Corn and Soybean Basis Behavior:

An Intertemporal, Cross-Sectional Analysis

by

Philip Garcia, Robert Hauser, and Alan Tumblin

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The number of studies on basis variability has increased considerably during the past few years. As illustrated by Greenhall et al., who suggest that in some cases the effectiveness of hedging is reduced more by basis risk than by yield risk, this increased attention toward basis behavior is well deserved. When studying basis behavior, it is usually recognized that basis variability in itself has little meaning. The importance of basis variability is revealed after it has been "standardized" through some type of hedging effectiveness measure.

Hedging effectiveness has often been measured in one of two methodological contexts. One approach is in a simulation-type framework where risks and returns of routine and selective hedging strategies during a particular time period are measured (surveyed well by Gray and Rutledge; Kenyon; and Leuthold and Tomek). The second approach uses variants of portfolio theory and, in general, focuses on the variance of hedged returns relative to the unhedged-return variance (e.g., Johnson; Heifner, Ederington). Interestingly, the implicit ex-ante basis-expectation process of the hedger is often ignored when measuring hedging effectiveness with either approach. Explicit specification of the process may lead to a more meaningful effectiveness measure. At the very least, as Peck notes, the use of basis in such analysis causes the focus to be more clearly on the rationale of hedging -- to benefit from the relative movements between two prices.

The objectives of this paper are (a) to present a hedging effectiveness measure similar to that used in the traditional portfolio approach but allowing for alternative basis expectation processes, and (b) to use this measure in conjunction with a mean-squared-error measure to examine the intertemporal and interregional behavior of changes in corn and soybean hedging effectiveness during 1966-83 for producers at ten locations in Illinois.

Methodology

There are two fundamental and important methodological characteristics of this analysis. First, evaluation of basis risk or hedging effectiveness focuses on realized outcomes relative to expected outcomes. Second, emphasis is placed on finding effectiveness measures for each year, contract, and elevator. Both characteristics will rely on the use of a lognormal time-diffusion process and thus we wish to first review some basic relationships of this process. (While discussed many places, an excellent review of this process can be found in Jarrow and Rudd (pp. 89-91)).

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Define $X_T = X_t \exp(\alpha, Y_t)$, where X_t a random variable at day t (t=1, 2,...T); exp is the exponential function; and Y_t is (T-t)/365, the time interval over [t, T] in years. If the ratio X_T/X_t is distributed lognormally, then α is the geometric mean of the instantaneous change in X. Given the changes are independent, then:

$$(1) \quad \alpha = m + \sigma^2/2$$

where m is the mean of the log changes in X per unit time, and σ^2 is the variance of the log changes per unit time. If the instantaneous variance is constant over [1, T] then it is appropriate to estimate σ^2 as the sample variance of $\ln(X_t/X_{t-1})$. When at time t, the variance of the expected distribution of $\ln(X_T)$ is this sample variance times T-t. An estimate of $\ln(\alpha)$ for a given t is $\ln(X_T/X_t)/Y_t$. Estimates of $\ln(\alpha)$ and σ^2 will be used here to evaluate hedging effectiveness. As will be shown, functions of the σ^2 estimates are similar to traditional hedging effectiveness measures (e.g., Heifner). Functions of $\ln(\alpha)$ are used in a mean-squared-error vein (e.g., Peck).

Considered are hedges placed at time t and lifted at T. It is assumed that the hedger believes that futures price is an unbiased forecast and thus the expected price for both a hedged and unhedged position is the futures price at t minus the basis (futures price minus cash price) expected for T at t. The following notation is used:

F_{tT}	= futures price at time t for expiration T
F_{TT}	= futures price at expiration
$E[B_{tT}]$	= expected basis at time t for expiration T
B_{TT}	= basis at expiration
$E[HP_{tT}]$	$= E[UP_{tT}] = F_{tT} - E[B_{tT}]$
RHP_{tT}	$= F_{tT} - B_{TT}$
RUP_{tT}	$= F_{TT} - B_{TT}$
DH_{tT}	$= E[HP_{tT}]/RHP_{tT}$
DU_{tT}	$= E[UP_{tT}]/RUP_{tT}$

where HP is hedged price, RHP is realized hedged price, UP is unhedged price, and RUP is realized unhedged price.

The focus of this analysis is on DH and DU -- the expected hedged (unhedged) outcome relative to the realized hedged (unhedged) outcome. Nine alternative calculations for these values were considered, depending on the basis expectation model. Each model is described below. Assume, for illustration, that expected basis for March soybeans is being found each trading day during the 90 day hedging period prior to March.

Method I. The expected basis is the current basis. On a given day, the basis expected for March is equal to that day's March futures price minus the cash price.

Method II. The expected basis is the current basis adjusted according to the return to storage implied by the prices of the two nearest futures contracts. For our March example, the annualized storage return is $(\ln F^2 - \ln F^1)/2/12$, where F^2 is the May futures price and F^1 is the March futures price. An annualized return is found each day. On a given day, this return is used to compound that day's cash price to March. The expected basis is the current futures price minus the compounded cash price.

Method III. The same procedure as in Method II is followed except only one storage return is used for the entire hedging period. This return is the average return found during the 45 day period prior to the hedging period.

Method IV. The expected basis is last year's expiration basis. The average basis during March 9 - March 15 of the previous year is used.

Method V. The expected basis is the average expiration basis for March 9 - March 15 of the past three years.

Method VI. The expected basis is determined by the basis trend occurring during the 30 days prior to the hedging period. Current basis during the pre-hedging period is estimated as a function of time to expiration (TTE) using ordinary least squares regression. The TTE coefficient is used during the hedging period to extrapolate the current basis to expiration. This is done daily.

Method VII. Given the regression results used in Method VI, the intercept (TTE = 0) is used as the expected basis. Thus, the expected basis does not change during the hedging period.

Method VIII. The same procedure as in Method VI is followed except the sample period used to find the TTE coefficient is the previous year's hedging period.

Method IX. The intercept of the regression in Method VIII is used as the expected basis.

Given a particular expected-basis model, the resulting DU and DH returns are assumed to follow the diffusion process summarized above. Under this assumption, hedging effectiveness can be measured in the portfolio-analysis tradition by dividing the variance of the ending distribution of lnDH by the variance of the lnDU distribution or, equivalently (because of the constant-instantaneous-variance assumption), the variance of $\ln(DH_i/DH_{i-1})$ divided by the variance of $\ln(DU_i/DU_{i-1})$, where $i = 1,2,\ldots n$ and n is the number of observations over [t, T]. The ratio can be rewritten as:

$$R = \frac{V(EC) + V(RC) - 2\,Cov(EC, RC)}{V(EC)}$$

where $V(\cdot)$ and $Cov(\cdot)$ is the sample variance and covariance, respectively; EC is $\ln(F_{iT} - E[B_{iT}]) - \ln(F_{i-1,T} - E[B_{i-1,T}])$; and RC is $\ln(F_{iT} - B_{TT}) - \ln(F_{i-1,T} - B_{TT})$. The estimate $\hat{E} = 1-R$ is similar to the hedging-effectiveness measure defined by Johnson. In this study's basis-expectation context where all quantity is hedged, Johnson's measure (under lognormality and a hedging ratio of one) is found by assuming that the expected basis is the current basis. However, if the basis decreases as expiration approaches, the hedging ratio (futures to cash position) that minimizes the variance of the hedged returns is less than one (e.g., Ederington; Heifner). Unfortunately, the implicit basis-expectation process used to find this minimum-variance ratio is defined by the same sample of prices used to define hedging effectiveness. This simultaneity causes hedging effectiveness to be overstated unless the hedger has perfect foresight in a rational-expectation sense.

An unappealing trait of this relative variance measure is that it is very sensitive to whether the basis expectation model yields different estimates from day to day, regardless of whether the new estimate is a better forecast than the previous day's forecast. The ratio R is very small if the changes in $E[B_{iT}]$ are small, suggesting that hedging effectiveness is high. Assume, for example, that there is no change in expected basis throughout the period (as in Methods IV, V, VII, and IX). Consider the EC and RC definitions given above but, for illustration, do not take the natural logarithm where specified. The result is that the numerator of R is zero since both EC and RC are equal to the first differences of futures price. Taking logs means that the basis terms do not cancel but the resulting numerator is still very small and potentially misleading. Thus, interpretation of this measure should be done with care. Comparisons of the measure across methods should not be made. Comparisons across time for a given method seem appropriate.

The second type of hedging effectiveness measure is based on estimates of $\ln(DH_{TT}/DH_{tT})$ and of $\ln(DU_{TT}/DU_{tT})$, equal to $\ln(\alpha_{tH})Y_t$ and $\ln(\alpha_{tU})Y_t$, respectively. Since $DH_{TT} = DU_{TT} = 1$, these estimates can be expressed as:

$$(2)\ \ln(\alpha_{tH})Y_t = \ln(F_{tT} - B_{TT}) - \ln(F_{tT} - E[B_{tT}])$$

$$(3)\ \ln(\alpha_{tU})Y_t = \ln(F_{TT} - B_{TT}) - \ln(F_{tT} - E[B_{tT}]).$$

Equations (2) and (3) are prediction errors. Equation (2) is the log of the expected hedged price minus the log of the price received from hedging. Equation 3 applies to the unhedged or open position. Each error is comprised of a geometric mean component (α) and a time component (Y_t). Therefore, if error levels are compared, they should be standardized for time.

For this analysis, each error is divided by its Y_t to standardize for time and then the mean of the squared errors are calculated. This mean-squared-error value is calculated for both the hedged positon (HMSE) and the unhedged position (UMSE) by year, contract, period, and elevator. When analyzing hedging effectiveness over time, it does not seem appropriate to examine just the HMSE values. For instance, the HMSE may increase over time, but at a slower rate than the UMSE leading us to believe that hedging effectiveness has increased. Therefore, the ratio of HMSE/UMSE is examined, and is referred to as the αE measure.

Data and Empirical Analysis

The proposed hedging effectiveness measures for corn and soybeans are examined using daily data from ten Illinois elevators (Figure 1) for the period 1966 through 1983. The elevators are members of the Illinois Market News Service sample and were selected to provide a geographic dispersion of prices. The prices, while not generated from a random sample, are considered to be representative of prices paid to producers throughout the state. Daily closing futures prices for December, March, and July corn, and November, March, and July soybean contracts are used. These contracts were selected to provide an assessment of the short-term hedging potential throughout the year.

The hedging effectiveness measure, E, and the MSE measure, αE, were calculated for the three month period prior to expiration for each contract, elevator, and year. Table 1 presents the time periods considered and the forward spreads employed to calculate expected prices where appropriate. It is assumed that the hedge is lifted during the first 15 days of the expiration month and that the realized unhedged price is the average price during this expiration period. For each contract, two hedging periods of approximately 1.5 months each were used in the analysis.

To minimize the effect of outliers and sample size on the variance calculations, the mean and the standard deviation of the first differences of lnDH and of lnDU were calculated across all elevators, time periods, contracts, and years. If the daily first difference was greater than three standard deviations from the mean then the observation was eliminated, reducing the number of observations by less than 1.5 percent. Subsequently, the number of daily observations within a period for any contract was examined. If fewer than 20 observations existed, the contract for that elevator was not used in the analysis. This procedure reduced the number of daily observations by an additional two percent. This data set is used to calculate the hedging effectiveness and the MSE measures discussed above.

In order to quantify E and αE measures, it is necessary to generate an estimate of basis expectation. It is assumed that producers are quasi-rational in their expectations about basis movements. That is, models that provide small forecast errors reflect producers' basis expectations.[1] As a first step, Theil coefficients (U_2) of basis forecasts based on the $\ln(\alpha)$ errors were calculated for each commodity, contract, period, and year. For descriptive purposes, the individual Theil coefficients then were averaged over time and their standard deviations calculated.

Several points emerge from examination of these average Theil coefficients (Table 2). First, MII, the use of the nearby forward spread, seems to perform well for the non-harvest contracts both in terms of the U_2 and its standard deviations. Second, during the harvest period it is difficult to "outperform" last year's basis, MIV, as a forecaster of this year's basis level. Third, MI, the approach which uses today's cash price as a forecast of ending cash price does not perform well relative to the above procedures. Similarly, the more complicated approaches (MVI - MIX) employing regression techniques do not provide many attractive results. Based on these findings, MII and MIV are used in the subsequent analysis of

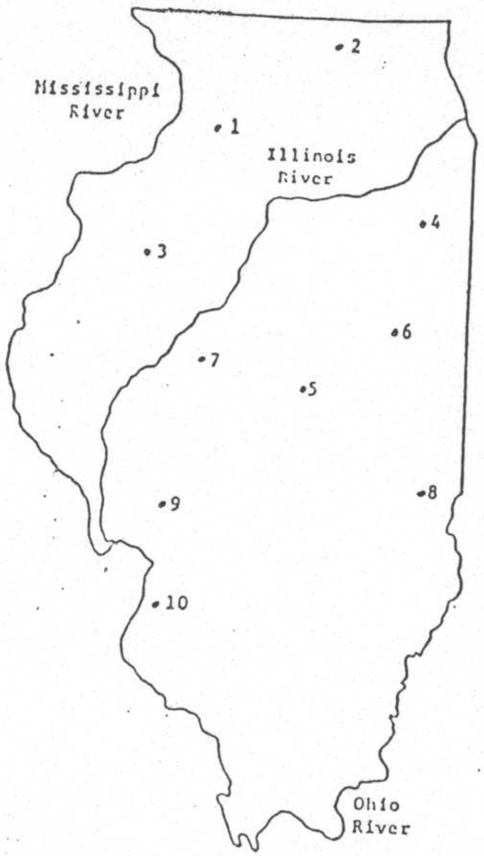

Figure 1. Elevator Locations.

Table 1. Intrayear Periods of Study and Spreads Used to Calculate Expected Storage Return.

Crop	Contract	Period 1	Period 2
Corn	December Contract	September 1 to October 15[a]	October 16 to November 30
		March-December spread[b]	March-December spread
	March Contract	December 1 to January 15	January 16 to February 28
		May-March spread	May-March spread
	July Contract	April 1 to May 15	May 16 to June 30
		July-May spread	September-July spread
Soybeans	November Contract	August 1 to September 15	September 16 to October 31
		January-November spread	January-Nov.spread
	March Contract	December 1 to January 15	January 16 to February 28
		March-January spread	May-March spread
	July Contract	April 1 to May 15	May 16 to June 30
		July-May spread	August-July spread

[a] Period over which hedging-effectiveness measures were calculated.

[b] Forward spread used in calculating expected price for Method II. The expected storage return and resultant expected price was calculated daily.

Table 2. Forecasting Accuracy of Alternative Expected Basis Mechanisms: Mean and Standard Deviation of Theil Coefficients by Commodity, Contract, and Period, 1966-1983

			Method								
Contract	Period	Statistic	I	II	III	IV	V	VI	VII	VIII	IX
Corn											
March	1	Mean	.0320 (6)[a]	.0206 (1)	.0221 (2)	.0265 (3)	.0275 (4)	.1063 (9)	.0384 (8)	.0339 (7)	.0294 (5)
		Standard Deviation	.0174 (4)	.0092 (1)	.0168 (3)	.0192 (6)	.0187 (5)	.0549 (9)	.0278 (8)	.0133 (2)	.0225 (7)
	2	Mean	.0372 (3)	.0323 (1)	.0324 (2)	.0628 (5)	.0637 (6)	.1120 (9)	.0917 (8)	.0400 (4)	.0699 (7)
		Standard Deviation	.0205 (3)	.0158 (1)	.0169 (2)	.0469 (6)	.0415 (5)	.0556 (8)	.0689 (9)	.0212 (4)	.0542 (7)
July	1	Mean	.0231 (6)	.0142 (3)	.0171 (5)	.0106 (1)	.0139 (2)	.0492 (9)	.0326 (8)	.0250 (7)	.0145 (4)
		Standard Deviation	.0150 (6)	.0068 (1)	.0084 (2)	.0095 (3)	.0113 (4)	.0313 (9)	.0229 (8)	.0170 (7)	.0145 (5)
	2	Mean	.0275 (3)	.0270 (2)	.0282 (4)	.0243 (1)	.0326 (7)	.0460 (9)	.0306 (5)	.0344 (8)	.0323 (6)
		Standard Deviation	.0135 (3)	.0116 (1)	.0129 (2)	.0218 (5)	.0276 (7)	.0365 (9)	.0235 (6)	.0185 (4)	.0326 (8)
December	1	Mean	.0586 (5)	.0462 (4)	N.A.	.0188 (1)	.0233 (2)	N.A.	N.A.	.0631 (6)	.0378 (3)
		Standard Deviation	.0370 (6)	.0286 (5)	N.A.	.0137 (1)	.0156 (2)	N.A.	N.A.	.0275 (4)	.0269 (3)
	2	Mean	.1069 (6)	.0805 (3)	N.A.	.0443 (1)	.0544 (2)	N.A.	N.A.	.1022 (5)	.0886 (4)
		Standard Deviation	.0428 (4)	.0407 (3)	N.A.	.0315 (1)	.0342 (2)	N.A.	N.A.	.0548 (5)	.0583 (6)
Soybeans											
March	1	Mean	.0201 (8)	.0087 (1)	.0109 (3)	.0112 (4)	.0094 (2)	.0361 (9)	.0130 (6)	.0198 (7)	.0114 (5)
		Standard Deviation	.0106 (4)	.0066 (1)	.0088 (2)	.0124 (6)	.0121 (5)	.0262 (9)	.0097 (3)	.0143 (8)	.0126 (7)
	2	Mean	.0240 (5)	.0137 (1)	.0170 (2)	.0240 (5)	.0201 (4)	.0293 (9)	.0192 (3)	.0250 (8)	.0245 (7)
		Standard Deviation	.0172 (4)	.0075 (1)	.0153 (2)	.0218 (8)	.0202 (6)	.0262 (9)	.0165 (3)	.0193 (5)	.0210 (7)
July	1	Mean	.0322 (4)	.0283 (2)	.0279 (1)	.0466 (8)	.0391 (6)	.0408 (7)	.0321 (3)	.0503 (9)	.0371 (5)
		Standard Deviation	.0724 (7)	.0562 (3)	.0578 (4)	.0904 (8)	.0631 (5)	.0556 (2)	.0483 (1)	.0961 (9)	.0695 (6)
	2	Mean	.0376 (3)	.0332 (1)	.0364 (2)	.0884 (9)	.0709 (8)	.0389 (4)	.0468 (5)	.0541 (6)	.0665 (7)
		Standard Deviation	.0637 (5)	.0459 (2)	.0486 (3)	.1685 (9)	.0863 (7)	.0415 (1)	.0605 (4)	.0860 (6)	.1058 (8)
November	1	Mean	.0295 (4)	.0394 (6)	N.A.	.0098 (2)	.0097 (1)	N.A.	N.A.	.0388 (5)	.0198 (3)
		Standard Deviation	.0223 (5)	.0255 (6)	N.A.	.0072 (1)	.0074 (2)	N.A.	N.A.	.0193 (4)	.0148 (3)
	2	Mean	.0316 (4)	.0254 (2)	N.A.	.0254 (2)	.0248 (1)	N.A.	N.A.	.0602 (6)	.0495 (5)
		Standard Deviation	.0163 (2)	.0125 (1)	N.A.	.0196 (4)	.0195 (3)	N.A.	N.A.	.0260 (5)	.0365 (6)

[a] Numbers in the parentheses represent the rank across methods.

Similarly, the more complicated approaches (MVI - MIX) employing regression techniques do not provide many attractive results. Based on these findings, MII and MIV are used in the subsequent analysis of basis risk associated with hedging and nonhedging. For comparative purposes, MI also is included.

The MSE measure, ∝E, is calculated under the assumptions that the expected basis is: 1) the current basis (MI); 2) based on the market's forward spread (MII) and; 3) last year's basis (MIV). The hedging effectiveness measure, E, is calculated using MI and MII. Method IV is not employed because the lack of variability in the hedged position during the individual contract limits its usefulness in calculating the ending variance. In addition, a hedging effectiveness measure was calculated under the traditional minimum variance procedures (e.g., Heifner).

Ordinary-least squares regression was used to examine the behavior of these measures by contract, commodity, and individual elevators. Specifically, for each contract, an equation was estimated by elevator and commodity. A trend variable was included to examine the behavior of these measures during 1966-1983, and a period dummy variable was included to assess the effect of time to expiration.

Findings

The results of selected regression analyses are presented in Tables 3-5. A separate equation is estimated for each elevator by contract, commodity, and selected basis expectation mechanism. Additionally, an equation is estimated with the variables averaged across elevators. In each equation, a time variable (i.e., 1=1966, 2=1967,...) and a dummy variable for the period nearest to expiration as the base are included. Table 3 and 4 provide information on selected regressions for the hedging effectiveness measure, E, for corn and for soybeans, respectively. The harvest and July contracts are presented for the hedging effectiveness measure. Results of the estimated relationships for March, in general, are similar to the July contract and are not presented.

Several points stand out on examining the two tables. First, regardless of the expectation measure, commodity or contract month, there existed a strong and positive relationship between the hedging effectiveness measure and the time variable. Second, higher adjusted R^2's, larger coefficient values for the time variable, and higher values of the t-statistic were encountered for the soybean relationships. Third, the coefficients across elevators appear to change considerably. Statistical tests on the homogeneity of slope and intercept coefficients across elevators by contract verified that similarity of coefficients was more the exception than the rule. Elevators and 2 and 10 at the extremes of the state tended to be independent of the others. During the harvest, elevators 3, 4, 6, and 7 appeared to behave in a similar fashion.[2] Fourth, the results of the dummy variables for the period effect were somewhat mixed. Only in the case of November soybeans did the period dummy variable enter significantly in a statistical sense, indicating a reduction in hedging

Table 3. Illinois Corn Hedging Effectiveness Regressions by Contract, Basis Expectation Mechanism, and Elevator, 1966-1983

Elevator	Method I Intercept	Method I Period	Method I Time	Method I $\bar{R}^2$	Method I D.W.	Method II Intercept	Method II Period	Method II Time	Method II $\bar{R}^2$	Method II D.W.
DECEMBER										
1	.49 (5.92)	.03 (0.38)	0.01 (1.44)	0.01	1.23	.42 (5.19)	-.04 (-0.52)	0.02 (2.32)	0.11	1.54
2	.34 (4.00)	.04 (0.58)	0.02 (1.99)	0.07	2.04	.33 (4.06)	-.06 (-0.84)	0.02 (2.25)	0.11	2.68
3	.44 (5.02)	.05 (0.59)	0.01 (1.53)	0.02	1.55	.40 (4.81)	.04 (0.60)	0.01 (1.86)	0.06	1.81
4	.40 (4.66)	-.0005 (- .01)	0.02 (2.50)	0.12	1.62	.36 (3.38)	-.10 (-1.11)	0.02 (2.14)	0.11	2.23
5	.20 (1.59)	.04 (0.38)	0.03 (2.95)	0.18	2.36	.04 (0.22)	.004 (0.02)	0.04 (2.73)	0.15	2.34
6	.40 (4.91)	.03 (0.38)	0.03 (3.64)	0.27	1.21	.36 (4.38)	-.02 (-0.23)	0.03 (3.85)	0.29	1.46
7	.42 (5.23)	.06 (0.84)	0.01 (1.54)	0.03	1.41	.38 (5.16)	.002 (0.03)	0.02 (2.36)	0.10	1.71
8	.07 (0.68)	.10 (1.03)	0.03 (3.23)	0.25	1.28	.004 (0.04)	.04 (0.40)	0.04 (3.60)	0.28	1.52
9	.31 (3.74)	.05 (0.66)	0.02 (3.12)	0.21	1.09	.24 (2.89)	-.03 (-0.39)	0.03 (3.96)	0.31	1.40
10	.54 (8.02)	-.003 (-0.06)	.004 (0.65)	-0.05	2.25	.52 (7.91)	-.04 (-0.63)	.004 (0.72)	-0.04	2.00
All	.73 (13.44)	.01 (0.31)	0.01 (1.31)	-0.01	1.41	.67 (11.15)	-.06 (-1.13)	0.01 (2.16)	0.11	1.63
JULY										
1	.51 (7.17)	-.12 (-1.88)	0.02 (3.01)	0.28	1.05	.48 (6.29)	-.11 (-1.57)	0.02 (2.78)	0.23	1.32
2	.12 (1.00)	-.04 (-.36)	0.04 (4.03)	0.34	1.76	.07 (.56)	.01 (0.08)	0.04 (3.84)	0.31	1.53
3	.38 (3.33)	-.05 (-.47)	0.03 (2.36)	0.12	1.18	.36 (3.07)	-.03 (-.33)	0.02 (2.08)	0.08	0.89
4	.41 (4.20)	-.05 (-.62)	0.03 (2.99)	0.20	1.89	.37 (3.63)	-.05 (-.56)	0.03 (2.81)	0.17	1.90
5	.30 (2.56)	-.04 (-.37)	0.03 (3.00)	0.21	2.05	.31 (2.79)	-.01 (-.14)	0.03 (2.87)	0.19	1.78
6	.34 (4.94)	-.01 (-.10)	0.04 (6.11)	0.54	1.18	.33 (4.36)	-.01 (-.09)	0.03 (4.88)	0.42	1.71
7	.44 (6.41)	-.01 (-.14)	0.02 (3.27)	0.23	1.22	.41 (5.45)	-.005 (-.07)	0.02 (2.94)	0.18	1.50
8	-.38 (-1.29)	-.07 (-.26)	0.08 (2.82)	0.18	1.26	-.42 (-1.62)	.09 (.38)	0.07 (2.95)	0.20	1.09
9	.18 (1.68)	.06 (.65)	0.04 (3.78)	0.30	1.81	.15 (1.27)	.09 (0.90)	0.04 (3.73)	0.30	1.57
10	.38 (2.03)	-.03 (-0.18)	0.02 (0.99)	-0.04	1.50	.34 (1.41)	-.06 (-.31)	0.02 (0.94)	-0.04	1.58
All	.60 (9.28)	-.01 (-.22)	0.02 (3.09)	0.20	1.86	.52 (6.44)	.03 (0.38)	0.02 (2.72)	0.16	1.62

Table 4. Illinois Soybean Hedging Effectiveness Regressions by Contract, Basis Expectation Mechanism, and Elevator, 1966-1983

	Method I					Method II				
Elevator	Intercept	Period	Time	$\bar{R}^2$	D.W.	Intercept	Period	Time	$\bar{R}^2$	D.W.
NOVEMBER										
1	.74 (7.89)	−.19 (−2.48)	0.01 (1.00)	0.16	1.59	.74 (7.62)	−.21 (−2.67)	0.01 (0.87)	0.18	1.64
2	.44 (5.24)	−.07 (−0.98)	0.03 (3.61)	0.29	1.10	.39 (4.44)	−.06 (−0.73)	0.03 (3.70)	0.30	1.03
3	.33 (1.84)	−.25 (−1.56)	0.05 (2.78)	0.22	1.25	.33 (2.20)	−.17 (−1.30)	0.04 (3.01)	0.23	1.00
4	.52 (5.60)	−.19 (−2.39)	0.03 (3.33)	0.32	2.00	.50 (5.18)	−.20 (−2.41)	0.03 (3.22)	0.31	2.01
5	.50 (6.21)	−.18 (−2.59)	0.03 (4.30)	0.43	1.45	.47 (5.35)	−.17 (−2.21)	0.03 (3.94)	0.37	1.35
6	.56 (6.67)	−.15 (−2.03)	0.03 (3.97)	0.37	1.30	.53 (6.64)	−.14 (−2.03)	0.03 (4.21)	0.39	1.13
7	.51 (5.66)	−.14 (−1.86)	0.03 (3.46)	0.30	1.12	.46 (5.00)	−.15 (−1.90)	0.03 (3.77)	0.34	1.07
8	.27 (2.93)	−.03 (−0.42)	0.05 (5.07)	0.45	2.07	.23 (2.38)	−.03 (−0.34)	0.05 (5.08)	0.45	2.28
9	.36 (4.17)	−.12 (−1.62)	0.04 (4.88)	0.44	1.43	.33 (3.73)	−.12 (−1.61)	0.04 (4.83)	0.44	1.37
10	.52 (5.14)	−.20 (−2.29)	0.02 (2.44)	0.23	1.50	.50 (4.81)	−.20 (−2.23)	0.02 (2.33)	0.21	1.38
All	.61 (6.70)	−.20 (−2.38)	0.03 (2.69)	0.26	1.89	.64 (6.62)	−.20 (−2.47)	0.03 (2.88)	0.29	1.69
JULY										
1	.36 (3.30)	−.04 (−.47)	0.04 (3.91)	0.34	1.52	.19 (1.73)	.08 (.86)	0.05 (4.70)	0.44	1.55
2	.21 (2.38)	−.07 (−.86)	0.05 (6.38)	0.59	1.51	.03 (.30)	.09 (1.07)	0.06 (6.72)	0.61	1.61
3	−.07 (−.43)	.05 (.33)	0.08 (5.13)	0.47	1.00	−.22 (−1.49)	.09 (.69)	0.08 (5.82)	0.54	0.79
4	−.07 (−.50)	.13 (1.05)	0.07 (5.47)	0.49	1.90	−.28 (−2.01)	.21 (1.80)	0.08 (6.57)	0.60	2.03
5	.04 (.27)	.10 (.80)	0.06 (4.80)	0.44	1.59	−.18 (−1.18)	.19 (1.35)	0.07 (5.32)	0.51	1.54
6	−.06 (−.37)	.21 (1.58)	0.07 (4.88)	0.45	1.86	−.15 (−1.25)	.25 (2.43)	0.07 (6.43)	0.60	1.76
7	.04 (.28)	.04 (.37)	0.06 (4.86)	0.44	0.88	−.14 (−1.03)	.17 (1.49)	0.07 (5.81)	0.55	1.17
8	−.02 (−.19)	.03 (.28)	0.07 (5.76)	0.53	1.72	−.22 (−1.85)	.13 (1.25)	0.08 (7.21)	0.65	1.60
9	.33 (3.84)	−.05 (−.72)	0.04 (5.56)	0.50	1.55	.14 (1.55)	.08 (1.01)	0.05 (6.57)	0.58	1.53
10	.53 (7.38)	−.09 (−1.48)	0.03 (4.57)	0.41	1.43	.31 (4.20)	.06 (.96)	0.04 (6.04)	0.54	1.39
All	.35 (2.87)	.01 (.10)	0.05 (4.22)	0.35	1.15	.03 (.21)	.16 (1.49)	0.06 (5.42)	0.49	1.40

TABLE 5. Illinois Soybean MSE Measure (α E) Regressions for November Contract, by Price Expectation Mechanism, and Elevator, 1966-1983

NOVEMBER

Elevator	Method I					Method II					Method IV				
	Intercept	Period	Time	$\bar{R}^2$	D.W.	Intercept	Period	Time	$\bar{R}^2$	D.W.	Intercept	Period	Time	$\bar{R}^2$	D.W.
1	0.32 (0.84)	0.07 (0.21)	0.01 (0.35)	-0.07	2.29	0.47 (1.09)	0.54 (1.55)	-0.02 (-0.52)	0.02	2.22	-0.03 (-0.35)	-0.03 (-0.53)	0.02 (2.02)	0.09	1.84
2	0.26 (0.93)	0.18 (0.74)	0.004 (0.16)	-0.05	2.36	0.30 (0.82)	0.59 (1.84)	-0.01 (-0.34)	0.05	2.09	0.26 (2.28)	-0.08 (-0.79)	-0.01 (-1.14)	-0.003	1.57
3	0.26 (0.84)	0.05 (0.20)	0.01 (0.48)	-0.06	2.24	0.32 (1.24)	0.50 (2.25)	-0.02 (-0.62)	0.11	2.11	0.47 (3.47)	-0.14 (-1.16)	-0.03 (-1.79)	0.09	1.57
4	0.41 (1.95)	0.11 (0.63)	-0.02 (-0.84)	-0.03	2.20	0.41 (2.02)	0.42 (2.41)	-0.03 (-1.58)	0.17	2.02	0.37 (3.80)	-0.07 (-0.85)	-0.02 (-2.52)	0.14	1.28
5	0.44 (2.20)	0.10 (0.60)	-0.02 (-0.87)	-0.03	2.11	0.50 (2.73)	0.43 (2.71)	-0.04 (-2.27)	0.25	2.16	0.33 (3.30)	-0.07 (-0.77)	-0.02 (-1.95)	0.07	1.19
6	0.40 (2.28)	0.17 (1.12)	-0.02 (-1.09)	0.01	2.14	0.50 (2.36)	0.43 (2.39)	-0.04 (-2.01)	0.20	2.16	0.25 (2.36)	-0.04 (-0.42)	-0.01 (-1.27)	-0.01	1.37
7	0.46 (1.50)	-0.01 (-0.06)	-0.004 (-0.15)	-0.07	2.22	1.23 (2.75)	0.15 (0.39)	-0.07 (-1.70)	0.03	1.61	0.90 (2.13)	-0.04 (-0.11)	-0.05 (-1.33)	-0.01	1.42
8	0.39 (1.50)	0.25 (1.10)	-0.01 (-0.37)	-0.02	2.07	0.30 (0.84)	0.71 (2.23)	-0.02 (-0.44)	0.10	2.00	0.27 (2.32)	-0.04 (-0.37)	-0.01 (-1.04)	-0.03	0.96
9	1.13 (2.01)	-0.40 (-0.82)	-0.03 (-0.66)	-0.03	2.09	1.22 (2.54)	0.10 (0.24)	-0.07 (-1.62)	0.02	2.08	0.62 (5.69)	-0.15 (-1.64)	-0.04 (-3.74)	0.32	1.90
10	0.35 (1.08)	0.11 (0.41)	0.01 (0.23)	-0.06	2.38	0.38 (1.01)	0.63 (1.92)	-0.01 (-0.40)	0.06	2.20	0.38 (3.30)	-0.13 (-1.28)	-0.02 (-1.44)	0.05	1.15
All	0.36 (1.27)	0.07 (0.30)	-0.001 (-0.06)	-0.07	2.22	0.40 (1.50)	0.53 (2.30)	-0.03 (-1.13)	0.13	2.08	0.34 (3.43)	-0.06 (-0.75)	-0.02 (-2.20)	0.10	1.23

effectiveness as the time to expiration increases. Finally, there is little to differentiate between the intertemporal relationships using MI versus MII which was considered to be the most effective forecaster of subsequent basis levels. In part, this might be explained by the short-term nature of the forecast period.[3]

Table 5 contains the estimated MSE relationship for the harvest soybean contract by alternative basis expectation mechanisms[4]. In general, the relationships are marked by their poor statistical fit. Many of the adjusted R^2's are negative, and only in the cases of regressions for the basis expectation methods MII and MIV do any results of statistical significance appear. It is interesting to note, however, that the sign of the time variable is generally negative, indicating that over time the relative predictive ability of the hedged price to nonhedged price has improved. This negative relationship is most evident in the equations which use the forward price spread and last year's basis as the expected basis.

As might be expected with such "poor" statistical fits, the coefficients across elevators and across basis expectation mechanisms for a particular elevator vary considerably. In these circumstances, it is difficult to generate too much excitement about systematic differences in the coefficients across elevators and specific pricing mechanisms.

In an attempt to assess the behavior of the ratio of MSE, the hedged MSE for each elevator and contract was regressed on time and period variables. The findings indicate that the corn MSE for the hedged position increased modestly over time for the December contract and declined modestly for March. Adjusted R^2's were somewhat higher (e.g., in cases reaching .33) than in the case of the ratio estimates. This suggests that over the data period, the MSE for the unhedged position for the December contract was declining relative to the hedged position and increasing relative to the hedged MSE for March. For soybeans, the unhedged MSE declined modestly through time for the November contract, but showed no relationship over time for March. Adjusted R^2's were much lower than those estimated in the case of the ratio equations. This suggests that the unhedged MSE's for November and March were increasing relative to the hedged position.

Summary and Conclusions

The primary focus of this research is to examine the effectiveness of hedging corn and soybean prices over time. This paper uses several measurements to quantify the changing effect of hedging on the variability of returns. We suggest that *ex-ante* cash expectations should be explicitly incorporated into both portfolio and MSE frameworks. An analysis is performed for the cases where a fixed and known quantity is being hedged.

The analysis suggests several points regarding the effects of hedging over time and also raises several questions. It appears that hedging effectiveness has increased over the sample period. Findings indicate that this increase has been more evident in soybeans than corn and in a relative sense more during the nonharvest period. Second, in terms of *ex-ante* basis forecasting, the accuracy of the alternative methods varies by contract.

During the nonharvest period (i.e., March and July contracts for corn and soybeans), the forward price spread method provides the smallest Theil coefficients. In the harvest period, it is difficult to improve on last year's basis as a forecaster. It is interesting to note that these straightforward methods consistently outperform other more complicated approaches examined in the analysis. Whether these methods (MII and MIV) provide accurate basis forecasts for other samples and commodities should be addressed. If their performance is judged satisfactory, their relative simplicity makes their use attractive.

Third, the use of the basis expectation mechanisms examined in this study had minimal influence on the results of hedging effectiveness over time. That is, the general results regarding hedging effectiveness are invariant to the expected basis used in the analysis. Interestingly, the results also are invariant to whether a routine hedging approach is employed or minimum variance framework is imposed on producer behavior. As mentioned earlier, the similarity in findings may be a function of the short-term nature of the hedging examined. That is, the methods used for generating expected price may have produced rather similar prices. Whether this similarity in results exists for more extended time horizons is an empirical issue which needs to be addressed. The importance of the alternative basis expectations only is manifested in the MSE measure for soybeans. In this instance, the forward price spread and last year's basis methods provide results that are more consistent with the hedging effectiveness measures.

Fourth, there existed a quantitative difference in the strength of the results between the hedging effectiveness measure and the MSE measure. The results of the hedging effectiveness analysis were clear and unambiguous regarding the improved position of the producer with hedging over time. The findings of the MSE analysis, while still consistent with the improved hedging position over time, were not persuasive. The reasons for this difference are not clear. Examination of the components of the MSE ratio measure did not provide any additional insight into the difference. To the authors, this points out that care should be taken in evaluating the benefits of hedging over time. Results may be dependent on the framework employed. It also suggests that further work needs to be undertaken to identify the conceptual differences between these two measures and why this might lead to potentially different implications. Work also should be directed to ascertain whether the differences in findings by method exists for other commodities.

Finally, while the overall conclusions regarding hedging effectiveness do not change across elevators, the differences in the estimated coefficients for individual elevators over time and across commodities suggest that local supply and demand factors and the individual elevator pricing practices have considerable effect on producer hedging potential. Such factors need to be further identified and investigated.

Footnotes

1. The empirical analysis which follows was not limited just to those mechanisms which generate the smallest forecast error.

2. Cluster analysis performed on the effectiveness measures failed, except for elevator 2, to separate the elevators into readily identifiable groups.

3. Hedging effectiveness measures under the assumption of ex-post variance behavior also were generated. Again, while the magnitude of coefficients differed across elevators, the results demonstrated a strong positive relationship between hedging effectiveness and time for both commodities.

4. Due to space limitations, complete results are not presented. Similar to the results discussed for hedging effectiveness, the relationships not presented do not change the nature of the subsequent discussion.

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