AN ANALYSIS OF ANTICIPATORY SHORT HEDGING USING PREDICTED HARVEST BASIS

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The use of the futures market as an aid in marketing farm commodities has been gaining in popularity among producers. Current hedging practices are largely based on average basis or basis movement over some historical time period. The difficulty with this approach is that the year to year variation in the calculated basis is large and using the mean value to predict basis in a given year does not give a highly accurate estimate. The objectives of this study were: (1) to determine if regression analysis could be used to accurately predict the harvest basis at planting time, and (2) to evaluate the performance of alternative hedging strategies using historical average basis estimates versus basis estimates based on regression analysis.

Anticipatory hedging as defined by Working may be carried out either in response to expected future needs (anticipatory long hedging) or in response to expected future sales (anticipatory short hedging) [3]. A producer uses anticipatory short hedging by selling a futures contract(s) before harvest and buying the contract(s) back at harvest when the cash grain is sold. The transactions of an anticipatory short hedge example are summarized in Table 1. The producer's net price ($1.20) is the harvest cash price ($1.15) plus the gain or loss on the futures contract(s) ($.05). Equivalently, net price is the short futures price ($1.25) plus the harvest basis ($-.05). Producers can use the latter relationship to lock-in on a net price any time before harvest if he can accurately predict the harvest basis. With a reliable estimate of harvest basis, this type of hedge may be used to increase price and/or reduce price variability.

The key to successful anticipatory short hedging is the ability to predict the harvest basis. Regression analysis was used to predict the harvest basis at planting time. This predicted basis was then used to predict the net price at harvest. The mean and standard deviation of actual net price for several hedging strategies were computed and compared to evaluate the relative performance of the alternative strategies.

PROCEDURE

The analysis pertained to producers of corn and soybeans in the Richmond, Virginia area. End of month cash prices at Richmond and Chicago, Chicago futures prices, and open interest data were gathered

Table 1. ANTICIPATORY SHORT HEDGING TRANSACTIONS

Cash Grain Transactions	Futures Transactions
April 30 - Plant corn	Sell December future @ $1.25 bu.
October 15 - Sell corn @ $1.15 bu.	Buy December future @ $1.20 bu.
Return of cash corn = $1.15 bu.	Gain on futures = $.05 bu.
Net Price = $1.15 + $.05 = $1.20[a]	

[a]Commission charges are not considered throughout this paper to simplify presentation.

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for the time period 1955 to 1971. Three time periods within a production year were selected to study basis movement between planting and harvest. The periods were chosen to start at alternative planting dates (March 31, April 30, and May 31) and end at approximate harvest date (October 15). With three time periods and two crops, six regression equations were needed to predict harvest basis for each time period and crop.

THE MODEL

The following variable notation was used:

NP = Net price.
RC_1 = Richmond cash price at planting.
RC_2 = Richmond cash price at harvest.
FP_1 = Chicago futures contract price at planting.
FP_2 = Chicago futures contract price at harvest.
B_1 = Richmond basis at planting.
B_2 = Richmond basis at harvest.

The net price received by producers using anticipatory hedging is defined as:

(1) $NP = RC_2 + FP_1 - FP_2$.

Since the Richmond basis at harvest (B_2) is:

(2) $B_2 = RC_2 - FP_2$

the equation for net price (1) reduces to:

(3) $NP = FP_1 + B_2$.

Estimated net price ($\hat{NP}$) at each planting date is determined by replacing B_2 in equation (3) by an estimate of harvest basis ($\hat{B}_2$) obtained through regression analysis based only on information available at planting time.

Thus, estimated net price is defined as:

(4) $\hat{NP} = FP_1 + \hat{B}_2$.

The development of a model to estimate the net price a producer receives for an anticipatory hedge is dependent upon his ability to predict the harvest basis at planting time, since the estimated net price equals the futures price at planting plus the estimated harvest basis.

The estimated Richmond basis at harvest ($\hat{B}_2$) is calculated by adding the initial basis at planting (B_1) to the predicted change in basis ($\hat{\Delta B}$) between planting and harvest ($\hat{B}_2 = B_1 + \hat{\Delta B}$). The predicted Richmond at harvest is then added to the futures price at planting to obtain the estimated net price as indicated in equation (4).

PREDICTING CHANGE IN BASIS

The Chicago basis (Chicago cash price minus Chicago futures contract price) will tend to approach zero as the delivery month of the futures contract is approached since theoretically the cash price and futures price must be equal in the delivery month [1, 3, 4, 5]. The larger the basis is at the beginning of the time period, the more the basis will change as the delivery month is approached. Thus, the change in basis from planting to harvest is a function of the initial basis [3]. Thus, the change in the Richmond basis (ΔB) is a function of the Chicago futures contract price at planting (FP_1) and the Richmond cash price at planting (RC_1), the two variables which determine the Richmond basis. The Chicago cash price at planting (CC_1) and the residual of open interest (OIR) with respect to a linear trend line were also included to reflect the national supply and demand situation.

The futures contract months traded were selected as close after harvest as possible to permit the maximum amount of convergence in the cash and futures prices. The better the convergence the more accurately harvest basis can be predicted as a function of the initial basis at planting. This criterion lead to the selection of the November futures soybean contract and the December futures corn contract.

Open interest in corn and soybeans futures contracts has been growing annually at a rate of 25 to 30% during the time period covered by the study. To eliminate this trend, open interest was regressed against a time trend variable and the residuals of this equation were included as an independent variable in predicting the change in basis.[1] These residuals indicate an above or below normal demand for grain.

Regression analysis was used to predict the change in the Richmond basis that occurs during the time periods using the four variables considered above. That is:

(5) $\hat{\Delta B} = f(FP_1, RC_1, CC_1, OIR)$

where $\hat{\Delta B}$, FP_1, RC_1, and CC_1 are as defined previously and OIR is the residuals of the predictive equations for open interest. The variables FP_1 and RC_1 were used instead of B_1 ($B_1 = RC_1 - FP_1$) in equation (5) since they improved the predictive power of the equations.

The results of the estimated equations for corn and soybeans are shown in Tables 2 and 3 respectively. Most of the variables mentioned above were significant at the 5 percent level with the exception of Chicago cash price in the corn equations and open interest residuals in the soybean equations, therefore these variables were dropped from the respective equations. The corn and soybean equations explain approximately 75-80 percent and 95 percent, respectively, of the variation in change in basis

[1] The simple linear regression explained approximately 70 percent of variation in the growth of open interest contracts during 1955-71.

Table 2. RICHMOND CHANGE IN BASIS EQUATIONS FOR CORN[a]

Time Period	Constant Term	Explanatory Variables FP_1[b]	RC_1[c]	OIR[d]	R^2	d[e]	Sy·x[f]
		Regression Coefficients					
First	49.19	.50599 (2.707)[g]	-.91231 (-5.590)	.000384 (2.121)	.735	1.92	5.26
Second	59.83	.22352 (1.107)	-.73885 (-5.052)	.000456 (2.819)	.814	1.96	4.55
Third	52.76	.45617 (1.863)	-.89485 (-5.531)	.000239 (1.764)	.788	2.17	5.56

[a]The dependent variable is the change in the Richmond basis from the beginning to the end of the time period.

[b]FP_1 is the closing price of the December futures contract on the beginning date of the time period.

[c]RC_1 is the closing Richmond cash price on the beginning date of the time period.

[d]OIR is the difference between actual and predicted open interest as estimated by a linear equation.

[e]d is the Durbin-Watson Statistic.

[f]Sy·x is the standard error of the estimate.

[g]Numbers in parenthesis are t ratios.

Table 3. RICHMOND CHANGE IN BASIS EQUATIONS FOR SOYBEANS[a]

Time Period	Constant Term	Explanatory Variables FP_1[b]	RC_1[c]	CC_1[d]	R^2	d[e]	Sy·x[f]
		Regression Coefficients					
First	13.110	.79892 (11.513)[g]	-.43946 (-4.325)	-.45559 (-4.999)	.959	1.72	2.96
Second	7.676	.81272 (11.835)	-.51459 (-5.707)	-.37336 (6.224)	.971	1.48	2.67
Third	12.21	.88441 (9.488)	-.55506 (-4.093)	-.42285 (-3.724)	.949	1.87	3.71

[a]The dependent variable is the change in the Richmond basis from the beginning to the end of the time period.

[b]FP_1 is the closing price of the November futures contract on the beginning date of the time period.

[c]RC_1 is the closing Richmond cash price on the beginning date of the time period.

[d]CC_1 is the closing Chicago cash price on the beginning date of the time period.

[e]d is the Durbin-Watson Statistic.

[f] Sy·x is the standard error of the estimate.

[g]Numbers in parenthesis are t ratios.

between planting and harvest. The higher R^2 for the soybean equations is due to the futures contract months traded. All futures transactions were in the month of November for soybeans and December for corn. Since the cash and futures markets prices converge as the delivery month approaches, this convergence was better for soybeans since the harvest date of October 15 was closer to the delivery month of soybeans than for corn.[2]

The regression equations indicate that the change in the Richmond basis is directly proportional to the price of the futures contract, and inversely proportional to the cash prices. The higher the futures contract price is at the beginning of the time period, the smaller the negative change in basis. Conversely, the higher the cash prices are at the beginning of the time period, the more negative the basis will change. The coefficient of the open interest variable is positive indicating that if a larger than normal amount of commodity is hedged for the month of delivery of the futures contract, then the basis will have a smaller negative change.

ALTERNATIVE HEDGING STRATEGIES

Four alternative hedging strategies were specified to compare the mean, variation in net price, and difference between actual and predicted net price when harvest basis was predicted by the historical average method versus regression analysis. Unhedged production was used as a base for evaluating the performance of the strategies.

I. Unhedged Production

Under this strategy, the producer does not use the futures market and sells in the cash market at harvest. Expected net price and actual net price are equivalent under this strategy and equal to the harvest cash price.

II. Completely Hedged Production Using Average Basis

This strategy assumes that planting occurs on April 30 and all production is hedged on that date and that the hedge is lifted on October 15. Expected net price is equal to:

(6) $\widehat{NP} = FP_1 + \bar{B}_2$

where $\bar{B}_2$ is the average of the harvest basis for the three previous years. Actual net price (NP) is defined in equation (3).

III. Completely Hedged Production Using Predicted Basis

This strategy is identical to strategy II except that the harvest basis predicted by the regression analysis ($\hat{B}_2$) is substituted for $\bar{B}_2$ in equation (6).

IV. Hedged if Expected Net Price is Greater Than the Average Harvest Cash Price for the Previous Three Years

The decision rule for strategy IV is to hedge if $\widehat{NP} \geq AC_2$ where AC_2 is the average cash price at harvest during the last three years. This strategy attempts to lock-in on expected net prices greater than recent prices in an attempt to guarantee higher returns. If $\widehat{NP} < AC_2$, the producer does not hedge and receives the cash price at harvest.

THE RESULTS

Table 4 contains the mean and standard deviation of actual net price and the standard deviation between expected and actual net price ($S_{\widehat{NP} \cdot NP}$). The data in Table 4 apply only to the second time period, that is hedged placed on April 30 and lifted on October 15.

For corn, the results indicate that strategies II, III, and IV involving use of the futures market produced both higher net prices and smaller standard deviations in net price than realized in the cash market during 1955-71. Strategy III appears to be the "best" strategy of those considered, since it produced the mean price equivalent to strategy II with a much smaller standard deviation between what the producer at planting time expected the net price to be at harvest compared to the actual net price at harvest (6.63 versus 3.97 cents per bushel).[3] This reduction in the standard deviation between expected and actual net price is due to the increased accuracy with which the harvest basis was predicted using regression analysis in strategy III in comparison to using the mean historical basis in strategy II. In contrast to generally accepted thought, strategies II and III indicate that in comparison to cash price alone it would have been profitable to hedge corn production automatically at planting during the time period covered by this study.

The evaluation of the strategies for soybeans is more difficult since all of the strategies involving the futures market (II, III, and IV) reduced actual net price in comparison to cash price, but they also reduced the standard deviation of actual net price. The lower mean price under strategies II, III, and IV is due largely to a generally upward trend in soybean prices over the period of study. Strategy IV generated

[2] The cash and futures prices in markets other than Chicago may not converge to zero as the closing date of the futures contracts approaches, but they will converge to a local average basis reflecting the local supply and demand situation relative to Chicago.

[3] There are many alternative strategies possible and each individual producer selects among the strategies in relation to his own economic situation. Therefore, no attempt is made to identify the "best" strategy.

Table 4. **MEAN AND STANDARD DEVIATION OF ACTUAL NET PRICE PER BUSHEL FOR SELECTED HEDGING STRATEGIES**

Strategy	$\bar{X}_{NP}$	S_{NP}	$S_{\hat{NP} \cdot NP}$[a]	$\bar{X}_{NP}$	S_{NP}	$S_{\hat{NP} \cdot NP}$[a]
			(cents per bushel)			
		Corn			Soybeans	
I	119.00	11.81	-	233.71	31.29	-
II	124.21	7.78	6.63	228.70	22.28	4.66
III	124.21	7.78	3.97	228.70	22.28	2.33
IV	120.93	9.64	6.64	200.26	22.87	11.15

[a]$S_{\hat{NP} \cdot NP}$ is the standard deviation between expected net price and actual net price.

a lower net price than the other strategies since the crop was not hedged in years when expected net price was below the average cash price for the previous three years. If the upward trend in soybean prices continues, the producer will have to decide if the somewhat lower returns (5 cents a bushel) are worth the 9 cent reduction in standard deviation of actual net price.

The most significant differences in Table 4 is that between the standard deviation of expected versus actual net price of strategies II and III for both corn and soybeans. These two coefficients indicate that using regression analysis to predict the harvest basis produces an estimate of expected net price superior to using the mean basis for some historical time period. Assuming the differences between actual and expected net price are normally distributed, strategy III indicates that a producer can lock-in on a price of soybeans at planting time with a 95 percent degree of certainty that he will receive a price within five cents above or below that lock-in price. This compares with a range of approximately 10 cents above or below the lock-in price when a historical mean basis is used to predict the basis in a given year. Even though strategy III indicates the producer can lock-in on a price with considerable certainty in a given year, the year to year variation in actual net price as indicated by its standard deviation will continue to be quite large.

CONCLUSIONS

This study indicates that regression analysis can be used at planting time to predict harvest basis with a considerable degree of accuracy. Using regression analysis to predict the harvest basis produces an estimate of expected net price superior to one obtained using an average basis for some historical time period. In addition, the results indicate that producers in the Richmond, Virginia area can use some simple hedging strategies to their advantage. For corn, it appears producers could both increase prices and reduce price variability by using the futures market. For soybeans, producers could reduce price variability at the expense of somewhat lower returns. Additional research involving more sophisticated hedging strategies and short-run cash price prediction models might indicate even more price enhancement and stability could be obtained by wise use of the futures market.

REFERENCES

[1] Gray, Roger W., and David J. S. Rutledge, "The Economics of Commodity Futures Markets: A Survey," *Review of Marketing and Agricultural Economics,* Vol. 39, No. 4, Dec. 1971, pp. 57-108.

[2] Irwin, H. S., "Seasonal Cycles in Aggregates of Wheat-Futures Contracts," *Journal of Political Economics,* Vol. 43, Feb. 1935, 34-49.

[3] Working H., "Futures Trading and Hedging," *American Economic Review,* Vol. 43, No. 3, June 1953, pp. 544-561.

[4] Working H., "Hedging Reconsidered," *Journal of Farm Economics,* Vol. 35, No. 4, Nov. 1953, pp. 544-561.

[5] Working, H., "New Concepts Concerning Futures Markets and Prices," *American Economic Review,* Vol. 52, No. 3, June 1962, pp. 431-459.