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Determination of Factors Driving Risk Premiums in Forward Contracts for Kansas Wheat

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Forward contracts are a risk management tool used by farmers to eliminate adverse price and basis movements prior to harvest. Elevators offering these forward contracts will offset their risk exposure by hedging their position in the futures market. However, the elevators are still exposed to basis risk and will, in turn, charge a premium to the farmers as compensation. Since 2007, basis volatility for hard red wheat in Kansas has increased, causing greater risk exposure for elevators offering forward contracts. The result has been an increase in average risk premiums of $0.06 to $0.10 per bushel. The primary factors driving this increase in the risk premium are basis and futures volatility, basis forecasting errors by elevators, and elevator- and time-specific fixed effects. The impact of this study is an increase in information for farmers on the relative costs of decreasing their basis risk exposure in a more volatile market.

Keywords: basis, forward contracts, risk premiums, Kansas wheat

Introduction

A grain farmer's choice of strategy for managing price risk must consider several sources of risk. The most obvious is downside risk of cash prices, which may occur between the time of planting and harvest. Farmers looking to eliminate pre-harvest price risk may choose between using the futures market to hedge a harvest cash price 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 margins, liquidity costs, brokerage fees, and paperwork. The cost of forward contracting is not as easily measured, but is considered to manifest as a wider implied basis relative to expected or historical harvest basis.

A farmer using the futures market to hedge price risk of their grain production 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 difference between the local cash price and the futures price at the time a hedge is placed does not change when the hedge is lifted. 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).

Purchasing a forward contract offered by the 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 deal with this transfer of risk by taking a long position in the futures market for the bushels they have agreed to purchase. Transferring risk

[1] If a farmer does not have a sufficient harvest to cover contracted bushels, in most cases, they purchase grain on the open market to fill the contract. 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.

(and the costs associated with hedging) from the farmer to the elevator does not occur without some 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 in the period January 2005 to the fall of 2007, basis generally followed a seasonal pattern with an average basis across all four locations of -$0.24/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 shifts noticeably, with less well-defined seasonal patterns and an average basis of -$0.688/bushel. The standard deviation of the basis jumps to $0.362/bushel, suggesting a 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 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. Previous research has estimated the risk premium on 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 of forward contracting costs 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.

The objective of this study is to determine if an increase in volatility of the wheat basis has affected the costs of forward contracting faced by grain farmers. Using historical forward contract bids from 18 Kansas elevator locations, we estimate a fixed effects model of the risk premium charged by elevators to cover their costs and risk exposure from forward contracts. Results indicate that increases in the volatility of basis, futures prices, 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 risk premiums through the use of a unique historical dataset. As discussed in Tomek and Peterson (2001) and Brorsen and Irwin (1996), the use of 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 on the cost of forward contracts for wheat by producers in the Great Plains. Taylor, Dhuyvetter, and Kastens (2003) examined the cost of forward contracting wheat across 48 Kansas locations during the time period 2000 to 2003. They found that the cost averaged $0.09/bushel for pre-harvest contracts and ranged from a high of $0.105/bushel in the 10th week of the year to $0.068/bushel in the 21st week of the year. Their results supported the hypothesis that the risk premium 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 increase in basis volatility has affected risk premiums for forward contracts.

Townsend and Brorsen (2000) conducted a study of the cost of forward contracting wheat in Oklahoma. They found that the cost of forward contracting ranges from $0.06/bushel to $0.08/bushel when contracts were executed 100 days prior to delivery. Differences in their cost estimates from the Taylor, Dhuyvetter, and Kastens study are likely due to the use data from a different time period (1986 to 1998) and the use of a single elevator location (Catoosa, Oklahoma). An earlier study of the cost of forward contracting for wheat in Oklahoma found a premium of $0.04/bushel over the time period 1975 to 1991 (Brorsen, Coombs, and Anderson 1995).

The exact estimates vary slightly across the studies, due to differences in time periods and locations. But all 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.

Theoretical Model

The cost a farmer bears when using a forward contract, C, is defined as follows

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

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 price offered by elevator i in year j at week t; and $r_{i,j,t}$ is the risk premium contained within the forward contract bid offered by elevator i in year j at week t. Using this specification, the cost of using the forward contract can only be calculated after harvest at time 0, when the actual harvest basis is known.

The terms in equation (1) may be rewritten as

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

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

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 (KCBOT) 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 KCBOT futures contract in year j during week t.[2] Substituting equations (2) and (3) into equation (1) and applying the expectations operator yields

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

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

where expectations are conditional on the information set at year j and week t. Futures prices are modeled as a martingale, such that $E_{j,t}\left[KC_j(0)\right] = KC_{j,t}(0)$. Therefore, equation (4) can be rewritten as

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

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

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

Equation (6) expresses the cost incurred by a farmer who uses a forward contract, $C_{i,j,t}$, to be comprised of two components. The first component is the difference between the elevator's expectations at week t of the basis at harvest, $E_{j,t}\left[B_{i,j}(0)\right]$, and the implicit basis they set within the forward contract, $B_{i,j,t}$. If the elevator accurately forecasts the harvest basis for their location, the difference between these terms will be zero. The second component in equation (6), $r_{i,j,t}$, is the risk premium portion of the forward contract.

If grain elevators are accurate forecasters of harvest basis, then the cost incurred by farmers will be exclusively the risk premium. However, if the basis error takes on a positive value and is larger in magnitude than the risk premium, elevators will lose money on their forward contracts and farmers will have received a payment rather than paid a premium. It is not possible to directly observe these individual components of the forward contracting cost measure and determine to what extent each may be driving observed costs.

Empirical Model

According to equation (6), if elevators are 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 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 risk premium is set by an elevator with these factors in mind and it is likely that changes in the volatility of these costs affect the level of risk premiums. 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, and the importance of other motivations for forward contracting (e.g. securing grain flows), it is possible the risk premiums will differ across elevators.

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

$$(7) \qquad r_{i,j,t} = \beta_1 + \beta_2 BV_{i,j-1} + \beta_3 R_{i,j-1} + \beta_4 IV_{j,t} + \beta_5 SB + \sum_{t=1}^{T} \beta_t W_t + \mu_i + \varepsilon_{i,j,t}$$

where $BV_{i,j-1}$ is the volatility of the implicit basis for forward contracts priced in the previous year; $R_{i,j-1}$is a binary variable indicating if the elevator made positive returns on the forward bids they priced in the previous crop year; $IV_{j,t}$ is the implied volatility in week t of the July wheat futures contract for year j; SB is a binary variable representing a structural break in the volatility of wheat basis; W_t are binary variables for each week 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 doesn't vary over time and $\varepsilon_{j,t}$ is iid. Equation (7) is estimated as a fixed effects model, accounting for both elevator- and time-specific factors on the risk premium.

The parameter $BV_{i,j-1}$ is included to determine the impact of increased volatility of local basis on the risk premium. It is measured as the standard deviation of the implicit basis of all forward contracts from the previous crop year. The implicit basis is set to equal the elevator's expectations of harvest basis. It will be adjusted from week to week as expectations of the basis at harvest are updated. We expect that if basis is highly volatile, then expectations of 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 affecting risk premiums for forward contracts.

A binary variable equal to one (zero) if an elevator made positive (negative) returns from the forward contracts priced in the previous year, $R_{i,j-1}$, is 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. Figure 2 shows average costs of forward contracting across elevators, but a visible pattern exists where forward contracts are priced higher than normal in the year following a negative cost year.[3] Thus we expect a negative sign on the parameter as it relates to the risk premium. A previous study of cattle feeder behavior showed that past actual returns may be more important in determining current firm decisions than expectations of returns (Kastens and Schroeder 1994).

In addition to these two backward-looking parameters, we include a measure of the volatility in the futures market, $IV_{j,t}$, which is the average implied volatility of calls and puts in a given week of the July hard red wheat contract on the KCBOT. If the July contract is highly volatile, it may increase the risk to the elevator from hedges taken on forward contracted grain. Therefore, we expect the effect of an increase in the implied volatility of the July contract will cause the risk premium to increase.

The inclusion of the structural break parameter, SB, is motivated by the apparent shift in the volatility of the wheat basis in Kansas (see figure 1). The parameter is specified as a binary variable equal to one if the observation occurred after the 2007 crop year and zero otherwise. Chow tests of this structural break were conducted on reduced-form model specifications and the hypothesis that all the coefficients are the same before and after the break was rejected. This led

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

us to specify the model with a parameter representing the average impact from the break on risk premiums set by elevators.

The remaining parameters in the model are binary variables representing the week of the pre-harvest 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 1st to the 25th week of the year. Previous research suggests that the risk premium on a forward contract would decline as harvest approaches (Taylor, Dhuyvetter, and Kastens 2003). We test for the existence of this trend across elevators by including the weekly binary variables.

Data

The data used in this analysis were collected from 18 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 bids were collected. The bids were collected each Wednesday from 2001 to 2012 during the months of January through June.[4] 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.[5]

The exact numbers of weeks forward bids are offered prior to the harvest period varies from year to year. We use the 4th 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). A historical series of the implied volatility for the KCBOT July wheat contract was obtained from Bloomberg. For most weeks, the implied volatility for both puts and calls were available, so we use an average of these two measures.[6]

Summary statistics of the model parameters are shown in table 1. The number of elevators in the sample is 18 and the observations per elevator range from 69 to 172, with an average of approximately 117 observations. The entire sample is comprised of 2,111 elevator- and time-specific observations.

Results

The estimated coefficients of the model described in equation (7) are presented in table 2. The model has an R^2 of 0.417 and an F test of the component error rejects the null hypothesis of the elevator-specific errors being equal to zero. This suggests that the risk premium varies across

[4] If a Wednesday bid was not available due to a holiday, the Thursday bid was collected.
[5] This is a data limitation found elsewhere in the literature (Townsend and Brorsen 2000; Brorsen, Coombs, and Anderson 1995)
[6] For weeks where the implied volatility of only puts or calls were available, that is the value used rather than an average.

elevators in a systematic manner. It also points to the need for further research to identify how the elevators differ in setting their risk premiums.

The impact of an increase in basis variability, as measured by the standard deviation of the implicit basis of last year's forward contracts, increases the risk premium for the contracts. The results support our hypothesis that higher basis volatility will translate into higher risk premiums for farmers. In the time period 2002 through 2007, the average of the standard deviation of the implicit basis was $0.031/bushel for the elevators in the sample. In the period following from 2008 to 2012, the average of the standard deviation increased to $0.101/bu. This increase multiplied by the coefficient of $BV_{i,j-1}$ results in an increase of $0.109/bushel in the risk premium due to the increase in basis volatility.

Similarly, the coefficient on the structural break parameter is also positive and statistically significant. This variable was based on a discernible increase in basis volatility in the fall of 2007 and indicates that for the period following the 2007 crop year, risk premiums increased by $0.052/bu. Taken together, the model suggests an average increase in risk premiums from basis volatility of $0.162/bu. Compared to estimates of risk premiums from previous studies that ranged from $0.06 to $0.105/bushel, the costs incurred by farmers to forward contract grain in the form of risk premiums has increased significantly. Using an average of the previously estimated premiums at $0.0825/bushel and assuming a 5,000 bushel contract, the cost of forward contracting prior to 2008 was approximately $412.50 per contract. Since that time the estimated cost has increased by $810 or 196%.

The other variability measure in the model is a forward-looking measure of the implied volatility of the July wheat contract. The coefficient on this parameter is positive and significant, providing further evidence that volatility, both experienced last year and expected in the current year, affects how elevators set risk premiums. The average implied volatility for the July wheat contract for the 2002 to 2007 period was 26.53 and it increased to an average of 37.40 for the 2008 to 2012 period. This increase in implied volatility is estimated to have caused a $0.034/bushel increase in the risk premium, holding all other parameters in the model constant.

The impact of realized profits (losses) to the elevator from forward contracts in the previous year has a negative impact on risk premiums. The coefficient on the binary variable indicates that if the elevator lost money on their forward contracts last year, they will attempt to recover some of these losses by increasing the risk premium in the following year by $0.268/bushel. All of the weekly binary variables are statistically insignificant at a 10% value.

Further Model Specification

The model, as specified in equation (7), explicitly accounts for a structural break, after the 2007 crop year, in the pricing of forward contracts. Evidence provided by the estimated coefficients support the hypothesis that different pricing regimes existed in the time periods before and after the structural break. The inclusion of a structural break parameter precluded estimated of a model specification with binary variables for each year of the analysis period, due to collinearity. The advantage of estimating a model with annual fixed effects is that any changes in factors affecting basis or risk exposure from forward contracts that occurred over the time period in question would be better controlled for in the model. Examples would include a new ethanol plant coming online or the lack of basis convergence that occurred in 2010 across the state of Kansas. These factors may affect all elevator locations, or only a subset. Regardless, it is important to control for annual time effects because the fixed component of the error term is meant to account for unobservable factors at an elevator location that do not vary across time. These considerations warrant further investigation of alternative model specifications.

We begin with estimation of a model where the structural break parameter is omitted and replaced with annual binary variables, $\sum_{j=1}^{J} \beta_j Y_j$. The remainder of the model specification is identical to that presented in equation (7). Rather than pooling the data across the full time period, the new model is estimated using the early period (2002-2007) to reflect the pre-structural break pricing regime and the later period (2008-2012) to reflect the post-structural break regime. This approach is part of a model search process where the fit of the model pre- and post-structural break is considered. The results of the fixed-effects estimation procedure are presented in table 3 for the early period and table 4 for the later period.

As compared to the model estimated across the entire time period, the impact of basis volatility is negative and statistically significant for the post-structural break period and not statistically significant in the pre-structural break period. This suggests that basis volatility in the previous crop year was not an important determinant in pricing forward contracts prior to the large increase in volatility observed after 2007. How profitable an elevator was in the previous year with regard to forward contracts, however, has been a statistically significant determinant of forward contract pricing across the entire period. In both periods, losing money on forward contracts in the previous year will cause the risk premium to increase. Finally, the impact of a forward-looking parameter, measured as the implied volatility of the harvest futures contract, is not statistically different from zero in either period. This is a different result from the model investigating structural change, where implied volatility was an important determinant of the risk premium.

Estimation of a model using the structural break parameter was necessary for investigating the nature of the data. However, due to collinearity issues, it cannot be included in a model of the entire time period that also contains annual fixed effects. Therefore, future work will focus on pooling the data into a single model of the entire time period to facilitate comparisons across the pre- and post-structural break periods, while also controlling for annual fixed effects.

Summary

The average risk premium for basis paid by wheat farmers to pre-price grain over the period 2008 to 2012 appears to have shifted significantly to a higher level. In this study we model risk premiums as a function of basis and futures volatility, forecast errors by elevators that cause negative returns on forward contracts, and elevator- and time-specific fixed effects. The results suggest that increased basis volatility, both realized and expected, has increased the cost to farmers when they forward contract their grain.

The significance of the recent shift in volatility of the basis becomes clear as farmers make choices between price risk management strategies. Use the futures market to hedge cash positions and risk large movements in basis, or use forward contracts to eliminate both futures price and cash basis risk? The tradeoff may not be much different than it was prior to this structural change. That is because, as the risk of basis changes has increased, so too has the cost of eliminating that risk for farmers. Other factors specific to the farmer need to be considered when choosing their marketing strategy, such as cash flow and interest expenses related to the margin account and the use of crop insurance to cover the bushels that have been forward contracted. Regardless of their decision, having a fuller understanding of the average costs they can expect to incur from forward contracting will improve farmers' price risk management.

Forward contracting costs is a combination of risk premium and the ability of elevators to accurately forecast harvest-time basis. Volatility increases the potential losses from basis movement and it decreases the ability of elevators to accurately forecast basis. Both situations will cause elevators to increase the costs paid by producers to forward contract.

We have presented evidence that increases in the volatility of wheat basis is correlated with a larger cost of forward contracting. Future research will focus on determining the factors that drive basis volatility and, subsequently, the cost faced by farmers to reduce price and basis risk in grain marketing.

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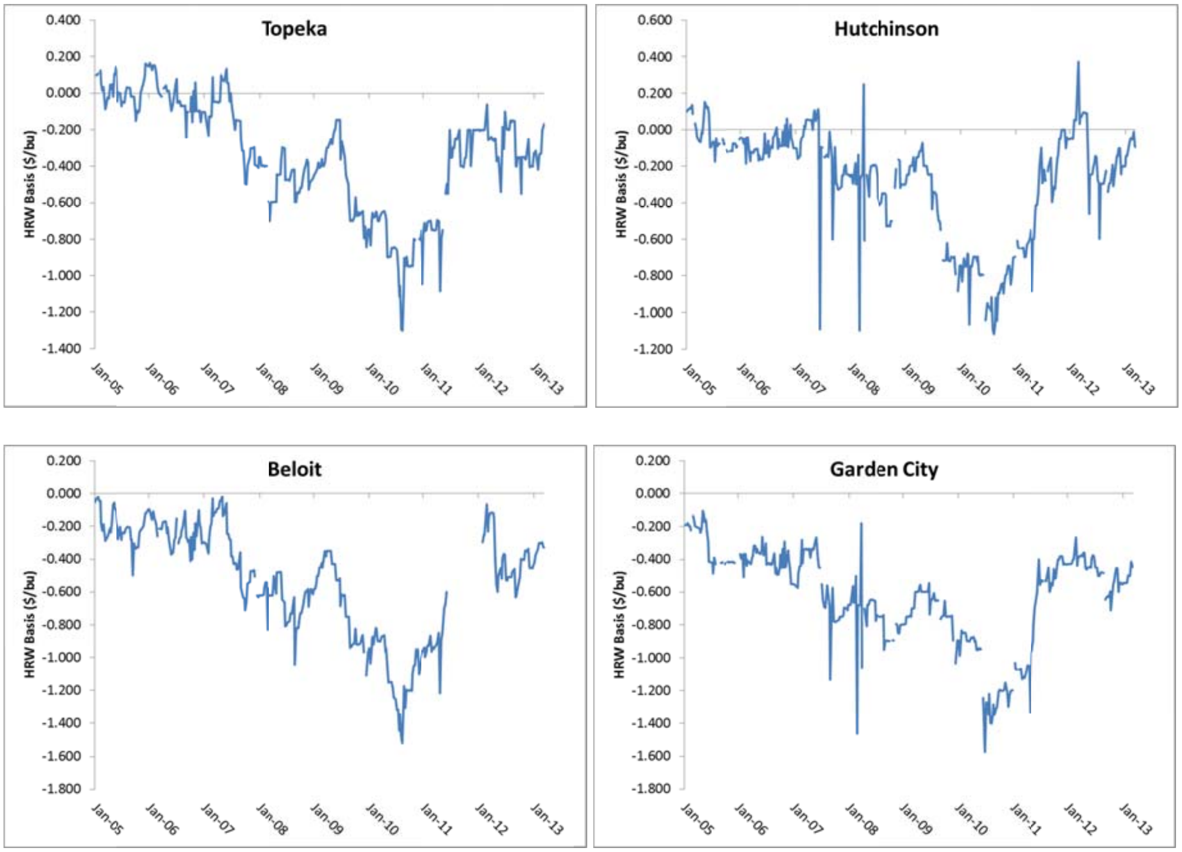

Figure 1. Nearby Hard Red Wheat Basis at Four Kansas Locations (Jan. 2005 – Mar. 2013)

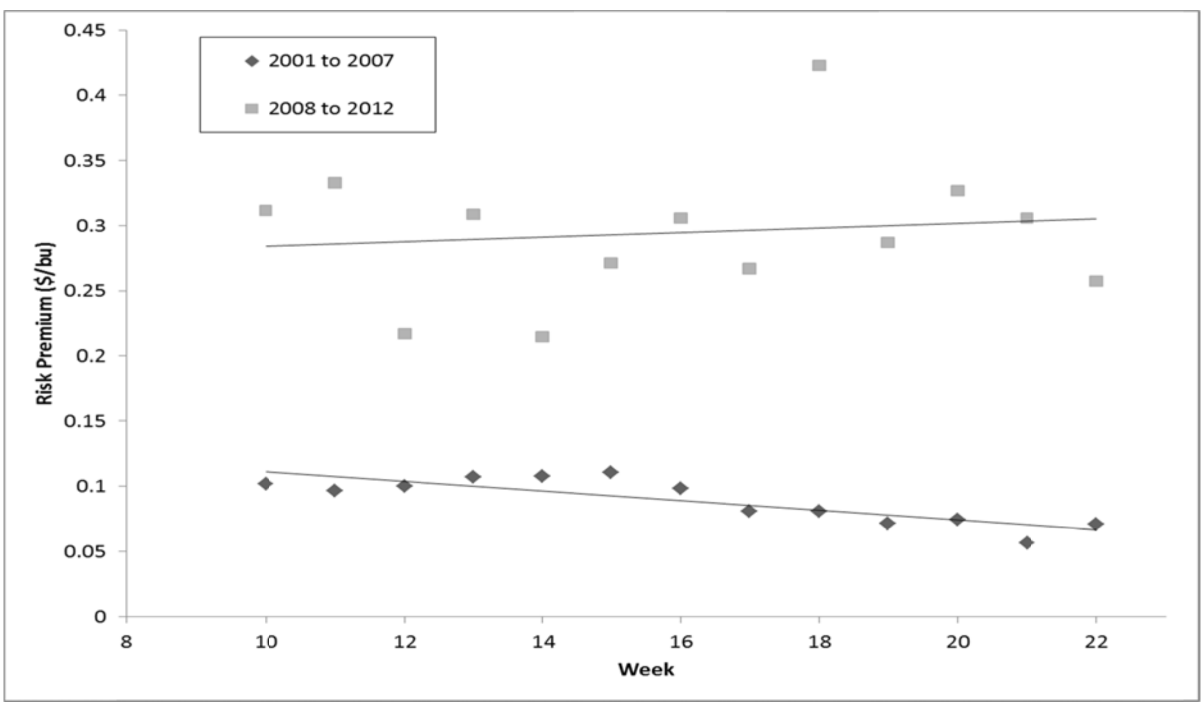

Figure 2. Average Forward Contract Risk Premium for HRW in Kansas

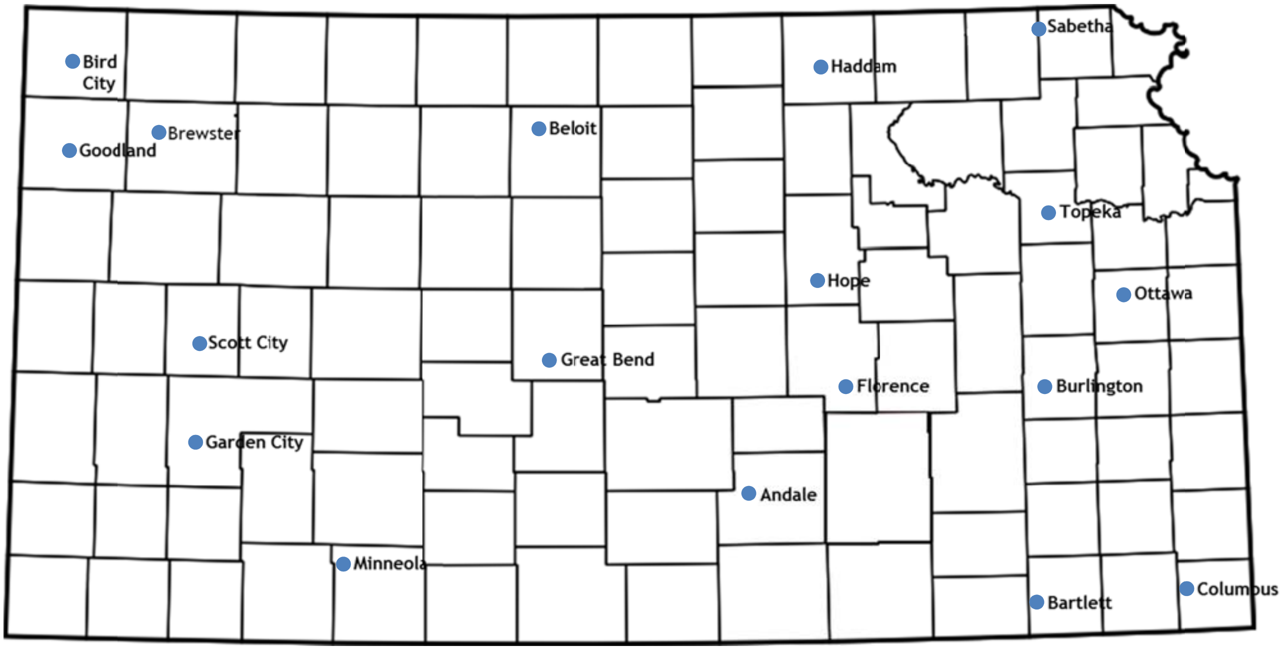

Figure 3. Grain Elevator Locations in Kansas

Table 1. Summary Statistics of Model Parameters

Parameter	Description	Mean	Standard Deviation	Minimum	Maximum
C	Cost of forward contract-ex post ($/bu)	0.194	0.300	-0.505	1.421
BV	Standard deviation of implicit basis levels in forward contracts,($/bu)	0.065	0.072	0.001	0.631
R	Binary variable equal to 1 if previous year's returns to elevator from forward contracts was positive, zero otherwise	0.825	0.380	0	1
IV	Implied volatility of puts and calls for July wheat futures contract	32.118	7.557	18.110	54.845
SB	Structural break model equal to 1 if observation from 2008-2012, zero otherwise	0.481	0.500	0	1
Y_1	2002 binary variable	0.057	0.232	0	1
Y_2	2003 binary variable	0.084	0.278	0	1
Y_3	2004 binary variable	0.097	0.296	0	1
Y_4	2005 binary variable	0.094	0.292	0	1
Y_5	2006 binary variable	0.106	0.307	0	1
Y_6	2007 binary variable	0.081	0.273	0	1
Y_7	2008 binary variable	0.120	0.325	0	1
Y_8	2009 binary variable	0.062	0.241	0	1
Y_9	2010 binary variable	0.096	0.295	0	1
Y_{10}	2011 binary variable	0.132	0.339	0	1
Y_{11}	2012 binary variable	0.070	0.255	0	1
W_1	Week 1 binary variable	0.005	0.072	0	1
W_2	Week 2 binary variable	0.006	0.078	0	1
W_3	Week 3 binary variable	0.010	0.102	0	1
W_4	Week 4 binary variable	0.011	0.106	0	1
W_5	Week 5 binary variable	0.014	0.118	0	1
W_6	Week 6 binary variable	0.036	0.186	0	1
W_7	Week 7 binary variable	0.046	0.209	0	1
W_8	Week 8 binary variable	0.049	0.216	0	1
W_9	Week 9 binary variable	0.048	0.214	0	1
W_{10}	Week 10 binary variable	0.058	0.233	0	1
W_{11}	Week 11 binary variable	0.057	0.232	0	1
W_{12}	Week 12 binary variable	0.055	0.228	0	1
W_{13}	Week 13 binary variable	0.059	0.236	0	1
W_{14}	Week 14 binary variable	0.057	0.232	0	1
W_{15}	Week 15 binary variable	0.036	0.186	0	1
W_{16}	Week 16 binary variable	0.052	0.221	0	1
W_{17}	Week 17 binary variable	0.056	0.230	0	1
W_{18}	Week 18 binary variable	0.054	0.225	0	1
W_{19}	Week 19 binary variable	0.057	0.233	0	1
W_{20}	Week 20 binary variable	0.049	0.216	0	1
W_{21}	Week 21 binary variable	0.045	0.206	0	1
W_{22}	Week 22 binary variable	0.045	0.207	0	1
W_{23}	Week 23 binary variable	0.037	0.189	0	1
W_{24}	Week 24 binary variable	0.030	0.170	0	1
W_{25}	Week 25 binary variable	0.027	0.164	0	1

Note: Number of observations is 2,111.

Table 2. Estimated Coefficients from Risk Premium Model: Time Period 2002 – 2012

Parameter	Coefficient	Standard Error	T-Statistic
BV	1.564	0.086	18.250
R	-0.268	0.015	-18.390
IV	0.003	0.001	3.330
SB	0.052	0.016	3.220
W_{2}	0.055	0.093	0.590
W_{3}	-0.054	0.084	-0.640
W_{4}	-0.076	0.083	-0.910
W_{5}	-0.065	0.080	-0.800
W_{6}	0.031	0.074	0.420
W_{7}	0.029	0.073	0.400
W_{8}	0.022	0.072	0.310
W_{9}	0.100	0.073	1.370
W_{10}	0.065	0.072	0.900
W_{11}	0.070	0.072	0.970
W_{12}	-0.014	0.072	-0.190
W_{13}	0.057	0.072	0.790
W_{14}	-0.015	0.072	-0.210
W_{15}	0.019	0.074	0.260
W_{16}	0.062	0.072	0.860
W_{17}	0.024	0.072	0.330
W_{18}	0.114	0.072	1.580
W_{19}	0.032	0.072	0.450
W_{20}	0.042	0.072	0.580
W_{21}	0.045	0.073	0.620
W_{22}	0.034	0.073	0.470
W_{23}	-0.024	0.074	-0.320
W_{24}	-0.004	0.075	-0.060
W_{25}	0.016	0.075	0.210
Intercept	0.150	0.074	2.030
R^2	0.417	Min. Obs. per Group:	69
No. of Observations:	2,111	Ave. Obs. per Group:	117
No. of Groups:	18	Max. Obs. per Group:	172

Table 3. Estimated Coefficients from Risk Premium Model: Time Period 2002 - 2007

Parameter	Coefficient	Standard Error	T-Statistic
BV	0.018	0.104	0.180
R	-0.023	0.007	-3.120
IV	-0.001	0.001	-0.610
Y_2	-0.130	0.009	-15.220
Y_3	-0.084	0.010	-8.240
Y_4	-0.024	0.008	-2.890
Y_5	-0.028	0.011	-2.500
Y_6	-0.143	0.011	-13.490
W_2	0.021	0.023	0.940
W_3	0.018	0.023	0.800
W_4	0.010	0.024	0.430
W_5	0.020	0.022	0.900
W_6	0.001	0.019	0.050
W_7	-0.019	0.019	-1.000
W_8	-0.017	0.019	-0.920
W_9	-0.030	0.020	-1.530
W_{10}	-0.026	0.020	-1.300
W_{11}	-0.031	0.020	-1.570
W_{12}	-0.027	0.020	-1.340
W_{13}	-0.027	0.020	-1.350
W_{14}	-0.021	0.020	-1.070
W_{15}	-0.021	0.020	-1.040
W_{16}	-0.030	0.020	-1.490
W_{17}	-0.033	0.020	-1.690
W_{18}	-0.031	0.019	-1.580
W_{19}	-0.034	0.019	-1.780
W_{20}	-0.031	0.019	-1.610
W_{21}	-0.054	0.019	-2.800
W_{22}	-0.035	0.019	-1.800
W_{23}	-0.035	0.021	-1.700
W_{24}	-0.033	0.022	-1.510
W_{25}	-0.038	0.024	-1.610
Intercept	0.205	0.023	9.010

R^2	0.467	Min. Obs. per Group:	9
No. of Observations:	1,096	Ave. Obs. per Group:	61
No. of Groups:	18	Max. Obs. per Group:	102

Table 4. Estimated Coefficients from Risk Premium Model: Time Period 2008 - 2012

Parameter	Coefficient	Standard Error	T-Statistic
BV	0.800	0.097	8.220
R	-0.045	0.017	-2.680
IV	-0.002	0.002	-0.740
Y_7	0.072	0.024	3.000
Y_8	-0.341	0.040	-8.420
Y_9	0.509	0.031	16.450
Y_{10}	-0.101	0.048	-2.130
W_3	-0.301	0.167	-1.810
W_4	-0.266	0.165	-1.610
W_5	-0.275	0.164	-1.680
W_6	-0.179	0.160	-1.120
W_7	-0.160	0.159	-1.000
W_8	-0.146	0.159	-0.920
W_9	-0.085	0.158	-0.540
W_{10}	-0.113	0.158	-0.720
W_{11}	-0.104	0.157	-0.660
W_{12}	-0.226	0.158	-1.430
W_{13}	-0.110	0.157	-0.700
W_{14}	-0.248	0.157	-1.570
W_{15}	-0.100	0.160	-0.620
W_{16}	-0.102	0.158	-0.650
W_{17}	-0.149	0.158	-0.940
W_{18}	0.020	0.158	0.130
W_{19}	-0.138	0.158	-0.870
W_{20}	-0.137	0.158	-0.860
W_{21}	-0.145	0.159	-0.910
W_{22}	-0.188	0.159	-1.180
W_{23}	-0.211	0.158	-1.330
W_{24}	-0.221	0.158	-1.390
W_{25}	-0.185	0.158	-1.170
Intercept	0.420	0.192	2.180

R^2	0.838	Min. Obs. per Group:	41
No. of Observations:	1,015	Ave. Obs. per Group:	56
No. of Groups:	18	Max. Obs. per Group:	79