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A REGIONAL COMPARISON OF RISK-EFFICIENT SOYBEAN MARKETING STRATEGIES

Cathy S. McKinnell, Kandice H. Kahl, and Charles E. Curtis, Jr.

Abstract

Risk-efficient portfolios from a subset of marketing strategies were identified using Target MOTAD. Portfolios were generated for Illinois, Arkansas, and South Carolina to determine whether regional price and yield characteristics affected the optimal marketing strategy selection during 1972-1985. The results support previous conclusions that the risk borne when following a combination of marketing strategies was less than the risk of any single marketing strategy examined. The results also show that the marketing strategies representing efficient risk-return combinations for a producer in one region were different from the efficient risk-return combinations for a producer in another region. Therefore, generic marketing advice would have produced results less preferred in one region than in another.

Key words: Target MOTAD, risk-efficient portfolio, futures and options contracts, hedging.

Soybean producers in the United States face income risk from various factors including yield and price variability, government policies, and shifts in foreign supply and demand. Better marketing techniques may enable producers to reduce this risk while maintaining adequate expected income. Producers should analyze alternative marketing strategies (e.g., forward pricing some of their expected output, selling their output at different times of the year, and using the futures market to establish a minimum selling price). Previous studies have analyzed numerous alternative marketing strategies and determined the preferred combinations of strategies for a particular commodity during a particular time period (e.g., Holland *et al.*; Bolen *et al.*; Persuad and Mapp; Klinefelter *et al.*; Curtis *et al.*). However, most studies have focused on a single location. The risk-efficient combinations of marketing strategies for one location may not be efficient for other locations. Even though soybean prices across the U.S. tend to move together, the magnitude of price changes varies across production areas due to differing regional production and marketing characteristics (e.g., acreage planted, yield, storage capacity, local demand, and available marketing alternatives). In addition, yields and costs are different across soybean producing regions. Thus, one might expect the income risk associated with a marketing strategy to be different across regions and therefore the optimal mix of risk-reducing strategies to be different.

The purpose of this study was to develop and compare risk-efficient portfolios of marketing strategies for soybean producers in different regions during the period 1972-1985. The three major soybean producing regions were studied: the Southeast, the Midwest, and the delta as represented by South Carolina, Illinois, and Arkansas, respectively. Illinois and Arkansas were chosen because they were significant producing states in their respective regions. South Carolina was selected because it was the state in which the study was conducted. Specific objectives of the study were (1) to examine the average revenue and risk of each soybean marketing strategy included in the set of representative strategies during the study period, and (2) to compare risk-efficient portfolios for the three states to see how sensitive portfolio composition is to differences in location.

MARKETING STRATEGIES

Producers can sell in the cash market at harvest or any time after harvest. They can forward price prior to planting, at planting, or any time during the growing and/or storage season. This analysis considered only a selected subset of marketing strategies from those available to soybean producers. Thirty-two strategies from ten marketing categories were examined over the marketing years 1972 through 1985 (Table 1). In selecting the subset of strategies, cash market sales were assumed to occur during the first

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Table 1. Soybean Marketing Strategies Examined

1. CASH MARKET SPECULATIVE STRATEGIES
   (1.1) Sell in cash market in November.
   (1.2) Store production unpriced and sell in cash market in April.

2. ROUTINE HEDGE
   (2.3) In May sell January contract, offset in November.
   (2.4) In July sell January. contract, offset in November.
   (2.5) In July sell May contract, offset in April.
   (2.6) In November sell May contract, offset in April.

3. ROUTINE NEAR-THE-MONEY PUT OPTION PURCHASE[a]
   (3.7) In May buy put option on January contract, offset in November.
   (3.8) In July buy put option on January contract, offset in November.
   (3.9) In July buy put option on May contract, offset in April.
   (3.10) In November buy put option on May contract, offset in April.

4. SELECTIVE THREE - AND FIVE-WEEK MOVING[b] AVERAGE HEDGE. START MONITORING MOVING AVERAGE SIGNAL IN:
   (4.11) May, sell January contract, offset in November.
   (4.12) July, sell January contract, offset in November.
   (4.13) July, sell May contract, offset in April.
   (4.14) November, sell May contract, offset in April.

5. SELECTIVE THREE - AND FIVE-WEEK MOVING AVERAGE NEAR-THE-MONEY PUT OPTION PURCHASE. START MONITORING MOVING AVERAGE IN:
   (5.15) May, buy put option on January contract, offset in November.
   (5.16) July, buy put option on January contract, offset in November.
   (5.17) July, buy put option on May contract, offset in April.
   (5.18) November, buy put option on May contract, offset in April.

6. MULTIPLE SELECTIVE THREE - AND FIVE-WEEK MOVING AVERAGE HEDGE. START MONITORING MOVING AVERAGE IN:
   (6.19) May, continue selling and offsetting hedges on January contract based on signals generated until November.
   (6.20) July, continue selling and offsetting hedges on January contract based on signals generated until November.
   (6.21) July, continue selling and offsetting hedges on May contract based on signals generated until April.
   (6.22) November, continue selling and offsetting hedges on May contract based on signals generated until April.

7. TOTAL COST-PLUS HEDGE WHEN LOCALIZED FUTURES PRICE EQUALS OR EXCEEDS THE OBJECTIVE PRICE. STARTING IN:
   (7.23) May, sell January contract, offset in November.
   (7.24) July, sell January contract, offset in November.
   (7.25) July, sell May contract, offset in April.
   (7.26) November sell May contract, offset in April.

8. VARIABLE COST - PLUS NEAR-THE-MONEY PUT OPTION PURCHASE WHEN THE LOCALIZED FUTURES PRICE EQUALS OR EXCEEDS THE OBJECTIVE PRICE. STARTING IN:
   (8.27) May, buy put option on January contract, offset in November.
   (8.28) November, buy put option on May contract, offset in April.

9. TOTAL COST-PLUS NEAR-THE-MONEY PUT OPTION PURCHASE WHEN THE LOCALIZED FUTURES PRICE EQUALS OR EXCEEDS THE OBJECTIVE PRICE. STARTING IN:
   (9.29) May, buy put option on January contract, offset in November.
   (9.30) November, buy put option on May contract, offset in April.

10. FUTURES/OPTIONS MARKET SPECULATIVE STRATEGIES
   (10.31) Sell crop on cash market and buy a May futures contract to be offset in April.
   (10.32) Sell crop on cash market and buy a May near-the-money call option contract to be offset in April.

[a]Option contracts are allowed to expire whenever the option premium is less than the transaction costs of exercising the option.
[b]For strategies involving buying and offsetting futures or option contracts, the cash market sale is assumed to occur when the futues or options position is offset in either November or April.

week in November (harvest)[1] or during April (after storage); forward pricing was considered beginning in the second week in May (at planting), in July (during the growing season), or in the first week in November. All futures contracts and profitable options were offset at the time of the cash market sale.[2]

Cash Market Speculation—The strategies in category 1 involved remaining unpriced until all of the production was sold in the cash market in either November or April.

Routine Hedge or Option Purchase—Strategies in categories 2 and 3 involved routinely selling a futures contract (category 2) or purchasing a near-the-money put option contract[3] (category 3) in May, July, or November and offsetting the position in November or April, when the soybeans were sold.

Selective Moving Averages Hedge or Option Purchase—In categories 4, 5, and 6, three-and five-week moving averages[4] were monitored for a "sell" signal beginning in May, July, or November. A "sell" signal was generated when the three-week moving average crossed and fell below the five-week moving average. Once a position in the futures market (category 4) or options market (category 5) was taken, it was held until the cash market sale. In category 6, however, after taking a short futures position, the market was monitored for a "buy" signal (i.e., when the three-week average crossed and rose above the five-week average) to offset the position. Thus, short positions were placed and liquidated each time the moving averages crossed.

Cost-plus Hedge or Option Purchase—In categories 7, 8, and 9, beginning in May, July, or November, a cost-plus price objective was compared to the expected price obtained by hedging in futures or to the expected minimum price obtained by buying a put option. If the price objective could be covered, a futures contract was sold (category 7) or a put option contract was purchased (categories 8 and 9). The cost-plus price objective was based on variable costs (category 8) or total production costs (categories 7 and 9) and expected yields if placed before harvest. If the market action criteria in categories 4 through 9 were not met, then no futures or options market position was taken and the crop was sold on the cash market at the date specified in the strategy.

Futures Market Speculation—The two strategies in category 10 involved selling all the production in the cash market at harvest and either buying a May futures contract or a May near-the-money call option and offsetting the position in April.

Strategy performance was measured by expected net revenues per acre (i.e., expected total revenues less storage and marketing transaction costs). Production costs were not subtracted because they were identical across marketing strategies. Many previous studies have analyzed strategies according to net price received (e.g., Curtis *et al.*). However, such studies overlook yield risk. Yield risk was incorporated to some degree in this study by using an expected yield in evaluating marketing strategies that were executed before harvest and using actual yields for strategies that were executed at harvest or following harvest. However, differences between expected yield and actual yield have different impacts on the outcomes of the various strategies. An analysis of strategy outcomes that incorporates these yield forecast errors is more realistic than an analysis of strategy outcomes that assumes that yield can be forecast perfectly.

TARGET MOTAD MODEL

In a world of certainty, economic theory indicates that firms maximize profits. When alternative outcomes are not known *a priori*, researchers have argued that risk must be incorporated in the objective function (Markowitz).

The Target MOTAD (Minimization of Total Absolute Deviations) model, as described by Tauer and Watts *et al.*, provides one method of incorporating risk in the objective function. In Target MOTAD, risk is defined as the absolute value of deviations below a fixed target. The target can be fixed at any level from which risk is to be measured. The ability to measure risk from an independent reference point, rather than the mean, is one advantage of Target MOTAD over MOTAD and mean-variance analysis.

[1] Although harvest for the three states varied over a period of nine weeks, the first week in November was used as the harvest date because each of the three states typically harvests to some degree in November (USDA, *Usual Planting and Harvesting Dates for U.S. Field Crops*).

[2] An option was profitable if the premium was greater than the transaction cost of selling the option (in this study, if the premium was greater than two cents per bushel).

[3] A put option gives the buyer the right but not the obligation to sell an underlying futures contract at the stated strike price. A near-the-money option has a strike price nearest the prevailing futures price.

[4] Strategies using moving averages were included as examples of simple strategies incorporating technical factors. The three- and five-week moving averages were arbitrarily selected as indicators of market trends.

In this analysis, soybean producers were assumed to be most concerned with covering their production costs each year. Producers were assumed to maximize expected profits subject to a certain level of risk of not covering their production costs (or, equivalently, minimize the risk of not covering their production costs subject to a certain level of expected revenues). Target MOTAD is an appropriate model because it permitted comparison of the strategies in the three regions based on this risk criterion (local total production cost). By defining the target as total production costs in each region, all strategies and portfolios of strategies can be compared according to their abilities to cover production costs. The specific model used in this study is as follows:

$$\text{minimize } vy^{-},$$

subject to

$$Ax \leq \text{or} \geq b,$$

$$rx = E,$$

$$(P - T)x + Iy^{-} \geq 0,$$

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

where

v = a 1-by-s vector in which each element is 1 and where s is the number of years considered (14 in the current study),

y^{-} = an s-by-1 vector of the absolute value of annual negative revenue deviations from the fixed target,

A = an m-by-n matrix of technical coefficients, where m is the number of constraints and n is the number of strategies,[5]

x = a n-by-1 vector of strategies,

b = a m-by-1 vector of constraints,

r = a 1-by-n vector of expected revenues for each strategy,

E = a scalar representing expected revenue required by the decision maker,

P = a s-by-n matrix of actual revenues for each activity in each year,

T = a s-by-n matrix in which all elements are the fixed target (i.e., total production costs),

I = a s-by-s identity matrix, and

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

The risk-efficient frontier is generated by parametrically varying expected revenues (E) and re-optimizing the model to find the portfolio with the minimum negative deviations from the given target. More specifically, the high end of the risk-efficient frontier was a maximum revenue linear programming solution where risk was not a constraint. This solution gives the maximum attainable expected revenue. The minimum point of the frontier was obtained by minimizing risk, with expected revenue greater than or equal to zero. Other values of expected revenues (approximately equally spaced between the maximum and minimum E values) were used to determine the remaining portfolios presented on the frontier. Risk-efficient frontiers were generated for each state using estimated total production costs as the target. This exogenous target was assumed representative of the level of revenues required for long-run survival. The total cost targets

Table 2. 1985-1986 Soybean Production Costs[a]

Item	South Carolina (33 bu/ac)	Illinois (45 bu/ac)	Arkansas (25 bu/ac)
	------- $/acre -------		
Variable Costs (V.C.):			
Seed	8.00	10.00	7.88
Fertilizer	29.52	23.00	8.12
Chemicals	18.60	19.00	14.28
Machinery	28.04	30.00	32.29
Labor	14.25	20.00	7.55
Interest on Operating Capital[b]	3.77	3.91	2.69
Land Charge[c]	24.74	103.78	37.75[d]
Total Variable Costs	126.92	209.69	110.56
Fixed Costs (F.C.):			
Machinery	35.83	42.00	37.27
Overhead[e]	8.17	8.47	5.82
10% of (V.C. + F.C.)	17.09	26.02	15.37
Total Production Costs	188.02	286.18	169.02

[a]Costs are from 1985 state extension budgets, except for the noted adjustments to make budgets consistent across states.
[b]The annualized 1985 six month T-bill rate was used to estimated the interest on operating capital for six months.
[c]Land charges represent "1985 Farms Rented for Cash: Gross Cash Rent per Acre" obtained from *USDA, Agricultural Resources: Land Values and Markets.*
[d]A land charge was not reported for Arkansas so the average of the 1984 and 1986 land charge was used.
[e]Overhead charges were calculated as 8% of total variable costs, excluding the land charge.

[5]The technical constraints were (1) the total amount produced had to be sold in the cash market during that crop year (i.e., in November and/or April), and (2) preharvest hedging was limited to no more than 60% of expected production to prevent losses from over-selling in the futures market when actual production was less than expected.

(including a 10 percent return for risk and management) were $188.02, $286.18, and $169.02 per acre for South Carolina, Illinois, and Arkansas, respectively (Table 2).

CALCULATION OF STRATEGY PERFORMANCE

Total revenues from the cash market were the product of the monthly average cash price (USDA, *Agricultural Prices*) and the state average yield[6] (USDA, *Agricultural Statistics*). Strategies involving pricing before harvest used an expected yield because the producer would not have perfect knowledge of actual yields. Expected yield was calculated as the median of the state average yields in the previous three years. The median yield, rather than an average yield, was used to reduce the impact of years with unusually high or low yields.

All futures market transactions used the Thursday settlement price for Chicago Board of Trade (CBT) soybeans (Wednesday prices were used if Thursday was a holiday). The January and May futures contracts were used for strategies lifting in November and April, respectively. The historical basis was calculated as the difference between the monthly state average cash price and the closing futures price for the first Thursday in the month. The expected basis (used in calculating the cost-plus objective prices) was a three-year moving average of the historical basis in that month.

Futures contract marketing fees were assumed to be three cents per bushel per round turn (including both a commission and an allowance for slippage[7]). The fee for trading option contracts was also three cents per bushel per round turn. However, if the option contract was unprofitable to sell back, marketing fees were only two cents per bushel.

Revenues generated by strategies involving storage must have the associated storage costs subtracted before they are compared with revenues generated by nonstorage strategies. In this study, monthly storage costs consisted of the variable costs of physical on-farm storage and the opportunity costs of the grain in storage.

Variable costs of on-farm storage were assumed to be constant in real terms during the period 1972-1985. These variable costs were estimated as $0.0224 per bushel per month in 1983 dollars, an estimate obtained from Farmer (1987) for a storage capacity of 13,000 bushels. In this study the opportunity cost of soybeans in storage was accounted for by multiplying the state's average November cash price (representative of the value the producer forgoes when the decision to store the crop is made) by the monthly nominal six-month Treasury Bill rate (*Economic Report to the President*) for the number of months the crop was to be stored.

The marketing strategies in categories 7 through 9 required comparing a price objective to the localized futures price. Two price objectives were calculated based on estimated variable and total costs of production for each state. Production costs were obtained from each state's 1985 soybean enterprise budget (Clemson University Cooperative Extension Service; Hinton; University of Arkansas Cooperative Extension Service). Real production costs for other years were assumed to equal real production costs in 1985. The price objective included production costs, marketing fees, and any applicable storage charges. Expected state average yields were used to generate per bushel price objectives. The premium (i.e., price) for a near-the-money option was estimated and added to the price objective in categories 8 and 9.

Since soybean options did not trade until 1984, no option premium data existed for the majority of the study period. As a result, premiums were estimated for the entire study period using Black's option pricing model in order to have a consistent measure of premiums. Wilson found no significant difference between soybean premiums estimated using Black's model and actual market premiums. In this study, market volatility for Black's model was estimated with five weeks of historical prices as used by Wolf.

Strategy revenues were adjusted by the Prices Paid by Farmers Index (1985=100) (USDA *Agricultural Statistics*). The prices paid index was chosen because it best reflects a producer's purchasing power to buy additional inputs. If the strategy revenues were not adjusted for inflation, strategies that performed well in the later years would be weighted more heavily than strategies performing well in the earlier years because of differences in nominal revenues.

RESULTS

The average revenue and average risk per acre associated with each individual marketing strategy for South Carolina, Illinois, and Arkansas were calculated and ranked (Tables 3 and 4). Risk was measured as the sum of deviations below the target divided by the number of years in the study period.

[6]The use of state average yields rather than individual farm yields may underestimate yield risk for an individual producer.

[7]Slippage is the difference between the price at which the producer expects an order to be filled and the price at which the order is executed.

Table 3. Average Revenue And Revenue Ranking Of Individual Marketing Strategies In South Carolina, Illinois And Arkansas, 1972-1985, In 1985 Dollars.

Strategy Number[a]	South Carolina		Illinois		Arkansas	
	Average Revenue	Revenue Ranking[b]	Average Revenue	Revenue Ranking[b]	Average Revenue	Revenue Ranking[b]
	$/acre		$/acre		$/acre	
1.1	157.89	21	274.45	20	182.37	17
1.2	168.11	6	289.89	5	187.63	7
2.3	144.24	32	250.85	32	166.67	32
2.4	154.73	25	267.72	26	178.68	25
2.5	162.04	14	280.05	12	181.22	20
2.6	165.65	9	282.21	11	185.19	11
3.7	160.44	16	278.96	16	185.11	12
3.8	157.27	22	272.86	21	181.70	19
3.9	165.38	10	284.50	9	184.50	14
3.10	173.52	1	298.03	1	193.13	1
4.11	152.21	30	264.73	29	175.67	29
4.12	154.12	28	267.23	28	178.09	27
4.13	161.73	15	279.98	13	180.63	22
4.14	158.77	18	270.48	24	177.86	28
5.15	156.75	23	272.75	22	180.79	21
5.16	151.90	31	263.78	30	175.42	30
5.17	166.06	8	285.90	8	185.24	10
5.18	166.19	7	284.45	10	185.43	8
6.19	154.97	24	269.19	25	178.91	24
6.20	154.11	29	267.47	27	178.17	26
6.21	170.95	4	295.08	3	191.14	4
6.22	168.63	5	288.10	7	188.23	6
7.23	154.60	27	262.79	31	167.88	31
7.24	154.61	26	271.45	23	180.32	23
7.25	162.52	13	275.03	19	181.84	18
7.26	163.23	12	278.61	17	184.18	15
8.27	158.38	20	278.08	18	185.25	9
8.28	173.01	2	297.35	2	193.12	2
9.29	160.01	17	279.47	14	185.10	13
9.30	171.80	3	292.81	4	192.02	3
10.31	158.70	19	279.24	15	182.92	16
10.32	165.02	11	288.96	6	189.46	5

[a]The strategies are defined in Table 1.
[b]The strategy with the highest average revenue is ranked 1, second highest is ranked 2, etc.

All three states shared the same four maximum average revenue generating strategies (strategies 3.10, 6.21, 8.28, and 9.30). No single strategy was the least risky in all states. However, category three (routine put option purchases) had the most strategies repeatedly ranking in the ten least risky strategies for all three states.

Risk-efficient frontiers for each state were derived using MPX-PC, a microcomputer based linear programming model (Pfeiffer). Risk-efficient portfolios lie all along the risk-efficient frontier. However, only four portfolios along each frontier are discussed (Table 5 and Figures 1 through 3). Portfolio 1 for each state was obtained by maximizing expected revenues without constraining risk. The other points were generated by minimizing risk given a specified expected revenue level. In each case, portfolio 4 represented the combination of strategies that minimized risk with expected revenue greater than or equal to zero, given that the soybeans were marketed within each crop year.

In Illinois and Arkansas at least one marketing strategy or portfolio generated average revenues large enough to cover the target during the study period; however, in South Carolina this was not observed. Of course, some producers may have covered costs because of differences in yields, costs, local basis, and other circumstances. Yet in actuality, many producers probably had substantially lower production costs than assumed here because of double-cropping soybeans and wheat. When adjustments were made to account for double-crop cost sharing and the risk-efficient frontier was re-estimated using a target of $109.47 per acre for South

Table 4. Average Risk And Risk Ranking Of Individual Marketing Strategies In South Carolina, Illinois And Arkansas, 1972-1985, In 1985 Dollars.

Strategy Number[a]	South Carolina Target = $188.02		Illinois Target = $286.18		Arkansas Target = $169.02	
	Average Risk[a]	Risk Ranking[b]	Average Risk	Risk Ranking[b]	Average Risk	Risk Ranking[b]
	$/acre		$/acre		$/acre	
1.1	36.46	20	26.13	12	12.14	10
1.2	35.66	17	35.36	25	15.14	21
2.3	46.85	32	46.10	31	20.64	31
2.4	39.83	26	39.31	28	15.80	26
2.5	32.09	6	25.83	10	12.50	12
2.6	31.34	4	21.58	2	10.12	3
3.7	34.13	9	20.89	1	8.99	1
3.8	36.57	21	24.68	5	12.28	11
3.9	32.03	5	30.64	19	13.82	16
3.10	30.70	2	24.97	7	11.69	5
4.11	42.52	30	39.42	29	15.48	23
4.12	41.12	29	33.07	23	14.69	19
4.13	35.33	16	24.14	4	12.64	13
4.14	35.03	12	31.21	22	15.69	25
5.15	37.18	22	24.96	6	11.75	7
5.16	40.30	28	29.97	16	16.23	27
5.17	33.00	7	30.66	20	15.44	22
5.18	35.99	18	35.78	26	17.73	29
6.19	39.48	25	30.10	17	15.69	24
6.20	40.03	27	27.18	13	14.93	20
6.21	30.16	1	26.08	11	14.05	18
6.22	35.24	15	34.02	24	16.94	28
7.23	39.38	24	42.82	30	20.66	32
7.24	38.34	23	38.52	27	14.00	17
7.25	34.55	10	30.83	21	11.88	8
7.26	34.86	11	28.01	14	11.93	9
8.27	36.20	19	21.97	3	8.99	2
8.28	31.21	3	25.65	9	11.69	6
9.29	35.19	14	25.61	8	10.99	4
9.30	33.97	8	30.62	18	13.52	14
10.31	43.59	31	47.15	32	19.02	30
10.32	35.15	13	29.48	15	13.74	15

[a]Risk is measured as the absolute value of the sum of the deviations below the total production cost target divided by the number of years (i.e., 14).

[b]The strategy with the lowest average risk is ranked 1, the second lowest is ranked 2, etc. Strategies having equal risk are ranked based on expected revenues.

Carolina (state extension estimate of total production costs in a double-crop system), the average risk for the maximum revenue portfolio dropped to only $.10 per acre and to zero for the minimum risk portfolio.[8]

As evident from Table 5, the risk from a portfolio of strategies could have been lower than the risk of any single strategy in a given state. By combining strategies with revenues that were less than perfectly positively correlated, revenues from a strategy that did not perform well in one year are offset by a strategy that performed well in that year. For example, in Illinois the least risky strategy generated $20.89 per acre in average risk, whereas portfolio 4 generated only $19.69 per acre in average risk. Risk reduction through marketing diversification was also apparent in South Carolina and Arkansas.

Strategy 3.10 (a routine put option purchase in November, offsetting in April) comprised 100 percent of the maximum average revenue portfolios in all three states. This result was expected because this strategy generated more revenue than any other strategy in each state over the study period. However, the risk-efficient portfolios differed across

[8]Detailed results of this analysis are available from the authors upon request.

Table 5. Risk-Efficient Portfolios Generated By Target Motad Using Total Production Costs As The Target For South Carolina, Illinois, And Arkansas, 1972-1985, In 1985 Dollars.

Portfolio Number	Average Revenue ($/acre)	Average Risk ($/acre)	Strategy as a Percentage of Portfolio							
			2.5	2.6	3.7	3.10	4.13	6.21	7.25	8.27
South Carolina: Target = $188.02 per acre										
1	$173.52	$30.70				100%				
2	$171.28	$29.08				73%	17%	10%		
3	$169.04	$28.45	20%			61%	19%			
4	$166.80	$27.93	14%			41%	29%		16%	
Illinois: Target = $286.18 per acre										
1	$298.03	$24.97				100%				
2	$291.89	$21.48			9%	59%	23%	9%		
3	$285.76	$20.34		16%	28%	24%	23%	9%		
4	$279.63	$19.69		10%	56%		34%			
Arkansas: Target = $169.02 per acre										
1	$193.13	$11.69				100%				
2	$190.70	$10.59				69%				31%
3	$188.27	$9.48				38%				62%
4	$185.84	$8.44			91%	9%				

states at lower risk levels. For example, the least risky portfolios in South Carolina and Illinois consisted mostly of routine put option purchases, routine hedges, and selective hedges. For Arkansas, the least-risk portfolio consisted of only routine put option purchases. Storage strategies represented 100 percent of South Carolina's least risk portfolio, and less than 50 percent in Illinois and 10 percent in Arkansas. Storage strategies comprised 100 percent of each state's maximum revenue portfolio.

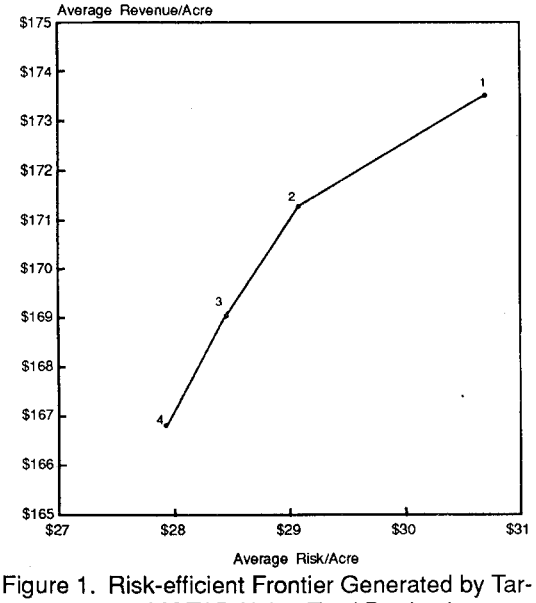

Figure 1. Risk-efficient Frontier Generated by Target MOTAD Using Total Production Costs as the Target for South Carolina, 1972-1985, in 1985 Dollars

In general, put option purchase strategies dominated the risk-efficient portfolios, accounting for 41 to 100% of portfolio composition. Others have shown that marketing strategies involving put option purchases often perform almost as well as the best possible strategy. Put option strategies perform almost as well as cash sales when price increases and almost as well as hedges when price declines (Chicago Board of Trade, 1985). Put option strategies performed well in this analysis because the study period included years with large price increases and years with large price decreases.

SUMMARY AND CONCLUSIONS

Risk-efficient portfolios were derived from a subset of marketing strategies, using a Target MOTAD model for producers in South Carolina, Illinois, and Arkansas. This study differed from many previous studies analyzing alternative marketing strategies because it focused on the effects of location on risk-efficient marketing strategy portfolio composition. It also differed from some previous studies in that it attempted to include yield risk by measuring strategy performance in terms of expected revenues per acre rather than price per bushel.

Specific risk-efficient portfolios were derived for the specified time period and locations examined and would be expected to be risk-efficient for future periods only if the future period were like the study

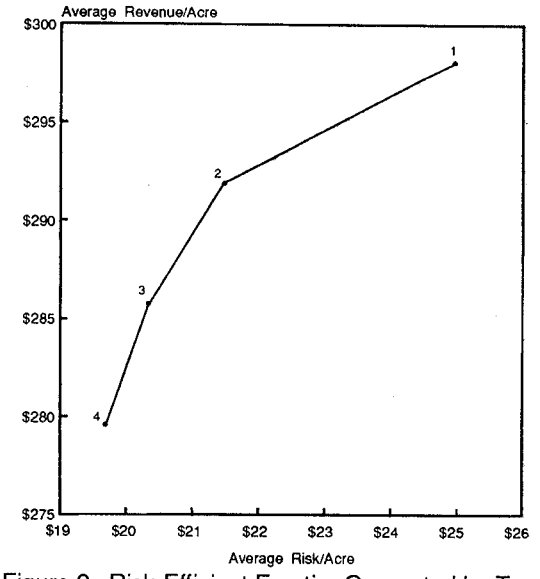

Figure 2. Risk-Efficient Frontier Generated by Target MOTAD Using Total Production Costs as the Target for Illinois, 1972-1985, in 1985 Dollars

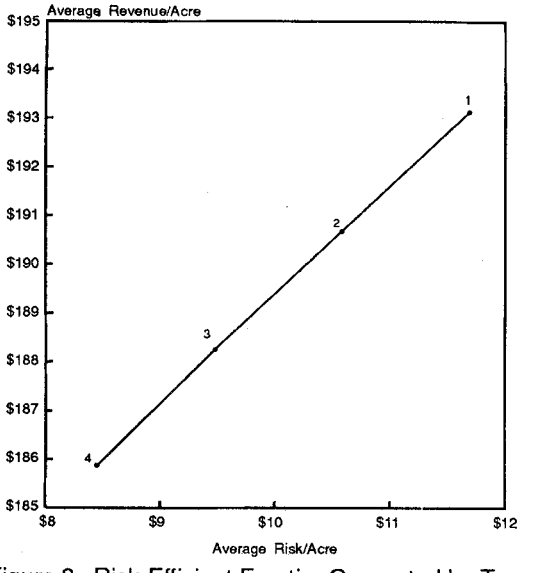

Figure 3. Risk-Efficient Frontier Generated by Target MOTAD Using Total Production Costs as the Target for Arkansas, 1972-1985, in 1985 Dollars

period. Nevertheless, this study verified what previous studies have found, that risk was reduced through diversifying marketing strategies. More specifically, these results show that risk-efficient portfolio composition varied across regions, and put option purchase strategies dominated most risk-efficient portfolios.

The results also showed that the marketing strategies representing efficient risk-return combinations for a producer in one region were different from the efficient risk-return combinations for a producer in another region. Therefore, generic market advice would have generated results less preferred in one region than in another. This finding seems intuitive, given the differences in prices, costs, and yields across regions.

In general, the risk-efficient portfolios contained more put option purchase strategies than hedges. Near-the-money put option purchases performed well in all three states during the storage period. Storage strategies represented 100% of the maximum average revenue portfolio in all three states. However, this finding may have been different if total, rather than variable, storage costs had been included. Unpriced cash sale strategies (heavily used by producers) and futures/options market speculative strategies did not enter any of the risk-efficient portfolios. Hence, over the period 1972-1985, higher average revenue and/or lower average risk might have been achieved by forward pricing rather than unpriced cash market sales.

REFERENCES

Black, F. "The Pricing of Commodity Contracts." *J. Financial Econ.*, 3(1976):167-179.

Bolen, K.R., C.B. Baker, and R.A. Hinton. "Marketing Corn and Soybeans Under Conditions of Market Risk." *Illinois Ag. Econ.* 18(1978):12-19.

Chicago Board of Trade. *Options on Agricultural Futures: A Home Study Course*, Chicago, 1985:31-32.

Chicago Board of Trade. *Statistical Annual Cash and Futures Data: Grains, Forest Products, Energy.* Chicago (1972-1985 issues).

Clemson University Cooperative Extension Service. *Enterprise Budgets.* Department of Agricultural Economics and Rural Sociology, Clemson University, 1985.

Curtis, C.E., G.H. Pfeiffer, L.L. Lutgen, and S.D. Frank. "A Target MOTAD Approach to Marketing Strategy Selection for Soybeans." *N. Central J. Agr. Econ.*, 9(1987):195-206.

Economic Report of the President, 1986. U.S. Government Printing Office, Washington, DC, 1986.

Farmer, C.M. "Economies of Storage." In *Grain Marketing: A Handbook For the South Carolina Producer*, H.M. Harris and C.E. Curtis, eds., Clemson, SC: Department of Agricultural Economics and Rural Sociology, Clemson University, 1987.

Hinton, R.A. "Cost of Growing Corn and Soybeans, 1985." *Farm Economics, Facts and Opinions*. Cooperative Extension Service, Department of Agricultural Economics, University of Illinois, 1986.

Holland, D., W.D. Purcell, and T. Hague. "Mean-Variance Analysis of Alternative Hedging Strategies." *So. J. Agr. Econ.*, 4(1972):123-128.

Klinefelter, D.A., S.T. Sonka, and C.B. Baker. "Selection and Screening of Marketing Options for Risk Evaluation." *Proceedings of the Western Regional Research Project W-149, An Economic Evaluation of Managing Market Risk in Agriculture*. Tucson, Arizona, 1980.

Markowitz, H.M. *Portfolio Selection: Efficient Diversification of Investments*. New Haven, CT: Yale University Press, 1959.

Persuad, T., and H.P. Mapp, Jr. "Analysis of Alternative Production and Marketing Strategies in South Western Oklahoma: A MOTAD Approach." *Proceedings of the Western Regional Research Project W-149, An Economic Evaluation of Managing Market Risk in Agriculture*. Tucson, Arizona, 1980.

Pfeiffer, George H. "MPS-PC: A Linear Programming System for the IBM Personal Computer: Version 2.1." Tucson: Research Corporation/Research Software, 1983.

Tauer, Loren W. "Target MOTAD." *Am. J. Agr. Econ.*, 65(1983):606-610.

U.S. Department of Agriculture. *Agricultural Prices*. Washington, DC: U.S. Government Printing Office, (various issues).

U.S. Department of Agriculture. *Agricultural Resources: Agricultural Land Values and Markets, Situation and Outlook Report*. Washington, DC: U.S. Government Printing Office, (June, 1986).

U.S. Department of Agriculture. *Agricultural Statistics*. Washington, DC: U.S. Government Printing Office, (various issues).

U.S. Department of Agriculture. *Crop Production*. Crop Reporting Board, Statistical Reporting Service, Washington, DC: U.S. Government Printing Office, 1985.

U.S. Department of Agriculture. *Usual Planting and Harvesting Dates for U.S. Field Crops*. Washington, DC: U.S. Government Printing Office, 1984.

University of Arkansas Cooperative Extension Service. *1985 Soybean Production Cost Estimates*. MP244, 1985.

Watts, J. Miles, L. Held, and G. Helmers. "A Comparison of Target MOTAD to MOTAD." *Canadian J. Agr. Econ.*, 32(1984):175-186.

Wilson, William W. "Option Price Behavior in Grain Futures Markets." *Proceedings of the NCR-134 Conference on Applied Commodity Price Analysis, Forecasting and Market Risk Management*. Chicago, IL, 1987.

Wolf, A. "Fundamentals of Commodity Options on Futures." *J. Fu. Markets*, 2(1982):391-408.