ANALYSIS OF SOYBEAN OPTIONS

MARKETING STRATEGIES

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ABSTRACT

This paper examines the returns and risk of soybean marketing strategies using futures and options. Two conclusions were suggested by the results. First, adding options strategies to traditional cash sales, static futures hedging, and storage hedging activities substantially improves risk-return tradeoffs. Second, adding technical futures hedging strategies to options hedging strategies further improves risk-return tradeoffs.

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Prior to the 1970's, farmers faced a relatively stable grain market and did not need sophisticated marketing strategies to secure a satisfactory price. However, the volatility of commodity prices in the 1970's and early 1980's focused attention on the need for risk-reducing marketing strategies. In response, a voluminous literature on marketing strategies has been produced. Examples include Kenyon and Cooper (1980) Purcell and Riffe (1980), Gorman, Schuneman, Catlett, Urquhart, and Southward (1982), and Bailey and Richardson (1985). These studies examined various marketing strategies using futures contracts. A significant new marketing alternative is available to farmers -- agricultural options contracts.

Two types of agricultural options are traded, puts and calls. A put option protects the buyer from a price decrease while leaving open the possibility of profiting from price increases. A call option provides just the opposite protection. Research is needed on the role of agricultural options in marketing strategies. Therefore, the purpose of this paper is to compare the returns and risk of soybean marketing strategies employing futures and/or options during the period from 1978 through 1983.

Following sections discuss risk theory, marketing strategies with and without options, results, and summary and conclusions.

Risk Theory

Modern risk theory can be traced to the development of the mean-variance (EV) model by Markowitz (1959). The EV model defines risk as the squared deviations of realized returns from expected returns. A related model, the mean-absolute deviation model (MOTAD), was developed by Hazell (1971). The MOTAD model defines risk as the absolute value of deviations of realized returns from expected returns. The MOTAD efficient set approximates the EV efficient set under the condition of normality of returns. MOTAD has the computational advantage of being specified as a linear programming model.

Both the EV and MOTAD models penalize positive deviations from expected returns. This assumption has been criticized by, among others, Markowitz (1959). For example, if several returns close to the mean and one return substantially greater than the mean are realized, then the activity could be considered relatively risky based on a variance or absolute deviation criteria. This distinction is especially important with respect to options strategies, which by definition generate skewed return distributions (Bookstaber and Clark, 1981). As a result, the application of either the EV or MOTAD model to options research is not likely to be valid.

A model that does not equally penalize positive and negative deviations is the mean-semivariance (SV) model, where risk is defined as the squared deviation of realized returns below expected, or target, returns. A linear alternative of mean-semivariance analysis is the Target MOTAD model. Like SV, Target MOTAD utilizes the negative deviations from a target income as the risk criterion. However, the Target MOTAD model calculates the absolute value of the negative deviations, thus allowing the use of a linear programming algorithm. The general form of Target MOTAD as formulated by Tauer (1983) and Watts, Held, and Hemers (1984) is as follows:

$$\text{maximize} \quad rx \qquad (1)$$

$$\text{subject to:} \quad Ax \geq \text{ or } \leq b \qquad (2)$$

$$T - Rx - y^- \leq 0$$

$$vy^- = D$$

$$x,\ y^- \geq 0$$

WHERE:

v = a 1 by s vector in which each element is "1/s" and s is the number of states of the world;

A = an m by n matrix of technical coefficients, where m is the number of constraints and n is the number of activities considered;

x = an n by 1 vector of activity levels;

b = an m by 1 vector of resource constraints;

y^- = an s by 1 vector of the absolute value of sub-target income deviations;

R = an s by n matrix of actual income for all activities for the s states of the world considered;

0 = a column vector of appropriate length (s or n, composed of zeros;

T = an s by 1 matrix in which all elements are the fixed per unit return target;

D = a scalar representing average deviations below the fixed income target;

r = a 1 by n vector of expected income for each activity.

By varying the scalar parameter D from zero to an unbounded solution an efficient frontier of marketing portfolios can be generated. Tauer (1983) has shown that portfolios on the Target MOTAD efficient frontier are free of any distributional assumption and are second degree stochastic dominant. Both of the previous attributes of the Target MOTAD model are highly desirable for empirical research on efficient marketing portfolios.

Simulation of Soybean Marketing Strategies

The soybean marketing strategies were assumed to be available to a Nebraska soybean producer. Five alternative groups of activities comprise the set of 115 strategies. These marketing groups consist of cash sales, static hedges, static hedges based upon a "cost plus" objective price, hedging on technical factors (moving averages), and put options. For each group of marketing activities, several combinations of starting dates and sale dates were examined. This involved the preharvest, harvest, and postharvest pricing and marketing of the soybeans. All groups also examined storage and non-storage sales.

The gross price derived for each marketing activity was determined from the Chicago Board of Trade price series. Each price was then adjusted to reflect storage costs (if any) including opportunity cost on unsold grain. Marketing strategies involving any futures contracts incurred commissions and margin costs. Futures trading profits (losses) received from all round turns during the marketing period were added to (subtracted from) the gross price received. The premium cost of put options was also deducted from the gross price. All strategies were adjusted to reflect the prevailing Nebraska basis for each period of sale. Net prices received were adjusted for inflation (1983 = 100).

The cash sale strategies consisted of four marketing activities. These strategies involved the sale of soybeans at the current cash price at alternative points during the year. These strategies did not involve any presale pricing or hedging. The commodity was sold at harvest or after a period of storage. The sale dates examined were the first week in November, January, March, and May.

The static hedge group of marketing strategies consisted of eighteen alternatives. Each strategy involved the placement of a short hedge at the same time period every year regardless of the prevailing futures price. Preharvest, harvest, and postharvest pricing periods were examined. The hedges were subsequently lifted in either the first week of November (harvest), January, March, or May.

The "cost plus" marketing activities identified a specific objective price based upon the producer's cost of production and a residual return. Twenty six cost plus strategies were examined. If a hedge is made at the objective price, the producer is assured of receiving a net price that covers their cost of production, storage, a return to management, and an adjustment for the local basis. If the objective price is not reached in the futures market, the producer remains unhedged until the predetermined marketing date, at which time the prevailing cash price is accepted. Pricing was initiated in the months of January, March, May, and July. Marketing dates examined were November, January, March, and May.

The largest group of marketing strategies examined involves the use of select market information (technicals) to aid in the forecast of future price movements. Fifty-five activities required the multiple placing and lifting of hedges depending on the relative magnitudes of two weekly moving averages. However, the use of moving averages as a marketing tool may be considered more speculative in nature because the producer at times may be "long" in the cash market (that is, in a position of holding unhedged grain). The weekly averages utilized were the 3, 5, 10, and 15. Several combinations were examined (i.e. 3 and 5 or 3 and 10 etc.). As previously mentioned, several starting dates and marketing dates were investigated for each combination of moving averages.

The final twelve marketing strategies utilized soybean put options. Due to the recent introduction of trading, put options premiums were unavailable over the study period. The studies by Jordan, Seale, McCabe, and Kenyon (1985) and Hauser and Neff (1985) suggest that Black's (1976) model performs reasonably well in pricing soybean options. Therefore, Black's model was used to simulate put options premiums. The formula is,

$$P = -e^{-rt}[F \times N(-d_1) - E \times N(d_2)]$$

where

$$d_1 = [\ln(F/E) + (\sigma^2/2)t]/\sigma(t)^{1/2}$$

$$d_2 = d_1 - \sigma t^{1/2}$$

and p = premium price for a put option

F = the price of the underlying futures contract

r = riskless interest rate per period

E = exercise price

t = number of time periods to expiration

σ = standard deviation of the percent change per period in the price of the underlying commodity

N(d) = value of the cumulative standard normal probability function around d

The interest rate on six-month U.S. Treasury bills was used as an estimate of the riskless interest rate. The fifty trading days previous to valuation of an option were used to estimate the volatility of futures prices.

Different option exercise prices and marketing dates were examined. Purchase dates were the first week of May, July, and November while sale dates included harvest and March. Two price objectives for exercise prices were investigated. Exercise prices of cost plus ten percent profit plus basis plus storage cost (if any) and at-the-money were employed to price the option. Several of the option strategies combined the use of an option and a hedge. After purchasing the option, the producer would sell the underlying futures contract at an objective price, if reached, equal to the exercise price plus 30 percent residual return.

Several constraints were placed on the marketing activities. Bushels sold were constrained to equal 100 bushels to assure that the amount of any one strategy found in a portfolio could be interpreted as a percent of the total mix. All preharvest pricing prior to July of each crop year was restricted to less than 60 percent and any pricing after July was restricted to 75 percent of the portfolio mix. This protected the producer from a loss in the futures when the cash crop was not sufficient to offset a futures position, due to unexpectedly low yields.

Soybean Marketing Strategy Results

To highlight the potential role of soybean options marketing strategies, three efficient marketing frontiers were estimated via the Target MOTAD model. Frontier I is comprised of commonly used marketing strategies. That is, cash sales, static futures hedges, and cost plus futures hedges. Frontier II adds put options strategies to those employed in Frontier I. Finally, Frontier III adds technical futures hedging strategies to those used in Frontier II. The presented frontiers were estimated with a target return level of $6.50 per bushel. Frontiers based on target returns above and below $6.50 per bushel were also estimated. Portfolio mixtures were not overly sensitive to the target level. These results are available from the authors upon request.

Table 1 presents the expected return, deviations below target, and portfolio mix for six selected portfolios along Frontier I. Activity (A), the most dominant in the majority of the portfolios, is a static hedge placed the first week in November on the March futures contract for a January delivery. Strategy (B) is a cost plus hedge that uses an objective price of the cost of production plus storage cost plus basis, plus a residual return of 30 percent of the cost of production. For activity (B) the producer places a hedge beginning in July at the objective price, if observed, on the July futures contract for May delivery. Strategy (C) is a cost plus 10 percent residual return hedge initiated in January (year of harvest) on the March futures

TABLE 1: Efficient Frontier (I): Cash Sales, Static Hedges, and Cost Plus Hedges; Selected Portfolios at a $6.50 per Bushel Target.

Portfolio Number	Expected Income ($/bu)	Average Deviations Below Target ($/bu)	Strategy[a] Portfolio Mixture (%) A	B	C	D	E	F
1	7.61	0.283	100					
2	7.58	0.242	87	11	2			
3	7.52	0.202	77			23		
4	7.44	0.161	59			41		
5	7.37	0.120	41			59		
6	7.09	0.080		3	60	25	12	

[a]The description of cash strategy is as follows:

A = Static hedge placed in November t on the March t+1 futures for a January t+1 sale (t represents year of harvest).

B = Cost plus hedge beginning in July t on the July t+1 futures for May t+1 delivery.

C = Cost plus hedge beginning in January t on the March t+1 futures for a January t+1 sale.

D = Cost plus hedge beginning in May t on the January t+1 futures for a November t sale.

E = Unhedged cash sale in May t+1.

F = Static hedge placed in July t on the January t+1 futures for a November t sale.

contract for a January sale. Activity (D) is also a cost plus 10 percent residual return hedge that begins in May on the January futures contract for a planned harvest delivery. Strategy (E) is an unhedged cash sale in May. Activity (F) is a static hedge placed in July on the January futures contract for a November sale.

Table 2 presents the results generated by adding options marketing strategies to those allowed on Frontier I. Two put option strategies (G and H) entered the efficient set of portfolios. Strategy (G), which involves the purchase of an at-the-money January put option in May for a November sale, entered four of the six present portfolios. Further, at higher expected returns the strategy was at least 40 percent of optimal portfolios. Strategy (H) involves the purchase of a March put option in July for a January sale. The strike price is the cost of production plus basis plus storage cost plus a 10 percent residual return. After the purchase of the option, a hedge is placed on the March futures contract at an objective price (if observed) of the strike price plus a 30 percent residual return. Strategy H was present in all six of the presented optimal portfolios. Strategy (I) starting in January (year of harvest) places a static hedge on the January futures at the price objective, cost of production plus 10 percent residual return, for November delivery. The remaining strategies listed in Table 2 were explained earlier.

Figure 1 graphically compares the risk-return tradeoffs of Frontiers I and II. Clearly, Frontier II, which includes options strategies, dominates Frontier I. Weighting each portfolio equally on each frontier, the mean expected return and average deviation below the target for frontier (I) are \$7.44 per bushel and \$0.181 per bushel, respectively, and for frontier (II) the means are \$7.44 per bushel and \$0.104 per bushel, respectively. The Frontier II provides an equal level of average expected return with a 43 percent

TABLE 2: Efficient Frontier (II): Cash Sales, Static Hedges, Cost Plus Hedges, and Options; Selected Portfolios at a $6.50 Per Bushel Target.

Portfolio Number	Expected Income ($/bu)	Average Deviation Below Target ($/bu)	Strategy[a] Portfolio Mixture (%)						
			A	G	H	D	E	F	I
1	7.73	0.132	25	60	15				
2	7.62	0.121	25	41	15	19			
3	7.51	0.110	25	23	15	37			
4	7.40	0.098	25	4	15	56			
5	7.27	0.087	13		15	60	12		
6	7.13	0.076			13		25	2	60

[a] The description of each strategy is as follows:

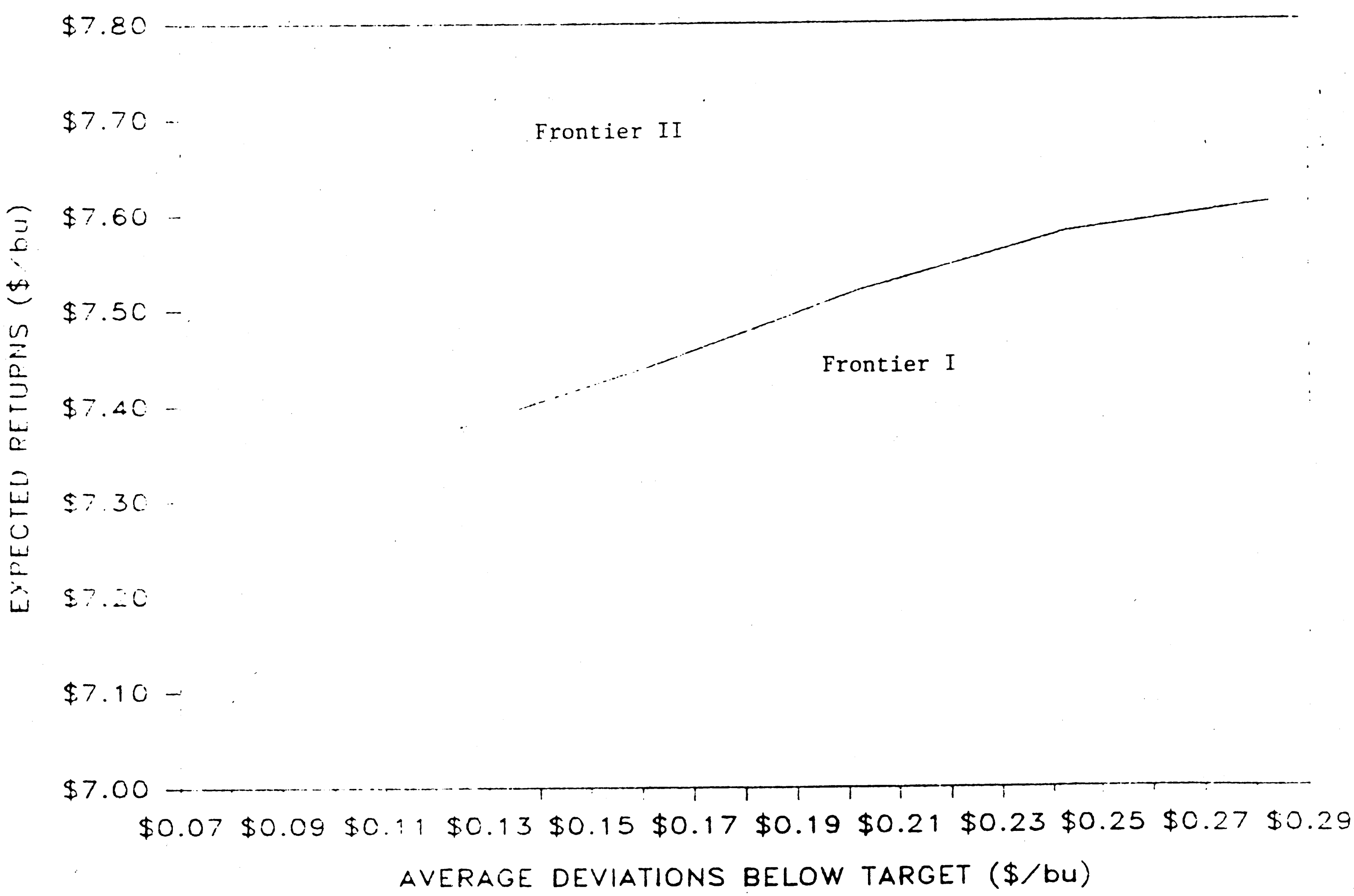
G = Purchase a January t+1 at-the-money put option in May t for a November t sale (t represents year of harvest).

H = Purchase a March t+1 put option in July t with the strike price equivalent to the cost of production plus basis plus storage cost plus residual return, for a January t+1 delivery; after purchase of option, place a hedge on March t+1 futures at an objective price (if observed) of the strike price plus 30 percent residual return.

I = Cost plus hedge beginning in January t on the January t+1 futures for a November t sale.

A, D, E, F defined in Table 1.

Figure 1: Target MOTAD Efficient Frontiers I and II.



reduction in average deviations below target. Therefore, adding options strategies to "traditional" fundamental futures and cash sales strategies may yield substantial risk-return improvements for producers.

The third frontier investigated consisted of cash sales, static hedges, cost plus hedges, put options, and technical futures hedging activities. Table 3 presents the results for six selected portfolios along Frontier III. Six of the eight marketing activities on the frontier are technical strategies. One put option strategy (G) entered the efficient portfolios. Activity (J) follows the 3 and 10 week moving averages on the January futures contract with hedging initiated in July for a November sale. Strategy (K) is the same as (J) except pricing begins in May. Activity (L) starts pricing in March following the 3 and 5 week moving averages on the January futures for a November delivery. Strategy (N) is identical to (L) except hedging is not initiated until July. Strategy (M) follows the 3 and 10 week moving averages beginning in November on the July futures contract for a May sale. Finally, activity (O) utilizes the 3 and 15 week moving averages on the March futures commencing in November for a January delivery. Strategies (A,G) were defined previously.

Figure II shows that Frontier III dominates Frontier II. Weighting each portfolio equally, the average expected income along Frontier III is $7.53 per bushel and the average deviation below the target is $0.089 per bushel, representing a 1.2 percent increase in expected returns and a 14 percent decrease in risk compared to frontier II. Therefore, utilizing both technical futures hedging and options strategies may provide producers with substantial risk-return improvements in marketing portfolios.

TABLE 3. Efficient Frontier III: Cash Sales, Static Hedges, Cost Plus Hedges, Options, and Technicals; Selected Portfolios at a $6.50 Per Bushel Target.

Portfolio Number	Expected Income ($/bu)	Average Deviation Below Target $/bu	Strategy[a] Portfolio Mixture (%) A	J	G	K	L	M	N	O
1	7.73	0.131	25	15	60					
2	7.68	0.114	25	15	9	51				
3	7.60	0.097	25	15		34	26			
4	7.51	0.080	23	15		2	50			
5	7.42	0.063	10	15			60	15		
6	7.22	0.046					60		15	25

[a]The description of each strategy is as follows:

J = 3 and 10 week moving averages (WMA) beginning July t on the January t+1 futures for a November t sale (t represents year of harvest).

K = 3 and WMA beginning in May t on the January t+1 futures for a November t sale.

L = 3 and 5 WMA beginning in March t on the January t+1 futures for a November t sale.

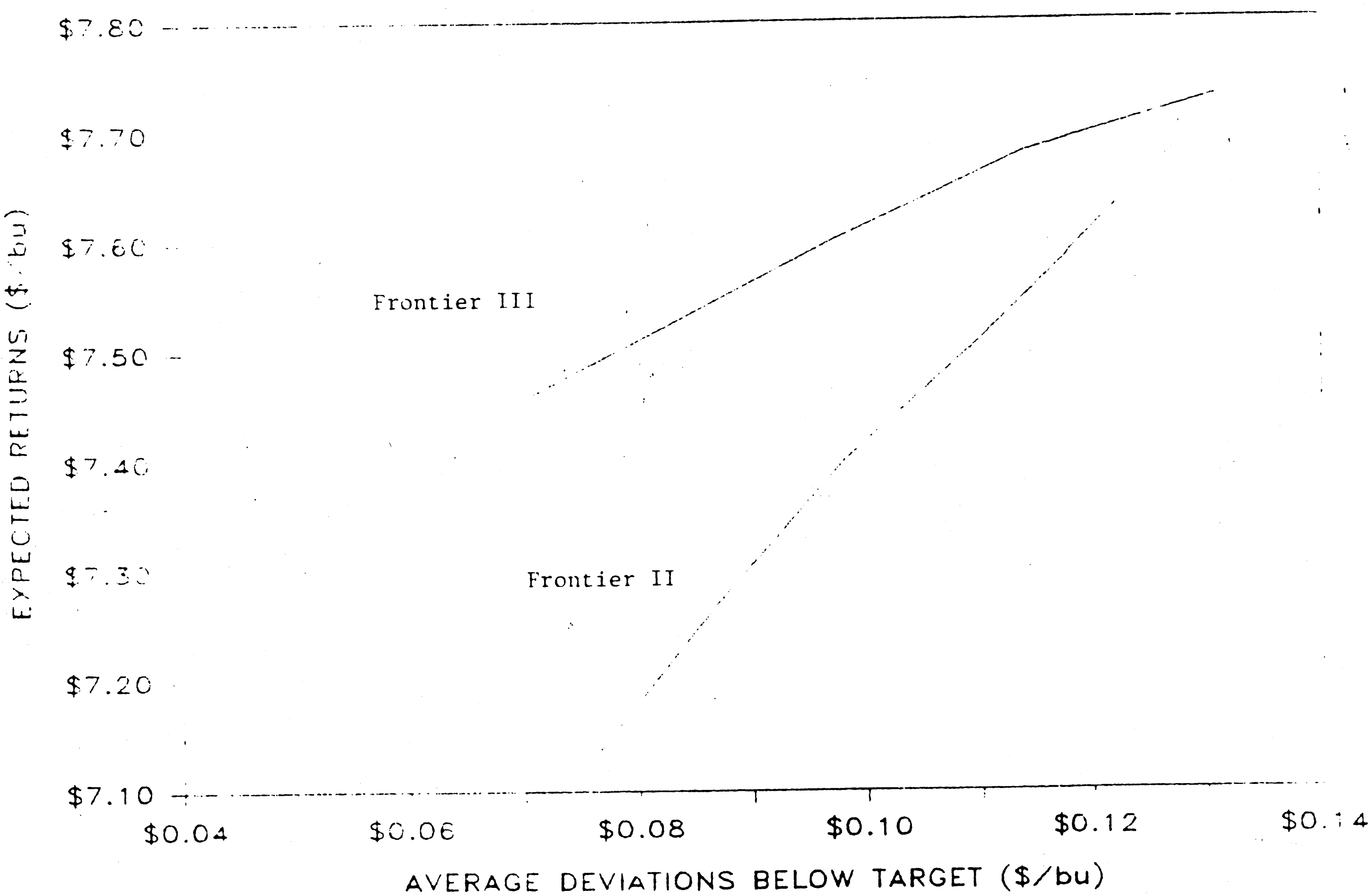
M = 3. and 10 WMA beginning in November t on the July t+1 futures for a May t+1 sale.

N = 3 and 5 WMA beginning in July t on the January t+1 futures for a November t sale.

O = 3 and 15 WMA beginning in November t on the March t+1 futures for a January t+1 sale.

A and G defined in Table 1.

Figure 2: Target MOTAD Efficient Frontiers II and III.



Summary and Conclusions

Commodity price volatility in the 1970s and early 1980s focused attention on producer's need for risk-reducing marketing strategies. A significant new marketing alternative is now available to producers -- agricultural options. This paper examined the returns and risks of soybean marketing strategies using both futures and options.

The set of marketing strategies were categorized into five separate groups: cash sales, static hedges, cost plus static hedges, technical futures, and marketing options. Each group of activities was characterized by several pricing and selling dates. The net price received by producers was calculated for each strategy. The optimal marketing portfolios were calculated using real (1983) dollars. The initial price was the nearby Chicago Board of Trade futures contract price for all sale dates minus any brokerage fees and storage costs. Any futures trading profit or loss was accounted along with an adjustment for the local basis for each marketing date. To develop the three efficient frontiers of marketing portfolios, the Target MOTAD model was employed. Those model selected optimal strategies by maximizing income and minimizing the sub-target income deviations. A target return of $6.50 per bushel was examined.

The results suggested two important conclusions. First, adding options strategies to traditional cash sales, static futures hedging, and storage hedging activities substantially improved risk-return tradeoffs. Specifically, average deviations below target returns were reduced 43 percent. Second, adding technical futures hedging strategies to options strategies further improved risk-return tradeoffs.

Two cautions should be noted with respect to the results. First, the soybean put options strategies examined in this study involved the simulation of the option premiums. thus, caution must be exercised in generalizing the options results for the study period. Actual market premiums and put options performances may differ in the marketplace. Second, it must also be kept in mind that the analysis was limited to soybean marketing activities. Different results may be provided by whole farm simulations.

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