Evaluating the Use of Options for Forward Pricing

Soybeans by Illinois Producers in a Risk

and Return Framework

by

Phil Eberle, John R. Harrel, and Lyle Solverson

EVALUATING THE USE OF OPTIONS FOR FORWARD PRICING SOYBEANS

BY ILLINOIS PRODUCERS IN A RISK AND RETURN FRAMEWORK

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Farm marketing has taken on increased importance in the past 10-15 years. Prior to 1970 farm prices were quite stable from year to year and within the year, and the selection of a marketing strategy was not important. Substantial volatility of commodity prices in the 1970's and 1980's has magnified the impact that commodity marketing decisions have had on farm businesses.

Average annual soybean prices received by farmers in Illinois, the monthly high and low prices and the standard deviations of intrayear prices are shown in Table 1 for 1960 through 1983. Average annual price received by farmers was very stable during the 1960's. The low average annual price of $2.36 occurred in 1961 and the high annual price of $2.87 in 1965. There was a range of $.51 per bushel in the average annual price during this 10 year time period. From 1970 through 1983 the low average annual price occurred in 1970 and the high price of $7.79 occurred in 1983. There was a range of $4.83 per bushel during this 14 year time period. Interyear price variability was much greater in the 1970's and early 1980's than during the 1960's.

Intrayear price variability is important to farmers making marketing decisions. Intrayear price variability was quite low in the 1960's. The range in monthly prices averaged $.51 per bushel during this period (Table 1). During the 1970's and early 1980's price volatility within the year was large. A range in monthly prices of $7.06 occurred in 1972. With the exception of 1970 and 1971 the monthly price range was greater than $1.00 per bushel, and the mean range was $2.33. Intrayear price volatility increased and marketing decisions became more important during the 1970's and 1980's.

The objectives of this paper were to evaluate three strategies to forward price soybeans at harvest: sell on the cash market, forward pricing via futures and forward pricing via options for the years 1970 to 1983. Our second objective is to use the information to illustrate how a producer may evaluate which strategy to select for a given year using 1985 as an example.

Methodology

The Marketing Alternatives

This research is concerned with marketing choices used by a producer in Southern Illinois. The marketing choice will be selected based on the returns and risk associated with that choice. For example, in any given year, cash sales may have the highest return; however, over a number of years returns may be low or high, thus the risk may be large.

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Three marketing alternatives are considered: 1) cash sales at harvest, 2) forward pricing via futures and 3) forward pricing via options. The expected relationships between these three alternatives are illustrated in Figure 1. Cash sales are shown as a 45° line. If soybeans are forward

TABLE 1. AVERAGE ANNUAL PRICES RECEIVED BY FARMERS IN ILLINOIS: MONTHLY HIGHS, LOWS, RANGES, STANDARD DEVIATIONS AND COEFFICIENTS OF VARIATION, 1960-1983

	SOYBEANS					
Crop Year	Average Price Received By Farmers ($/bu.)	Monthly Highs ($/bu.)	Monthly Lows ($/bu.)	Range ($/bu.)	Standard Deviation ($/bu.)	Coefficient of variation*
1960	2.47	3.14	1.99	1.15	0.38	15.36
1961	2.36	2.44	2.26	0.18	0.05	2.29
1962	2.46	2.54	2.28	0.26	0.08	3.29
1963	.53	2.70	2.37	0.33	0.12	4.78
1964	74	2.93	2.40	0.53	0.15	5.55
1965	2.87	3.57	2.33	1.24	0.37	12.70
1966	2.75	2.90	2.54	0.36	0.10	3.60
1967	2.54	2.60	2.41	0.19	0.07	2.68
1968	2.50	2.61	2.25	0.36	0.12	4.37
1969	2.51	2.78	2.25	0.53	0.17	6.31
1970	2.96	3.26	2.81	0.45	0.13	4.49
1971	3.20	3.44	2.83	0.61	0.23	7.10
1972	6.15	10.20	3.14	7.06	2.29	37.18
1973	5.99	7.63	5.17	2.46	0.81	13.50
1974	6.05	8.21	4.97	3.24	1.01	16.70
1975	5.23	6.79	4.35	2.44	0.91	17.42
1976	7.02	9.30	5.26	4.04	1.31	18.69
1977	6.09	6.80	5.23	1.57	0.50	8.26
1978	6.95	7.57	6.29	1.28	0.41	5.96
1979	6.48	7.69	5.82	1.87	0.54	8.28
1980	7.52	8.35	6.37	1.98	0.57	7.58
1981	6.07	6.41	5.33	1.08	0.29	4.78
1982	5.93	7.70	5.10	2.60	0.87	11.37
1983	7.79	8.44	6.53	1.91	0.58	7.42

*Coefficient of Variation is equal to $\frac{standard\ deviation}{mean} \times 100$

Source: *Illinois Agricultural Statistics.* Illinois Cooperative Crop Reporting Service, Various Issues.

priced via futures, futures contracts are sold against anticipated soybeans harvested in the fall. In Figure 1, futures contracts are sold at $6.50 per bushel. If the basis problem is not considered, a price of $6.50 is locked in for fall harvest. Forward pricing via the option market is the third alternative considered. For this choice a put option is purchased with a strike price of $6.50 for a premium of $.25. If prices at harvest are below the strike price, the option would be exercised. If prices at harvest rose above $6.50 the option would be allowed to expire and the farmer would receive the cash price less the premium ($.25).

The choice of a market alternative is obvious. If the price at harvest time
was greater than $6.50 per bushel, cash sales is the best alternative. If
the price at harvest time was less than $6.50, forward pricing via futures
is the best alternative. However, Figure 1 demonstrates that forward pricing
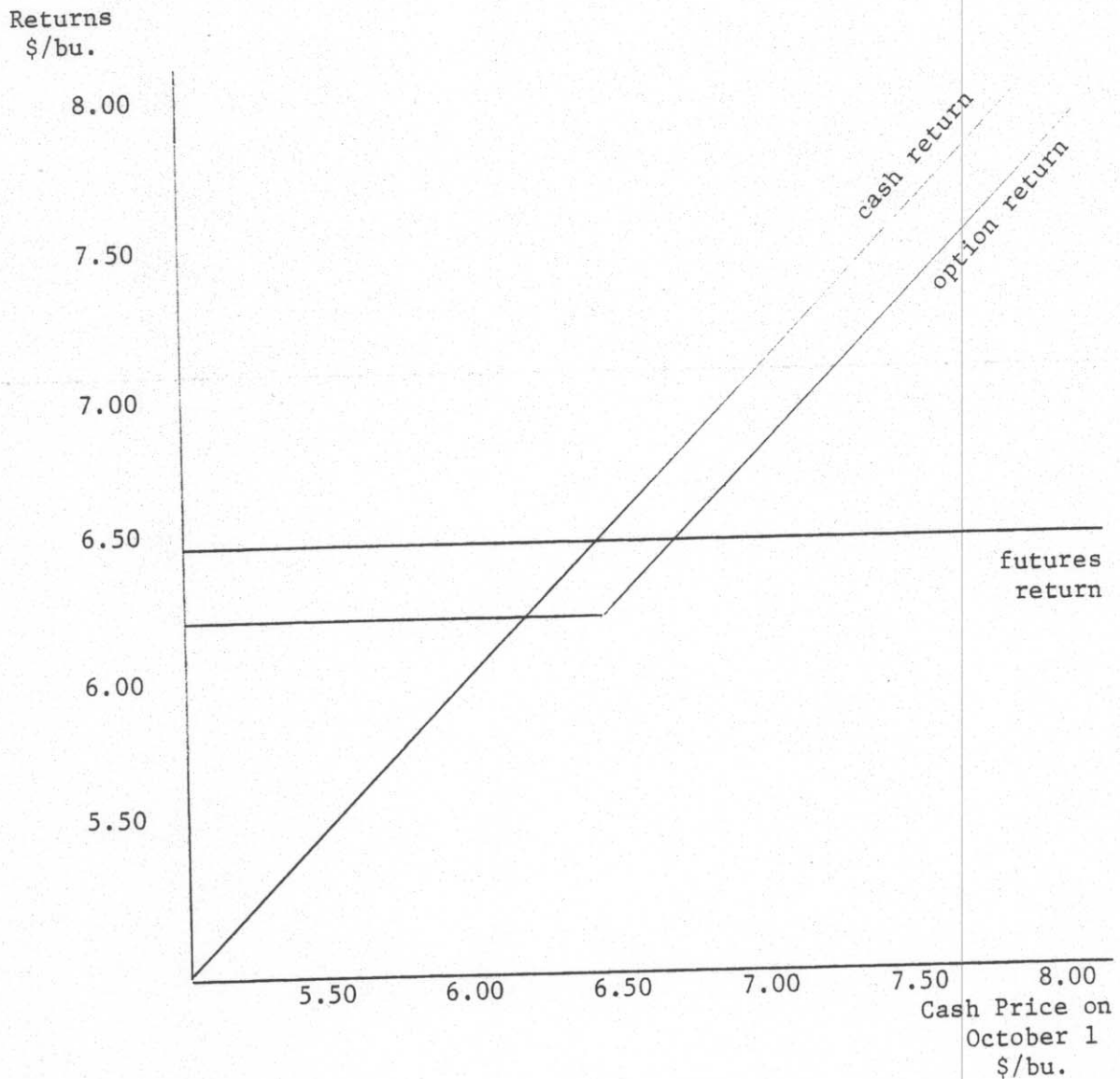
Returns
$/bu.

Figure 1. Relationship between Cash Sales, Forward Pricing
Via Futures and Forward Pricing Via Options

via options is the second best alternative unless the price at harvest is
the strike price plus or minus the premium (in our example between $6.25 and
$6.75). In this special case, forward pricing via options has the lowest
return. If cash price at harvest was $8.00, the producer would receive $8
from a local buyer; If he had forward priced via options he would have allowed
the option to expire and would have received the cash price minus the option
premium ($7.75 per bushel). Forward pricing via futures would have resulted
in a price of $6.50 per bushel. If the price at harvest was $5.00, the
producer would have received $5.00 from a local buyer. Forward pricing via

futures would have resulted in a price of $6.50. If forward pricing was done by buying put options the producer would have exercised the option and would have received the futures price minus the premium ($6.25). If the producer could forecast price with great accuracy he would sell cash if prices were expected to be high at harvest and forward price via futures if he expected prices to be low at harvest. If prices cannot be forecasted accurately, buying a put option is an alternative.

The Model

The three marketing alternatives considered were 1) cash sales, 2) forward pricing via futures, and 3) forward pricing via options. An example of these methods is shown in Table 2 for the 1985 crop year. If alternative 1 is

TABLE 2. A COMPARISON OF CASH SALES, FORWARD PRICING VIA FUTURES, AND FORWARD PRICING VIA OPTIONS, 1985

Date	Alternative 1: Sell To Local Buyer on Oct. 1	Alternative 2: Forward Price via Futures	Alternative 3: Forward Price Via Options
April 1 1985	Do nothing. Expected price = futures - expected basis = $6.05¼ - $.20 = $5.85¼	Sell NOV Futures at $6.05¼ - historical basis estimated at $.20. Expected price = futures - expected basis - transaction costs = $6.05¼ - $.20 - $.03 = $5.82¼	Buy $6.25 NOV put at 31¢. Expected price = strike price - premium - expected basis - transaction cost = $6.25 - $.31 - $.20 - $.03 = $5.71
October 1 1985	Sell to local buyer at $4.96	Sell to local buyer at $4.96 - buy NOV futures at $5.13½. Selling price = $4.96 + ($6.05¼ - $5.13½) - $.03 = $5.84 3/4	Sell cash to local buyer at $4.96. Exercise the option by taking a short futures position. Selling price = $4.96 + ($6.25 - $5.13½) - $.31 - $.03 = $5.73½

selected, the producer does nothing on April 1 and sells to a local buyer on October 1. His expected price on April 1 is the November futures price minus the expected basis on October 1. In this example the expected price was $5.85¼ and the price received on October 1 was $4.96. If alternative 2 were selected the producer would sell November futures on April 1, sell to a local buyer on October 1 and buy back the November futures. His expected price on April 1 is equal to the November futures minus an expected basis minus transaction costs. In this example the expected price was $5.82¼ on April 1 and the price received on October 1 was $5.84 3/4. The third alternative is to buy a put option on April 1 at a $6.25 strike price, the closest in the money strike price. On October 1 the soybeans are sold to a local buyer and the option is exercised. His expected

price on April 1 is the strike price minus the premium minus the expected basis minus transaction costs. In this example the expected price on April 1, 1985 was $5.71 and the price on October 1, 1985 was $5.73½.

These calculations were made for each alternative from 1970-1983. The initial time periods considered were April, May, June, July and August. The harvest time period was October 1 of each year.

The Data

Soybean cash prices were obtained from the Illinois Grain and Livestock Newsletter. These prices represent the cash price received by farmers at interior elevators in the southwestern part of Illinois.

Futures prices were taken from the Chicago Board of Trade Statistical Annuals and The Wall Street Journal. They were the closing prices of the November soybean contract on the days that the hedges were placed and lifted.

Options began trading on soybeans in October of 1984. Since options were not traded between 1970 and 1983 premiums had to be estimated. The premiums were estimated using the Black (1976) formula. We followed the procedure outlined by Wolf and Labuszewski in estimating the premiums. The variables used in the Black formula are: 1) the underlying futures price, 2) the strike price, 3) the time to expiration of the option, 4) the effective interest rate, and 5) the volatility of the underlying commodity. Premiums were estimated at the beginning of the forward pricing period based on the futures price at that time. The strike price selected was that strike price which was in the money and closest to the futures price. The historical soybean price volatility was estimated. The price volatility of the underlying futures contract was calculated by estimating the variance of the logarithm of the ratio of 32 successive days' soybean futures prices up to the day the option was to be purchased. The short-term interest rate was computed from the average discount of a U.S. Treasury Bill which had almost the same time to mature as the option had to expire. These data were obtained from The Wall Street Journal and the Chicago Merchantile Exchange Statistical Annuals. See Table 3 for the calculated premiums.

TABLE 3. PREMIUMS CALCULATED FOR THE NEAREST IN THE MONEY PUT OPTIONS FOR THE MONTHS OF APRIL AND AUGUST

Year	April	August
1970	.21	.21
1971	.15	.15
1972	.15	.11
1973	.88	1.04
1974	.62	.75
1975	.70	.47
1976	.23	.58
1977	.49	.54
1978	.50	.35
1979	.41	.51
1980	.32	.69
1981	.68	.39
1982	.40	.25
1983	.52	.53

The Measurement of Risk

This study simulates a farmer who grows soybeans. The farmer is concerned that the price of soybeans may fall between planting and harvest. To make a production decision in the spring, the producer must form some notion of an expected price. Peck points out that, "after planting the only relevant price variability is that which makes his forecast differ from the actual price" (Peck 1977, p. 238). Specifically, the variation was measured as the amount by which the price received at harvest (the realized price) was lower than the expected price. This difference measures a producer's price risk.

This risk was measured by the Mean Square Loss (MSL). This measurement only used negative differences in realized and expected prices. For example, in 1974 when the realized price was $8.95 and the expected price was $5.33½, the variation was not considered risk--the harvest time price was above expectations. However, in 1975 when the realized price was $5.02 and the expected price was $5.58¼, the variation was considered risk and used in calculating the MSL. The farmer's main concern is when realized price is less than the expected price.

The Mean Squared Loss was calculated as follows:

$$MSL = \frac{\Sigma (RP-EXP)^2}{N}$$

where: RP = the realized price (harvest time price),
         EXP = expected price,
         N = number of years.

Expected and Harvest Time Prices

We considered the results of selling soybeans at harvest using no forward pricing mechanism, forward pricing via futures and forward pricing via options from 1970 through 1983. The farmer's objective is to receive a high price with little risk. Mean prices for each alternative were calculated. Risk is the amount by which realized (harvest prices) were lower than expected prices. The initial time periods considered were April, May, June, July and August. The harvest time period was the first week in October. Only the results of forward pricing in April (prior to planting), and August (the weather influence) are reported in detail (Tables 4 and 5). Summaries are provided for each of the forward pricing months (Table 6).

Results of Marketing Decisions in April and Cash Sales in October

A summary of the cash, futures, and options alternatives are shown in Table 4. Realized prices (RP), expected prices (EXP), and the difference between the two (RP-EXP) are shown for each year from 1970 through 1983. The mean return and the Mean Squared Loss (MSL) are also shown.

On April 1, 1974 the expected cash price was $5.33½, the harvest time price was $8.95. The realized price was $3.61½ greater than expected. When forward pricing via futures was used the expected price was $5.30½. The realized price was $5.18; the realized price was 12½¢ below expectations. When put options were used to forward price, the realized price was $8.31½, $3.50 above

TABLE 4. APRIL EXPECTED PRICES, REALIZED PRICES AND PRICE DIFFERENCES FOR CASH, FUTURES AND OPTIONS. MEAN AND MEAN SQUARED LOSS (MSL)*, 1970-1983

		Cash			Futures			Options	
Year	Expected Price (EXP)	Realized PRICE (RP)	(RP - EXP)	Price (EXP)	PRICE (RP)	(RP -EXP)	Price (EXP)	PRICE (RP)	(RP -EXP)
1970	2.35 1/4	2.65	+ .29 3/4	2.32 1/4	2.29 3/4	-.02 1/2	2.32 1/4	2.42 1/2	+ .10 1/4
1971	2.66 3/4	2.83	+ .16 1/4	2.63 3/4	2.57	-.06 3/4	2.62	2.66 1/2	+ .04 1/2
1972	2.93	3.20	+ .27	2.90	2.87 3/4	-.02 1/4	2.84 1/2	3.03 1/2	+ .19
1973	3.90	5.56	+1.66	3.87	3.60 3/4	-.26 1/4	3.11	4.66 1/2	+1.55 1/2
1974	5.33 1/2	8.95	+3.61 1/2	5.30 1/2	5.18	-.12 1/2	4.81 1/2	8.31 1/2	+3.50
1975	5.58 1/4	5.02	- .56 1/4	5.55 1/4	5.35	-.20 1/4	4.94 1/4	4.74	- .20 1/4
1976	4.55 1/2	5.82	+1.26 1/2	4.52 1/2	4.41	-.11 1/2	4.35	5.57 1/2	+1.22 1/2
1977	6.85 1/4	4.94	-1.91 1/4	6.82 1/4	6.92 1/2	+.10 1/4	6.54 1/4	6.64 1/2	+ .10 1/4
1978	5.65	6.09	+ .44	5.62	5.63 1/2	+.01 1/2	5.26 1/2	5.57 1/2	+ .30 1/2
1979	6.59	6.68	+ .09	6.56	6.56	0	6.36 1/2	6.36 1/2	0
1980	5.94 1/4	7.40	+1.45 3/4	5.91 1/4	5.84 1/2	-.06 3/4	5.69 3/4	7.06 1/2	+1.36 3/4
1981	7.84 1/2	5.91	-1.93 1/2	7.81 1/2	7.71 1/2	-.10	7.34	7.24	- .10
1982	6.12 1/4	4.95	-1.17 1/4	6.09 1/4	6.15 1/2	+.06 1/4	5.86	5.92 1/2	+ .06 1/2
1983	6.39 3/4	8.35	+1.95 1/4	6.36 3/4	6.64 1/2	+.27 3/4	5.98	7.81 1/2	+1.83 1/2
Mean		5.59 1/2			5.12 1/2			5.57 1/2	
MSL		.65			.011			.004	

*MSL = $\frac{\Sigma(RP - EXP)^2}{N}$. The difference (RP - EXP) is used only when RP is less than EXP.

TABLE 5. AUGUST EXPECTED PRICES, REALIZED PRICES AND PRICE DIFFERENCES FOR CASH, FUTURES AND OPTIONS. MEAN AND MEAN SQUARED LOSS (MSL)*, 1970-1983

		Cash			Futures			Options	
Year	Expected Price (EXP)	Realized PRICE (RP)	(RP - EXP)	Expected Price (EXP)	Realized PRICE (RP)	(RP -EXP)	Expected Price (EXP)	Realized PRICE (RP)	(RP -EXP)
1970	2.65 3/4	2.65	- .00 3/4	2.63 3/4	2.61 1/4	-.02 1/2	2.57 1/4	2.54 3/4	- .02 1/2
1971	3.02 1/4	2.83	- .19 1/4	3.00 1/4	2.93 1/2	0.06 3/4	2.87	2.80 1/4	- .06 3/4
1972	2.96	3.20	+ .24	2.94	2.91 3/4	0.02 1/4	2.90	3.07 1/2	+ .17 1/2
1973	7.49	5.56	-1.93	7.47	7.21	-.26	6.45	6.19	- .26
1974	8.38	8.95	+ .57	8.36	8.23 1/2	-.12 1/2	7.95	8.18 1/2	+ .23 1/2
1975	5.59 1/4	5.02	- .57 1/4	5.57 1/4	5.37	-.20 1/4	5.17 1/4	4.97	- .20 1/4
1976	5.61	5.82	+ .21	5.59	5.47 1/2	-.11 1/2	5.26 1/2	5.22 1/2	- .04
1977	4.99 1/4	4.94	- .05 1/4	4.97 1/4	5.07 1/2	+.10 1/4	4.49 1/4	4.59 1/2	+ .10 1/4
1978	5.57 1/2	6.09	+ .51 1/2	5.55 1/2	5.57	+.01 1/2	5.43	5.72 1/2	+ .29 1/2
1979	6.69 1/2	6.68	- .01 1/2	6.68	6.68	0	6.26 1/2	6.26 1/2	0
1980	7.76 1/2	7.40	- .36 1/2	7.74 1/4	7.67 1/2	-.06 3/4	7.32 3/4	7.26	- .06 3/4
1981	6.95	5.91	-1.04	6.93	6.83	-.10	6.63	6.53	- .10
1982	5.67	4.95	- .72	5.65	5.71 1/2	+.06 1/2	5.51	5.57 1/2	+ .06 1/2
1983	7.08	8.35	+1.27	7.06	7.34	+.28	6.73 1/2	7.80 1/2	+1.07
Mean		5.59 1/2			5.68 3/4			5.48	
MSL		.42			.011			.009	

*MSL = $\frac{\Sigma(RP - EXP)^2}{N}$. The difference (RP - EXP) is used only when RP is less than EXP.

TABLE 6. MEAN RETURN AND MSL FOR THE CASH, FUTURES AND OPTIONS MARKETING ALTERNATIVES FOR APRIL THROUGH AUGUST

Marketing Alternative	April Return ($/bu.)	MSL	May Return ($/bu.)	MSL	June Return ($/bu.)	MSL	July Return ($/bu.)	MSL	August Return ($/bu.)	MSL
Cash	5.59 1/2	.65	5.59 1/2	.68	5.59 1/2	.63	5.59 1/2	.33	5.59 1/2	.42
Futures	5.12 1/2	.011	5.12	.011	5.26 1/4	.011	5.35	.011	5.68 3/4	.011
Options	5.57 1/2	.004	5.59 3/4	.001	5.61 1/4	.006	5.53 3/4	.008	5.48	.009

the expected price. In 1974 the price received by the farmer was higher when cash sales were made at harvest. The option price was below the cash price by approximately the premium and the futures alternative was considerably lower.

In 1977 forward pricing via futures yielded a price of $6.92½, cash sales a price of $4.94, and forward pricing via options a price of $6.64½. Again, the option alternative was second best, but very close to the best alternative.

The mean price over the 14 year time period was $5.59½ for cash sales, $5.12½ when forward pricing was done via futures, and $5.57½ when forward pricing by buying put options. If the risk of receiving a price at harvest that is substantially below harvest time prices (1977, 1981, and 1982) is not important, sales at harvest look very attractive as compared to forward pricing via futures and somewhat better than buying put options. When risk is measured by the MSL, risk is much higher for cash sales than for forward pricing via futures or options.

Results of Marketing Decisions Made in August and Cash Sales in October

A summary of the cash, futures, and options alternatives are shown in Table 5. Realized prices (RP), expected prices (EXP) and the differences between the two (RP - EXP) are shown for each year from 1970 through 1983. The mean return and the Mean Squared Loss (MSL) are also shown.

August is an important month for the soybean crop. August is generally considered a weather month. Prices may be, and often are, bid up on rumors of dry weather. The mean price received when cash sales were made was $5.59½ and the MSL was .42. When forward pricing via futures was done in August the mean price was $5.68 3/4 and the MSL (the measurement of risk) was considerably lower than for cash sales. Forward pricing with options had the lowest mean price of the three alternatives in August.

Summary of the April Through August Marketing Decisions

A summary of the marketing decisions are shown in Table 6. The mean price and the MSL for each marketing decision is shown for each month.

The mean return for cash sales at harvest time was higher than the mean returns for the two forward pricing techniques three out of five months. Risk, as measured by the MSL, was consistently the highest for cash sales. This means that the risk of receiving a price lower than expected was the greatest for cash sales.

Forward pricing via futures produced lower mean returns in most months than the other two alternatives. The mean return for the futures alternative was substantially lower than cash sales and the options strategy in the early months (April, May, June and July).

Selections of Alternative Soybean Marketing Strategies Based on Returns and Risks

This section illustrates how producers with different attitudes toward risk and different abilities to withstand risk can evaluate pricing strategies. The 1985 crop year is used as an example. In order for producers to evaluate the tradeoff between risk and returns, they must consider price possibilities

of each strategy or the distribution around the expected futures price for each strategy. The price distribution about the expected cash price is based on the relationship between realized price and expected price from 1970 to 1983. The distribution around the expected futures price is based on the 1970 to 1983 differences between the actual October basis and the expected October basis. Once the distributions for cash prices and basis are calculated, the price distribution for options is calculated by subtracting the premium plus transaction costs from the cash price when the cash price outperforms futures. When futures outperforms cash, the option price is calculated by subtracting the premium and the difference between the strike price and futures price from the futures price. The forward marketing strategies for pricing soybeans in October are examined for the months of April and August.

Forward Pricing in April

Our producer begins by estimating the expected price as presented before in Table 2. Our producer, realizing that using the futures price and the historical basis has not always resulted in the best forecast of October soybean prices, then constructs the possible price possibilities around the expected cash and futures price. The possible cash prices for October are found by using the ratio of realized October price to expected October cash price for the years 1970 to 1983. To estimate the price possibilities for forward pricing via futures, the differences between the actual October basis and the forecasted basis for the years 1970 to 1983 are subtracted from the expected price. These price ratios and basis differences appear in Table 7.

TABLE 7. REALIZED TO EXPECTED CASH PRICE RATIOS AND DIFFERENCES BETWEEN ACTUAL AND PREDICTED OCTOBER BASIS FOR THE YEARS 1970 TO 1983

| Year | Cash Price Ratios | | Basis Difference |
	April	August	
1970	1.13	1.00	-.03
1971	1.06	.94	-.07
1972	1.09	1.08	-.02
1973	1.43	.74	-.26
1974	1.68	1.07	-.13
1975	.90	.90	-.20
1976	1.28	1.04	-.12
1977	.72	.99	.10
1978	1.08	1.09	.02
1979	1.01	1.00	.00
1980	1.25	.95	-.07
1985	.75	.85	-.10
1981	.81	.87	.06
1983	1.30	1.18	.28

From these price ratios and basis differences a cumulative probability distribution was created for October cash prices and forward pricing via futures. The price possibilities for forward pricing via options is constructed by subtracting the April 1st premium of $.31 on a November put option plus $.015 transaction fee from the cash price when cash outperforms futures and by subtracting the premium of $.31 less the difference between the $6.25 strike price and the April 1 November futures price of $6.05¼ from the futures price. These prices and their associated cumulative probabilities for forward pricing in April are shown in Table 8 and Figure 2.

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TABLE 8. CUMULATIVE PROBABILITY DISTRIBUTIONS FOR EXPECTED OCTOBER 1985 SOYBEAN PRICES

Cumulative Probability	April			August		
	Cash	Futures	Options	Cash	Futures	Options
.07	4.22	5.56	5.45	3.79	4.82	4.70
.14	4.41	5.62	5.51	4.35	4.88	4.76
.21	4.73	5.70	5.58	4.46	4.96	4.84
.29	5.26	5.71	5.59	4.59	4.97	4.85
.36	5.93	5.72	5.61	4.79	4.98	4.86
.43	6.21	5.76	5.88	4.87	5.01	4.90
.50	6.31	5.76	5.98	5.06	5.01	4.90
.57	6.39	5.80	6.06	5.10	5.06	4.94
.64	6.59	5.80	6.26	5.10	5.06	4.94
.71	7.29	5.82	6.96	5.30	5.08	4.98
.79	7.47	5.84	7.15	5.46	5.10	5.14
.86	7.63	5.88	7.31	5.52	5.14	5.20
.93	8.34	5.92	8.01	5.58	5.18	5.26
1.00	9.81	6.10	9.49	6.03	5.36	5.71
Mean Price	6.47	5.78	6.49	5.00	5.04	5.00

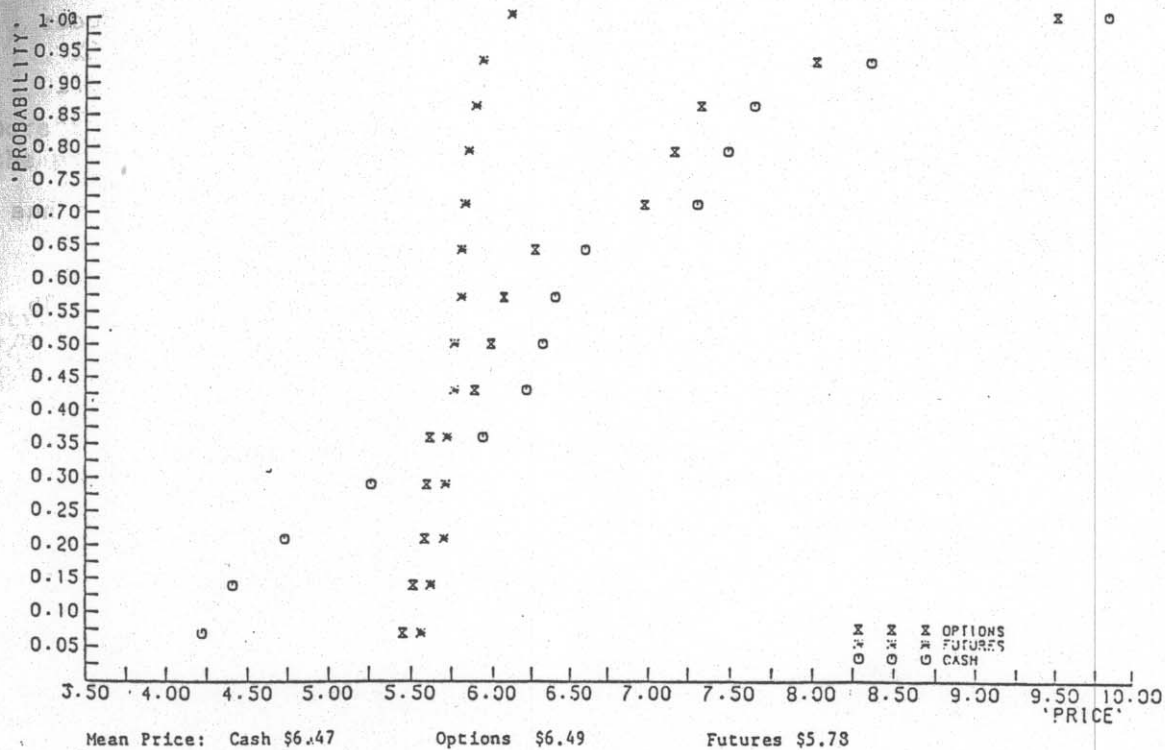Mean Price: Cash $6.47   Options $6.49   Futures $5.78

Figure 2.   Calculated Probability Distribution for October 1985 Soybean Prices in April

From these probability distributions it is possible to estimate a mean price for each alternative.

Our producer can now examine the risk and returns from each marketing strategy. A greater price variability for the cash marketing strategy is clearly shown in Figure 2. Cash prices range from $4.22 to $9.81. Forward pricing via futures has the least price variation with prices ranging from $5.56 to $6.10. The variability in futures is a result of the variation in the October basis. Forward pricing via options, as expected, offers a range of prices greater than futures but less than cash. The range is from $5.45 to $9.49. The mean price for the cash, options and futures alternative is $6.47, $6.49 and $5.78, respectively. The mean price for options is the highest but only slightly higher than cash.

Our producer, being rational and risk adverse, prefers forward pricing via options over cash sales. Returns are as high for options but risk is less. Whether our producer prefers options over futures depends on how risk adverse our producer is. By selecting futures our producer could further reduce his risk of receiving lower prices but would forego a higher mean price.

To determine whether to select the options or futures strategy our producer considers his ability to assume risk. If our producer has $95 an acre in production cost, requires another $30 an acre to meet family living expenses and expects an average yield of 35 bushels an acre, he would require $3.57 to meet production and family living expenses. If he has no outstanding debt, then there is no problem in meeting this price goal no matter which marketing strategy is selected. So our producer selects the strategy providing the highest mean profit potential, forward pricing via options. If our producer on the other hand had an average investment of $1500 an acre and had a 40% debt to asset ratio which resulted in principal and interest payment of $71 an acre, then he would need a price of $5.60 a bushel to meet his financial obligations. If our producer adopts a safety first criteria that he will not select a strategy with more than a 25% chance of being below $5.60, our producer would select forward pricing via futures because this alternative has less than a 14% chance of being below $5.60. Cash and options have a 29% chance of falling below the $5.60 breakeven price. If the price fell below $5.60 the expected loss of the options strategy is $.06 3/4 a bushel or $2.36 an acre. The expected loss with cash would be $1.02 1/4 a bushel or $35.70 an acre. The loss with the cash would increase our producer's debt to asset ratio by approximately 2.4%, assuming the loss was financed by additional borrowing, or would have wiped out his family living allowance.

It would appear that given our probability distribution about the April price that forward pricing via options is the preferred strategy unless certain producers have safety first criteria that cannot be met by the options strategy. It should be noted again that options were considered only at the nearest in the money strike price. If our producer desired to reduce risk further, he could do so by buying a November put with a strike price higher than $6.25.

Forward Pricing in August

The cumulative probabilities for forward pricing in August appear in Table 8 and Figure 3. The range in prices for the cash and options strategies has narrowed with the approach of the harvest month. Forward pricing via futures has the highest mean price of $5.04 with cash and forward pricing via options having a $5.00 mean price. Futures is the preferred strategy having a slightly higher mean price and the least risk. One would expect as we approach October
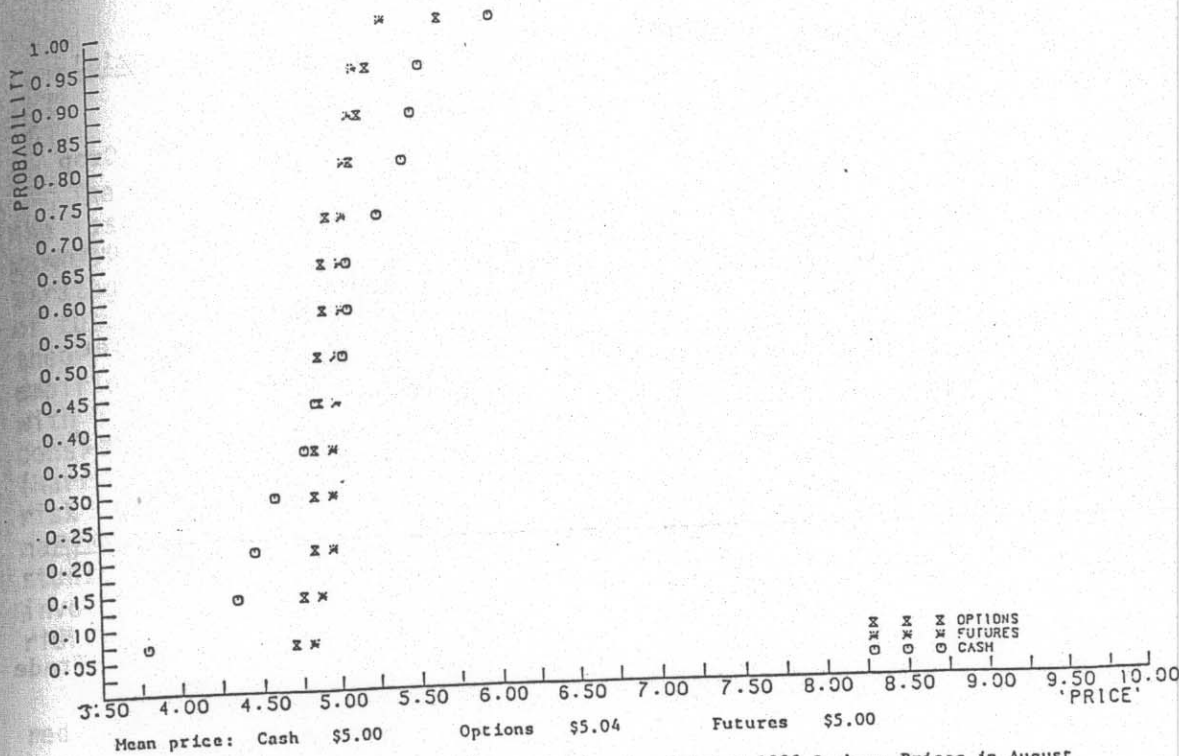
Figure 3. Calculated Probability Distribution for October 1985 Soybean Prices in August

more is known about the prospective crop, thus the variability is reduced and the price difference between the three strategies is less.

Summary and Conclusion

The objective of this paper was to compare three forward pricing strategies: selling on the cash market, forward pricing via futures and forward pricing via options in a risk and return framework. Because options in soybeans were not traded before 1984, option premiums were simulated by use of the Black model for the years 1970 to 1983. For any given year the option strategy is the second best, but over a period of time the option strategy can have the highest or nearly the highest average price. These were our findings for the months of April, May and June. The risk of forward pricing is the difference between the realized October price and expected price at the time of forward pricing. Because our producer is concerned about possible losses (realized price being less than expected price), risk was measured as Mean Squared Loss (MSL). For the time period 1970 to 1983, forward pricing via options and forward pricing via futures had the lowest MSL.

Finally it was demonstrated how the historical ratios between realized and expected cash price and the historical differences between the actual and predicted October basis could be used to generate cumulative probability distributions around the expected price for the cash and futures strategies. With these distributions a cumulative probability distribution for forward pricing via options is constructed. With these price distributions a producer can evaluate the risk and returns of each strategy.

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