LONG-TERM HEDGING ANALYSIS
FOR SOYBEANS, 1973-95

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Abstract:

The study analyzed a two-year hedge for soybeans in three states trying to capture high prices. The differences in prices received over a 23 year period were not significant when compared to annual hedges or cash sales.

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The theoretical and empirical evidence on hedging agricultural commodities has been

discussed in numerous studies (Wisner; Leuthold, et al.; Working) which suggest that hedging

using the futures market is beneficial. However, the full benefits of the hedging may not be

obtained or evaluated accurately as long as an incomplete futures market exists. Gardner argued

that a futures market may be incomplete due to a missing long-term futures market.   He

evaluated this missing futures market for corn, soybeans and cotton, and found little empirical

support for multi-year futures contracts.   The evaluation was based on decisions to place and lift

hedges at fixed points in time during the Spring and Fall, respectively. However, Gardner did not

evaluate the possibilities of long-term hedging using more flexible decision rules. Three related

studies (Huang, Turner and Houston; French and Turner; Kim and Conley) followed Gardner's

concept but assumed a producer would place a long-term hedge only when prices were favorable.

The distribution of futures prices helped identify opportunities for locking-in a favorable price

above an average multi-year price. They concluded that a strategic rollover hedging strategy has

the potential to increase prices received by producers over a multi-year period. This study applied

similar decision rules. It modified the methodology developed by Gardner to evaluate the risks

and returns of long-term hedging strategies under certain decision rules designed to take

advantage of an unusually high price that occurs during a multi-year period. The geographic focus

of the study was central Illinois, northern Iowa and eastern Nebraska.

Objective of the Study

The objective of the study was to empirically analyze a two-year hedging for soybeans under

special conditions. This was accomplished by developing an out-of-sample or ex-ante decision rule, and deriving a model to compare two-year hedge pricing with cash sales and annual hedging over a 23 year period.

A pivotal assumption in the analysis was a decision maker's perception of historical price levels, and how the hedge decision was based on historical prices. Trying to reasonably reflect decision behavior, the analysis was based on the cumulative frequency distribution of the past four years of prices, relative to a current year, with a trigger price for a hedge set at the upper 10 percent of the distribution. Additional triggers were set at the upper 30 and 50 percent, respectively, to further explore the possibilities.

Methodology

Decision Rules

This study relied on out-of-sample data to develop a decision rule. As an example, Figure 1 represents the cumulative frequency distribution or CFD for November soybean futures prices over the 1987-90 time period. The cumulative probability is on the vertical axis, which gives the probability that an actual futures price from 1987 through 1990 was above a specific price. This CFD shows that the probability was 0.10 that November soybean futures prices were above $7.60 over the 1987-90 time period.

The time period for this study was 1973 through 1995. The first CFD was created using data for 1969-72. The 0.10 probability or 10 percent trigger price was $329.25 which was applied out-of-sample to the following year of 1973. The November futures prices exceeded the trigger price on January 5, 1973 and was $352.25. This was the starting price for placing a two-year hedge over the 1973-74 period. Subsequently, a CFD was created based on 1971-74 data to identify a 10 percent trigger price applied to 1975. The trigger price was $755.75, but during the

2

year November futures did not reach that level and a mid-October cash sale was made. This sequence of creating CFDs and identifying trigger prices continued up through 1995.

It was assumed that if a November futures price for soybeans met the condition for a 2-year hedge before September 20 then a decision maker locks in a price for the expected bushels to be harvested each year for the next two years.   But futures contracts are available only to hedge bushels for delivery at the end of the first year, and not at the end of the second year or beyond. The 2-year hedge for soybeans was specified as follows.   If the futures price before September 20 was higher than the trigger price, then November futures contracts were sold in a quantity equal to expectations for two years of harvested soybeans. On October 15 of the first year the first year crop was sold, with the current November futures contracts being lifted. The next year's expected harvest was then hedged.   Then, on October 15 of the second year, the second year crop was sold, and the hedge was closed.

Multi-Year Hedge Equations

The equations for a two-year hedge and longer given in this section were derived from Gardner's (1989) article on rollover hedging.   In the beginning of a 2-year hedge, two years of expected harvest, each of quantity Q, are sold in the futures market shown as 2Q in Equation 1. One year's harvest is for delivery at the end of first crop year, and the second year's harvest for the end of the second year.   Denote the price of a futures contract traded at time t=0 for delivery at t=1 as $F_{1,0}$.   Then the decision maker's revenue R_O established at t=0 is:

$$(1) \qquad R_0 = F_{1,0}\ 2Q$$

Revenue in the first year, t=1 is given in Equation 2.   At harvest time of the first year, two futures contracts are bought back with the futures price of $F_{1,1}{}^O$, which is the futures price at the end of the first year in October.   At the same time, the first crop is sold for a cash market price on

October 15 of P_1^O. The remaining contract is rolled over by selling next year's futures contract

at price $F_{2,1}^O$. The transaction cost is c times the number of contract traded.

$$(2) \quad R_1 \;=\; -F_{1,1}^{O} 2Q + P_1^{O}Q + F_{2,1}^{O}Q - c2Q$$

Revenue for the second year, t=2, as specified by Gardner is:

$$(3) \quad R_2 \;=\; -F_{2,2}^{O}Q \;+\; P_2^{O}Q \;-\; cQ$$

On October 15 of the second year, the second year hedges are lifted at $F_{2,2}^O$, and the second year's

harvest will be sold in the spot market for P_2^O. The transaction cost for the second year is cQ.

   Revenue for the whole two-year period is the sum of equations 1, 2 and 3.

Generalizing to an n-year long-term hedge LTH where n is 2, 3, or 4 years and dividing by nQ to

express revenue per unit output, the n-year sum is written as:

$$(4) \quad P_{LTH} \;=\; F_{1,0} + \frac{1}{n}\sum_{t=1}^{n}[\,(P_t^{O} - F_{t,t}^{O}) + (n-t)(F_{t+1,t}^{O} - F_{t,t}^{O}) - (n-t+1)c\,]$$

Equation 4 can be translated into Equation 5 for easier interpretation.

$$(5) \quad P_{LTH} \;=\; F_{1,0} \;+\; \frac{1}{n}\sum_{t=1}^{n}[\,B^{O} + (n-t)\,S^{O} - (n-t+1)\,c\,]$$

Where P_{LTH} is the expected price per bushel for the LTH. The term $F_{1,0}$ is the initial futures price

received from selling n crops forward. If receipts are to be perfectly and inexpensively locked in at

t=0, the terms in square brackets must sum to zero. This possibility depends on the following

three main elements. The first is the term B^O which is the contemporaneous cash-futures basis on

October 15 that arises in any short hedge. The second element is the term S^O. This is also a

basis, or a spread on October 15, between the year-ahead futures and the nearby futures price.

The final term is the transactions cost of the hedge.

Data Sources

The November soybean futures prices from the Chicago Board of Trade, reported in Wall

Street Journal, were collected on a weekly basis. The cash prices for No. 1 yellow soybeans in

Nebraska (Omaha), Iowa (North Central) and Illinois (processors), were collected from the

Omaha World Herald, and USDA's Grain Market News. The transaction cost for the hedging is

calculated by adding the brokerage fee and opportunity cost of the margin requirements as

Gardner did. The maximum fee and margin requirements were used in the analysis to reflect the

cost to a small trader.

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Results

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Figure 2 shows cash, annual hedge and two-year hedge prices in Nebraska over the 1973-95 time

period. With the benefit of hindsight, a soybean producer or agribusiness handling grain would see

basis statistics as given in Table 1. Over the 23 year period, the average basis for No. 1 yellow

soybeans at Omaha was 33.0¢ per bushel under the November futures price in mid-October. The

standard duration was 20.3¢ per bushel. The "t" statistic of 7.8 leads to the rejection of the null

hypothesis that the average basis was zero. The average basis for Iowa and Illinois were 46.5¢ and

13.2¢ per bushel under the November futures, respectively, for mid-October. They were non-zero

as well.

The average inter-year spread (not shown in Table 1) was 4.9¢ per bushel and the "t" statistic of

0.4 suggest the average value was not significantly different than zero. However, one standard

Figure 2. Nebraska Soybean Prices for Long-Term Marketing Strategies, 1973-95
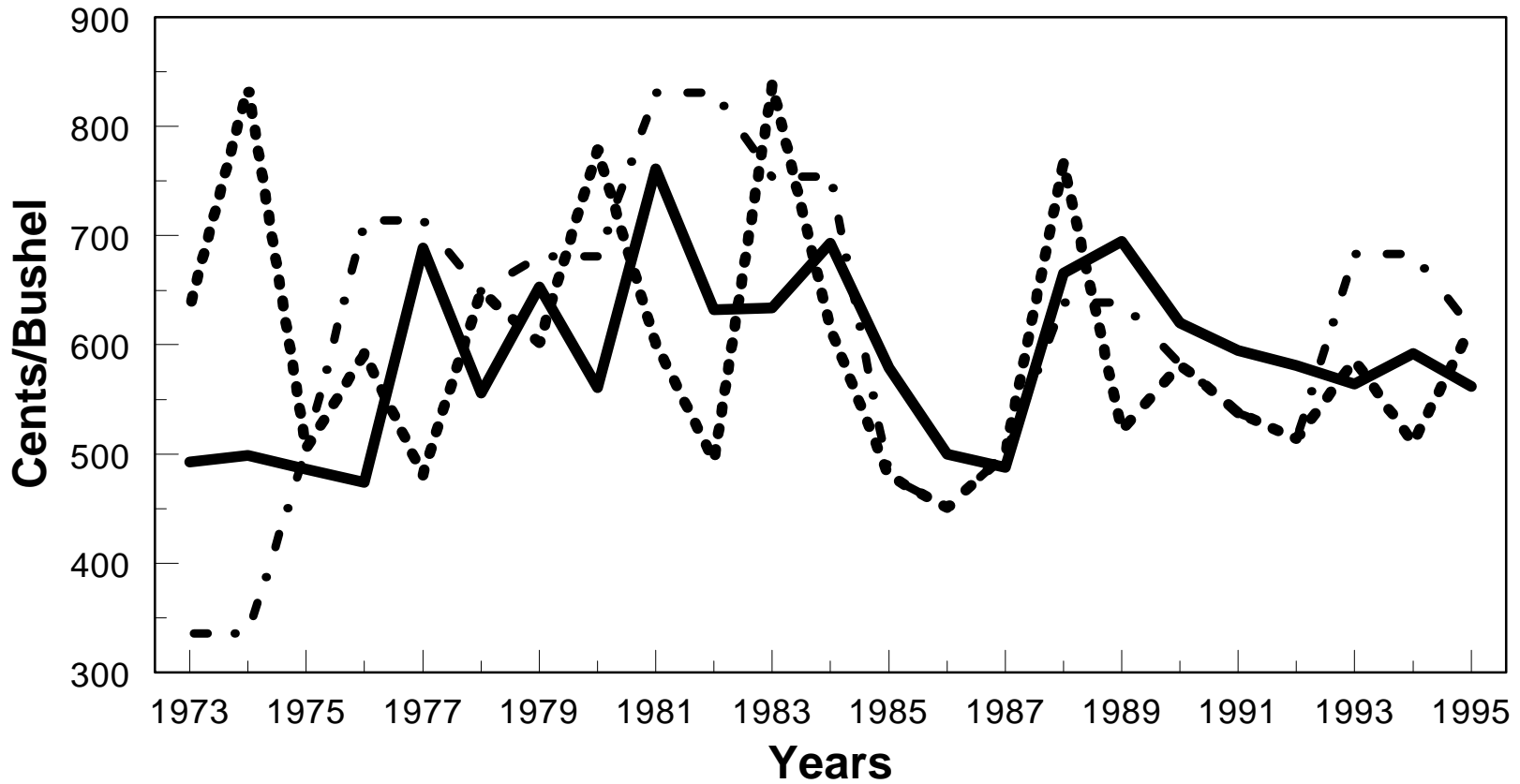
Table 1. Basis, Cash and Hedge Statistics for Soybeans, 1983-95

	Nebraska	Iowa	Illinois
	------------------------- cents/bushel-------------------------		
Basis	-33.0	-46.5	-13.2
Std. Dev.	20.3	19.6	21.6
Cash	595.6	582.0	615.3
Std. Dev.	113.4	113.0	118.2
Annual Hedge	590.6	577.1	610.4
Std. Dev.	79.5	91.0	96.2
Two-Year Hedge - 10%	613.9	600.4	633.6
Std. Dev.	137.5	153.8	158.1
Two-Year Hedge - 30%	596.4	582.9	616.1
Std. Dev.	125.1	140.4	145.3
Two-Year Hedge - 50%	593.8	580.3	613.6
Std. Dev.	120.0	135.8	139.7

deviation of 57.6¢ per bushel along with the range from minus 174.5¢ to plus 95.8¢ shows the amount of variability that occurred from one mid-October date to the next.

Price statistics for the five marketing strategies are also given in Table 1. The average cash price for soybeans at Omaha in mid-October was 595.6¢, and was nominally greater than the average price of 590.6¢ received by placing an annual hedge on the first of May each year. Statistically the two prices were not different. The annual hedge price included a transactions cost of 2.6¢ which,

Figure 3. Expected Price and Standard Deviation of Price for Nebraska Soybeans, 1973-95
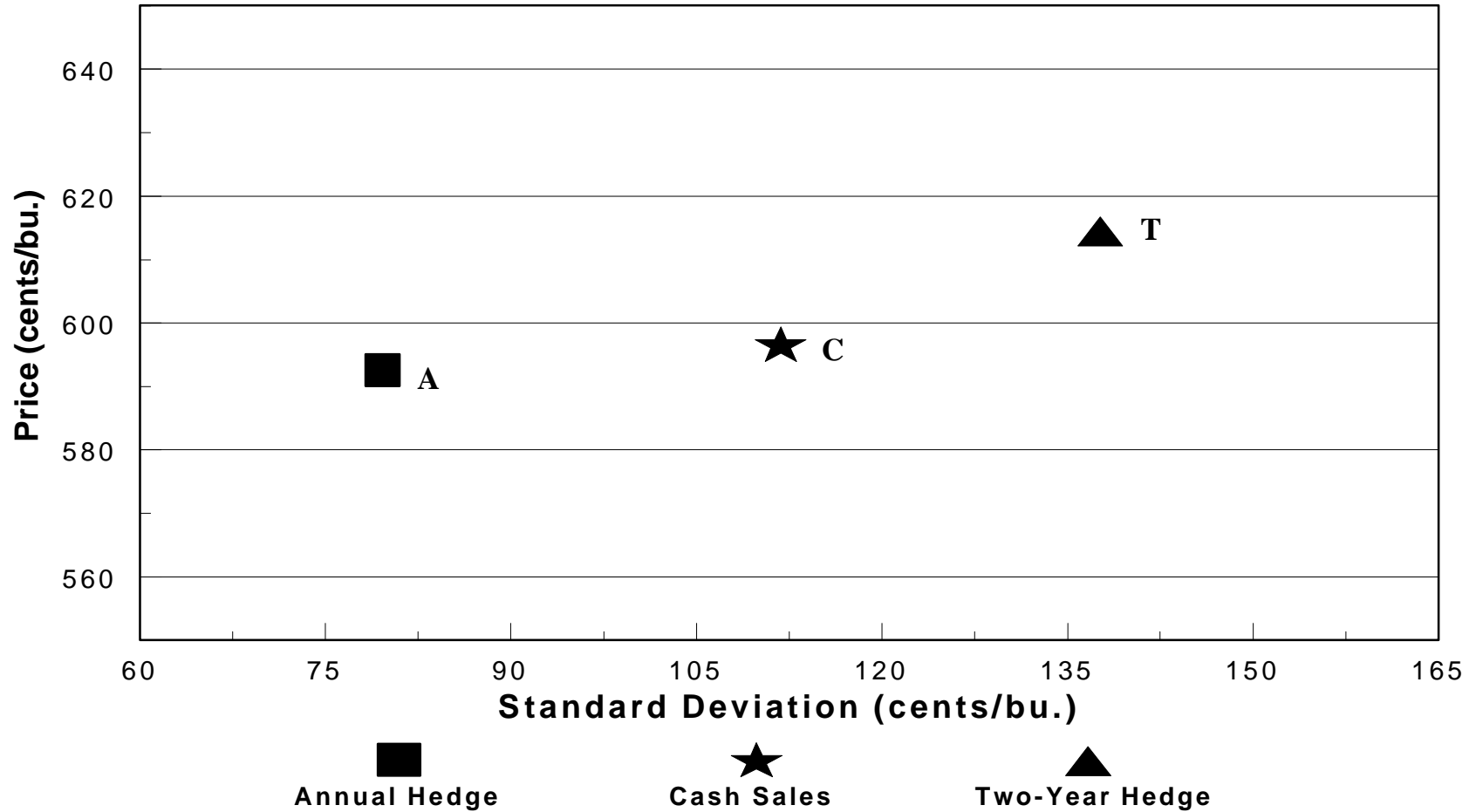
when added back in, would bring the hedge and cash prices even closer together. The nominal variability of cash prices at Omaha was greater than for annual hedge prices as shown by the standard deviation of 113.4¢ compared to 79.5¢, respectively. An "F" test showed the variances were not significantly different.

In Nebraska, the average price for a two-year hedge strategy using a 10% trigger was 613.9¢, and in nominal values looked greater than the average prices for cash sales and annual hedging. Statistically, the two-year hedge average price was no different than the other two price averages. Two-year hedge prices had greater nominal variability, as measured by the standard deviation of 137.5¢, when compared to the other two price series. The difference in variability was statistically significant for two-year hedges versus annual hedges, but not for cash sales. The same statistical results held for the two-year hedges using 30% and 50% triggers, as well.

The average (expected) prices and standard deviations of Nebraska prices are given in Figure 3. The E-V points for the three strategies, graphically shows what was discussed in Table 1. Annual hedging (A) had the lowest nominal price and lowest variability followed by cash sales (C) for both E-V values, and then followed by the two-year hedge -10% (T) strategy. Visually, the E-V figure suggests that to receive a higher average price, a decision maker would end up assuming more risk. However, the visual interpretation is not statistically confirmed because, as discussed earlier, the nominal average prices for the two-year hedge at 613.9¢ and for the annual hedge at 590.6¢ were not significantly different. The variability of annual hedges were significantly different and lower than for two-year hedges. The variability of cash sales were not significantly different than either annual hedges or two-year hedges. While the nominal values given in Table 1 and Figure 3 are different in Nebraska than for Iowa and Illinois, all of the statistical comparisons found for Nebraska hold the same for each of those states.

In general, a risk-averse producer or agribusiness wants to receive the best price with the lowest variability. In this analysis, annual hedging is better than a two-year hedge strategy even when trying to set two-year hedges triggered at a price in the upper 10 percent of past prices.

Conclusions

Over the 23 year period of 1973-95, soybean prices were at times very high caused by a number of uncertain factors. Reflecting on these price patterns over an extended period of time suggests the possibility of trying to capture the benefits of higher prices for more than one year. Hedging over multiple crop years involves additional uncertainties related to supply and demand conditions, and adds the risk associated with inter-year spreads to the basis risk.

The results showed that in mid-October the average basis in Illinois, Iowa and Nebraska was significantly different than zero, and the average inter-year spread on the futures market was not. The results for the three locations also showed that using a high trigger price for a two-year hedge, when applicable, leads to an average price over the 23 years which is no better than for cash sales at harvest, or a simple annual hedge set in May. The variability or risk associated with the two-year hedge was higher than for cashes which was higher than for annual hedging.

One conclusion is that attempts to capture multi-year benefits from a higher price, when it happens even at the upper 10 percent level of past prices, is very elusive. Another conclusion, primarily intuitive versus empirical, is that in the long-run, the underlying conditions for supply, demand, and price determination appear to even out the pricing strategies. In a short-run period, a decision maker may achieve greater price benefits from a multi-year strategy versus a simple strategy, but in a subsequent period may experience losses, which argues for a convergence of pricing outcomes over an extended period. It appears the judicious use of the futures market can reduce the variability of prices, but not for multi-year hedging.

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