SELECTION AND SCREENING OF MARKETING OPTIONS FOR RISK EVALUATION

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During the 1970's several studies applied Markowitz's [8] risk-return efficiency criteria to marketing strategies or options available to farmers and ranchers in an attempt to determine the efficient strategies based on historical price or net return patterns. This work included studies by Holland, Purcell and Hague [5] and later by Leuthold [7] which analyzed cattle marketing strategies employing livestock futures.

More recently, Bolen, Baker and Hinton [1] used mean-variance analysis to determine statistically dominant marketing strategies for corn and soybeans. In their study, the determination of dominant strategies represented a screening device for determining which of several commonly available marketing options would be entered as marketing activities in a quadratic programming model developed to generate optimal marketing strategies based on maximizing expected net cash flows subject to varying degrees of risk aversion. Models of this type allow the decision process to coordinate the production, marketing, and finance functions. Additionally, consumption activities and income tax considerations can be included which further complicate the decision process but produce more realistic solutions for family farm operations.

The information presented in this paper is based on a study conducted by Klinefelter [6] which focused on the development of a set of optimal grain marketing strategies for corn and soybean producers under a number of different scenarios. The strategies developed assumed that farmers are looking for optimal price averaging strategies to use as guidelines in establishing their marketing programs. Therefore, the marketing strategies developed were intended to provide information to farmers on this basis and were not highly individualized. Such general strategies, however, might prove useful as control rules to incorporate into more sophisticated intertemporal optimization models designed to consider both historical data and changes in a farmer's expectations created by updating information on yields, prices, and financial conditions.

One of the problems with many of the more sophisticated optimization models has been that the algorithms available tend to restrict the size of the model and therefore make it necessary for researchers to limit the number of activites included in the model. A common technique for limiting the number of available options to a more manageable size has been to prescreen a number of available options on the basis of risk-return dominance and then to include only the dominant options as activities in the portfolio choice model.

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The researchers previously mentioned have noted that such screening excludes covariance relationships, both between marketing options for one commodity and between alternative commodities, and ignores other factors such as cash flow considerations and the time value of money which might bring some of the screened options into the optimal marketing strategies when considered in the context of the total firm.[1/] Given these concerns, one segment of the Klinefelter study analyzed the potential effect of prescreening marketing options on the basis of dominance tests. Results from that analysis are presented here.

The objectives of this paper are twofold. The first, is to examine the risk-return dominant marketing options when all proposed options are entered as potential activities in the farm decision model. The second is to compare the expected net cash flows and the variability of these flows for the unrestricted model with those generated when the model is restricted to selecting from only the dominant options.

Model Formulation

The farm decision model employed in this analysis determined "optimal" marketing strategies for corn and soybeans, the principal cash grains produced in the study region. Using an objective function that maximized expected net cash flows, the model had 44 rows and 135 columns. A linear programming technique based on Hazell's 1971 formulation [3] was chosen to incorporate risk into the model. This risk model is similar to portfolio choice mean-variance models which assume normality of outcomes and a quadratic utility function.

The basic formulation of the model is:

$$\begin{aligned} &\text{maximize} && C'X - \varepsilon KLd^{-} \\ &\text{subject to} && AX \leq B \\ & && DX + Id^{-} \geq 0 \\ & && X,\ d^{-} \geq 0 \end{aligned}$$

where X, A, B, C, and D represent the activity levels, technical coefficients, resource constraints and requirements, expected net cash flows, and deviations in net cash flows, respectively, This model includes an actual net cash flow observation in each of S years for each marketing option in X. The difference between the observed net cash flow and the expected net cash flow in a particular year is an element of D, the deviation matrix. The vector, d, represents total annual negative deviations summed over all marketing options entering the solution. The elements of d are summed over S years by L, a row vector of ones, to give a total negative deviation over all years in the historical data series. This sum is transformed into an estimate of the standard deviation by multiplying by the constant K, where K equals $\frac{2}{S\sqrt{2(S-1)}}\sqrt{3\cdot\pi}$. This estimate of the standard deviation

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[1] On the other hand for crop-share landowners, the cash flows of an operating farmer are irrelevant in any event, and "should" be ignored.

based on absolute devations about the mean was originally developed by Herrey [4] and has been used by Simmons and Pomareda [9] and Brink and McCarl [2] . The tradeoff between expected net cash flows and risk is represented by the risk aversion coefficient, ε. Parameterizing ε upwards produces an efficient set of marketing strategies characterizing decision makers with increasing aversion to risk.

Data

The model was specified for two representative farm situations. These representative farms were based on samples of data drawn from Logan County in central Illinois and from Effingham County in southern Illinois using Illinois Farm Business Farm Management records for the period 1973-77. The original study also considered the period 1965-77, but these results produced similar conclusions and are excluded to reduce the length of the presentation. The central Illinois region represents some of the most productive and drought resistant soils in the state while the southern Illinois region represents primarily clay laden timber soils which result in lower yields and greater susceptibility of yields to weather variation.

Table 1, describes some of the marketing options commonly available to farmers producing corn and soybeans. The twenty-nine options specified for each crop represent several options: preharvest contracting for harvest or post-harvest delivery, selling for cash at harvest or out of storage following harvest, and forward contracting at harvest or out of storage for later delivery. The marketing options for both crops are differentiated in terms of the timing of the decision to sell and the delivery month.

For each option, a series of per acre net cash flows was constructed. Mid-month cash prices and forward contract bids to farmers were collected for each year in the time period and used with the sample farm record yield data to construct the data series. Prices in each year were net of storage costs associated with the marketing option (assuming commercial storage rates).

Within the model, cash receipts and variable costs of production were separated for each activity to provide for the magnitude and timing of cash flows. The pricing period used was twenty months long, beginning in January prior to planting and extending through the growing season and the delivery period following harvest. The delivery period for which the model was constructed was a twelve-month period beginning on September 1 and extending until the following August 31. This time frame was specified to begin as the crops were harvested and assumed that all crops were sold prior to the harvest of the following year's production. Cash inflows and outflows were specified to occur in six two-month time periods as they would typically occur during the production and marketing process. This cash flow formulation assumes a continuing farm operation of a fixed size. A designated marketing year, t, refers to the calendar year in which the beginning of the marketing period falls and assumes that cash receipts during the period are derived from crops producted in year t even though sales and cash receipts may occur in the calendar year t + 1.

Table 1

MARKETING OPTIONS FOR CORN AND SOYBEANS

Option Number	Marketing Option Description
	Corn Marketing Options
2	Contract Corn in January, t for Harvest
3	Contract Corn in January, t for January, t+1
4	Contract Corn in March, t for Harvest
5	Contract Corn in March, t for January, t+1
6	Contract Corn in March, t for March t+1
7	Contract Corn in May, t for Harvest
8	Contract Corn in May, t for January, t+1
9	Contract Corn in May, t for March, t+1
10	Contract Corn in May, t for May, t+1
11	Contract Corn in July, t for Harvest
12	Contract Corn in July, t for January, t+1
13	Contract Corn in July, t for March, t+1
14	Contract Corn in July, t for May, t+1
15	Contract Corn in July, t for July, t+1
16	Sell Corn for Cash at Harvest
17	Contract Corn at Harvest for January, t+1
18	Contract Corn at Harvest for March, t+1
19	Contract Corn at Harvest for May, t+1
20	Contract Corn at Harvest for July, t+1
21	Sell Corn for Cash in January, t+1
22	Contract Corn in January, t+1 for March, t+1
23	Contract Corn in January, t+1 for May, t+1
24	Contract Corn in January, t+1 for July, t+1
25	Sell Corn for Cash in March, t+1
26	Contract Corn in March, t+1 for May, t+1
27	Contract Corn in March, t+1 for July, t+1
28	Sell Corn for Cash in May, t+1
29	Contract Corn in May, t+1 for July, t+1
30	Sell Corn for Cash in July, t+1

Table 1 (Cont.)

Option Number	Marketing Option Description
	Soybean Marketing Options
32	Contract Soybeans in January, t for Harvest
33	Contract Soybeans in January, t for January, t+1
34	Contract Soybeans in March, t for Harvest
35	Contract Soybeans in March, t for January, t+1
36	Contract Soybeans in March, t for March, t+1
37	Contract Soybeans in May, t for Harvest
38	Contract Soybeans in May, t for January, t+1
39	Contract Soybeans in May, t for March, t+1
40	Contract Soybeans in May, t for May, t+1
41	Contract Soybeans in July, t for Harvest
42	Contract Soybeans in July, t for January, t+1
43	Contract Soybeans in July, t for March, t+1
44	Contract Soybeans in July, t for May, t+1
45	Contract Soybeans in July, t for July, t+1
46	Sell Soybeans for Cash at Harvest
47	Contract Soybeans at Harvest for January, t+1
48	Contract Soybeans at Harvest for March, t+1
49	Contract Soybeans at Harvest for May, t+1
50	Contract Soybeans at Harvest for July, t+1
51	Sell Soybeans for Cash in January, t+1
52	Contract Soybeans in January, t+1 for March, t+1
53	Contract Soybeans in January, t+1 for May, t+1
54	Contract Soybeans in January, t+1 for July, t+1
55	Sell Soybeans for Cash in March, t+1
56	Contract Soybeans in March, t+1 for May, t+1
57	Contract Soybeans in March, t+1 for July, t+1
58	Sell Soybeans for Cash in May, t+1
59	Contract Soybeans in May, t+1 for July, t+1
60	Sell Soybeans for Cash in July, t+1

Results

In Figures 1 through 4 the mean negative deviation and the expected return (specifically the 1973-77 mean gross return per acre are plotted for, respectively, the corn marketing options in Logan and Effingham counties and the soybean marketing options in Logan and Effingham counties. Because the linear programming type risk model was used rather than a quadratic programming model, the mean negative deviation was used rather than the variance as the risk measure. For ease of presentation, the marketing options are labeled by number in these figures. Table 1 associates each option number with the description of that option. The circled options identify the marketing options that emerged as "dominant" in the sense that for a given expected return no option would yield a smaller mean negative deviation or for any given mean negative deviation no option would yield a higher expected return.

Figure 1 for Logan County indicates that thirteen of the twenty-nine corn marketing options survive the dominance test. Figure 2 indicates that there are also thirteen dominant corn marketing options based on the Effingham County data. Figures 3 and 4 array the soybean marketing options for Logan and Effingham counties, respectively. Eight of the twenty-nine marketing options are dominant in Logan County, while only six options survive the dominance test in Effingham county.

One of the objectives of this paper was to look at the relationship between the dominant marketing strategies for a model which had all options available as activities. Tables 2 and 3 present the optimal marketing strategies for such a situation in Logan and Effingham counties, respectively. These strategies were generated by paremeterizing the risk aversion coefficient, ϵ, in five steps over a range from 0 to 2.0. In discussing these strategies the decision maker is referred to as risk neutral, moderately risk averse, medium risk averse, risk averse, and extremely risk averse, respectively. These results serve as benchmarks for comparisions involving the marketing options included in the unrestricted optimal marketing strategies and the options determined to be dominant in the risk-return dominance test. These benchmark strategies will also be compared with the optimal strategies generated when the model is restricted to marketing activities involving only those options which survive the dominance tests.

Comparing the dominant corn marketing options for Logan County in Figure 1 with the options that enter the optimal corn marketing strategies presented in Table 2 reveals that four of the seven options which are included in the optimal strategies were not dominant. These four options are: 2, preharvest contracting in January for harvest delivery; 17, contracting at harvest for January; 18, contracting at harvest for March; and 28, selling out of storage in May for cash. The three dominant corn marketing options which did enter the optimal strategies are: 4, preharvest contracting in March for harvest; 19, contracting at harvest for May; and 20, contracting at harvest for July. For example, at the medium risk aversion level, $\emptyset$=.5606, the optimal marketing strategy includes none of the dominant options.

A comparison of the dominant soybean marketing options for Logan County in Figure 3 with the options entering the optimal soybean marketing strategies in Table 2 provides similar results. Only two of the five

Table 2

OPTIMAL MARKETING STRATEGIES BY DEGREE OF RISK AVERSION FOR LOGAN COUNTY: BENCHMARK RESULTS

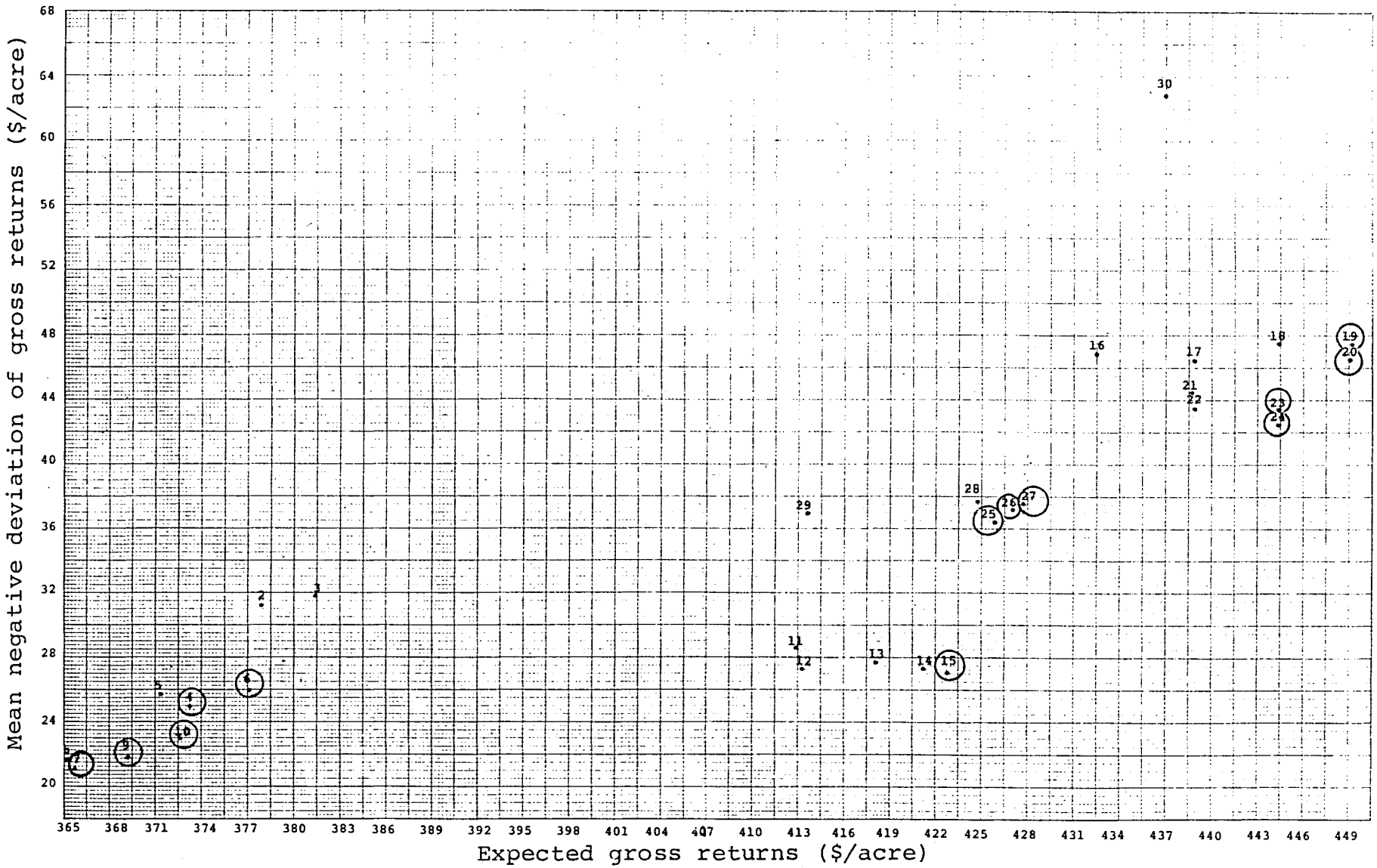
				Corn Options							Soybean Options				
ø	Expected Net Cash Flow	Estimated Standard Deviation	Total Negative Deviation	Jan I-Har	Mar I-Har	Har-Jan II	Har-Mar II	Har-May II	Har-Jul II	May II-Cash	Mar I-Har	Mar I-Mar II	May I-Har	Jul I-Har	May II-Cash
	dollars			percentages							percentages				
.0	107737.58	44897.33	80088.00					100.0						100.0	
.2803	105017.57	29562.40	52733.50			20.0	22.7	43.2	14.1					28.4	71.6
.5606	99086.55	21331.87	38051.85	19.3		20.0	60.7				2.6		5.1		92.3
.8409	82677.79	6677.16	11910.73		49.0		23.8			27.2		52.6	7.7		39.7
1.1212	82677.79	6677.16	11910.73		49.0		23.8			27.2		52.6	7.7		39.7

Table 3

OPTIMAL MARKETING STRATEGIES BY DEGREE OF RISK AVERSION FOR EFFINGHAM COUNTY: BENCHMARK RESULTS

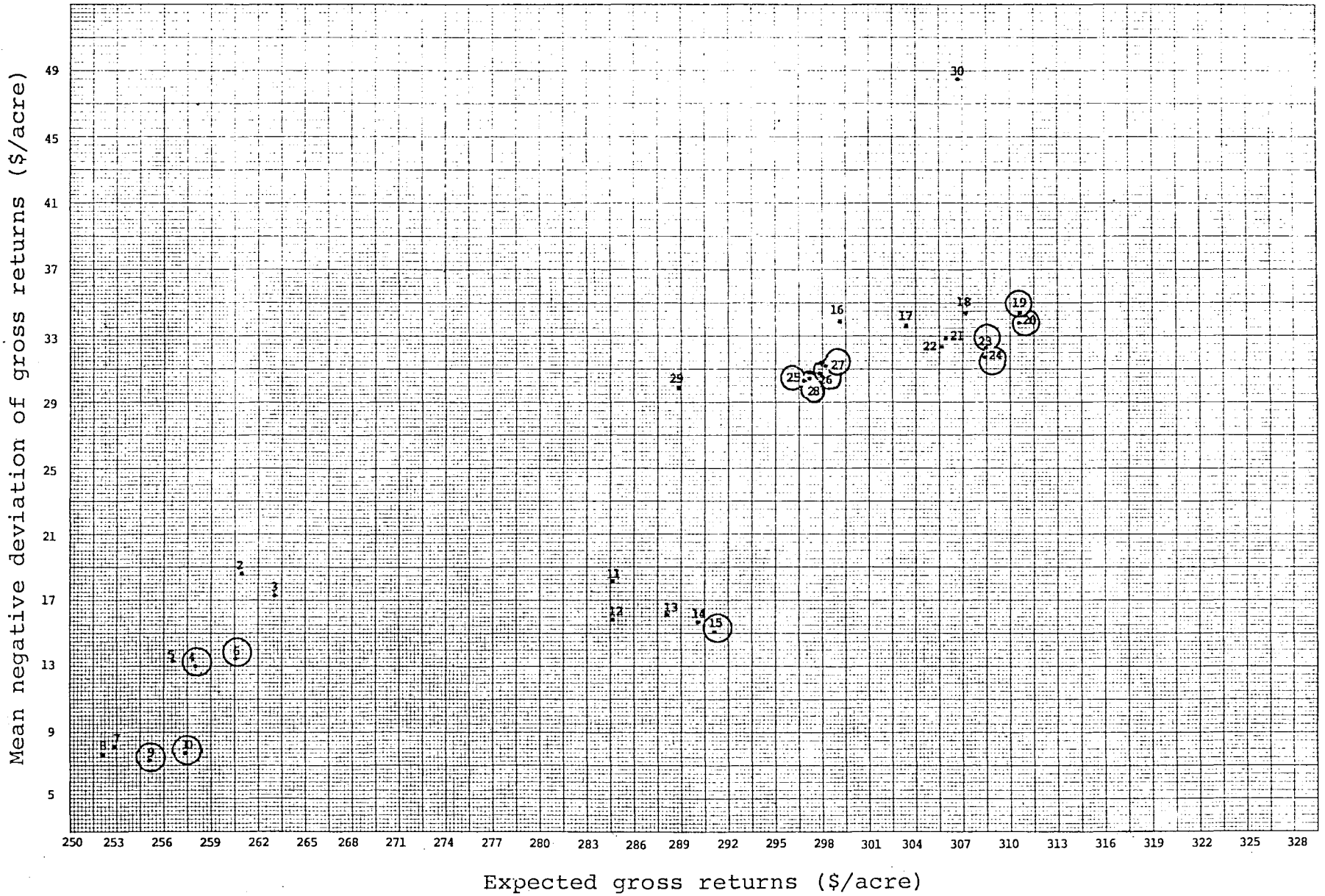
				Corn Options					Soybean Options				
ø	Expected Net Cash Flow	Estimated Standard Deviation	Total Negative Deviation	Jan I-Har	Mar I-Jan II	Har-Jan II	Har-Mar II	Har-May II	May I-Har	Jul I-Har	Har-Cash	May II-Cash	Jul II-Cash
	dollars			percentages					percentages				
.0	78061.01	31051.07	55389.00					100.0		100.0			
.2803	76601.11	19456.79	34797.08			11.6	27.0	61.4		38.7		51.8	9.5
.5606	70470.75	11951.01	21318.24	10.9		4.3	27.0	57.8	31.9		10.2	57.9	
.8409	62049.49	5535.34	9874.31	71.0				29.0	25.4		47.2	27.4	
1.1212	57763.11	2898.50	5170.36		84.7			15.3	32.9		49.0	18.1	

Figure 1



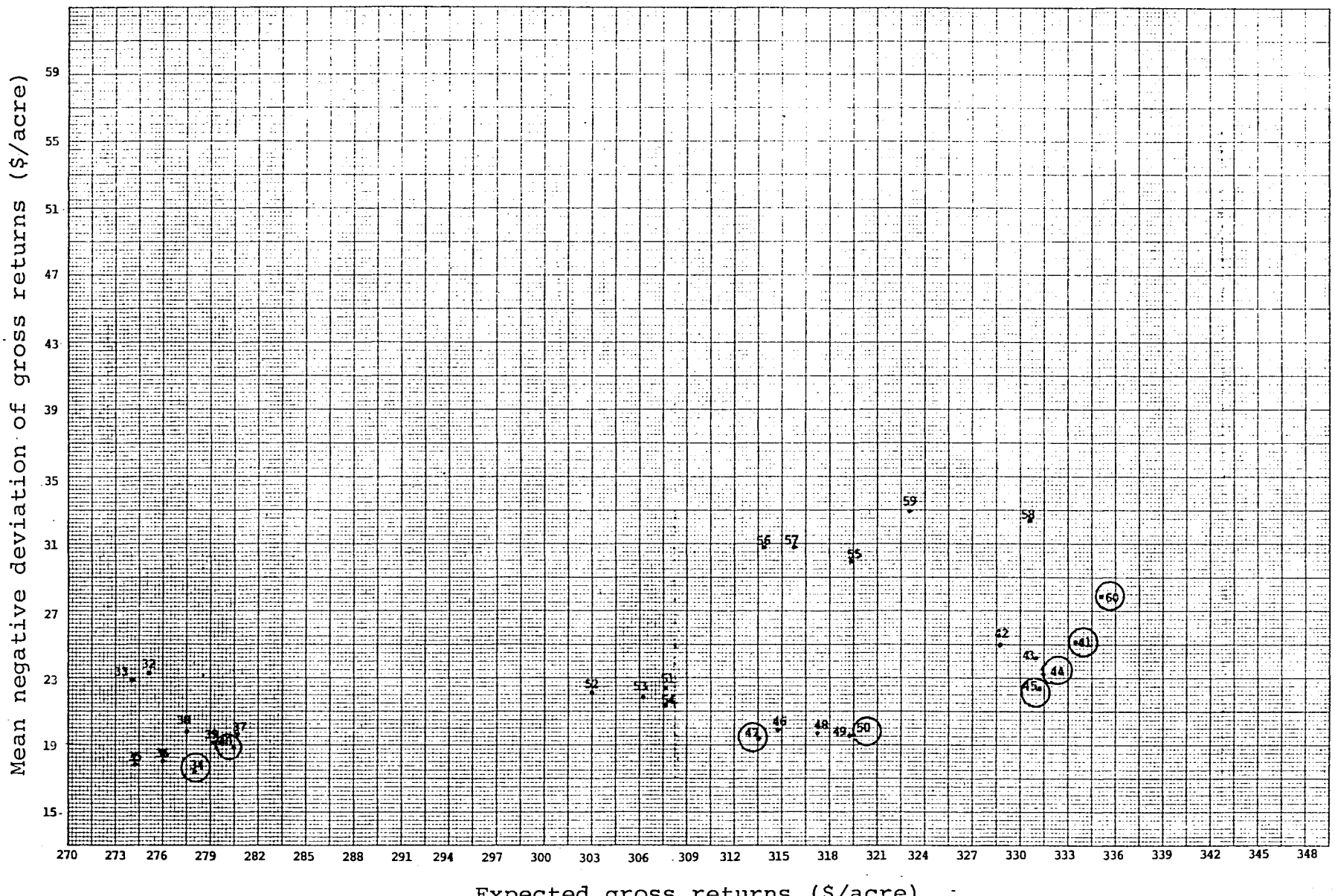
EXPECTED GROSS RETURNS AND MEAN NEGATIVE DEVIATIONS FOR LOGAN COUNTY, CORN, 1973-77.

Figure 2



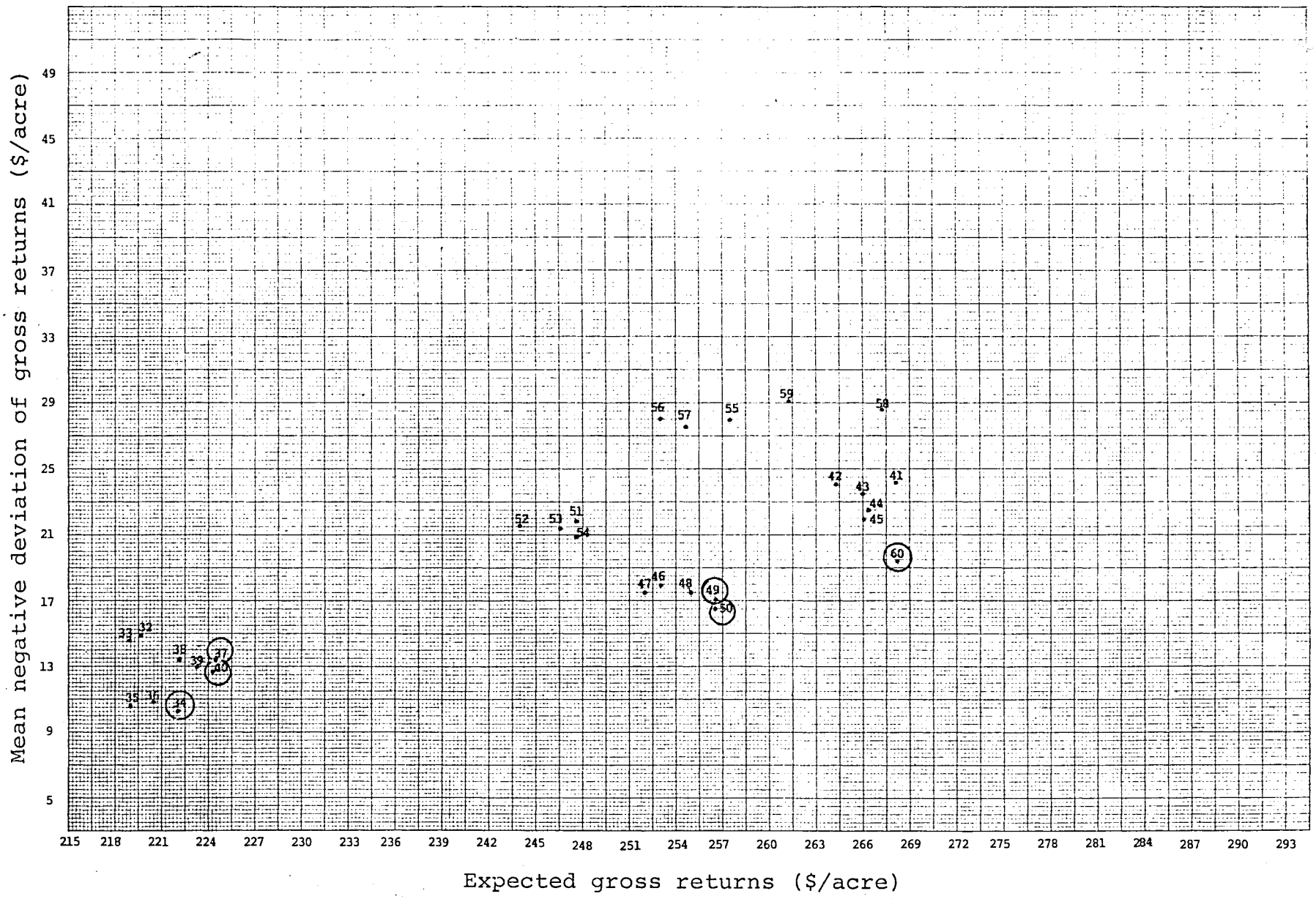
EXPECTED GROSS RETURNS AND MEAN NEGATIVE DEVIATIONS FOR EFFINGHAM COUNTY, CORN, 1973-77.

Figure 3



EXPECTED GROSS RETURNS AND MEAN NEGATIVE DEVIATIONS FOR LOGAN COUNTY, SOYBEANS, 1973-77.

Figure 4



EXPECTED GROSS RETURNS AND MEAN NEGATIVE DEVIATIONS FOR EFFINGHAM COUNTY, SOYBEANS, 1973-77.

options appearing in the optimal strategies would have been retained based on the dominance test. The two options are; 34, preharvest contracting in March for harvest delivery and 41, preharvest contracting in July for harvest. The three options which would have been excluded are: 36, preharvest contracting in March for delivery the following March; 37, preharvest contracting in May for harvest; and 58, selling in May for cash. Again, using the optimal strategy for the medium risk averter as an example; the only dominant option in the strategy is preharvest contracting in March for harvest which accounts for only 2.6 percent of the sales.

An analysis of the Effingham County results produces similar conclusions. Comparing the corn marketing options which enter the optimal strategies in Table 3 with the dominant corn marketing options from Figure 2 shows that four of the five options were not dominant. The four options are: 2, preharvest contracting in January for harvest delivery; 5, preharvest contracting in March for January; 17, contracting at harvest for January; and 18, contracting at harvest for March. The one dominant option which does appear in the optimal strategies is 19, contracting at harvest for May delivery. Specifically looking at the medium risk averter's optimal strategy reveals that in Effingham County the dominant option, 19, appears in the strategy and accounts for 57.8 percent of the corn sales.

Table 3 and Figure 4 provide the basis for comparing the options included in the Effingham County optimal soybean marketing strategies with the dominant options for the period. As in the Logan County results, three of the five options entering the optimal strategies would have been excluded by dominance test prescreening. The optimal nondominant options are: 41, preharvest contracting in July for harvest delivery; 46, selling at harvest for cash; and 58, selling out of storage in May for cash. Only the options of preharvest contracting in May for harvest delivery, 37, and selling out of storage in July for cash, 60, are both optimal and dominant. Reference to the optimal soybean marketing for the medium risk averse decision maker reveals the dominant option, 37, accounts for 31.9 percent of the sales.

These results would strongly indicate factors, such as cash flow considerations and the time value of money, in addition to expected returns and variability of returns for each option or marketing strategy are indeed important and that prescreening options based on dominance tests could produce strategies which are less than optimal.

Optimal Strategies Incorporating Only Dominant Marketing Options

In order to evaluate this hypothesis, Tables 4 and 5 present the results of generating optimal marketing strategies for Logan and Effingham counties, respectively, after restricting the marketing options considered to the dominant options for the 1973-77 period. These results are compared with the benchmark strategies in Tables 2 and 3 based on the same decision models with all marketing options considered.

Comparing the restricted optimal strategies for Logan County in Table 4 with the benchmark strategies in Table 2 indicates no difference at the risk neutral level since both the corn marketing option to forward contract at harvest for May delivery and the soybean marketing option to preharvest contract in July for harvest delivery were dominant options. At the moderately risk averse level the restricted optimal corn marketing strategy is

Table 4

OPTIMAL MARKETING STRATEGIES BY DEGREE OF RISK AVERSION FOR LOGAN COUNTY: DOMINANT OPTIONS, 1973-77 DEVIATION SERIES

	Expected	Estimated	Total	Corn Options				Soybean Options			
Ø	Net Cash Flow	Standard Deviation	Negative Deviation	Mar I-Har	Jul I-Jul II	Har-May II	Har-Jul II	Mar I-Har	May I-May II	Jul I-Har	Jul II-Cash
	dollars			percentages				percentages			
.0	107737.58	44897.33	80088.00			100.0				100.0	
.2803	103584.54	33384.50	59551.38		46.9	39.6	13.5			100.0	
.5606	83498.53	9997.65	17833.83	82.5			17.5	37.7		59.6	2.7
.8409	83006.31	9524.85	16990.45	81.8			18.2	32.3	8.9	58.8	
1.1212	83006.31	9524.85	16990.45	81.8			18.2	32.3	8.9	58.8	

Table 5

OPTIMAL MARKETING STRATEGIES BY DEGREE OF RISK AVERSION FOR EFFINGHAM COUNTY: DOMINANT OPTIONS, 1973-77 DEVIATION SERIES

	Expected	Estimated	Total	Corn Options					Soybean Options		
Ø	Net Cash Flow	Standard Deviation	Negative Deviation	Mar I-Har	Mar I-Mar II	Jul I-Jul II	Har-May II	Mar II-Cash	May I-Har	Har-May II	Jul II-Cash
	dollars			percentages					percentages		
.0	74134.61	34757.77	62001.04				81.4	18.6			100.0
.2803	71769.97	28006.47	49958.02	13.8			86.2		8.8	13.0	78.2
.5606	55539.88	4531.97	8084.14	14.0	71.7	14.3			45.8	54.2	
.8409	55381.50	4375.44	7804.93	88.9		11.1			44.1	55.9	
1.1212	55381.50	4375.44	7804.93	88.9		11.1			44.1	55.9	

to preharvest contract 46.9 percent of the crop with the remainder contracted at harvest for later delivery, while the benchmark strategy forward contracted all of the crop at harvest. The soybean marketing strategy is unchanged from the risk neutral strategy, while the benchmark strategy changed to preharvest contracting only 28.4 percent of the crop with the remainder sold during the post-harvest period for cash. The expected net cash flow is $1,433.03 lower and the estimated standard deviation is $3,822.10 larger than for the benchmark strategy. The medium risk averter preharvest contracts 82.5 percent of the expected corn production for harvest delivery and forward contracts only 17.5 percent of the corn at harvest compared to nearly reversed situation of 19.3 and 80.7 percent, respectively, in the benchmark results. The soybean marketing strategy also reverses the seasonal pattern of sales with 97.3 percent perharvest contracted compared to 7.7 percent in the benchmark strategy and 2.7 percent sold during the post-harvest period for cash compared to 92.3 percent. Although expected net cash flows fall by $13,588.02, the estimated standard deviation also decreases by $11,334.22. The corn marketing strategy for the risk averse decision maker reduces the seasonal diversification of sales by preharvest contracting 81.8 percent of the expected production and forward contracting 18.2 percent at harvest while the henchmark strateby preharvest contracted 49 percent of the crop, forward contracted 23.8 percent at harvest, and sold 27.2 percent during the post-harvest period for cash. Soybean sales are also more concentrated with all of the expected production preharvest contracted as compared to only 60.3 percent in the benchmark strategy in which the remaining 39.7 percent was sold for cash during the post-harvest period. Although the expected net cash flow increases by $328.52, the estimated standard deviation increases by $2,847.69. The extreme risk averter's optimal marketing strategy is the same as the risk averter's for both crops as was the case in the benchmark strategy. The result of restricting the options to only those surviving the dominance test is to produce either lower expected net cash flows or a higher estimated standard deviation of net returns or both at each level of risk aversion except the risk neutral.

A comparison of the restricted marketing strategies for Effingham County in Table 5 with the benchmark results in Table 3 indicates a change in the optimal strategy even at the risk neutral level because the marketing option to preharvest contract soybeans in July for harvest delivery, which accounted for all sales in the benchmark strategy, was not among the dominant options. The decision maker now forward contracts 81.4 percent of the corn crop at harvest and sells 18.6 during the post-harvest period for cash, compared to forward contracting all of the crop at harvest in the benchmark strategy. The soybean marketing strategy shifts from preharvest contracting all of the expected production to selling all of the crop for cash during the post-harvest period. Expected net cash flows fall by $3,926.40 while the estimated standard deviation increases by $3,706.70.

At the medium level of risk aversion the corn marketing strategy involves preharvest contracting all of the expected production while the benchmark strategy preharvest contracted only 10.9 percent with the remainder forward contracted harvest at The medium risk averter's soybean marketing strategy preharvest contracts 45.8 percent of the crop and forward contracts 54.2 percent at harvest, while the benchmark strategy

preharvest contracted 31.9 percent, sold 10.2 percent at harvest for cash, and sold 57.9 percent during the post-harvest period for cash. The estimated standard deviation is $7,419.04 less than for the benchmark strategy; but, the expected net cash flow is also reduced by $14,930.87.

The restricted optimal marketing strategies for both the risk averse and the extremely risk averse decision maker are identical and involve sales patterns for both corn and soybeans which are more concentrated than in the benchmark strategies. All of the expected corn production is preharvest contracted, while the soybean marketing strategy preharvest contracts 44.1 percent of the crop and forward contracts the rest at harvest. These compare to the benchmark corn marketing strategies for the risk averter and the extreme risk averter which divided sales between preharvest contracting and forward contracting at harvest. The benchmark soybean strategies were also more diversified with sales allocated among preharvest contracting, cash sales at harvest, and post-harvest cash sales. The estimated standard deviation for the risk averter is less than the benchmark strategy by $1,159.90; but, the expected net cash flow is $6,667.99 lower. At the extreme risk aversion level the estimated standard deviation is $1,476.94 larger and the expected net cash flow $2,381.61 less than for the benchmark strategy.

In the Effingham County results, the expected net cash flows for the restricted optimal strategies are less for every level of risk aversion; and for all but the medium and the risk averse levels, the estimated standard deviation of returns are greater than the benchmark strategies. Thus, comparisons for both Logan and Effingham counties support the hypothesis that prescreening alternatives based on dominance testing can produce suboptimal solutions in terms of expected returns and variability of returns when the optimal marketing strategies are considered in the context of the total firm.

In addition to changing the options included in the optimal strategies and thus altering the level and variability of expected returns, the restricted strategies result in seasonal shifts in the timing of the decision to sell or contract. For example, when the marketing period is divided into preharvest, harvest, and post-harvest periods, restricting the strategies to only dominant options virtually elimimates post-harvest sales of both corn and soybeans in Logan County. The only minor expection is the cash sale of 2.7 percent of the soybeans out of storage in July by the medium risk averter. The elimination of post-harvest soybean sales from the restricted optimal strategies is also true for the medium risk averse, the risk averse, and the extremely risk averse decision maker in Effingham County. Although there are no post-harvest corn sales in the Effingham County restricted optimal strategies, neither were there any in the benchmark strategies. However, the restricted corn marketing optimal strategies also eliminate harvest period options in Effingham County at the medium and higher levels of risk aversion. Therefore, the result of restricting the marketing alternatives to only dominant options also restricts the seasonal diversification of sales.

Concluding Remarks

Several implications arise from the results of this study. First,

comparisions of the marketing options selected as dominant with the marketing options entering the optimal marketing strategies do not indicate a strong relationship between the two sets, implying that other factors such as covariation, cash flow considerations and the time value of money, in addition to expected returns and variability of returns are of considerable significance. Second, restricting the decision model to only dominant options can significantly reduce expected returns and increase the variability of returns for the total firm. A third result indicated that restricting the decision model to only the dominant options also had the effect of reducing seasonal diversification of sales.

A more general implication indicated by these results relates to the trade-off between the theoretical advantages of a quadratic programming formulation versus the expanded activity and constraint set typically available in a linear programming model augmented to reflect returns variability. These results suggest that limiting the activity set included in a model, even when prescreened in a seemingly plausible manner, may distort the recommendations derived from the model. This concern appears to be particularly relevant when attempting to model the complex setting of managing a farm firm.

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