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Portfolios of Agricultural Market Advisory Services: How Much Diversification Is Enough?

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This study analyzes the potential risk-reduction gains from naive diversification among market advisory services for corn and soybeans. The total possible decrease in risk through naive diversification is small, mainly because advisory prices are highly correlated on average. Moreover, because marginal risk-reduction benefits decrease rapidly with size and the cost of holding the portfolios increases linearly due to services' subscription fees, it is optimal to limit portfolio size to a few advisory programs. Based on certainty equivalent measures and two representative risk-aversion levels, preferred portfolio sizes are between one and three programs.

Key Words: corn, diversification, market advisory service, portfolio, soybeans

JEL Classifications: G11, Q10, Q12, Q14

Marketing decisions are an important part of farm business management. Farmers are interested in enhancing farm income and reducing income variability when marketing crops. There are many tools to assist farmers in such marketing decisions. Several surveys, including Patrick, Musser, and Eckman and Schroeder et al., report that farmers specifically viewed one of these tools, professional market advisory services, as an important source of marketing information and advice. For a subscription fee, market advisory services offer specific advice to farmers on how to market their commodities. It is often thought that advisory services can process market information more rapidly and efficiently than farmers to determine the most appropriate marketing decisions.

Several studies have analyzed the effectiveness of market advisory services. Gehrt and Good examined the returns for corn and soybean producers, assuming they had followed the recommendations of five advisory services over 1985–1989 and compared returns against a market benchmark price. They concluded that there is some evidence that services could beat the benchmark price. Martines-Filho analyzed the preharvest recommendations of six advisory services for corn and soybeans over the 1991–1994 production

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years and found evidence supporting the ability of the services to generate a higher return than a market benchmark. In 1994, the Agricultural Market Advisory Services (AgMAS) Project was initiated at the University of Illinois to expand research on market advisory service performance. The AgMAS Project has monitored and evaluated about 25 advisory services each crop year, and the empirical findings have been disseminated through various AgMAS research reports. For example, Irwin, Martines-Filho, and Good presented results from the evaluation of corn and soybean advisory services over 1995–2000. When both average price and risk were considered, only a small fraction of services performed better than the average price offered by the market. On the other hand, a majority of the services performed better than the average price received by farmers as reported by the U.S. Department of Agriculture (USDA).

The research reviewed above examines the pricing performance of market advisory services on a stand-alone basis only. In other words, individual advisory services are evaluated against benchmark prices without analyzing possible gains from diversification among these services. In reality, farmers can choose more than one advisory service and market a proportion of production following the advice of each of the selected services. According to survey results reported by Isengildina et al., farmers that subscribe to advisory services often subscribe to multiple services. The sample for this survey was drawn from Midwest, Great Plains, and southeastern U.S. producers who subscribed to a satellite information delivery service that offers electronic delivery of advisory-service recommendations. Survey results show that 57% of the farmers subscribed to two or more services and 20% subscribed to three or more services. Moreover, in recent years, several grain companies developed and began offering contracts where grain is priced according to the recommendations of an advisory service (e.g., Hagedorn et al.). A specific example is the Ag Horizon ProPricing MarketPros contract offered by Cargill. Farmers can select from three different advisory services in this contract. These new marketing contracts make it relatively simple for farmers to diversify across advisory services. This suggests information on the magnitude of potential gains from diversification and the number of services needed to maximize risk-reduction benefits should be of considerable interest.

The relationship between the number of portfolio components and portfolio risk has been widely studied for the stock market (e.g., Elton and Gruber; Evans and Archer). It is well known that, when stocks are randomly selected to construct equally weighted portfolios, portfolio risk decreases as the number of stocks increases. But, as the number of stocks increases, the decrease in risk from adding a new component diminishes to the point that, after several stocks have been added, the benefits of adding a new component become very small. The same concepts can be applied to portfolios of market advisory services. A farmer who follows a large number of randomly selected advisory services can expect to have more stable pricing performance than a farmer following fewer services. But the risk-reduction gain from following an additional service becomes smaller as portfolio size increases. Moreover, because there is a subscription cost associated with each service, the increase in the cost of holding a portfolio may offset the risk-reduction benefits above some portfolio size.

The purpose of this study is to analyze the relationship between risk-reduction benefits and the number of market advisory services followed in corn and soybeans. Data on market advisory prices and revenue for 17 advisory programs over 1995–2000 are obtained from Irwin, Martines-Filho, and Good. Based on these data, the risk level for portfolios including 1–17 programs is estimated along with the cost of holding these portfolios. In order to compare portfolios of different sizes, certainty equivalents are computed for two levels of risk aversion. The results provide new information on the magnitude of potential diversification benefits and the optimal number of advisory services to follow to achieve the benefits.

The following section discusses the costs and benefits of naive diversification among market advisory services. Data and procedures are then described. Following that, results for portfolios of different sizes are compared in terms of standard deviation reductions and certainty equivalents for different levels of risk aversion. The final section presents the summary and conclusions.

Risk-Reduction Benefits and Costs of Diversification

Portfolio theory shows that diversification across advisory services has the potential of reducing price variability. Then, a reasonable question to ask is how much diversification is enough, or in other words, how many advisory services should be included in a farmer's portfolio to capture these risk-reduction benefits. In this study, the relationship between risk and the number of components is analyzed for naively diversified portfolios. Naive diversification is a term commonly used in the finance literature to refer to portfolios that are constructed by randomly selecting the stocks to be included and assigning equal weight to each component.

Naive diversification is not necessarily the optimal method of constructing portfolios. For example, the Markowitz portfolio-selection model implies that the assets to be included in a portfolio and their respective weights should be selected to minimize portfolio variance for a given level of expected return. Under this model, the composition of optimal portfolios is based on expected returns, variances, and correlations of individual assets. Although the Markowitz model is in theory a more preferred approach, naive diversification is widely used in practice (e.g., Lhabitant and Learned). The reason is that naive portfolios are a reasonable alternative when information on individual expected returns, variances, and correlations is limited, and therefore, the estimates for these parameters may not be reliable. In this case, naive diversification is likely to be a more reliable method for constructing portfolios.

The basic idea is that a portfolio of size N can be constructed by randomly selecting N advisory services from the set of services available to the farmer and assigning equal weight of $1/N$ to each service (this means that the farmer applies the recommendations from each advisor to $1/N$ of total production). For each equally weighted combination of N advisory services, the expected crop price/revenue will be the average of the expected price/revenue of the services participating in the portfolio, and the portfolio variance can be computed as

$$(1) \qquad \sigma^2_{\text{port}} = \sum_{i\in k}\left(\frac{1}{N}\right)^2\sigma_i^2 + \sum_{i\in k}\sum_{j\in k}\left(\frac{1}{N}\right)^2\rho_{ij}\sigma_i\sigma_j,$$

where σ_i^2 is the variance for program i, ρ_{ij} is the correlation coefficient between programs i and j, and k is the set of services that are included in the portfolio. Note that summations are over the programs that are part of the portfolio. With naive diversification, there are several different possible combinations of advisory services for each portfolio size, all occurring with the same probability. Consider, for example, the case where four services are available to the farmer (A, B, C, and D) and the farmer decides to follow the recommendations of two ($N = 2$). Naive diversification implies that the farmer randomly chooses any of the six possible two service portfolios, AB, AC, AD, BC, BD, or CD, with the same probability.

A commonly used measure to characterize the risk level of naive portfolios is the expected variance. Expected variance for a naive portfolio of N components is the average portfolio variance among all possible combinations of the available services in sets of N. An analytical expression for expected portfolio variance was derived from Equation (1) by Elton and Gruber,

$$(2) \qquad E(\sigma^2_{\text{port}}) = \frac{1}{N}(\bar{\sigma}_i^2 - \bar{\sigma}_{ij}) + \bar{\sigma}_{ij},$$

where $(\bar{\sigma}_i^2)$ is the average variance for all available advisory services and $(\bar{\sigma}_{ij})$ is the average covariance between all pairs of services. Note that averages are taken across the entire set of services available to the farmer. Equation (2) shows that portfolio expected variance declines as portfolio size increases. For very large N, expected portfolio variance asymptotically approaches average covariance. Also, for $N = 1$, expected variance is just the average variance across services. The term $(\bar{\sigma}_i^2 - \bar{\sigma}_{ij})$ in Equation (2) represents diversifiable risk, i.e., the risk that can be removed by increasing the number of portfolio components. The second component, $(\bar{\sigma}_{ij})$, represents nondiversifiable risk. The notion that risk decreases with size at a decreasing rate can be seen directly in Equation (2).

Note, e.g., that, for $N = 2$, half of the diversifiable risk is eliminated, for $N = 5$, 80% of the diversifiable risk is eliminated, and for $N = 10$, 90%. The size of the reduction in expected variance depends on the magnitude of the difference between the average variance and average covariance compared with the magnitude of the average covariance.

Many studies employ expected variance (Equation (2)) as the only source of risk for naive portfolios (e.g., Billingsley and Chance; Henker; Statman). However, if expected variance is the measure of concern, the dispersion of portfolio variance should also be considered. Recall that expected variance is the average variance across all possible combinations of advisory services for a given portfolio size and, because a farmer will randomly choose only one combination, the realized variance is likely to be different from the expected variance. In other words, not only the expected variance but also the variance of the variance should be considered. Elton and Gruber derived a rather complicated mathematical formula for the variance of the variance, which is not presented here for the sake of space. The relevant fact is that, for smaller portfolio sizes, the range of values that realized variance can take is wider, or, in other words, the variance of the portfolio variance is higher. Optimal portfolio size can be underestimated if the variance of portfolio variance is ignored.

However, as pointed out by Elton and Gruber, expected variance (Equation (2)) does not properly describe the risk associated with randomly selected portfolios. Expected variance only measures the average dispersion of the portfolio price/revenue with respect to its own average price/revenue, without considering the probability that the expected price/revenue for the selected portfolio will be different from the population expected price/revenue. For example, the risk in selecting a single service ($N = 1$) not only depends on the average variance across services but also on the uncertainty that the expected price/revenue of the selected service will be different from the population average. Elton and Gruber propose the following measure of total risk for naive portfolios:

$$(3) \qquad \sigma^2_{T\text{port}} = \frac{1}{N}(\bar{\sigma}^2_i - \bar{\sigma}_{ij}) + \bar{\sigma}_{ij} + \frac{1}{N}\left(1 - \frac{N-1}{M-1}\right)\sigma^2_{\bar{p}},$$

where M is the number of services available to the farmer and $\sigma^2_{\bar{p}}$ is the variance of the expected advisory price/revenue. This formula adds a new component to Equation (2) that depends on the dispersion of expected price/revenue across services. This component equals zero if all advisory services have the same expected price/revenue or if the portfolio contains all available services ($M = N$). Note that increasing portfolio size also reduces this second component of expected variance, which implies that, when it is ignored, the benefits from adding services in a portfolio are underestimated. Henceforth, the term total portfolio variance refers to the variance as measured in Equation (3).

When determining optimum portfolio size, it is necessary to compare marginal risk-reduction benefits with the marginal cost of adding extra services in the portfolio. If there were no fees associated with subscribing to the advisory services, portfolio expected price/revenue would be independent of size and equal to the average price/revenue across all services. Then, in the absence of costs, it would be optimal for the farmer to select the minimum-risk portfolio that includes all available services. However, in reality, there is an annual subscription fee associated with each program and, consequently, cost increases linearly in portfolio size. Because the marginal risk reduction decreases rapidly with size, it is optimal to limit diversification in the presence of subscription costs.

In this study, the tradeoff between risk reduction and cost is analyzed within an expected utility framework. For the expected utility computations, the risk level for naive portfolios as well as the decrease in expected revenue due to subscription costs are considered.

Data and Procedures

Data on corn and soybean net advisory prices and corn/soybean revenue from 1995 through 2000 are drawn from Irwin, Martines-Filho, and Good. The sample consists of the 17 advisory programs that were followed by the AgMAS Project in each of these 6 crop years. The term advisory program is used because several advisory services have more than one distinct marketing program. Recommendations of individual market advisory programs collected by the AgMAS Project over these years were used to compute a net price that would be received by a farmer in central Illinois that sells grain based on the recommendations of each program. Details on the computations can be found in Irwin, Martines-Filho, and Good. The analysis is applied not only for corn and soybean prices individually but also for corn/soybean revenue because many subscribers to advisory programs produce both corn and soybeans. A corn–soybean rotation practice where each crop is planted on half of the farmland is common among central Illinois farmers. The per-acre revenue for each commodity is found by multiplying the net advisory price for each market advisory program by the corn or soybean yield for each year. A simple average of the two per-acre revenues is then taken to determine the total revenue obtained from this practice, which is called 50/50 revenue here.

Table 1 shows the expected value, standard deviation, average correlation, and annual subscription costs for each advisory program for corn price, soybean price, and 50/50 revenue. Corn advisory prices range from \$2.20/bushel to \$2.76/bushel, with an average of \$2.38/bushel. Soybean advisory prices range from \$5.86/bushel to \$6.80/bushel, with an average of \$6.19/bushel. Revenue ranges from \$304/acre to \$358/acre, with an average of \$316/acre. The average correlation between programs is highest for soybean advisory prices (0.78), in the middle for corn advisory prices (0.73), and lowest for 50/50 revenues (0.65). The correlation values in Table 1 show that, in general, advisory prices are highly correlated with each other. But there are some exceptions. For instance, Allendale (futures only) and Brock (hedge) for corn and Ag-Resource and Brock (hedge) for soybeans have low average correlations with other programs.[1] The last column of Table 1 presents annual subscription costs in 2000. These subscription costs are paid on a per-farm basis and range from a minimum of \$99 to a maximum of \$600, with an overall average of \$304.[2]

Based on the individual estimates for corn, soybeans, and 50/50 revenue, the estimated average variance and average covariance among all 17 programs is computed, as well as the variance of expected prices/revenue across services. Then, the estimated total variance for portfolios of 1–17 programs is calculated using Equation (3). The results are reported in terms of standard deviation for the different number of programs in the portfolio. The values for expected variance (Equation (2)) and the dispersion in the variance are also computed. The dispersion of the portfolio variance is measured by 90% confidence intervals around expected variance. To compute bounds for the confidence interval at a given portfolio size N, portfolio variance is computed for each possible combination of N programs. Then, the lower and upper bounds correspond to the 5th and 95th percentiles of portfolio variance, respectively, for each size.

Because farmers generally combine corn and soybeans in their production systems, the 50/50 revenue figures may be the most relevant. Based on this, the trade-off between risk reduction and increasing cost is analyzed in terms of expected utility only for the 50/50 revenue case. Because revenue is measured on a per-acre basis, it is necessary to express subscription cost on a per-acre basis, which requires assumptions about farm size. In this study, two farm sizes are considered, 500 acres and 2,000 acres, the same sizes employed in other AgMAS studies of advisory-program performance in corn and soybeans.

The economic value of portfolios of different sizes is analyzed for the two farm sizes. In order to compare alternatives with different expected values and risk levels, as is the case when comparing portfolios of different sizes, it is necessary to make an assumption about the decision maker's risk-aversion characteristics. It is assumed that farmers have a negative exponential utility function,

$$(4) \qquad U(w) = -e^{-\lambda w},$$

where $U(w)$ is the utility as a function of

[1] The expected prices/revenue and prices/revenue variance–covariance matrices were also computed using the Sharpe single index model (Sharpe). The estimated values obtained under this procedure are nearly identical to the traditional sample estimates presented in Table 1. The alternative results are available from the authors on request.

[2] Subscription costs varied little over the sample period.

Table 1. Six-Year Average, Standard Deviation, Average Correlation, and Subscription Costs for 17 Market Advisory Programs, Corn and Soybean Net Advisory Price, and 50/50 Advisory Revenue, 1995–2000 Crop Years

	Corn Net Advisory Price ($/Bushel)			Soybean Net Advisory Price ($/Bushel)			50/50 Advisory Revenue ($/acre)			
Market Advisory Program	Average	Standard Deviation	Average Correlation	Average	Standard Deviation	Average Correlation	Average	Standard Deviation	Average Correlation	Annual Subscription Cost ($)
Ag Review	2.39	0.29	0.68	5.86	1.03	0.83	310	38	0.76	360
AgLine by Doane (cash only)	2.43	0.40	0.84	6.14	0.77	0.88	319	29	0.79	300
AgResource	2.76	0.67	0.66	6.80	0.41	0.34	358	43	0.36	600
Agri-Mark	2.42	0.65	0.80	6.45	0.98	0.69	324	43	0.54	300
AgriVisor (aggressive cash)	2.53	0.45	0.85	6.06	0.74	0.88	324	32	0.79	299
AgriVisor (aggressive hedge)	2.39	0.41	0.83	6.16	0.86	0.85	316	30	0.75	299
AgriVisor (basic cash)	2.36	0.26	0.83	6.03	0.69	0.87	312	27	0.78	299
AgriVisor (basic hedge)	2.36	0.34	0.83	6.14	0.85	0.87	314	31	0.79	299
Allendale (futures only)	2.30	0.18	0.21	6.23	0.65	0.83	313	20	0.19	300
Brock (cash only)	2.33	0.33	0.80	6.06	0.69	0.88	310	33	0.77	240
Brock (hedge)	2.34	0.20	0.20	6.31	0.66	0.46	318	35	0.20	240
Freese–Notis	2.35	0.46	0.81	6.05	0.67	0.86	311	39	0.78	360
Pro Farmer (cash only)	2.27	0.54	0.85	6.14	0.77	0.88	306	38	0.74	420
Pro Farmer (hedge)	2.29	0.51	0.84	6.30	0.76	0.88	311	38	0.75	420
Stewart–Peterson Advisory Reports	2.20	0.41	0.83	6.25	0.63	0.77	304	29	0.75	150
Stewart–Peterson Strictly Cash	2.35	0.39	0.83	6.06	0.69	0.86	311	32	0.76	99
Top Farmer Intelligence	2.39	0.41	0.73	6.24	0.35	0.71	319	17	0.51	180
Descriptive Statistics										
Average	2.38	0.43	0.73	6.19	0.74	0.78	316	33	0.65	304
Median	2.36	0.41	0.83	6.14	0.69	0.86	313	32	0.75	299
Minimum	2.20	0.18	0.20	5.86	0.35	0.34	304	17	0.19	99
Maximum	2.76	0.67	0.85	6.80	1.03	0.88	358	43	0.79	600
Range	0.57	0.49	0.65	0.93	0.67	0.55	54	26	0.60	501

Notes: Results are shown only for the 17 advisory programs included in all 6 years of the AgMAS corn and soybean evaluations. A crop year is a 2-year window from September of the year previous to harvest through August of the year after harvest. The average correlation for each service is computed as the average of the 16 correlation values between a given program and each of the other programs.

wealth, w, and λ is the coefficient of absolute risk aversion (ARA). The main advantage of negative exponential utility is that expected utility under this function has a known expression for many outcome distributions and, therefore, is often used as a simplification of a more complicated preference structure. If individuals have negative exponential utility and $\tilde{w}$ is normally distributed with mean μ and variance σ^2, expected utility is

$$(5) \qquad E[U(\tilde{w})] = -e^{-\lambda[\mu-(1/2)\lambda\sigma^2]}.$$

In the present case, the farmer's final wealth (w) corresponds to an initial net worth value, which can be considered fixed, plus random crop revenue net of subscription costs. In the expected utility computation, it is assumed that crop revenue (net of subscription costs) is the only random component of the farmer's final wealth. Variation in other corn and soybean nonland production costs is assumed to be negligible. Given that, in practice, the variability of nonland production costs is much lower than the variability of crop revenue, this assumption is reasonable. To compute expected utility for each portfolio size, it is necessary to assume values for the ARA coefficient. Reported values of relative risk-aversion coefficients (RRA) are more stable between studies and, in general, values range between zero and six (e.g., Myers; Saha, Shumway, and Talpaz; Szpiro). Based on this evidence, RRA coefficients of two and six are selected to represent low- and high-risk aversion decision makers. ARA values are computed by dividing these RRA coefficients by an estimated net worth of \$662,752 and \$2,651,000 for 500- and 2,000-acre farms, respectively.[3]

The procedure to compute the expected utility for a farmer from selling the crops according to the recommendations of a portfolio of N randomly selected advisory programs is as follows. First, for each portfolio size N, $N = (1, 2, \ldots, 17)$, all possible combinations of programs are listed. Then, for each combination, portfolio expected revenue and portfolio variance are computed. The expected revenue for a combination k of size N is computed as the average expected revenue for the programs participating in the portfolio minus the sum of subscription costs for all programs in the portfolio divided by farm size,

$$(6) \qquad \bar{r}_k = \frac{1}{N}\sum_{i\in k} \bar{r}_i - \frac{1}{FarmSize}\sum_{i\in k} C_i,$$

where $\bar{r}_i$ is the average revenue for program i and C_i is the annual subscription cost for program i. The variance for each combination k of size N, (σ_k^2), is computed by plugging the sample estimates in Equation (1).

Next, based on the expected revenue and variance, the expected utility for each combination is computed by Equation (4),

$$E[U(\tilde{w})]_k = -e^{-\lambda[E(R)_k(1/2)\lambda\sigma_k^2]}.$$

Because each combination has the same probability of being selected, the expected utility of randomly selecting one of these combinations is equal to the average expected utility across possible combinations,

$$(7) \qquad E[U(\tilde{w})]_N = \frac{1}{S_N}\sum_{k=1}^{S_N} E[U(\tilde{w})]_k,$$

where S_N is the number of possible combinations for size N ($S_N = 17!)/[N!(17 - N)!]$). By comparing the expected utility for each value of N, it is possible to determine the preferred portfolio size.

Note that the average portfolio variance across all combinations (Equation (2)) does not enter directly in the expected utility computation; instead, expected utility is computed for each possible combination of programs. The proposed method takes into account the fact that each of the possible combinations for a certain portfolio size has a different expected price/revenue and a different variance. Therefore, this procedure incorporates not only the risk measured by the average portfolio variance for a certain size but also the risk due to the dispersion in portfolio expected price/revenue and portfolio variance.

Another measure closely related to expected utility is the certainty equivalent. The certainty equivalent (CE) for a random outcome

[3] The net worth value for a 500-acre farm corresponds to the value published in the Illinois grain farms financial benchmarks section at the *farmdoc* website: http://www.farmdoc.uiuc.edu/finance/benchmark_pdfs/si01.pdf. For a 2,000-acre farm, the net worth value is assumed to be four times the 500-acre net worth.

$(\tilde{w})$ is the amount of wealth for which the decision-maker is indifferent between that outcome with certainty and the random outcome,

$$(8) \qquad E[U(\tilde{w})] = U[CE(\tilde{w})].$$

Both expected utility and certainty equivalent allow ranking risky alternatives, but in this study, results are presented in terms of certainty equivalent because this is a more meaningful measure from an economic perspective. The alternative with the largest certainty equivalent has the greatest expected utility and, therefore, is preferred over alternatives with lower certainty equivalents. The preferred portfolio sizes for each computed ARA level and farm size are determined by ranking the portfolios according to certainty equivalent values.

Results

Table 2 presents total standard deviations for naive portfolios versus the number of programs in portfolios for corn, soybeans, and 50/50 advisory revenue. The values for standard deviation are computed as the square root of the total portfolio variance as defined in Equation (3). The first standard-deviation value is the standard deviation for a portfolio of one program. This corresponds to the case where the farmer selects, at random, one program among the 17 and follows the recommendation for only that program. In the case of corn, the standard deviation for a one-program portfolio is \$0.446/bushel; for soybeans, this value is \$0.765/bushel; and for 50/50 revenue, this value is \$35.44/acre. Note that these values correspond to $\sqrt{\bar{\sigma}_{ij} + \sigma^2_{\bar{p}}}$ in Equation (3).

The portfolio standard deviations presented in Table 2 show, as expected, that, when the number of programs in the portfolio increases, portfolio standard deviation decreases at a decreasing rate. For example, in the case of corn, when a second program is added to the portfolio, the standard deviation decreases by \$0.039/bushel; when a third program is added, the decrease is \$0.014/bushel; and with a fourth program, the decrease is \$0.007/bushel. After numerous programs have been added in the portfolio, adding another one has only a very small risk-reduction effect. For example, in soybeans, the difference in standard deviation between portfolios of 16 and 17 programs is only \$0.0005/bushel.

The portfolio of all 17 advisory programs has the lowest risk level among the naive portfolios selected from this set of programs. The total standard deviation values for 17 program portfolios are \$0.369/bushel, \$0.655/bushel, and \$26.86/acre for corn, soybeans, and 50/50 revenue, respectively. The difference in standard deviation between 1 and 17 programs is \$0.0768/bushel, \$0.1108/bushel, and \$8.5840/acre for corn, soybeans, and revenue, respectively. These values are the total possible reduction in risk through naive diversification among the 17 programs. This risk reduction expressed as a percentage of the risk of one-program portfolios is 17.2% in corn, 14.5% in soybeans, and 24.2% with 50/50 revenue. Recall from Equations (2) and (3) that the proportion of risk that can be removed by naive diversification depends on the relationship between average variance and average covariance. The lower the ratio, $\bar{\sigma}_{ij}/\bar{\sigma}^2_i$, the greater the proportion of risk that can be removed by increasing portfolio size. This ratio is the smallest (0.63) for 50/50 revenue, where risk reduction is greatest; largest for soybeans (0.78), where risk reduction is the lowest; and in the middle for corn (0.72).

Comparing these results to other studies in the finance literature, it is evident that the possible gains through naive diversification are relatively low in the case of advisory programs. For example, note that increasing the number of advisory programs in a portfolio from 1 to 10 reduces the revenue standard deviation by 23%. In contrast, Elton and Gruber report that increasing the number of U.S. stocks in a portfolio from 1 to 10 reduces standard deviation by 51%; and in Billingsley and Chance's study for naive portfolios of commodity trading advisors (CTAs), the risk reduction from portfolios of size 1 to 10 is 40%. The reason for the contrasting results is that the average covariance for advisory programs is closer to the average variance than in the other cases, or, in other words, the average correlation is higher for advisory programs' prices/revenues. For example, in the aforementioned studies, the average correlation between U.S. stocks was 0.15 and between CTAs around 0.25. These values are much lower compared with the

Table 2. Naive Diversification Results for Market Advisory Programs

	Corn Net Advisory Price			Soybean Net Advisory Price			50/50 Advisory Revenue		
Number of Programs in the Portfolio	Total Portfolio Standard Deviation ($/Bushel)	Marginal Decrease in Portfolio Standard Deviation ($/Bushel)	Decrease in Risk vs. One Program Portfolio (%)	Total Portfolio Standard Deviation ($/Bushel)	Marginal Decrease in Portfolio Standard Deviation ($/Bushel)	Decrease in Risk vs. One Program Portfolio (%)	Total Portfolio Standard Deviation ($/Acre)	Marginal Decrease in Portfolio Standard Deviation ($/Acre)	Decrease in Risk vs. One Program Portfolio (%)
1	0.4460			0.7654			35.4400		
2	0.4070	0.0390	8.74	0.7087	0.0567	7.41	31.1750	4.2650	12.03
3	0.3931	0.0139	11.85	0.6888	0.0199	10.01	29.6180	1.5570	16.43
4	0.3860	0.0071	13.45	0.6786	0.0102	11.35	28.8070	0.8110	18.72
5	0.3817	0.0043	14.42	0.6724	0.0062	12.15	28.3100	0.4970	20.12
6	0.3788	0.0029	15.07	0.6682	0.0042	12.70	27.9730	0.3370	21.07
7	0.3767	0.0021	15.55	0.6652	0.0030	13.09	27.7300	0.2430	21.76
8	0.3751	0.0016	15.90	0.6630	0.0022	13.38	27.5470	0.1830	22.27
9	0.3739	0.0012	16.18	0.6612	0.0018	13.61	27.4030	0.1440	22.68
10	0.3729	0.0010	16.40	0.6598	0.0014	13.79	27.2880	0.1150	23.00
11	0.3721	0.0008	16.58	0.6587	0.0012	13.95	27.1930	0.0950	23.27
12	0.3714	0.0007	16.73	0.6577	0.0010	14.07	27.1140	0.0790	23.49
13	0.3708	0.0006	16.86	0.6569	0.0008	14.18	27.0470	0.0670	23.68
14	0.3703	0.0005	16.97	0.6562	0.0007	14.27	26.9890	0.0580	23.85
15	0.3699	0.0004	17.07	0.6556	0.0006	14.35	26.9390	0.0500	23.99
16	0.3695	0.0004	17.15	0.6551	0.0005	14.42	26.8950	0.0440	24.11
17	0.3692	0.0003	17.22	0.6546	0.0005	14.48	26.8560	0.0390	24.22

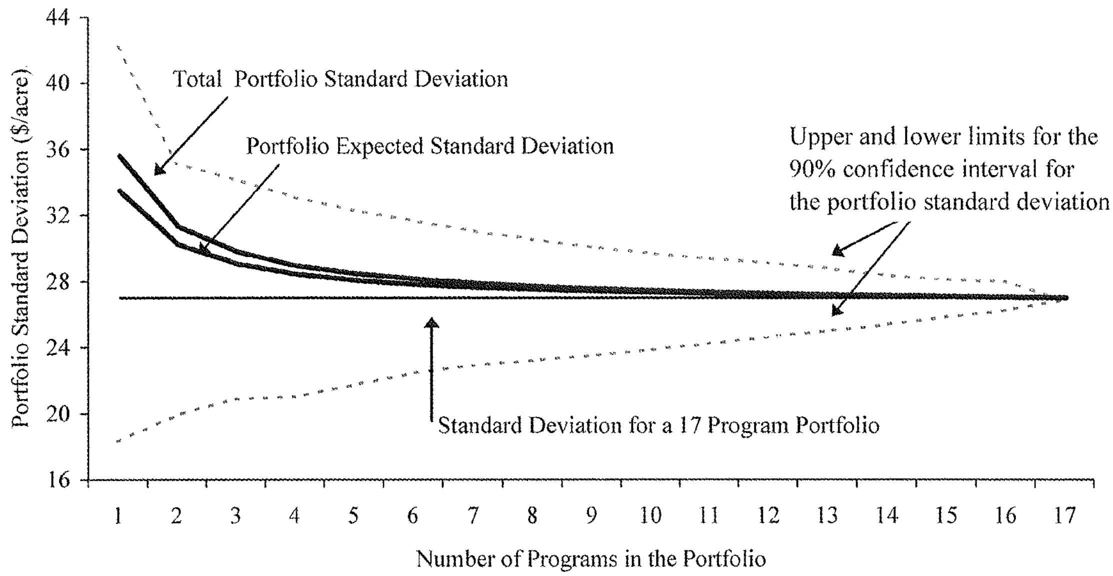


Figure 1. Standard Deviation for Farm Revenue of Equally Weighted Portfolios of Market Advisory Programs Versus the Number of Programs in the Portfolio

values of average correlation for advisory services presented in Table 1 (0.73, 0.71, and 0.65 for corn, soybeans, and 50/50 revenue, respectively).[4]

The results discussed to this point consider total portfolio standard deviation as the risk measure for naive portfolios. However, as mentioned before, expected standard deviation (Equation (2)) is also commonly used for characterizing the risk of naive portfolios. Figure 1 shows graphically the relationship between size and risk level for 50/50 revenue portfolios. The figures for corn and soybean price, which are not presented for the sake of space, show similar results. The two thick solid lines show the values for standard deviation for different portfolio sizes. The lower of these two lines corresponds to the square root of the expected portfolio variance as measured by Equation (2), the higher corresponds to the square root of total portfolio variance (Equation (3)). Note that the lines are quite close to each other, indicating that the dispersion of expected revenue across programs is not a major factor in the risk level of naive portfolios. This happens because the variation in expected revenue across programs is relatively low compared with the variation in individual program revenue across years. The dashed lines are the 90% confidence interval limits for the expected standard deviation. Note that, as the number of services increases, not only does the expected standard deviation decrease but so does the variability of the expected standard deviation. The expected portfolio standard deviation (Equation (2)) completely measures the risk level of naive portfolio only in the case where all services have the same expected revenue, variance, and covariance.

In order to determine preferred portfolio size, it is necessary to consider not only the risk-reduction benefits from diversification but also the cost associated with holding portfolios of different sizes. The average annual sub-

[4] The sample employed in this study includes four advisory services that have two or more programs: AgriVisor, Brock, Pro Farmer, and Stewart–Peterson. Not surprisingly, the average correlation between programs within the same service is higher than the correlation between programs of different services. It is therefore possible that diversification benefits across a wide sample of single program advisory services may be underestimated based on the present sample. To evaluate the influence of services with multiple programs on the gains from naive diversification found in this study, two additional sets of results were computed. For those services with multiple programs, only cash programs (e.g., aggressive cash for AgriVisor) were included in the first case and only hedge programs (e.g., basic hedge from AgriVisor) in the second case. Risk reduction through naive diversification improved only modestly compared with the case where all programs were considered. These results are available from the authors on request.

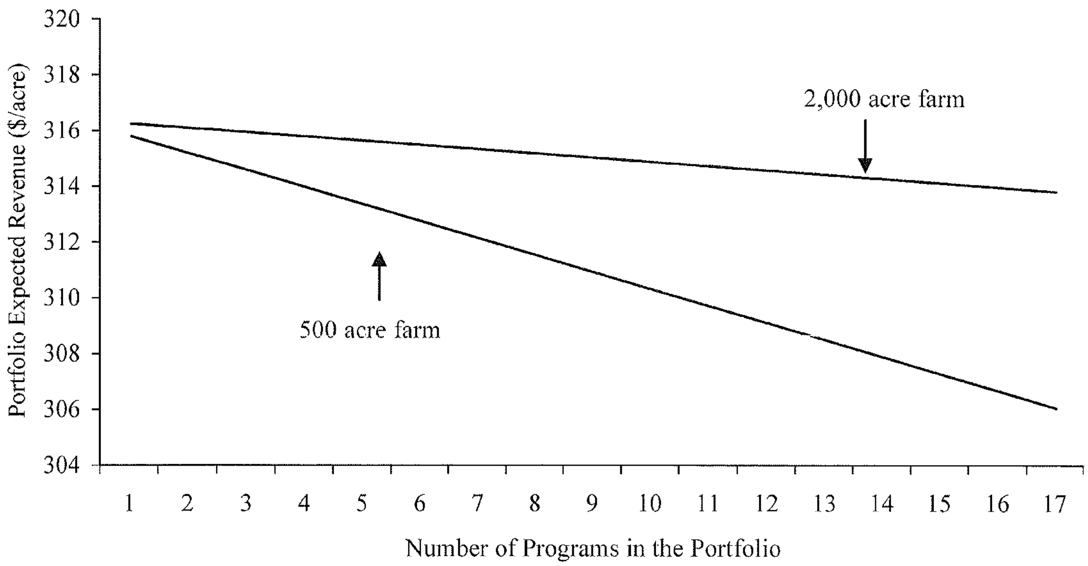


Figure 2. Expected Farm Revenue for Equally Weighted Portfolios of Market Advisory Programs Versus the Number of Programs in the Portfolio

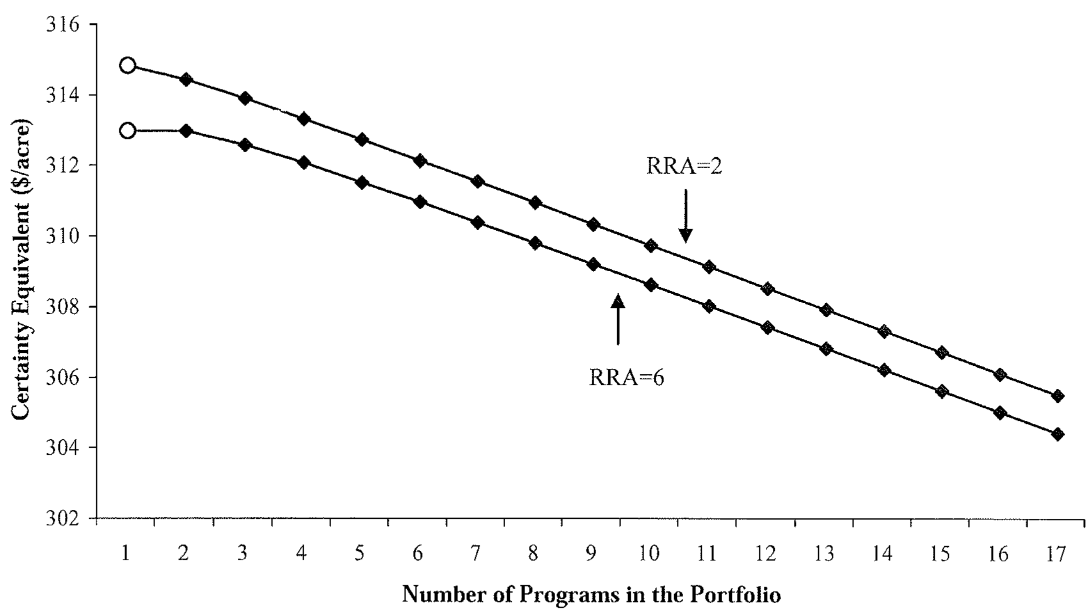
scription cost for advisory programs was $304 (Table 1). Then, the marginal cost of adding an extra service in the portfolio is $0.608/acre for a 500-acre farm and $0.152/acre for a 2,000-acre farm. Note, for instance, that a five-program portfolio costs $3.04/acre for a 500-acre farm and $0.76/acre for a 2,000-acre farm. While these costs are not large, they also are not economically trivial, particularly relative to average returns to farm operator management, labor, and capital in Illinois, typically about $50 per acre for grain farms (Lattz, Cagley, and Raab). Figure 2 plots the expected revenue per acre net of services' fees as a function of portfolio size.

Both risk reduction and cost are considered in the expected utility computation as described in the methodology section. Figure 3 presents the results of the expected utility evaluation. Figure 3A presents the certainty equivalent values for a 500-acre farm and Figure 3B for a 2,000-acre farm, for both levels of relative risk aversion, two and six. The figures show that, for the smaller size farm, the preferred portfolio size is one under both levels of risk aversion. For a 2,000-acre farm, the preferred portfolio sizes are two and three with low and high levels of risk aversion, respectively. As expected, the preferred portfolio size is larger for the larger farm size. This occurs because subscription fees represent a lower proportion of gross farm revenue for the larger farm and, hence, the cost impact of increasing portfolio size is lower for larger farms.[5]

The preferred sizes for portfolios of advisory programs are much smaller compared with other results reported in the finance literature. For example, Statman recommended including 30 or 40 components in naive portfolios of U.S. stocks. Billingsley and Chance and Lhabitant and Learned analyzed diversification among CTAs and hedge funds, respectively, and they conclude that around 10 components should be included in the portfolios. These differences can be explained again by the specific characteristics of the problem being analyzed in the current study. The relatively high total subscription costs associated with larger portfolios of advisory programs and the relatively low risk-reduction benefits due to the high correlation among advisory programs' prices and revenues limit optimal

[5] The optimal number of programs was also computed considering only expected variance as defined in Equation (2). In this case, expected utility is a function of the average variance across all combinations for each size. Certainty equivalent values are higher compared with the case where all sources of risk are considered, the largest differences in portfolios with few services. However, the optimal number of programs does not differ from the results presented in the text.

Panel A: 500 acre farm



Panel B: 2,000 acre farm

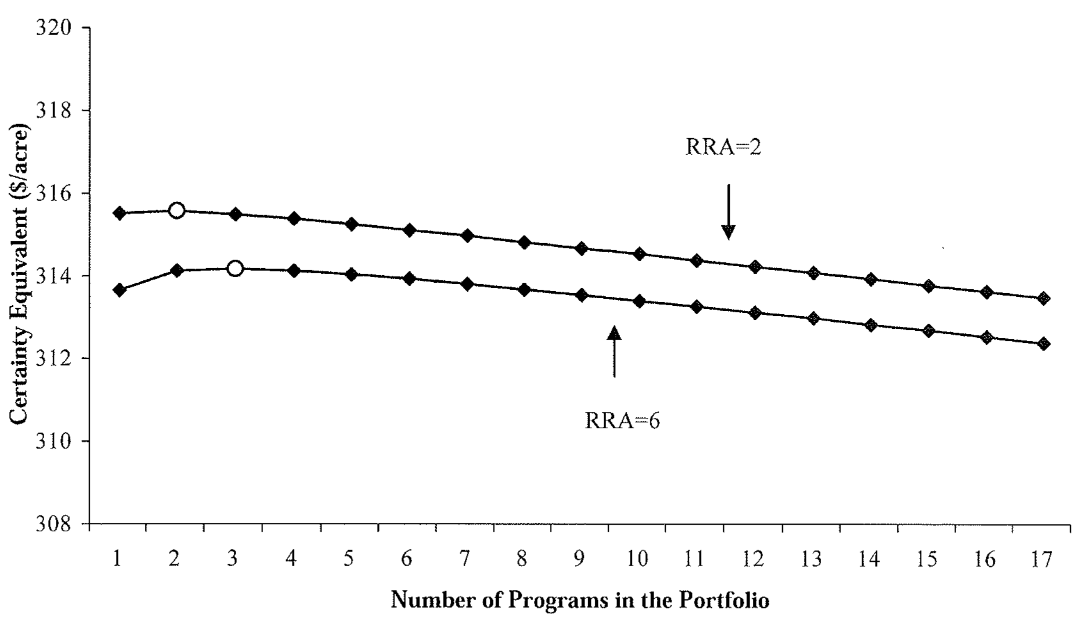


Figure 3. Certainty Equivalents for 50/50 Advisory Revenue Versus the Number of Programs in the Portfolio

Notes: Open circle symbols correspond to the highest certainty equivalent values. RRA stands for relative risk aversion coefficient.

portfolios of advisory programs to only a few components.

According to these results, there does not appear to be strong justification for farmers adopting portfolios with large numbers of advisory programs. Moreover, it is important to emphasize that the cost of implementing, monitoring, and managing the marketing strategies recommended by advisory programs is not accounted for in the analysis. Such costs are difficult to measure but are likely to be substantial (Tomek and Peterson), adding further to the disadvantage of managing advisory service portfolios of greater size.

The results obtained here are reasonably consistent with actual data on farmers' use of advisory programs. According to survey results of Isengildina et al., 94% of farmers that subscribe to advisory services follow three or fewer programs. Still, a small proportion of farmers subscribe to four or more programs, which can be considered overdiversification based on the results of this study. When considering such cases, it is important to note that advisory services provide other products to their subscribers beyond specific marketing recommendations. These products include analysis of the USDA market reports, general market commentary and analysis, price forecasts, and weather forecasts. The importance of these additional products is supported by results from the aforementioned survey, which indicates that most farmers who subscribe to advisory services view all of these products as valuable inputs to management decisions.

Summary and Conclusions

Agricultural market advisory services offer specific advice to farmers about marketing their commodities. Farmers can subscribe to one or more of these programs and follow their advice to manage price risk. According to portfolio theory, a combination of these programs may have risk/return benefits compared with individual programs, and survey evidence suggests that many farmers subscribe to several programs at the same time. This study evaluates the potential risk-reduction gains from naive diversification (equal-weighting) among market advisory programs. In particular, this study analyzes the relationship between the risk and number of components for naive portfolios using data for 17 market advisory programs obtained from the AgMAS Project at the University of Illinois. Corn and soybean net advisory prices, as well as combined corn/soybean revenue, are examined.

The standard deviation for portfolios of 1–17 advisory programs is computed using the analytical relationship derived from the classical formula for portfolio variance. Increasing the number of components in naive portfolios reduces portfolio standard deviation, but the marginal decrease in risk from adding a new program decreases rapidly with portfolio size. For instance, in the case of corn, the total standard deviation of a one-program portfolio is \$0.446/bushel and, when a second program is added, the total standard deviation decreases by \$0.039/bushel. By adding a third program, standard deviation decreases by \$0.0139/bushel, and adding a fourth program decreases it only \$0.007/bushel.

The standard deviation reduction through naive diversification is relatively small compared with the results obtained in previous studies of financial portfolios, and this is mainly because advisory prices, on average, are highly correlated. Moreover, because the cost of holding portfolios increases with size due to services' subscription fees, there is a clear trade-off between decreasing risk and increasing cost. Based on certainty equivalent measures for farms of 500 and 2,000 acres and two representative risk-aversion levels, preferred portfolio sizes are between one and three. According to these results, there does not appear to be strong justification for farmers adopting portfolios with large numbers of advisory services. The results obtained are reasonably consistent with actual data on farmers' use of advisory programs. According to the survey results of Isengildina et al., 94% of farmers that subscribe to advisory services follow three or fewer programs.

Further analysis of the possible benefits from diversification among advisory services requires the evaluation of portfolios constructed using optimization models. Under this approach, an efficient set of optimal portfolios of market advisory programs is constructed by minimizing portfolio variance for each level of expected net price or revenue. The portfolio components and weights are selected based on each program's expected price, variance, and covariances. The main difficulty in constructing such optimal portfolios is obtaining reliable estimates for these values from the available data.

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