0.688/bushel. The standard deviation of the basis jumped to $0.362/bushel, suggesting a possible structural shift in local basis. The implications of this shift in volatility of local wheat basis include reduced accuracy of basis forecasts and increased risk from unexpected movements in the basis for hedgers.

This increase in basis volatility has implications for the level of price risk protection offered by futures and options contracts. Only forward contracts, which transfer basis risk to the elevator offering the forward contract, fully protect producers from both downside price and basis risk.[2] Previous research has estimated the costs of forward contracts for wheat in the Great Plains to range between six and nine cents a bushel (Townsend and Brorsen, 2000; Taylor, Dhuyvetter, and Kastens, 2003). These estimates use data collected prior to the fall of 2007, thereby reflecting a period of relatively stable basis levels. Given the dramatic increase in basis volatility over the past five years, an updated estimate is warranted.

This study determines the effect of increased volatility of wheat basis on the cost of forward contracting wheat. Using historical forward contract bids from eighteen Kansas elevator locations, we estimate a random effects model of the forward contracting costs charged by elevators to cover their transaction costs, basis forecasting errors, and risk exposure from hedging forward contracts. Results indicate that increases in the volatility of basis, the July wheat futures price, changes in the available market information as harvest approaches, and realized returns to the elevator from forward contracting in previous years all influence their pricing strategies for forward contracts.

This study contributes to the literature by updating previous estimates of the costs of forward contracting and formally identifying the factors that drive those costs through the use of a unique panel dataset. As discussed in Tomek and Peterson (2001) and Brorsen and Irwin (1996), the use of

[2] Throughout our assessment we omit counter-party risks faced by both the farmer and elevator.

data that directly measure the costs of forward contracting allows for more accurate evaluation by farmers of the relative costs of the various risk management strategies available.

Literature Review

Several studies have been conducted measuring the cost of wheat forward contracts for producers in the Great Plains. Taylor, Dhuyvetter, and Kastens (2003) examined the cost of forward contracting wheat across forty-eight Kansas locations from 2000 to 2003. They found that costs averaged \$0.09/bushel for preharvest contracts and ranged from a high of \$0.105/bushel in the tenth week of the year to \$0.068/bushel in the twenty-first week of the year. Their results support the hypothesis that costs would decline as harvest approaches and information uncertainty decreases. While this study focused on Kansas wheat forward contracts, the results are likely to be outdated if the recent increase in basis volatility has affected the costs paid by farmers for forward contracts on wheat.

Townsend and Brorsen (2000) conducted a study of the cost of forward contracting wheat in Oklahoma. They found that the forward contract cost ranges from \$0.06/bushel to \$0.08/bushel when contracts were executed 100 days prior to delivery. Differences in their estimate from the Taylor, Dhuyvetter, and Kastens (2003) study are likely due to the use of data from a different time period (1986 to 1998) and the use of a different elevator location (a terminal elevator in Catoosa, Oklahoma). An earlier study of the cost of forward contracting for wheat in Oklahoma found a cost of \$0.04/bushel over the time period 1975 to 1991 (Brorsen, Coombs, and Anderson, 1995). While the exact estimates vary slightly across the studies, due to differences in time periods and locations, all of the estimates fall within a range of \$0.04/bushel to \$0.105/bushel. On a 5,000 bushel contract, the expected cost of forward contracting, according to previous research, would be between \$200 and \$525 per contract.

Studies of other crops have found varying results with regard to the magnitude (or even existence) of costs associated with forward contracting. Stringer and Sanders (2006) analyzed both corn and soybean forward contract bids from 1975 through 2004 for seven Illinois locations. Their findings indicated no statistically measurable forward contract cost for corn, a result consistent with other research finding forward contract costs for corn to be a negligible \$0.01/bushel (Shi et al., 2004). Farmers did pay a premium for soybeans, with costs ranging from \$0.025/bushel to \$0.045/bushel. Their results are similar to those found by Elam and Woodworth (1989), in which the cost of forward contracting for soybeans was higher than for corn.

Theoretical Model

The cost a farmer bears when taking out a forward contract, $C_{i,j,t}$, from elevator i in year j and week t is defined as

$$C_{i,j,t} = P_{i,j}(0) - F_{i,j,t}(r_{i,j,t}), \tag{1}$$

where $P_{i,j}(0)$ is the harvest cash price offered by elevator i for wheat in crop year j; $F_{i,j,t}$ is the forward contract bid offered by elevator i in year j and week t; and $r_{i,j,t}$ is a risk premium contained within that forward contract bid that is used to cover the elevator's risk exposure from offering forward contracts. Using this specification, the cost of the forward contract cannot be calculated until after harvest at time 0, when the actual harvest basis is known.

The terms in equation (1) may be rewritten as

$$P_{i,j}(0) = B_{i,j}(0) + KC_j(0) \tag{2}$$

and

$$F_{i,j,t}(r_{i,t}) = B_{i,j,t}(r_{i,j,t}) + KC_{j,t}(0), \tag{3}$$

where $B_{i,j}(0)$ is the basis at harvest for elevator i in crop year j; $KC_j(0)$ is the value of the Kansas City Board of Trade (KCBT) July futures contract for hard red winter wheat at harvest in year j; $B_{i,j,t}(r_{i,j,t})$ is the implicit basis within the forward contract offered by elevator i in crop year j and week t; and $KC_{j,t}(0)$ is the value of the July wheat futures contract in year j during week t.[3] Substituting equations (2) and (3) into equation (1) and applying the expectations operator to determine the cost of forward contracting a farmer expected to pay yields

$$C_{i,j,t} = E_{j,t}[B_{i,j}(0)] + E_{j,t}[KC_j(0)] - B_{i,j,t}(r_{i,j,t}) - KC_{j,t}(0), \tag{4}$$

where expectations of harvest time basis and futures prices are conditional on the information set in year j and week t. Futures prices are modeled as a martingale, such that $E_{j,t}[KC_j(0)] = KC_{j,t}(0)$ (Townsend and Brorsen, 2000). Therefore, equation (4) can be rewritten as

$$C_{i,j,t} = E_{j,t}[B_{i,j}(0)] - B_{i,j,t}(r_{i,j,t}). \tag{5}$$

If we assume the risk premium $r_{i,j,t}$ is an additive component of the implicit basis within the forward contract offered, then equation (5) becomes

$$C_{i,j,t} = E_{j,t}[B_{i,j}(0)] - B_{i,j,t} + r_{i,j,t}. \tag{6}$$

Equation (6) expresses the cost a farmer who uses a forward contract expects to pay. The first two terms are the difference between the elevator's expectations at week t of the basis at harvest, $E_{j,t}[B_{i,j}(0)]$, and the implicit basis set within the forward contract at week t, $B_{i,j,t}$. The third term in equation (6), $r_{i,j,t}$, is the risk premium portion of the forward contract, which covers the costs of hedging the forward contracts and any adverse movement in the basis that may decrease the effectiveness of their hedges.

If the elevator accurately forecasts the harvest basis for their location, the differences among these terms will be zero and the cost of forward contracting the farmer expects to pay will be the risk premium, $r_{i,j,t}$. If the basis forecast from the elevator is not accurate and the harvest basis is stronger (i.e., less negative) than the implicit basis, then the cost of using the forward contract is greater than the risk premium. Conversely, if the harvest basis is weaker (i.e., more negative) than the implicit basis by an amount larger than the risk premium, then the elevator will lose money on their forward contracts and the farmer will receive a higher price for their forward contracted grain than if they had sold that grain for cash at harvest. Given the increase in basis volatility that has been observed since 2008, the probability of the difference being zero has decreased, and it possible to observe both positive and negative costs of forward contracting.

The basis forecast error has an expected value of zero. However, alternative basis forecasting approaches employed by elevators may lead to biased forecasts which, in turn, would result in observed costs of forward contracting not composed solely of the risk premium. It is not possible to directly observe the individual components of the forward contracting cost and parse out risk premiums from this potential basis forecasting error. Therefore, we proceed to the empirical analysis using the *ex post* cost of forward contracting, $C_{i,j,t}$, as the dependent variable of interest defined as

$$C_{i,j,t} = B_{i,j}(0) - B_{i,j,t}. \tag{7}$$

Empirical Model

According to equation (6), if elevators are accurately setting the implicit basis of the forward contract at time t equal to the harvest basis, then the cost of forward contracting borne by farmers

[3] In this study, we use to the July futures contract for wheat, traded on the KCBT. This contract transferred to the Chicago Board of Trade in April 2013.

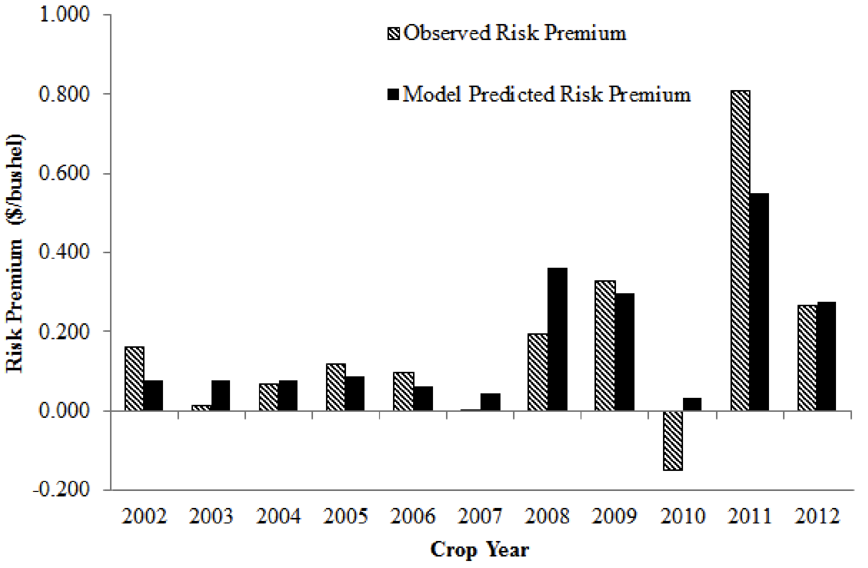

Figure 2. Comparison of Observed and Predicted Forward Contracting Costs by Year

is equal to the risk premium. The elevator's risk exposure from executing a forward contract for wheat includes basis risk, changes in the cost of transportation, and the probability of default by a farmer (Townsend and Brorsen, 2000). The cost of a forward contract is set by an elevator with these factors in mind, and it is likely that changes in the volatility of these factors affect the level of forward contract costs. Crop insurance has decreased the risk of default on forward contracts by farmers and risk from changes in transportation costs affects all the elevators, but the variability in basis may not affect all elevators in the same manner. Depending on their individual risk portfolio, management strategy, financing arrangements with lenders, and the importance of other motivations for forward contracting (e.g., securing grain flows), it is possible forward contract costs will differ across elevators.

We use the following empirical model to determine what factors contribute to the formation of forward contract costs by elevators:

$$(8) \qquad C_{i,j,t} = \beta_1 + \beta_2 BVOL_{i,j-1} + \beta_3 RET_{i,j-1} + \beta_4 HARVPj,t + \beta_5 W_t + \beta_6 W_t^2 + \mu_i + \varepsilon_{i,j,t},$$

where $BVOL_{i,j-1}$ is a measure of the volatility of the implicit basis at elevator i for forward contracts priced in the previous crop year $(j-1)$; $RET_{i,j-1}$ measures the returns to elevator i from grain priced with forward contracts in the previous crop year; $HARVP_{j,t}$ is the price in week t of the July wheat futures contract for year j; W_t and W_t^2 are linear and quadratic weekly trend variables for each week t of the crop year that forward contracts for wheat are offered; $\boldsymbol{\beta}$ is a vector of coefficients to be estimated; and $\mu_i + \varepsilon_{i,j,t}$ is a component error structure where μ_i is elevator-specific and does not vary over time and $\varepsilon_{j,t}$ is i.i.d.

The parameter $BVOL_{i,j-1}$ is included to determine the impact of increased volatility of local basis on the cost of forward contracting. It is measured as the standard deviation of the implicit basis of all forward contracts offered by an elevator during the previous crop year. The implicit basis is set to equal the elevator's expectations of harvest basis. It is adjusted from week to week as expectations of the basis at harvest are updated. If basis is highly volatile, then expectations of harvest basis will be updated often and, possibly, in larger magnitudes. Therefore, estimation of this variable will allow testing of the hypothesis that increased basis volatility positively affects the cost of forward contracts.

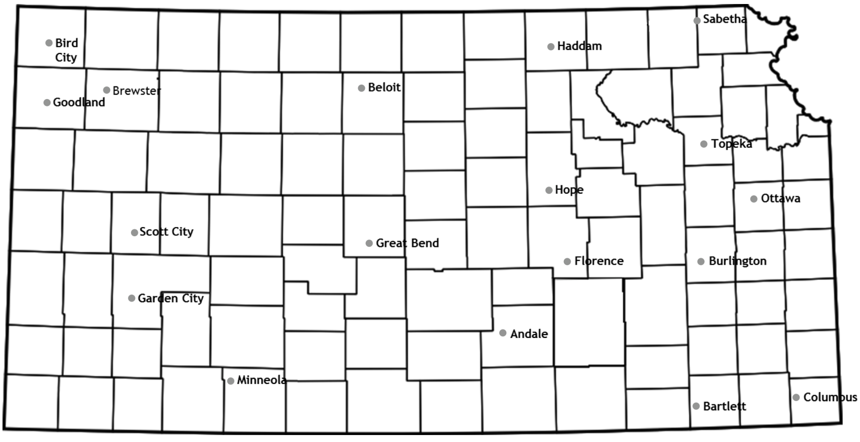

Figure 3. Grain Elevator Locations in Kansas

The variable $RET_{i,j-1}$ is a measure of the possible profit or loss the elevators would have incurred from grain contracted at various bid prices. Estimated returns to contracting are included in the model to account for the possibility that elevators may try to make up for lost revenue on forward contracts they priced incorrectly.[4] The cost of forward contracting averaged across all the elevators in the sample is displayed in figure 2. A visible pattern exists where forward contracts are priced higher than normal in the year following a negative cost year.[5] Thus we expect a negative sign on the parameter as it relates to the cost of forward contracting. The inclusion of a retrospective measure of returns is supported by findings in a study of cattle feeder behavior that found past actual returns may be more important in determining current firm decisions than expectations of future returns (Kastens and Schroeder, 1994).

In addition to these two backward-looking parameters, we include a measure of the expected harvest price of wheat, $HARVP_{j,t}$, as measured by the July wheat futures contract. Higher futures prices may correspond with larger price movements and higher amounts of cash needed to manage margin accounts by the elevator. Therefore, we expect the effect of an increase in the price of the July contract will cause the forward contracting cost to increase.

The remaining parameters in the model are linear and quadratic weekly trend variables, W_t and W_t^2, representing the week of the preharvest period when forward contracts for wheat are offered by elevators. The exact number of weeks forward contract bids are offered differs by elevator but ranges from the first to the twenty-fifth week of the year. Previous research suggests that the costs of forward contracts for wheat in Kansas declines linearly as harvest approaches (Taylor, Dhuyvetter, and Kastens, 2003). The likely reason for a decline in costs as harvest approaches is a corresponding increase in information on the quantity and quality of the local wheat harvest. With more information, elevators have a decreased risk of inaccuracy in their harvest basis forecasts. The expected sign of the linear weekly trend variable is negative, while the sign of the quadratic effect is expected to be positive or zero.

Data

Data used in this analysis were collected from eighteen elevators located across the state of Kansas. The locations were selected based on two criteria: geographic diversity and consistency of availability of forward contract bids. Figure 3 presents the locations from which forward contract

[4] In some cases, the elevator may have passed on the profit or loss from the forward contract if they simultaneously sold the grain further down the supply chain. For purposes of this analysis, we refer to it as the elevator's profit or loss.

[5] A negative cost meaning farmers receive more for their forward contracted grain than they would have if they had waited to sell at harvest.

Table 1. Summary Statistics of Model Parameters

Variable	Description	Mean	Std Dev	Min	Max	N
Full Period: 2002–2012						
C	Cost of forward contract ($/bu)	0.188	0.285	−0.505	1.421	2,111
$BVOL$	Standard deviation of previous year's implicit basis level ($/bu)	0.065	0.072	0.001	0.631	
RET	Average of previous year's returns to the elevator on forward contracts ($/bu)	0.149	0.239	−0.303	0.943	
$HARVP$	Price of July wheat futures contract ($/bu)	5.276	2.035	2.933	9.221	
W	Weekly trend variable	14.442	5.836	1	25	
W^2	Weekly trend variable squared	242.625	169.929	1	625	
Prestructural Break Period: 2002–2007						
C		0.087	0.086	−0.187	0.436	1,096
$BVOL$		0.031	0.022	0.003	0.089	
RET		0.102	0.067	−0.042	0.260	
$HARVP$		3.898	1.014	2.933	5.885	
W		14.289	5.940	1	25	
W^2		239.437	167.066	1	625	
Poststructural Break Period: 2008–2012						
C		0.324	0.384	−0.505	1.421	1,015
$BVOL$		0.102	0.088	0.001	0.631	
RET		0.202	0.334	−0.303	0.943	
$HARVP$		7.113	1.545	4.823	9.221	
W		14.646	5.691	2	25	
W^2		246.871	173.660	4	625	

bids were collected. The bids were collected each Wednesday from 2001 to 2012 during the months of January through June.[6] The use of lagged variables for basis volatility and profitability of forward contracts for the elevators causes observations from 2001 to be dropped from the regression dataset. The forward contract bids used in this study are offered (but not necessarily accepted) bids. We are unable to observe the actual quantities of grain contracted at different bid levels.[7]

The exact numbers of weeks forward bids are offered prior to the harvest period varies from year to year. We use the fourth week of June as the harvest week, which—in a typical crop year—will coincide with the majority of Kansas wheat having been harvested. The harvest week selection was guided by previous studies of Kansas wheat basis (Taylor, Dhuyvetter, and Kastens, 2006; Kastens and Dhuyvetter, 1999).

Summary statistics of the model variables are shown in table 1. The number of elevators in the sample is eighteen and the observations per elevator range from 69 to 172, with an average of 117 observations. The entire sample comprises 2,111 elevator- and time-specific observations.

Model Selection and Estimation

Structural Change Tests

With the discernible changes in basis levels and volatility noted in figure 1, a test for structural change in the forward contract pricing strategies of elevators is justified. The model specification

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[6] If a Wednesday bid was not available due to a holiday, the Thursday bid was collected.
[7] This is a data limitation found elsewhere in the literature (Townsend and Brorsen, 2000; Brorsen, Coombs, and Anderson, 1995).

given in equation (7) was estimated for a pooled dataset and separately for observations between 2002 and 2007 as well as those between 2008 and 2012 for the presumed pre- and poststructural break periods, respectively. Results of a Chow test for the existence of a structural break indicate the model parameters are jointly statistically different when estimated separately for the two periods.

If the underlying drivers of the forward contract pricing strategy are not the same in the pre- and poststructural break periods, the model specification may not be identical for the two periods. Negative returns to elevators from forward contracting are not observed in the dataset until 2011 and the standard deviation of the implied basis was nearly three times higher in the post-structural break period. These differences between the periods are likely to affect which factors are relevant to elevators' pricing strategies.

Three model specifications were estimated for the pre- and poststructural break periods. The first model is a subset of the parameters in equation (8) and is specified as follows:

$$C_{i,j,t} = \beta_1 + \beta_2 W_t + \beta_3 W_t^2 + \mu_i + \varepsilon_{i,j,t}, \tag{9}$$

where the cost of forward contracting is a function of linear and quadratic weekly trend variables to proxy for the amount of information that is presumed to be available as the weeks prior to harvest decline. The second model is specified similarly as

$$C_{i,j,t} = \beta_1 + \beta_2 HARVP_{j,t} + \beta_3 W_t + \beta_4 W_t^2 + \mu_i + \varepsilon_{i,j,t} \tag{10}$$

and includes both the weekly trend variables and the week t July wheat futures price.

Models (8), (9), and (10) were estimated for each period using Maximum Likelihood to subsequently calculate Akaike information criteria (AIC) values. These values are presented in table 2. The preferred model for the prestructural break period, based on the AIC, is model (10), in which the forward contract cost is a function of the July wheat futures price and weekly trend variables. Model (8) is the preferred model for the poststructural break period.

Unobservable Heterogeneity

The primary benefit of working with a panel dataset is the ability to account for both cross-sectional and time-series effects on the dependent variable. One of the challenges, however, is the impact of unobservable (to the researcher) characteristics of the cross-sectional units (i.e., individual grain elevators) on the accuracy of coefficient estimates and subsequent conclusions drawn from the analysis. To address unobservable heterogeneity, either a fixed effects (FE) or random effects (RE) panel data model can be employed. The choice between the FE and RE models is a tradeoff between bias and variance. The RE model can introduce bias to the coefficient estimates, but this model also tends to have a smaller variance as compared to the FE model. If it is determined that the bias from the RE model is negligible, then its improved variance makes it a preferred modeling option for this analysis.

The RE model requires that the individual units (i.e., elevators) be uncorrelated with the independent variables. This means that the unobserved characteristics of the elevators such as management style, risk management strategies, and/or business structures should not be correlated with the X matrix. In our data, it is possible that the elevator units are correlated with the regressors $BVOL$ and RET as they may be determined by risk management strategies that are likely to differ across companies. The correlation between the preferred model regressors and the individual elevators is listed in table 3. The correlations are 0.0741 and −0.2608 for the pre- and poststructural break periods, respectively. These are both relatively low levels of correlation, implying that the assumption of no correlation between the regressors and individual elevators required for the RE model is not inappropriate.

The variance of the FE and RE models for both the pre- and poststructural break periods is measured by the root mean squared error (RMSE) and is listed in table 3. The difference between

Table 2. Tests for Forward Contracting Cost Model Specification

	Model Specification Tests					
	Prestructural Break Period: 2002–2007			Poststructural Break Period: 2008–2012		
Parameter	Equation (7)	Equation (8)	Equation (9)	Equation (7)	Equation (8)	Equation (9)
BVOL	−0.682***			2.347***		
	(0.131)			(0.104)		
RET	0.041			−0.614***		
	(0.039)			(0.030)		
HARVP	−0.011***		−0.022***	0.031***		0.081***
	(0.002)		(0.002)	(0.006)		(0.008)
W	0.003	0.003	−0.001	0.042***	0.030***	0.042***
	(0.002)	(0.002)	(0.002)	(0.008)	(0.011)	(0.010)
W^2	−0.0001***	−0.0002***	0.0000***	−0.0012***	−0.0010***	−0.0012***
	(0.0001)	(0.0001)	(0.0001)	(0.0003)	(0.0004)	(0.0003)
Intercept	0.123***	0.086***	0.199***	−0.333***	0.118	−0.588***
	(0.022)	(0.014)	(0.018)	(0.082)	(0.077)	(0.099)
Log Likelihood	1,323.35	1,508.87	1,554.34	−128.86	−460.13	−406.65
AIC	−2,634.70	−3,011.73	−3,100.68	269.71	926.25	821.30
			(Preferred Model)	(Preferred Model)		

Notes: Models estimated using Random Effects-Maximum Likelihood estimation. Errors reported in parentheses are robust standard errors, clustered by elevator location. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

the FE and RE models is very slight. Work by Clark and Linzer (2014), suggests that if the number of observations per individual unit is at least twenty, the remaining bias in the RE estimates, as well as the improvement in variance, is negligible. This is the case for our data, which has eighteen units (elevators) and an average of seventy-five observations per unit in the prestructural break period and an average of fifty-six observations in the poststructural break period.

The estimated coefficients from both the FE and RE models, for both time periods, are given in table 3. The similarity of the estimated coefficients suggests bias is low, while the change in the RMSE is also very small. Given the negligible difference between the FE and RE models, as far as statistical performance is concerned, we proceed with the RE model as a matter of preference.

Results

Models for the pre- and poststructural break periods were estimated using a random effects Generalized Least Squares (GLS) method. The model is estimated using an error structure comprised of both elevator-specific and time-specific (year and week) components. Estimated coefficients from model estimation are presented in table 3. Observed and predicted costs from the models for each year of the sample are presented in figure 2.

Prestructural Break Period

The prestructural break model of equation (10) fits the data with an R^2 of 0.102 overall.[8] This compares to an overall model fit of R^2 equal to 0.394 for the poststructural break model. The lower R^2 of the prestructural break model is likely driven by the comparatively low amount of variation in

[8] The R^2 for model fit within and between locations is also given in table 3. The within R^2 represents the fit of the model with respect to the time series aspects of the data, while the between R^2 is a measure of model fit corresponding to the cross-sectional nature of the data.

Table 3. Cost of Forward Contracting Model Results for Preferred Models

	Prestructural Break Period: 2002–2007		Poststructural Break Period: 2008–2012	
Parameter	RE-GLS Model	FE-OLS Model	RE-GLS Model	FE-OLS Model
$BVOL$			2.241^{***}	2.366^{***}
			(0.4905)	(0.5628)
RET			-0.548^{***}	-0.625^{***}
			(0.0672)	(0.0705)
$HARVP$	-0.022^{***}	-0.022^{***}	0.038^{***}	0.030^{***}
	(0.0076)	(0.0078)	(0.0070)	(0.0091)
W	−0.0013	−0.0014	0.0405	0.043^{***}
	(0.0030)	(0.0030)	(0.0136)	(0.0137)
W^2	−0.00003	−0.00003	-0.001^{***}	-0.001^{***}
	(0.0001)	(0.0001)	(0.0004)	(0.0004)
$Intercept$	0.199^{***}	0.199^{***}	-0.370^{***}	-0.333^{***}
	(0.0375)	(0.0392)	(0.1048)	(0.0953)
R^2				
Overall	0.1024	0.1022	0.3944	0.3891
Within	0.0878	0.0878	0.4991	0.5011
Between	0.2128	0.2123	0.5713	0.5944
RMSE	0.0754	0.0749	0.2827	0.2664
Correlation(u_i, Xb)		0.0741		−0.2608
Number of Obs:	1,352		1,015	
Avg. Obs per Group:	75		56	
Min. Obs per Group:	24		41	
Max. Obs per Group:	120		79	

Notes: Errors reported in parentheses are robust standard errors, clustered by elevator location. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

the dependent variable for the period between 2002 and 2007. The relative lack of change in forward contracting costs makes model specification more challenging and arguably less important. This would explain the use of nonparametric measures of forward contract costs in studies predating the structural break (Townsend and Brorsen, 2000; Taylor, Dhuyvetter, and Kastens, 2003).

Poststructural Break Period

Results from model (8) estimated using observations from the poststructural break period suggest a better fit and statistically measurable impacts from backward-looking factors. An increase in basis variability, as measured by the standard deviation of the implicit basis of last year's forward contracts ($BVOL_{i,j-1}$), increases the cost of forward contracts. Multiplying the coefficient of $BVOL_{i,j-1}$ by its average value between 2008 and 2012 provides an estimated increase in the cost of $0.228/bushel attributable to the increased basis uncertainty elevators face. Stated differently, if the harvest basis forecasts are continually changing, which reflects uncertainty in the market, elevators will increase what they charge farmers to forward contract in exchange for accepting a higher level of basis risk.

The coefficient for the impact of realized profits (losses) to the elevator from forward contracted grain in the previous year ($REG_{i,j-1}$) has a negative impact on the cost of forward contracting. The coefficient indicates that for every $0.10/bushel an elevator is estimated to have lost on their forward contracts in the previous year, they attempt to recover some of these losses by increasing what they charge farmers in the following year by $0.05/bushel. The largest loss incurred by an elevator in the sample was −$0.30/bushel and happened in 2011. That elevator is projected to

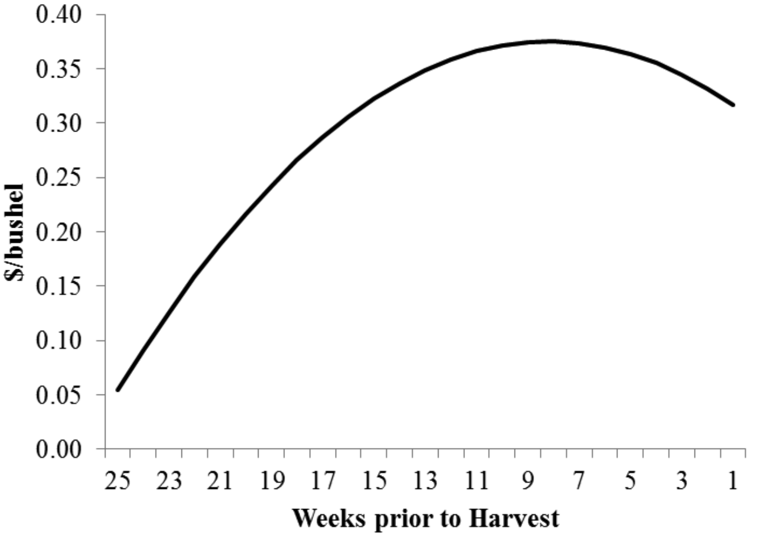

Figure 4. Impact on Cost of Forward Contracting Due to Time Remaining Prior to Wheat Harvest

increase the cost of forward contracting in 2012, due to a loss on forward contracts in the previous crop year, by $0.15/bushel.

The estimated coefficient on the price of the July wheat futures contract ($HARVP_{j,t}$) is positive and statistically significant. A $1.00/bushel increase in the futures price causes a $0.04/bushel increase in the cost of forward contracting. As compared to the variables measuring the previous years' implicit basis volatility and returns from forward contracts, the July wheat futures price is a forward looking variable and appears to play an important role in the determination of forward contract prices. A possible reason for this would be that higher futures prices may correspond with larger amounts of cash needed to manage margin accounts by the elevator. The poststructural break period was not only marked by higher basis volatility, but also higher cash and futures prices for wheat. The exact nature of the relationship between higher price levels and volatility is unknown, but does appear to filter down to elevator decisions on pricing risk.

Linear and quadratic weekly trend variables were included to determine whether there is a systematic impact on forward contracting costs due to the amount of time left prior to wheat harvest. The coefficients of the weekly trend variables are both statistically different from zero with a positive sign on the linear trend and a negative sign on the quadratic trend variable. Figure 4 presents the impact on forward contracting costs as harvest approaches. There is an increase in costs as time expires from twenty-fuve to eight weeks prior to harvest. However, the chart shows a turning point in the overall effect with eight weeks remaining and a decline in costs from week seven until harvest. The hypothesis that forward contracting costs would decrease as harvest approaches due to greater information on the quantity and quality of the wheat crop is supported, but only with approximately seven weeks remaining before harvest.

The estimated cost of forward contracting, obtained by using the respective model coefficients and mean values of the variables for the two periods analyzed, are $0.086/bushel for the prestructural break and $0.327/bushel for the poststructural break period. A per bushel forward contracting cost of $0.086 for wheat in the prestructural break period is within the range of estimates by previous studies ($0.04 to $0.105/bushel), which were all conducted prior to 2007. As hypothesized, however, the increase in observed volatility of the basis since 2007 has increased the cost to farmers for forward contracting wheat nearly four-fold.

The cost of a 5,000 bushel forward contract is between \$200 and \$525, using the estimates from previous studies. The estimated cost during the prestructural change period from the models presented here is \$430 per 5,000 bushel contract. That cost increases to \$0.327/ bushel or \$1,635 per contract in the poststructural change period.

To demonstrate the impact of this increase in the costs to farmers, consider a 3,000-acre farm in south-central Kansas. The typical rotation for nonirrigated cropland in this part of the state would be wheat alternated with another crop (corn, grain sorghum, or soybeans). The average winter wheat yield in south central Kansas was 42.2 bushels per acre in 2012. If this farm were to forward contract one-third of its expected wheat production, the total amount under contract would be 21,100 bushels. At a cost of \$0.327/bushel, the total cost this farm could expect to pay would be \$6,900 to manage price risk using forward contracts.

During the time period that basis volatility was increasing, so too was the price of wheat. The average cash price at harvest between 2002 and 2007 was \$3.64/bushel, while the average harvest price was \$6.63/bushel between 2008 and 2012. Although farmers received higher prices for their wheat, the cost of forward contracting measured as a percentage of the average harvest price increased from 2.38% to 4.94% in the two periods analyzed.

Conclusion

Basis is historically more stable than both cash and futures prices, which allows farmers and elevators to hedge the price of wheat with little risk of adverse basis movements. Starting in late 2007, a structural shift in the Kansas wheat basis occurred with implications for wheat hedging and forward contracting. The results of this study indicate the shift in basis risk exposure increased the costs of forward contracts for both farmers and grain elevators. The cost incurred by farmers from forward contracting manifests as a wider implicit basis bid. This cost increased from an average of \$0.086/bushel between 2002 and 2007 to an average of \$0.327/bushel between 2008 and 2012.

Several factors are shown to impact the average cost of forward contracting with elevators. When forecast errors cause realized returns on forward contracts to be negative, the cost of forward contracting increases the following crop year. Greater uncertainty about harvest prices—caused by both basis volatility and time remaining to harvest—increase costs, as does a higher price level of the July wheat futures contract.

The market conditions that have increased basis risk, and the corresponding costs of forward contracts, were caused by a structural shift, exact nature of which is uncertain. One source of tremendous volatility in the basis during the poststructural change period was the lack of basis convergence across the state of Kansas in the summer of 2011. Terms specified in the KCBT wheat contract resulted in storage costs of warehouse receipts being lower than the market price of storage (Irwin et al., 2011; O'Brien and Barnaby, 2010). The contract was altered in September 2011, helping to correct some of the basis volatility observed. To the extent that this correction prevents similar events in the future, basis volatility and the costs paid by farmers to forward contract wheat may begin to return to near historic levels in coming years. Ultimately this requires ongoing reassessment of both forward contracting costs and the underlying drivers.

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