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Implications of Basis Changes to Put Option Trading

by

Brian H. Schmiesing**

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Biographic Information

for

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Brian H. Schmiesing is assistant professor, Economics Department, South Dakota State University. He holds a B.S. from North Dakota State University, M.S. from the University of Kentucky and Ph.D. from the University of Wisconsin. His teaching and research have centered on grain marketing strategies, agribusiness management for cooperatives and strategies for improving risk management by producers.

Implications of Basis Changes to Put Option Trading

Agricultural commodity options are based on futures contracts. Producers buying put options are subject to basis risk. Unlike a storage hedge, a put buyer must be concerned with how the basis changes. Eight basis change scenarios are analyzed to indicate why this is true. In addition, the returns to buying a put are contrasted with a storage hedge. Recommendations are made on how a producer might develop a strategy for when to use a put option versus hedging.

IMPLICATIONS OF BASIS CHANGES TO PUT OPTION TRADING

Option trading on a limited number of domestically produced agriculutral commodities began in October 1984. The most discussed option strategy for producers has been the purchase of put options. The buyer of a put option has the right to sell a specific futures contract at a pre-determined price before the option's expiration. Put strategy proponents have argued that the purchase of the put enables the producer to establish a basement price for the commodity and still have the ability to take advantage of upward price movements (4, 5).

Put options have been advocated as being an alternative to a storage hedge. A put buyer's capital requirement is limited to the premium paid for the option, while a hedger has the possibility of margin calls beyond the initial margin deposit. Hedging limits the producer's ability to benefit from favorable price changes, because hedging substitutes basis variability for price variability. The purchase of a put option limits the amount of downward price risk and enables the producer to benefit from positive price movements.

Is this marketing strategy too good to be true? In a competitive economy, higher potential returns are frequently associated with higher risks. Put options are not an exception to this rule. The put options currently being traded are based on futures contracts. Buying put options does not enable the producer to avoid basis variability.

The profitability of storage hedges and buying puts are both affected by changes in the basis. Campbell has argued persuasively for the clarification of how basis changes affect the relative profitability of put option strategies and hedging (2). The understanding of basis has long been recognized as an essential for an effective hedging program. The level of this understanding by a put buyer must equal or exceed the level required for hedging.

Examined in the paper is how basis changes affect the profitability of option and futures marketing strategies. First, the terminology and concepts related to the pricing of put option premiums are reviewed. Second, the relationships between basis changes and total gross returns to the two marketing strategies are established. Third, eight scenarios for how the basis might change are specified. These specified basis changes are analyzed for their impact on the profitability of hedging or purchasing a put option. Finally, the implications of the analysis for producers are discussed.

Basic Terminology and Concepts of Put Options

A put option has a predetermined futures contract price specified on the option contract. This predetermined price is referred to as the "strike price" for the put. For example, a $6.25 strike price for a Chicago Board of Trade May put option refers to the right to sell a May Chicago Board of Trade soybean futures contract at $6.25 (Table 1).

A number of options with different strike prices may exist for a specific futures contract. In Table 1, three strike prices have been specified and this implies the existance of three put options for the May futures contract. A hedger has to only determine which futures contract month to use in the hedge. A put buyer must both determine the futures contract month and select which put to buy.

The put's purchase price is the put premium. For example, the $6.25 put has an option premium of 33 cents per bushel (Table 1). The size of the Chicago Board of Trade soybean futures contract is 5,000 bushel. Each cent of the put premium has a value of $50.00. Therefore, the buyer of a $6.25 put would have to pay a premium of $1,650 to purchase the put.

Option premiums have two components, intrinsic value and time value. Intrinsic value of the option is the dollar value of the option if the option

Table 1. Put Option Premiums on November 1 with a $6.50 Settlement Price for the May Soybean Futures Contract.[a]

Settlement Price for Futures	Strike Price	Put Premium	Option Delta	Classification of Put Option
	$6.25	22	.36	Out-of-the-Money
$6.50	$6.50	33	.47	At-the-Money
	$6.75	46	.58	In-the-Money

[a]Premiums are in cents per bushel and based on the Black Scholes option pricing model. Assumptions of the model were a price volatility of 20 percent, an interest rate of 14.5 percent, and 166 days till the expiration date of the option.

were exercised immediately. A put's intrinsic value is positive only if the strike price of the option is greater than the current futures contract price. If the strike price is equal to or less than the futures contract price the intrinsic value of the option is zero. Time value simply equals the option premium minus the option's intrinsic value.

A Classification Scheme for Options

Options can be classified into three basic groups: in-the-money, at-the-money, and out-of-the-money (10). This classification scheme is based on the relationship between the strike price and futures contract price. An in-the-money put has intrinsic value and its strike price is greater than the futures contract price. For an at-the-money put the strike price and futures contract price are equal. Out-of-the-money puts are puts, where strike price is less than the futures contract price.

An example of each category of this classification scheme is presented in Table 1. The in-the-money put is the $6.75 put with an intrinsic value of 25 cents and time value of 21 cents. The put buyer could buy a May futures contract at $6.50 and exercise the $6.75 put option to receive $6.75. This would imply a gross return to the transaction of 25 cents which equals the intrinsic value for the $6.75 put. The time value of 21 cents equals the difference between the premium (46 cents) and the intrinsic value of the put (25 cents).

The remaining two options consist entirely of time value, because the intrinsic value of the puts equals zero. A put buyer, who exercised either of these options, would not have a positive return to the transaction. At-the-money options have the largest time value. The $6.50 put is the at-the-money put and has a time value of 33 cents. The $6.25 put is out-of-the-money and the 22 cent option premium consists entirely of time value.

This classification scheme can be directly related to an option concept that must be understood if put options are going to be used effectively as a marketing strategy. This concept is known as delta.

Delta

A put's delta measures the percentage by which the put premium will change if the underlying futures contract price changes (10). Put premiums are inversely related to the futures contract price. A decrease in the futures contract price will result in an increase in the put premium, while an increase in the futures contract price will result in a decline in the option premium. The delta indicates how much of the futures contract price change will be reflected in the option premium.

Delta can be calculated by using a number of different theoretical formulas. Among the most popular being the Black/Scholes model. This formula is simple enough that a calculator can be used to calculate delta (10). A number of microcomputer programs are also available (7, 8, 9).

As delta increases, the percentage of the futures price change reflected in the put premium also increases. For example, a $6.25 option has a delta of .36, while a $6.50 option has a delta of .47. Assume the futures contract price declines by 1 percent. The $6.25 put premium would increase by .36 of a percent and the $6.50 put premium would increase by .47 of a percent.

Delta can range between zero to 1.00. A put option can have a delta indicating no response to a futures contract price change or a 100 percent response to the price change. However, the typical put will have a delta somewhere between these extremes.

Therefore, all put options do not provide the same level of price protection to the put buyer. Buyers of puts with low deltas will not receive the same amount of price protection as buyers of puts with high deltas. Buyers of large

delta puts will experience larger increases in their put premiums if the futures contract price declines. However, the opposite is also true. Increases in the futures contract prices result in the largest premium declines for puts with large deltas.

Basic Characteristics of Delta

The size of the delta can be related to the classification scheme discussed earlier. Out-of-the-money puts have smaller deltas than in-the-money puts. A simple way to remember this fact, is to note that the larger the put premium for a specific futures contract, the larger the delta. As the intrinsic value of the put increases, the larger its delta.

Delta is not constant for a specific put option. Increases in the futures contract price decreases a put's delta. Also, as the amount of time until expiration of the option declines, the delta for out-of-the-money option declines and the delta for in-the-money options increases.

The amount of time until expiration of the option also affects the size of the option premium.

Time Before Expiration

As a put's expiration date approaches, the time value contained in the option premium will decline. The time value contained in an option premium is a deteriorating asset (4). The basic reason for the decline is that the probability of a large futures contract price movement declines as the expiration date approaches. The time value of an option premium is the dollar value of expectations for future price movements. For example, the likelihood of a one dollar increase or decline in a soybean futures contract price is larger nine months prior to the expiration date of the option than when the option's expiration date is only 5 days away. The deterioration of time value represents a cost to the put buyer, that is not paid by a hedger.

Puts are based on futures contracts and the previous paragraphs have discussed how the size of the option premium is related to the futures contract price and time until expiration of the option. However, a producer buying a put option will eventually have or currently has a position in the cash market. Therefore, a producer buying puts must be concerned with basis changes. The next section will describe how basis changes affect the profitability of hedging and buying put options as marketing strategies.

Hedging and the Basis

Hedging involves taking a position in the futures market as a substitute for the cash transaction. A producer having grain in storage may sell a futures contract to hedge the cash position. This type of hedge is a selling hedge and is directed to providing the producer with price protection against a price decline on the inventory owned. The change in the basis determines the effectiveness of the price protection and the gross returns to the hedge. The change in the basis is determined when the cash and futures positions and liquidated i.e. when the grain is sold in the cash market and the futures contract is bought back. The change in the basis equals the basis at the liquidation of the hedge minus the basis at the placement at the hedge.

During the time the hedge is held, the basis can remain unchanged, narrow or widen. If the basis remains unchanged, prices in the cash and futures markets change by exactly the same amount. This "perfect" hedge implies the gains and losses in the two markets exactly offset each other. A narrowing of the basis implies the cash price has strengthened relative to the futures market. If the change in the basis is positive, the basis has narrowed. With a storage hedge, the narrowing of the basis implies a gross profit to the hedger before commissions, margin expense, and storage costs for the grain. A widening of the basis implies the cash price has weakened relative to the futures

contract price. This basis change is negative and implies a gross loss for a selling hedge.

The change in basis determines the gross returns of the hedge. The profitability of the put option strategy depends instead on the change in the cash market and change in the option premium.

Buying Puts and the Basis

The gross returns to the option strategy equal the net change in the cash market price, plus the net change in the put premium during ownership of the put. The net change in the put premium depends upon the futures contract's price movement, the option's delta, and deterioration of the time value of the put. A put option strategy would give the producer the identical result to a hedge only if the put had a delta equal to one and if the time value in the premium equaled zero.

Unlike hedging, the gross returns from buying a put are indirectly related to the basis change. Typically, the put premium will partially reflect the change in the futures contract price. Therefore, how the basis changes has a major impact on the returns of a put option. The next section will describe eight case scenarios of how the basis might change, when a producer owns a put or is using a storage hedge.

Background Information for Eight Basis Change Scenarios

The eight basis change scenarios are based on a situation, where a soybean producer in the western corn belt has 5,000 bushel of soybeans in storage on November 1. The producer has the choice of either buying a put option at the premium levels specified on Table 1 or hedging the soybeans. If the producer buys a May put option, the producer will offset the position in the options market by selling the option on March 1. If the producer uses a storage hedge,

the producer will sell a May futures contract on November 1 and offset the hedge by buying back the May futures contract on March 1. In both marketing strategies, the 5,000 bushels of soybeans would be sold on March 1. In all eight scenarios the May futures contract price on November 1 was assumed to be $6.50.

The basis change analysis uses basis changes between November 1 and March 1. Four of the eight scenarios assumed the basis narrowed by 50 cents. The remaining four scenarios assumed the basis widened by 50 cents.

Four Scenarios of How the Basis Might Narrow

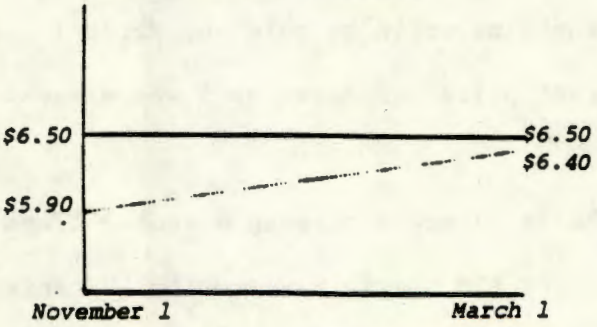
The basis was assumed to narrow by 50 cents from an initial basis of -60 cents on November 1 to -10 cents on March 1 in all four scenarios (Figure 1). The basis was defined as the local cash price minus the May futures contract price. This implies the cash price was 60 cents under the May futures contract price on November 1 and 10 under the May futures contract price on March 1.

The standard scenario of how the basis might narrow 50 cents during a storage hedge is presented in Panel N-1 of Figure 1. This is the scenario that frequently appears in textbooks and trade publications discussing storage hedges (6). The futures price is assumed to remain constant and the cash price improves by 50 cents. All the improvement in the basis can be attributed to the cash market. The underlying logic being that the futures contract price is unbiased and accurate forecaster of future soybean prices. The increasing cash price reflects a positive carrying charge for storing the cash commodity.

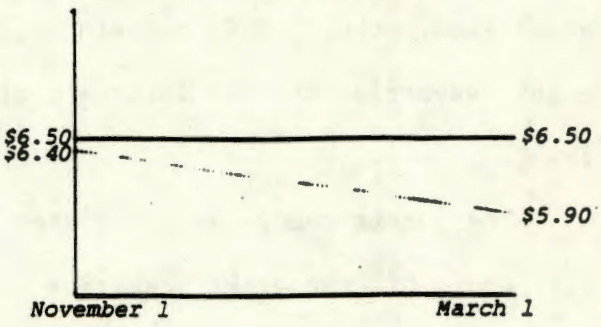
Although the above is the standard scenario, at least three alternative scenarios on how the basis might narrow can be developed. The cash market price can remain constant and the futures market price falls (Panel N-2). Both the futures market and the cash market prices decline, but the futures contract price falls by a greater amount (Panel N-3). Also, the price in both markets

Figure 1: EIGHT SENARIOS OF HOW THE BASIS COULD CHANGE BETWEEN NOVEMBER 1 AND MARCH 1

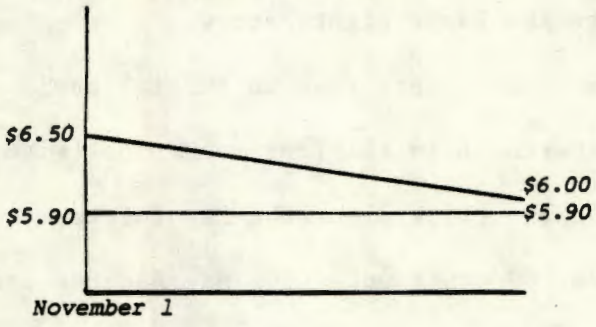
N-1: Futures Price is Constant and Cash Price Increases



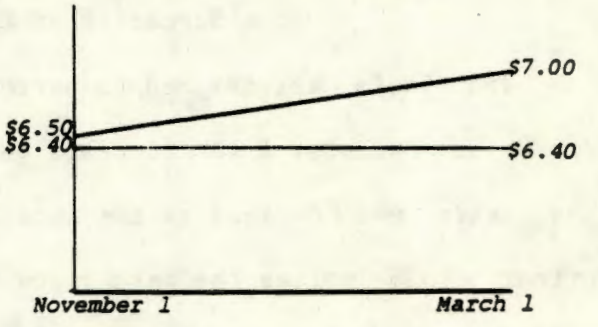
W-1: Futures Price is Constant and Cash Price Decreases



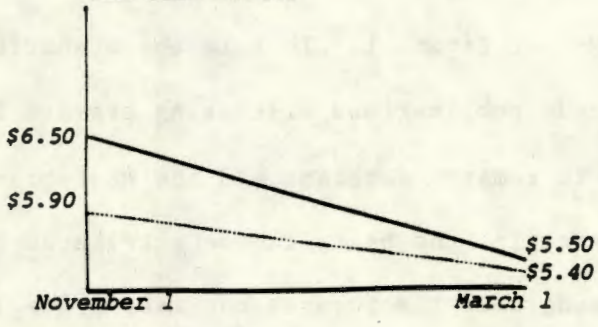
N-2: Futures Price Falls and Cash Price is Constant



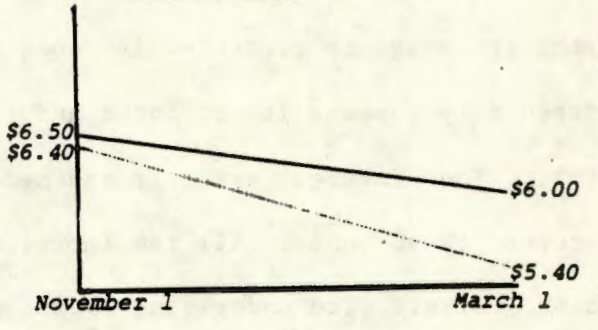
W-2: Futures Price Increases and Cash Price is Constant



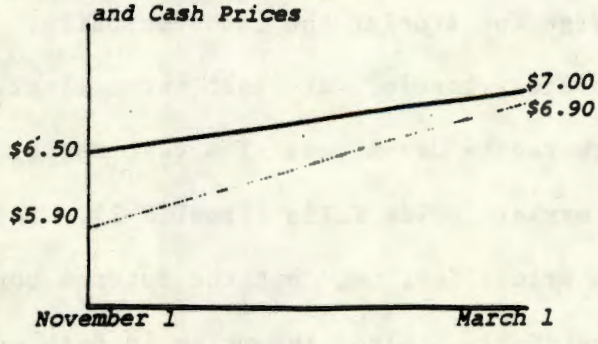
N-3: Declining Futures and Cash Prices



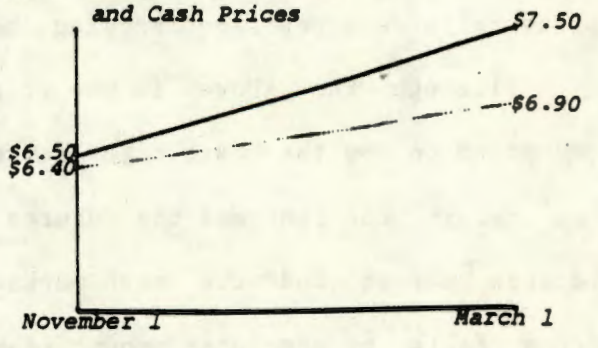
W-3: Declining Futures and Cash Prices



N-4: Increasing Futures and Cash Prices



W-4: Increasing Futures and Cash Prices



Legend: Futures Price ——— *Cash Price* .....

could increase, but the cash price increases by a greater amount than the futures price (Panel N-4).

Four Scenarios of How the Basis Might Widen

In the last four scenarios the basis widened by 50 cents between November 1 and March 1. On November 1 the basis was assumed to be only -10 cents in these four scenarios. The cash price was $6.40 and the May futures contract price was $6.50. The narrower basis on November 1 was assumed, because the potential for a widening of the basis is greater when a narrow basis exists.

The four scenarios of the widening basis do have some similarities to the basis narrowing scenarios. The first scenario, W-1, like the first scenario of the narrowing of the basis assumed the futures price does not change and the adjustment in the basis occurs in the cash market. Because the basis is assumed to widen, the cash price must fall. In contrast, the second scenario assumes the cash price is constant and the 50 cent decline in the basis is caused by an increasing futures contract price (Panel W-2). The third scenario assumes a 50 cent decline in the prices beyond the basis widening. The adjustment in the basis is assumed to occur in the cash market (Panel W-3). The final scenario involves a 50 cent increase in prices beyond the basis change. The widening of the basis is assumed to occur in the futures contract price (Panel W-4).

Other scenarios on how the basis might narrow or widen could be developed. However, the eight scenario's do demonstrate four basic situations, that could occur: (1) all the basis change occurs in the cash market; (2) all the basis change occurs in the futures market; (3) the basis change occurs in downward trending markets; and (4) the basis change occurs in upward trending markets. Analyzed in the next section are the implications of these basis changes to a storage hedge and buying a put.

Description of Analysis

The gross returns to each strategy were analyzed. This was done to clearly demonstrate how basis changes impact on the profitability of storage hedges and buying puts. In the development of actual trading strategies, the analysis should incorporate commissions, margin requirements and storage costs. The analysis examined the returns for a storage hedge and the three put options specified in Table 1.

The gross returns to either marketing strategy can be broken into two parts. The cash market change is independent of the marketing strategy selected. Reported in the first column of Table 2 and the cash price changes for the eight scenarios presented in Figure 1.

This cash market change must be adjusted for the gross returns in the futures market or options market. The gross return to futures position in a storage hedge is the negative of the futures contract price change. In a storage hedge, the hedger is "shorting" the futures market. An increase in the futures contract price results in a gross loss in the futures market position and visa versa.

The total gross returns are presented for all three put options in Table 1. The analysis assumes the puts would be sold before they expire. This implies a proportion of the put premiums will likely be time value. The change in the option premium equals the difference between the premium paid on November 1 and the premium received when the option was sold on March 1.

The total gross return to a specific strategy under each scenario simply equals the sum of the two changes. The narrowing basis scenarios are the first scenarios to be discussed.

Table 2. Gross Returns from Buying Put Options or Hedging Under Eight Scenarios of How the Basis Might Change.

Description of the Basis Change	Change in the Cash Price	Hedging Strategy: Gross Return to Futures Trade	Hedging Strategy: Total Gross Return	Put Option Strategies: Out-of-the-Money $6.25 May Put: Change in the Option Premium	Out-of-the-Money $6.25 May Put: Total Gross Return	At-the-Money $6.50 May Put: Change in the Option Premium	At-the-Money $6.50 May Put: Total Gross Return	In-the-Money $6.75 May Put: Change in the Option Premium	In-the-Money $6.75 May Put: Total Gross Return
BASIS NARROWS BY 50 CENTS FROM A WIDE BASIS OF 60 CENTS UNDER									
N-1 Futures Price Is Constant and Cash Price Increases	.50	.00	.50	- .14	.36	- .15	.35	- .14	.36
N-2 Futures Price Falls and Cash Price Is Constant	.00	.50	.50	.10	.10	.19	.19	.29	.29
N-3 Declining Futures and Cash Prices	- .50	+1.00	.50	.53	.03	.67	.17	.79	.29
N-4 Increasing Futures and Cash Prices	+1.00	- .50	.50	- .21	.79	- .29	.71	.37	.63
BASIS WIDENS BY 50 CENTS FROM A NARROW BASIS OF 10 CENTS UNDER									
W-1 Futures Price Is Constant and Cash Price Declines	- .50	.00	- .50	- .14	- .64	- .15	- .65	- .13	- .63
W-2 Futures Price Increases and Cash Price Is Constant	.00	- .50	- .50	- .21	- .21	- .29	- .29	- .37	- .37
W-3 Declining Futures and Cash Prices	-1.00	+ .50	- .50	.10	- .90	- .19	- .81	- .29	- .71
W-4 Increasing Futures and Cash Prices	+ .50	-1.00	- .50	- .22	.28	- .33	+ .17	- .44	+ .16

A Narrowing Basis Implies Gross Profits in Storage Hedge

In all four scenarios the basis narrowed by 50 cents and this implies a gross profit in the selling hedge. No matter how the basis narrowed the gross profit to the hedge was determined by the basis change. If a producer can adequately forecast the basis change, the producer can obtain an estimate of the potential returns to a selling hedge.

Gross Returns to a Put Strategy

Unlike the selling hedge, how the basis narrows has a major impact on the returns to a put option strategy. The profitability of an option strategy equals the sum of the change in the cash market price and the change in the option premium. No matter which put option is purchased and later sold, the cash market price change will be unaltered. However, each option does have a unique set of returns under the different basis scenarios.

A put option is a deteriorating asset, because the time value of an option declines as the option approaches expiration. In Scenario N-1, the futures market price remained constant, so the put option premiums declined between the purchase and sale of the options. For example, the $6.25 option declined by 14 cents (Table 2). The gross profit of this put strategy would have been 36 cents or 14 cents less than a storage hedge. The largest loss was associated with the at-the-money option, i.e. the put with largest time value on November 1.

In the scenario of a declining futures price and constant cash price, the impact of delta on the profitability of the put strategies was apparent. The narrowing basis was entirely associated with a 50 cent decline for the futures contract. The in-the-money option with the highest delta had the largest premium change. The $6.75 put premium increased 29 cents versus 10 cents for the $6.25 option. The in-the-money put represented the best put strategy but the gross return was still smaller than a hedge.

In the third scenario the cash price declined by 50 cents and futures price declined by $1.00. Again the in-the-money put option provided the greatest price protection and gross profits among the put option strategies.

In the fourth scenario the futures contract price increased and the cash price increased. In this scenario the put option with the largest delta will experience the largest decline in the premium. The out-of-the-money put was the best strategy. Because a put strategy enables the producer to capture the returns of an upward trending market, all the puts had a higher gross return than hedging. If a larger price increase had been specified, the put option strategy would have been even more superior.

The put strategy's variability of the gross returns is partially related to the size of the delta. Out-of-the-money puts have the greatest variability of returns relative to the other two put classifications. But the variability of returns also implies the potential for greater returns if a strong upward price movement occurs in the cash and futures markets. However, in-the-money puts provide a greater level of price protection. This fact was also evident in the widening basis scenarios.

Widening Basis Implies a Gross Loss for a Hedge

A widening basis implies that the cash price has weakened relative to the futures market. If the basis widens by 50 cents, a storage hedge will have a gross loss before commissions, margin expense and storage costs. For hedging the gross return equaled -50 cents for the four scenarios.

Implications of a Widening Basis to a Put Strategy

Again the put option strategies provides the producer with an uncertain outcome for a specific basis change. If the futures price does not change, the put premium will decline because of the deterioration of time value. This loss

of revenue was in addition to a 50 cent deterioration in the cash price for a total gross return of -64 cents (Table 2).

Puts performed better in the scenario where the cash price remained constant and the futures contract price increased by 50 cents. Due to of the inverse relationship between the put premium and futures contract price, the change in the put premium was negative. However, the negative premium changes were smaller than change in the futures market prices. The out-of-the-money option performed the best, because of its low delta. The return was as low as -37 cents for the in-the-money option.

The worst scenario for the put option strategy was when there was a downward trend in the futures and cash markets. A put premium will only partially reflect the price decline in the futures market. A downward trending market and weakening basis is not the type of market in which to buy a put option.

As with the previous increasing price scenario, the increasing price scenario with a widening basis reflected favorably on the put strategy. With total gross returns being favorable for all three option strategies.

Implications for Producers

The major implication is that the purchase of a put option does not guarantee a basement price independent of type of basis change. The size of the basis change and how the basis changed can greatly alter the put strategy's returns. Analyzing historical price information is probably even more important when using of put options than when hedging. Traditional basis charts used in hedging are only part of the information required for the formation of a put strategy. A producer must examine how the basis levels were achieved for the specific futures contract.

A realistic strategy in trading options can not be developed without an adequate understanding of delta. Electronic spreadsheets and available option pricing models must be used to completely evaluate the risks of a put strategy (7, 8, 9).

When should a producer consider using a put option as a risk management tool? The purchase of a put would to be a superior strategy when expectations are for a general improvement in prices and the narrowing of the basis results primarily from an improvement in the cash market prices. The least favorable conditions would be a downward trending market with a widening basis. Also, if profit margins are tight, the put strategy may jeopardize a profit that could otherwise be obtained through hedging.

A possible method for controlling part of the basis risk for a put strategy would be to buy a put option and use a basis fixed contract at a local elevator. This type of speculation would limit the risk to changes in the futures market price and establish a definite basement cash price to be obtained by the producer. However, this strategy would remove the potential returns if the basis narrowed more than planned.

Conclusion

A fundamental difference exists between using a selling hedge and buying a put option. In buying a put option, the producer must also be concerned with HOW the basis change will occur.

Put options are based on a futures contract. A put does not provide producers price protection from declines in the cash market and only partial protection against futures market price declines.

To use put options effectively producers and their marketing advisors must understand delta. The size of delta shows approximately what percent of the price change in the futures contract will actually be reflected in the put

premium. Larger deltas imply a greater degree of protection against downward price trends in the futures market, but limit the returns of the producer if the futures market has an upward price trend.

Effective use of put options requires the put buyer to have at least four essential characteristics. First, the put buyer must understand hedging, the futures market and the factors that determine the size of the option premium. Second, the put buyer must have access to a data base of futures and cash prices. The data base can then be used to determine the historical basis levels and how the basis has changed historically. Third, the put buyer should have access to a computer system or market advisor with a computer system. The computer system enables the put buyer to test how sensative the alternative marketing strategies are to changes in cash and futures market prices. Fourth, the put buyer must know the production costs of the farming operation and its level of risk exposure to price declines. All four characteristics are essential for the development of a marketing plan which effectively manages the price risk of the farming operation.

Frequently puts are presented as being a simple tool for managing price risk. The higher potential returns a put offers over storage hedges does imply the producer has to accept more price risk. A put strategy does not allow the producer to avoid basis risk.

The put option strategy does allow the producer to benefit from commodity price improvements. Put options should be used when producer's market analysis establishes that conditions are correct for this marketing strategy. They represent a useful marketing alternative between speculation in the cash market and hedging.

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