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

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DISCLAIMER

The advisory service marketing recommendations used in this research represent the best efforts of the AgMAS Project staff to accurately and fairly interpret the information made available by each advisory service. In cases where a recommendation is vague or unclear, some judgment is exercised as to whether or not to include that particular recommendation or how to implement the recommendation. Given that some recommendations are subject to interpretation, the possibility is acknowledged that the AgMAS track record of recommendations for a given program may differ from that stated by the advisory service, or from that recorded by another subscriber. In addition, the net advisory prices presented in this report may differ substantially from those computed by an advisory service or another subscriber due to differences in simulation assumptions, particularly with respect to the geographic location of production, cash and forward contract prices, expected and actual yields, storage charges and government programs.

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Abstract

Agricultural market advisory services offer specific advice to farmers on how to market their commodities. Farmers can subscribe to one or more of these services and follow their advice as a way of managing price risk. According to portfolio theory, a combination of these services may have risk/return benefits compared to individual services. This report analyzes the potential risk reduction gains from naïve diversification among market advisory services for corn and soybeans. Results show that increasing the number of (equal-weighting) services reduces portfolio expected risk, but the marginal decrease in risk from adding a new service decreases rapidly with portfolio size. The risk reduction benefits of naïve diversification among advisory services is relatively small compared to the results obtained in previous studies for stock portfolios, and this is mainly because advisory prices, on average, are highly correlated. A one service portfolio has only a 20%, 16% and 32% higher expected standard deviation than the minimum risk naïve portfolio for corn, soybeans and 50 /50 revenue, respectively. Most risk reduction benefits are achieved with small portfolios. For instance, a four service portfolio has only 5%, 4% and 9% higher expected standard deviation than the minimum risk naïve portfolio for corn, soybeans and 50/50 revenue, respectively. Based on these results, there does not appear to be strong justification for farmers adopting portfolios with a large number of advisory services. Farmers may well choose portfolios with as few as two or three programs, since the relatively high total subscription costs associated with larger portfolios can be avoided while obtaining most of the benefits from diversification.

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Introduction

One of the most important areas in agricultural farm management is the management of risks. Various surveys conducted across the United States in the 1990's found that price risk is one of farmers' biggest management challenges (e.g., Patrick and Ullerich, 1996; Coble et al., 1999; Norvell and Lattz, 1999). There are many tools to assist farmers in price risk management. Patrick, Musser and Eckman (1998) and Schroeder et al. (1998) reported that farmers specifically viewed one of these tools, professional market advisory services, as an important source of information in their efforts to manage price risk. 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.

Despite this general view, limited economic analysis has been done to test the true effectiveness of advisory services. Gehrt and Good (1993) examined the returns for corn and soybeans producers assuming they had followed the recommendations of five advisory services over 1985-89 and compared returns against a benchmark price. They concluded that there is some evidence that services could beat the benchmark price. Martines-Filho (1996) analyzed the pre-harvest recommendations of six advisory services for corn and soybeans over the 1991-94 production years. Slight evidence was found supporting the ability of the services to generate a higher return than the compared 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. In the most recent report, Irwin, Martines-Filho and Good (2002) presented results from the evaluation of corn and soybeans advisory services over 1995-2000. When both average price and risk are considered, only a small fraction of services for corn and a moderate fraction for soybeans outperformed market benchmarks. On the other hand, a majority of the services outperformed a farmer benchmark for both crops.

The research reviewed above examined the pricing performance of market advisory services only on a stand-alone basis. 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 certain proportion of production following the advice of each of the selected services. For example, a farmer can choose two advisory services and market 50% of grain production applying recommendations of one service and the other 50% applying recommendation of another service. Furthermore, according to portfolio theory (Markowitz, 1952), a combination of advisory services may have greater risk/return benefits compared to individual services or benchmarks. Portfolio theory shows that a portfolio of advisory services may reduce price risk compared to a single service and still obtain the same expected price. Therefore, diversifying among several services may be a better alternative for farmers compared to following an individual service. Farmers should be interested in the magnitude of potential gains from diversification and on how many advisory services should be included in the portfolio to capture risk reduction benefits.

The relationship between the number of portfolio components and portfolio risk has been widely studied in the finance literature (e.g., Markowitz, 1959; Elton and Gruber, 1977). 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 becomes 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 who follows fewer services. But, the risk reduction gain from following an additional service gets smaller as the portfolio size increases. Hence, there is a trade-off between the complexity of following a large number of services and the risk reduction benefits from greater diversification.

The purpose of this study is to analyze the relationship between size and risk for portfolios of market advisory services in corn and soybeans. Data on market advisory prices over 1995 to 2000 are obtained from Irwin, Martines-Filho and Good (2002). Based on these prices, the risk for portfolios of 1 to 17 components is estimated. The results provide information on the number of advisory services that a farmer should follow in order to minimize price risk.

The rest of this article is organized as follows: the next two sections explain the mathematics of diversification and the analytical relationship between risk and size for randomly-selected portfolios. Next, data and methodology are described. Finally, results are presented and discussed.

Mathematical Concepts Related to Portfolio Theory

Portfolio theory shows how a combination of assets or, in this case, advisory services, may represent a better alternative for farmers than individual services. In order to fully understand how portfolio theory aids a farmer's decision, a few mathematical concepts need to be defined. The first concept behind portfolio theory is expected return or, in the advisory services' case, expected price. To begin, define P_{ik} as each of the possible net prices received by advisory service *i*. Then, the expected price for advisory service *i* is simply the weighted-average of the prices received by the advisory service over all possible *k* outcomes, with the weights being the probability that a given net price P_{ik} occurs. The computation of expected net price $E(P_i)$ for service *i* is:

(1) $$E(P_i) = \sum_{k=1}^{K} P_{ik} f(P_{ik})$$

where $f(P_{ik})$ is the probability that the advisory service *i* receives net price P_{ik}.

The second mathematical concept associated with portfolio theory is risk or, in the grain marketing case, price risk. By comparing an advisory service's price received in each crop year to the advisory service's expected price, a farmer can determine the magnitude of risk associated with the advisory service. If the advisory service consistently receives a price close to its expected price over time, the advisory service is categorized as having little risk. Similarly, if the advisory service has large and frequent deviations from its expected price, the service is said to have high risk. However, a measure is needed to quantify this price risk. Because this price risk can be thought of as the dispersion of advisory service prices from period-to-period, a statistical measure known as variance is used to compute the level of risk. The variance of an individual advisory service, $\left(\sigma_i^2\right)$, is the weighted-average of the squared deviations between each possible price and the expected price of that advisory service:

(2)
$$\sigma_i^2 = \sum_{k=1}^{K} (P_{ik} - E(P_i))^2 f(P_{ik}).$$

Standard deviation is the more common risk measure plotted in return/risk space, and it is simply the square root of the variance. Consequently, the larger the variance or standard deviation, the more unlikely the advisory service will receive a price close to its expected price. Likewise, the smaller the variance or standard deviation, the more likely the service will obtain a price that is close to the expected price.

Another important statistical concept in portfolio theory is covariance, which measures the tendency of advisory service prices to move up or down together. The covariance between advisory service *i* and *j*, $\left(\sigma_{ij}\right)$, can be defined as:

(3)
$$\sigma_{ij} = \sum_{k=1}^{K} (P_{ik} - E(P_i))(P_{jk} - E(P_j)) f(P_{ik}, P_{jk})$$

where $f\left(P_{ik}, P_{jk}\right)$ is the joint probability of prices P_{ik} for the i^{th} service and P_{jk} for the j^{th} service occurring. However, covariance is often hard to interpret because it depends on the units of measurement of the i^{th} and j^{th} advisory service prices. To overcome this problem, a new statistic, termed the correlation coefficient, is introduced.

The correlation between advisory services is just a different way of presenting the covariance for easier interpretation of the relationship that exists between the advisory services in the portfolio. Correlation can be quantitatively defined as:

(4)
$$\rho_{ij} = \frac{\sigma_{ij}}{\sigma_i \sigma_j}$$

where ρ_{ij} is the correlation coefficient between the i^{th} and j^{th} advisory service in the portfolio, σ_{ij} is the covariance between the i^{th} and the j^{th} advisory service in the portfolio, σ_i and σ_j are the standard deviations of the i^{th} and j^{th} advisory service in the portfolio, respectively. The relevance of correlation in portfolio theory can be shown easily. Correlation can take on any value from -1 to +1. A negative correlation between two advisory services simply means that the corresponding prices for those services tend to move in opposite directions. A positive correlation between two advisory services means that the services' prices tend to move in the same direction. From a risk standpoint, the most desirable correlation coefficient is a value of -1. A perfectly negative relationship between advisory services would mean that perfect diversification of risk is achieved. The reason perfect diversification occurs with a correlation of -1 is that the prices of the two advisory services always move in opposite directions. When one service receives a low price, the other service will always receive a high price, and vice versa. Therefore, price risk is reduced as much as possible. However, the chance of this type of a relationship is exceedingly small. It can be shown that any correlation value less than +1 leads to a reduction in risk, when the comparison is between an investment in a portfolio of advisory services compared to an individual service. Only investing in one service means that a farmer must accept the price risk associated with that service. However, if two services have a correlation less than +1, one service's poor performance is offset by the other service's performance. For this reason, price risk can be successfully reduced with any correlation less than +1.

The previous paragraphs defined the concept of expected price and variance for individual services and covariance for pairs of advisory services. The rest of this section presents measures that characterize portfolios of services, that is, portfolio expected price and portfolio variance. The expected portfolio price depends on individual services' expected prices and the weights of the services in the portfolio. Since the net price for a portfolio of services is a linear combination of individual service prices, the expected price of a portfolio of services is the weighted-average of the expected prices of the advisory services in the portfolio:

(5) $$E(P_{port}) = \sum_{i=1}^{N} X_i E(P_i)$$

where $E(P_{port})$ is the expected price of the portfolio and X_i are the weights for each advisory service in the portfolio, and the weights sum to one. The variance of a portfolio depends not only on the individual variances of the portfolio components, but also on the covariances between the services, and is defined as:

(6) $$\sigma^2_{port} = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ i \neq j}}^{N} X_i X_j \sigma_{ij}$$

where σ^2_{port} is the portfolio variance, and X_i and X_j are the weights of the i^{th} and j^{th} advisory services in the portfolio respectively.

An example can help in explaining how portfolio theory aids a farmer's decision to select a portfolio of advisory services over one individual service. Suppose a farmer has 100,000 bushels of corn to market and is considering two advisory services, A and B. The hypothetical prices for both services from 1995-2000 are presented in Table 1. If the farmer invests all bushels in A or B, and prices fluctuate in the future as they have in the past, the expected price for either service is $2.46/bushel (average price for 1995-2000). However, the risk associated with each advisory service is such that price in a particular year could be substantially different than what the farmer expects. On the other hand, if the farmer invests half of the corn bushels in each advisory service, the expected price would be the same, $2.46/bushel, but, as shown in Figure 1, the price variability for this portfolio of services will be less that the price variability for the individual services. The reason risk is reduced with a portfolio of the two advisory services versus just one service is due to the fact that the correlation between their respective prices is less than +1. Figure 1 shows that their prices do not always move in the same direction and by the same amount. Thus, diversification helps reduce the risk associated with advisory services. Consequently, the correlation between advisory service prices is important when constructing a portfolio of services.

Relationship Between Portfolio Risk and Size

The previous section presented the mathematics of portfolio diversification and explained why a portfolio of services can have risk/return benefits when compared to individual services. Based on this fact, a reasonable question to ask is how much diversification is enough, or in other words, how many advisory services should be included in a portfolio to minimize price risk. In this study the relation between the risk and number components is analyzed for "naively" diversified portfolios. "Naïve 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.

Naïve diversification is not necessarily the optimal way of constructing portfolios. For example, the Markowitz portfolio selection model (1952) 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 the individual assets' expected return, variance and correlations. Although the Markowitz model is in theory a better approach, naïve diversification is widely used in practice (e.g., Lhabitant and Learned, 2002). The reason why this approach is so commonly applied is that naïve portfolios are a very reasonable alternative when information on individual expected returns, variance and correlations is limited, and therefore, the estimates for these parameters may not be reliable. In this case, naïve diversification is likely to be a safer way of constructing portfolios, since, as it will be explained in the rest of this section, the risk and return of naïve portfolios depends only on the average expected return, average variance and average covariance for the set of assets to be included in the portfolio. Averages of these parameters can be estimated more accurately than the individual values, with this advantage being more important when data available for the estimation is limited.

It is well known that when stocks are randomly-selected and combined in equal proportions in a portfolio, the risk of the portfolio declines as the number of different stocks increases (e.g., Markowitz, 1959; Elton and Gruber, 1977). Or, in other words, portfolios with a larger number of securities have lower variance than portfolios with a smaller number of securities. In naïve diversification, risk always decreases with portfolio size, but it goes down at a decreasing rate as more stocks are added. At some point, the diversification gain from adding another stock becomes negligible. Hence, when decision makers select portfolio size they need to consider the tradeoff between the decreased risk due to a more effective diversification and the operational disadvantage and cost associated with managing a more complicated portfolio.

The idea of naïve diversification can be also applied to portfolios of market advisory services. The basic idea is that a portfolio of size N can be constructed by randomly-selecting N advisory services from the set the 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). Hence, it is useful to analyze the risk level of naïve portfolios containing different numbers of advisory services.

The derivation of the analytical relationship between portfolio risk and size was presented by Elton and Gruber (1977). When the portfolio weights are equal ($X_i = 1/N$, for all *i)*, the portfolio variance equation (6) can be written as:

(7) $$\sigma^2_{port} = \sum_{i=1}^{N} \left(\frac{1}{N} \right)^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} \left(\frac{1}{N} \right)^2 \sigma_{ij} .$$

In naïve diversification, the portfolio components are selected at random from the set of available services, hence, 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 ($N = 2$). Naïve diversification implies that the farmer will follow any of the six possible two service portfolios: AB, AC, AD, BC, BD or CD. The risk measure that characterizes naïve portfolios of size N is the expected variance. Expected portfolio variance is just the average portfolio variance among all possible combinations of the available services in sets of N and is computed as:

(8) $$E(\sigma^2_{port}) = N \left(\frac{1}{N} \right)^2 \overline{\sigma_i^2} + N(N-1) \left(\frac{1}{N} \right)^2 \overline{\sigma_{ij}}$$

where $E(\sigma^2_{port})$ is the expected variance of a portfolio of N advisory services, $\overline{\sigma_i^2}$ is the average variance for all available advisory services and $\overline{\sigma_{ij}}$ is the average covariance between all pairs of services. Note that these measures are averages along the whole set of services available to the farmer. Rearranging equation (8):

(9) $$E(\sigma^2_{port}) = \frac{1}{N} \overline{\sigma_i^2} + (1 - \frac{1}{N}) \overline{\sigma_{ij}} .$$

Finally, another way to write equation (9) is:

(10) $$E(\sigma^2_{port}) = \frac{1}{N} (\overline{\sigma_i^2} - \overline{\sigma_{ij}}) + \overline{\sigma_{ij}} .$$

The previous analytical expressions not only allows one to quickly determine the expected portfolio variance for any portfolio size, but also shows which factors affect portfolio risk. Equations (9) and (10) show that portfolio variance declines as portfolio size (N) increases. Specifically, as N increases, the effect of the difference between average variance and covariance decreases, and portfolio variance becomes close to the average covariance for very large N.

It is not unreasonable to think that, instead of applying equation (10), simulation could be used to compute expected portfolio variance. In fact, several research studies determine the expected portfolio variance using simulation instead of applying the exact formula (e.g., Evans and Archer, 1968; Billingsley and Chance, 1996; Lhabitant and Learned, 2002). In the case of market advisory portfolios, the procedure under simulation would be to first randomly-select N services and then compute the portfolio variance according to equation (7), then repeat the procedure a large number of iterations, and finally compute the average portfolio variance among all iterations, which is the estimate for the expected portfolio variance. This procedure can be done for all the values of N to be evaluated. This simulation approach will give an approximation of the exact expected portfolio variance, with the approximation more accurate the higher the number of iterations. As pointed out by Elton and Gruber (1977), simulation is a powerful tool to be used in the cases where the exact formula for the desired computation does not exist. However, since in the present case the formula to compute the exact result exists, applying equation (9) is preferred, because it is more accurate and simpler.

The financial literature includes numerous studies analyzing the relationship between portfolio size and risk (e.g., Evans and Archer, 1968; Wagner and Lau, 1971; Elton and Gruber, 1977; Lloyd, Hand and Modani, 1981; Bird and Tippett, 1986; Statman, 1987; Newbould and Poon, 1993; Billingsley and Chance, 1996; O'Neal, 1997; Henker, 1998; Henker and Martin, 1998; Lhabitant and Learned, 2002). The next section presents a brief description for several of these studies. The reviewed publications include "classic" articles on risk versus size for US stock portfolios, a study employing Australian data, an article evaluating portfolios of commodity trading advisors and an article analyzing hedge funds portfolios. These studies provide a representative sampling of the results available in the empirical literature on naïve diversification. The last two articles are of particular interest because diversification among commodity trading advisors and hedge funds managers would appear to be closely related with the topic of the current study.

Previous Empirical Studies

Evans and Archer's classic study (1968) was the first attempt to measure the relationship between the number of assets in a portfolio and portfolio risk. They employed a simulation approach to construct naïve portfolios of stocks listed in the S&P500 Index, and found that the standard deviation of 5 and 10 stock portfolios was only 15% and 7% higher, respectively, than the minimum possible standard deviation (the minimum possible standard deviation corresponds to portfolio that includes all available assets). In contrast, the expected standard deviation of a one stock portfolio was 72% higher than the minimum possible. It was concluded that there was probably no economic justification for increasing portfolio sizes beyond 10 securities. Elton and Gruber (1977) employed the analytical relationship presented in equation (9) and (10) to compute the expected variance for naïve portfolios of stocks listed on the New York Stock

Exchange. They found that a one stock portfolio had an expected standard deviation 157% higher than the minimum risk portfolio, and that 50 stocks were needed to have an expected standard deviation 11% higher than the minimum possible. In contrast to Evans and Archer's results, portfolios of 6 and 10 stocks had standard deviations 93% and 56% higher than the minimum risk portfolio. Elton and Gruber (1977) pointed out that even though it was true that the first 10 or 12 stocks provided most of the advantages from diversification, there were still significant risk reduction beyond adding 12 to 15 stocks. Bird and Tippett (1986) measured the advantages of naïve diversification using Australian stock data, also employing the analytical relationship between portfolio risk and size. Results show that individual stocks had, on average, a standard deviation 144% higher than the minimum risk portfolio. Portfolios of 5 and 10 stocks had 47% and 23% higher standard deviations than the minimum risk portfolio, and more than 25 stocks were needed to obtain a standard deviation only 10% higher than the minimum. They concluded that portfolios of 10 stocks could not be considered well-diversified. Statman (1987) conducted a marginal analysis using Elton and Gruber's (1977) empirical results. The basic idea was that diversification should be increased as long as the marginal benefits exceed the marginal costs. Statman expressed both risk benefits and costs of holding portfolios in units of expected return and concluded that naïve portfolios should include at least 30 to 40 stocks to be considered well-diversified.

Billingsley and Chance (1996) conducted a simulation analysis of the optimal number of commodity futures trading advisors (CTAs) in a portfolio. They found that individual CTAs had, on average, 84% higher standard deviations than the portfolio including all 120 available CTAs. Portfolios of 3 and 11 CTAs had about 30% and 10% higher standard deviations, respectively, than the 120 CTA portfolio. They reported that less than 10 CTAs were needed to capture most of the naïve diversification benefits. In a more recent study, Lhabitant and Learned (2002) computed by simulation the expected variance for hedge fund portfolios of different sizes. They recommended including 5 to 10 hedge funds to eliminate 75% of diversifiable risk.

The obvious conclusion that can be drawn from this brief review is that there is not a unique optimal portfolio size. Different characteristics of the assets to be included in a portfolio, as well as the cost related to include a new component, will determine the reasonable portfolio size in each situation. Recall that the relation between size and risk reduction benefits depends mainly on the difference between the average variance and the average covariance (equation 10). On one hand, when the difference is low (the average correlation coefficient will be relatively high) the possible benefits of naïve diversification will be small and portfolios with a few assets capture almost all diversification benefits. This seems to be the case with portfolios of CTAs and hedge funds (Billingsley and Chance, 1996; Lhabitant and Learned, 2002). This seems also to be the case with the Evan and Archer (1968) study, although several other publications obtained quite different results for stocks portfolios. On the other hand, when the difference between the average variance and average covariance is high, the potential benefits from naïve diversification are higher and may still be considerable after many assets have been included in the portfolio. This last case appears to be the situation in the studies by Elton and Gruber (1977) and Bird and Tippett (1986).

Data and Methodology

Data on corn and soybean net advisory prices and corn/soybean revenue from 1995 through 2000 are drawn from Irwin, Martines Filho and Good (2002). The sample consists of the 17 advisory programs that were followed by the AgMAS Project in each of these six crop years. The term "advisory program" is used because several advisory services have more than one distinct marketing program. Recommendations of individual marketing 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 the grain based on the recommendations of each program. Details on the computations can be found in Irwin, Martines-Filho and Good (2002). The analysis is applied not only for corn and soybean prices individually, but also for corn/soybean revenue because many subscribers to advisory services produce and market both corn and soybeans. A corn-soybean rotation practice where each crop is planted on half of the farmland is very 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.

Estimates of expected prices (revenue), variances and covariances are needed to compute the portfolio expected price (revenue) and portfolio variance. Since the sample size is small compared to the number of parameters to be estimated, the single index model (SIM) proposed by Sharpe (1963) is employed in the estimation. The Sharpe model presents a way to reduce the number of parameters to be estimated and, therefore, becomes a preferred approach compared to traditional sample estimates when the available data set is small (Frankfurter, Phillips and Seagle, 1976). This approach is based on the simplifying assumption that net prices and revenues for the different market advisory programs are related only through common relationship with some index, in this case, a market benchmark, according to the following linear model:

$$P_{it} = \beta_{1i} + \beta_{2i} P_{mt} + \varepsilon_{it} \tag{11}$$

where P_{it} is the price for advisory program i in year t, β_{1i} is the component of advisory program i's price that is independent of market performance, β_{2i} is the expected change in price of advisory program i relative to the change in price of the market index, P_{mt} is the price for the market index in year t, and ε_{it} is the random component of P_{it} which has expected value of zero.[1] A key assumption of the SIM is that error term for the different services, ε_{it} and ε_{jt}, are independent of each other. This assumption basically means that the only reason advisory program prices vary together is due to co-movement with the market index.

When the SIM is used to estimate the co-movement of the advisory programs relative to a market index, the previous regression model is run with advisory program prices and market

[1] The benchmark corresponds to the average market cash price for the marketing window and it was obtained from Irwin, Martines-Filho and Good, 2002

benchmark prices. The regression estimates are used to obtain parameter estimates that approximate the expected price and variance for each program and the covariance between each pair of programs. The estimated expected price of advisory program i $\left(\hat{P}_i\right)$ is:

(12)
$$\hat{P}_i = b_{1i} + b_{2i}\hat{P}_m$$

where b_{1i} is the estimate of the independent component of advisory program i's price, b_{2i} is the estimate of the slope coefficient obtained from the regression of advisory program i's prices on the market index price, and $\hat{P}_m$ is the sample average benchmark price. The value for expected price for a program obtained under the SIM is equal to the sample average price for that program. The estimated variance of advisory program i $\left(\hat{\sigma}_i^2\right)$ is:

(13)
$$\hat{\sigma}_i^2 = b_{2i}^2\hat{\sigma}_m^2 + \hat{\sigma}_{\varepsilon i}^2$$

where $\hat{\sigma}_m^2$ is the estimated variance of the market index, and $\hat{\sigma}_{\varepsilon i}^2$ is the estimated error variance of the regression with advisory program i and the market index. The covariance between two advisory programs is:

(14)
$$\hat{\sigma}_{ij} = b_{2i}b_{2j}\hat{\sigma}_m^2$$

where $\hat{\sigma}_{ij}$ is the estimated covariance between advisory program i and advisory program j, and b_{2i} and b_{2j} are the estimated slope coefficients from advisory program i's and j's respectively. It is easy to see how SIM reduces the amount of data needed for estimating parameters and helps to provide more efficient estimates. Each advisory program's regression with the index generates three parameter estimates, which leads to a total of 51 (3*17) estimates, instead of 153 (17 variances and 136 covariances) when using the traditional estimation procedure.

Tables 2 and 3 present some of the SIM estimation results. Table 2 shows the expected prices and standard deviation for each advisory program for corn, soybeans 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 \$5.85/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. Table 3 presents the average correlation between each program and the rest of the programs. The values in this table show that, in general, advisory prices are highly correlated with each other, and this is mainly due to their correlation with the market benchmark price. The average correlation between programs is higher for soybean advisory price (0.75), in the middle for corn advisory price (0.71) and lower for 50/50 revenue (0.61). But there are some exceptions. For instance, Allendale (futures only) and Brock (hedge) for corn and AgResource and Brock (hedge) for soybeans have very low average correlation with other programs.

Based on the individual SIM estimates for corn, soybeans and 50/50 revenue, the estimated average variance and average covariance among all 17 programs are computed. Then, the estimated expected variance for portfolios of 1 to 17 programs is calculated using equation (9). The expected variance results for the different number of programs in the portfolio are reported in terms of total and marginal gains from increasing portfolio size, as well as plots of risk vs. size.

It is important to remark that, because advisory programs are randomly-selected to construct portfolios in this study, the results do not depend directly on estimates for individual advisory programs, but on averages among all programs. Note that the expected price (revenue) and price (revenue) variance for naïve portfolios are computed based only on the estimates for average price, average variance and average covariance.

Results

Initially, results are focused on the risk characteristics of naïve portfolios of advisory programs, rather than expected price (revenue). The reason is that, under the assumption that advisory program costs are not related to portfolio size; random selection of advisory programs for equally-weighted portfolios restricts the expected price (revenue) to be equal to the average expected price (revenue) among all programs. In other words, the expected net price (revenue) will not change when the number of programs in the portfolio increases. The expected portfolio prices (revenue) are the averages presented in Table 2: $2.38/bushel for corn price, $6.19/bushel for soybean price and $316/acre for 50/50 revenue. The assumption that advisory program costs are not related to portfolio size will be relaxed later in this section.

Tables 4, 5 and 6 present average standard deviations for naïve portfolios versus the number of programs in portfolios for corn, soybeans and 50/50 advisory revenue, respectively. Starting at the left of the each table, the first standard deviation value is the expected standard deviation of 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 of only that program. In the case of corn, the expected standard deviation for one program portfolios is $0.44/bushel, for soybeans this value is $0.75/bushel and $34.61/acre for 50/50 revenue. These expected portfolio standard deviation values equal the average standard deviation among all programs (the average standard deviation presented in Table 2). Note that this is easy to check in equation (9), since if $N = 1$ the second term of the equation cancels out.

The portfolio standard deviations presented in Tables 4, 5 and 6 show that when the number of programs in the portfolio increases the portfolio standard deviation decreases. However, the third column in each table reveals that the marginal decrease in risk is lower each time another program is added. For example, in the corn case, when a second program is added to the portfolio the expected standard deviation decreases by $0.035/bushel, when a third program is added $0.012/bushel, a fourth program $0.006/bushel. The decrease in standard deviation by adding a program is lower for larger size portfolios, and after several 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 $0.0004/bushel. The negative sloped lines in the three panels of Figure 2 provide a visual perspective on the relationship between portfolio risk and size.

The portfolio of all 17 advisory programs has the lowest risk level among the naïve portfolios selected from this set of 17 programs. The expected standard deviation values for 17 programs portfolios are $0.368/bushel, $0.652/bushel and 26.74 $/bushel for corn, soybeans and 50/50 revenue, respectively. The difference in standard deviation between 1 and 17 programs is $0.0684/bushel, $0.0992/bushel and $7.8670/acre, respectively. These values are the total possible reduction in risk through naive diversification among the 17 programs. This risk reduction can also be expressed as a percentage of the risk of one program portfolios. For example, the standard deviation reduction from 1 to 17 programs is 16 % of the expected standard deviation for following a single program (one program portfolios) in corn, 13 % in soybeans and 23 % with 50/50 revenue. Note that this percentage is greatest for 50/50 revenue, where the average correlation between programs is lowest (0.61, Table 3). The percentage is lowest for soybeans, where the average correlation is largest (0.75, Table 3), and it is in the middle for corn, where the average correlation has a value in between the other two (0.71, Table 3). Recall from equation (10) that the diversification effect depends on the difference between the average variance and average covariance. When correlation is close to one, the average variance and covariance are close, and the potential benefits from naïve diversification are small.

Figure 3 presents the relationship between the portfolio variance and the number of programs in the portfolio. The shape of the curves is exactly the same as in Figure 2, since the variance is just the standard deviation squared. The purpose of presenting Figure 3 is to show how the portfolio variance approaches the average covariance when the number of portfolio components increases. This shows that the lowest possible risk level of randomly-selected portfolios is determined by the average covariance between the portfolio components. Adding more and more programs will make portfolio variance become almost equal to the average covariance between them. Note that equation (10) also indicates this fact: as N increases the first terms approaches the value of zero and the portfolio variance becomes the average covariance.

Comparing these results with the results from other studies it is evident that the possible gains through naïve diversification are relatively low in the case of advisory programs. This is because, on average, advisory prices are highly correlated. The last column of Tables 4, 5 and 6 present the ratio between the risk of a portfolio of size N and the minimum possible risk. The minimum risk considered here corresponds to the square root of the average covariance, which, as was mentioned before, measures the portfolio risk for very large N. Other authors define minimum risk as the expected standard deviation of the portfolio containing all available assets in the data set, but this definition does not seem to be appropriated for this study, where the number of available programs is only 17, which is a relatively low portfolio size. One can argue that there may be still gains from diversification beyond 17 programs and hence, the square root of the average covariance seems to be better measure of minimum risk for naïve portfolios. The expected standard deviation for one program portfolios is only 20%, 16% and 32% greater than the minimum risk for corn, soybeans and 50/50 revenue respectively. These percentages are very low compared, for example, with the 157% and 144% differences in risk between one stock and all stocks portfolios reported by Elton and Gruber (1977) and Bird and Tippett (1986), respectively. The last columns of Tables 4, 5 and 6 also show that three program portfolios have only 7%, 6% and 12% higher risk than the minimum possible standard deviation for corn, soybeans and 50/50 revenue, respectively. These portfolio sizes are very small compared to Elton and Gruber's (1977) results, where 50 stocks were needed for a portfolio standard deviation 11% higher than the risk of a portfolio including all available stocks. The naïve diversification benefits for market advisory programs are more similar to those for portfolios of CTAs and hedge funds (Billingsley and Chance, 1996; Lhabitant and Learned, 2002), where the authors recommend including less than 10 components in the portfolios.

The results presented so far indicate that the possible risk reduction benefits from naïve diversification among market advisory programs are relatively small, and it is possible to gain most of the risk reduction from diversification holding small portfolios. Beyond a portfolio size of four or five the benefits from adding another program are very small, and the disadvantages of managing a more complicated portfolio may exceed the risk reduction benefits. More specifically, a complete analysis of naïve diversification benefits should also consider the cost associated with holding portfolios of different sizes. For portfolios of advisory programs, this issue is more important compared to stock portfolios, since there is a subscription fee associated with each program, so portfolio costs unambiguously increase with size.

The average subscription cost for the 17 programs between 1995 and 2000 was $304 per year (Irwin, Martines Filho and Good, 2002). Based on this average value, the second column of Table 7 presents the subscription cost for portfolios of 1 to 17 programs.[2] Note that portfolios with many programs are expensive. For example, a portfolio of all 17 programs costs $5,168/year. Because farm costs are commonly expressed in dollars per acre, Table 7 also shows the subscriptions cost per acre and the net 50/50 per acre revenue for two farm sizes: 500 acres and 1,000 acres. Net revenues were computed by subtracting the per acre subscription cost from the expected 50/50 revenue. Note, for instance, that a five program portfolio costs $3.04/acre for a 500 acre farm and $1.52/acre for a 1,000 acre farm. These costs are economically non-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, 2001). Given these results, it is not unreasonable, then, for a farmer to choose portfolios with fewer than four or five programs, since with the first two or three programs a farmer can get most of the benefits from diversification at a lower cost. For example, if a farmer follows two randomly-selected programs, the expected portfolio standard deviation for 50/50 revenue is only 14.7% ($30.68/$26.74) higher that the minimum standard deviation and captures 50% (15.47% / 22.73%) of the total possible gains from naïve diversification. Finally, it is important to emphasize that the cost of implementing, monitoring and managing the marketing strategies recommended by advisory programs was not accounted for in the analysis. Such costs are difficult to measure, but are likely to be substantial (Tomek and Peterson, 2001), adding further to the disadvantage of managing advisory service portfolios of greater size.

Summary and Conclusions

Agricultural market advisory services offer specific advice to farmers on how to market their commodities. Farmers can subscribe to one or more of these programs and follow their advice as a way of managing price risk. According to portfolio theory, a combination of these programs may have risk/return benefits compared to individual programs. This report evaluates the potential risk reduction gains from naïve diversification (equal-weighting) among market advisory programs. In particular, this study analyses the relationship between the risk and

[2] This analysis does not account for the possibility that multiple programs offered by an advisory service may be followed for a single subscription fee. Accounting for this possibility would not substantially alter the results presented in Table 7.

number of components for naïve 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 in this study.

The expected standard deviation for portfolios of 1 to 17 advisory programs was computed using the analytical relationship between risk and size that is derived from the classical formula for portfolio variance. Results for corn and soybeans advisory prices and 50/50 revenue are reported in terms of total and marginal gains from increasing portfolio size, as well as plots of risk versus size.

Results show that increasing the number of programs reduces portfolio expected standard deviation, but the marginal decrease in risk from adding a new program decreases rapidly with portfolio size. For example, in the corn case, the expected standard deviation of a one program portfolio is $0.437/bushel, when a second program is added the expected standard deviation decreases by $0.035/bushel, when a third program is added $0.012/bushel, a fourth program $0.006/bushel.

The total standard deviation reduction through naïve diversification is relatively small compared to the results obtained in previous studies for stock portfolios, and this is mainly because advisory prices, on average, are highly correlated. A one program portfolio has 20%, 16% and 32% higher standard deviation than the minimum risk naïve portfolio for corn, soybeans and 50/50 revenue, respectively. Moreover, most risk reduction benefits are achieved with small portfolios. For instance, a four program portfolio has only 5%, 4% and 9% higher risk than the minimum risk naïve portfolio for corn, soybeans and 50/50 revenue, respectively. Based on these results, there does not appear to be strong justification for farmers adopting portfolios with large numbers of advisory services. Farmers may well choose portfolios with as few as two or three programs, since the relatively high total subscription costs associated with larger portfolios can be avoided while obtaining most of the benefits from diversification. For example, if a farmer follows two randomly-selected programs, the expected portfolio standard deviation for 50/50 revenue is only 14.7% higher that the minimum standard deviation and 50% of the total possible gains from naïve diversification are captured.

For a more complete analysis of the possible benefits from diversification among advisory services, it is necessary to evaluate 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 prices, variances and covariances, not just on averages of these parameters as is the case with this study. The main difficulty in optimal portfolios is obtaining good estimators for these values from the available data.

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Table 1. Hypothetical Comparison of Price Variability of Individual Advisory Services Versus a Portfolio of Services

Year	Price		
	Service A	**Service B**	**50/50 Portfolio of A and B**
	--$/bushel--	**--$/bushel--**	**--$/bushel--**
1995	2.40	3.00	2.70
1996	2.90	2.20	2.55
1997	2.25	2.80	2.53
1998	2.75	2.00	2.38
1999	1.90	2.35	2.13
2000	2.56	2.41	2.49
Expected Price	2.46	2.46	2.46
Standard Deviation	0.36	0.37	0.19

Table 2. Six-Year Average and Standard Deviation for 17 Market Advisory Programs, Corn and Soybean Net Advisory Price and 50/50 Advisory Revenue, 1995-2000 Crop Years

	Corn Net Advisory Price		Soybean Net Advisory Price		50/50 Advisory Revenue	
Market Advisory Program	**Average**	**Standard Deviation**	**Average**	**Standard Deviation**	**Average**	**Standard Deviation**
	--- $/bushel ---		--- $/bushel ---		--- $/acre ---	
Ag Review	2.39	0.30	5.86	1.04	310	39
AgLine by Doane (cash-only)	2.44	0.41	6.15	0.78	319	29
AgResource	2.76	0.71	6.80	0.46	358	47
Agri-Mark	2.42	0.66	6.45	1.03	324	47
AgriVisor (aggressive cash)	2.53	0.46	6.06	0.75	324	33
AgriVisor (aggressive hedge)	2.39	0.42	6.16	0.87	316	31
AgriVisor (basic cash)	2.36	0.26	6.03	0.69	312	27
AgriVisor (basic hedge)	2.36	0.34	6.14	0.86	314	31
Allendale (futures only)	2.30	0.20	6.23	0.65	313	22
Brock (cash only)	2.33	0.33	6.06	0.70	310	33
Brock (hedge)	2.34	0.22	6.32	0.71	318	38
Freese-Notis	2.35	0.47	6.05	0.67	311	39
Pro Farmer (cash only)	2.28	0.54	6.14	0.78	306	39
Pro Farmer (hedge)	2.29	0.51	6.33	0.74	311	39
Stewart-Peterson Advisory Reports	2.20	0.41	6.25	0.65	304	29
Stewart-Peterson Strictly Cash	2.35	0.39	6.06	0.69	311	33
Top Farmer Intelligence	2.39	0.42	6.24	0.37	319	18
Descriptive Statistics:						
Average	2.38	0.44	6.19	0.75	316	35
Median	2.36	0.41	6.15	0.71	313	33
Minimum	2.20	0.20	5.86	0.37	304	18
Maximum	2.76	0.71	6.80	1.04	358	47
Range	0.57	0.50	0.94	0.67	54	29

Note: Results are shown only for the 17 advisory programs included in all six years of the AgMAS corn and soybean evaluations. A crop year is a two-year window from September of the year previous to harvest through August of the year after harvest.

Table 3. Average Correlation Between Each Market Advisory Program and Other Programs, Corn and Soybean Net Advisory Price and 50/50 Advisory Revenue, 1995-2000 Crop Years

	Average Correlation with Other Programs		
Market Advisory Program	**Corn**	**Soybeans**	**50/50 Revenue**
Ag Review	0.68	0.80	0.73
AgLine by Doane (cash-only)	0.81	0.84	0.72
AgResource	0.63	0.25	0.27
Agri-Mark	0.78	0.63	0.43
AgriVisor (aggressive cash)	0.82	0.84	0.72
AgriVisor (aggressive hedge)	0.78	0.80	0.66
AgriVisor (basic cash)	0.80	0.84	0.74
AgriVisor (basic hedge)	0.78	0.83	0.72
Allendale (futures only)	0.18	0.83	0.31
Brock (cash only)	0.80	0.84	0.74
Brock (hedge)	0.19	0.50	0.33
Freese-Notis	0.80	0.84	0.74
Pro Farmer (cash only)	0.82	0.83	0.67
Pro Farmer (hedge)	0.82	0.83	0.71
Stewart-Peterson Advisory Reports	0.82	0.75	0.73
Stewart-Peterson Strictly Cash	0.82	0.85	0.75
Top Farmer Intelligence	0.68	0.66	0.45
Descriptive Statistics:			
Average	0.71	0.75	0.61
Median	0.80	0.83	0.72
Minimum	0.18	0.25	0.27
Maximum	0.82	0.85	0.75
Range	0.64	0.60	0.48

Note: The average correlation for each service is computed as the average of the 16 correlations values between a given service and each of the other services.

Table 4. Naïve Diversification Results for Market Advisory Services, Corn Net Advisory Price.

Number of Programs in the Portfolio	Portfolio Expected Standard Deviation	Marginal Decrease in Portfolio Standard Deviation	Decrease in Risk vs. One Program Portfolio	Ratio of Portfolio Risk to Minimum Risk
	--- $/bushel ---	--- $/bushel ---	--- percent ---	
1	0.437			1.2010
2	0.402	0.0349	7.98	1.1051
3	0.390	0.0123	10.81	1.0712
4	0.383	0.0063	12.25	1.0539
5	0.379	0.0038	13.13	1.0433
6	0.377	0.0026	13.72	1.0362
7	0.375	0.0019	14.14	1.0311
8	0.374	0.0014	14.46	1.0273
9	0.373	0.0011	14.71	1.0243
10	0.372	0.0009	14.91	1.0219
11	0.371	0.0007	15.07	1.0199
12	0.370	0.0006	15.21	1.0183
13	0.370	0.0005	15.33	1.0169
14	0.369	0.0004	15.43	1.0157
15	0.369	0.0004	15.51	1.0147
16	0.369	0.0003	15.59	1.0137
17	0.368	0.0003	15.66	1.0129

Table 5. Naïve Diversification Results for Market Advisory Services, Soybean Net Advisory Price.

Number of Programs in the Portfolio	Portfolio Expected Standard Deviation	Marginal Decrease in Portfolio Standard Deviation	Decrease in Risk vs. One Program Portfolio	Ratio of Portfolio Risk to Minimum Risk
	--- $/bushel ---	--- $/bushel ---	--- percent ---	
1	0.7510			1.1641
2	0.7001	0.0509	6.78	1.0851
3	0.6823	0.0178	9.15	1.0575
4	0.6732	0.0091	10.36	1.0434
5	0.6677	0.0055	11.10	1.0349
6	0.6640	0.0037	11.59	1.0292
7	0.6613	0.0027	11.94	1.0250
8	0.6593	0.0020	12.21	1.0220
9	0.6577	0.0016	12.42	1.0195
10	0.6565	0.0012	12.58	1.0176
11	0.6555	0.0010	12.72	1.0160
12	0.6546	0.0009	12.83	1.0147
13	0.6539	0.0007	12.93	1.0136
14	0.6533	0.0006	13.01	1.0126
15	0.6527	0.0005	13.08	1.0118
16	0.6523	0.0005	13.15	1.0110
17	0.6518	0.0004	13.20	1.0104

Table 6. Naïve Diversification Results for Market Advisory Services, 50/50 Corn Soybean Revenue

Number of Programs in the Portfolio	Portfolio Expected Standard Deviation	Marginal Decrease in Portfolio Standard Deviation	Decrease in Risk vs. One Program Portfolio	Ratio of Portfolio Risk to Minimum Risk
	--- $/acre ---	--- $/acre ---	--- percent ---	
1	34.6100			1.3223
2	30.6830	3.9270	11.35	1.1723
3	29.2570	1.4260	15.47	1.1178
4	28.5170	0.7400	17.60	1.0895
5	28.0640	0.4530	18.91	1.0722
6	27.7580	0.3060	19.80	1.0605
7	27.5370	0.2210	20.44	1.0521
8	27.3700	0.1670	20.92	1.0457
9	27.2400	0.1300	21.29	1.0408
10	27.1350	0.1050	21.60	1.0367
11	27.0490	0.0860	21.85	1.0335
12	26.9770	0.0720	22.05	1.0307
13	26.9160	0.0610	22.23	1.0284
14	26.8640	0.0520	22.38	1.0264
15	26.8180	0.0460	22.51	1.0246
16	26.7780	0.0400	22.63	1.0231
17	26.7430	0.0350	22.73	1.0218

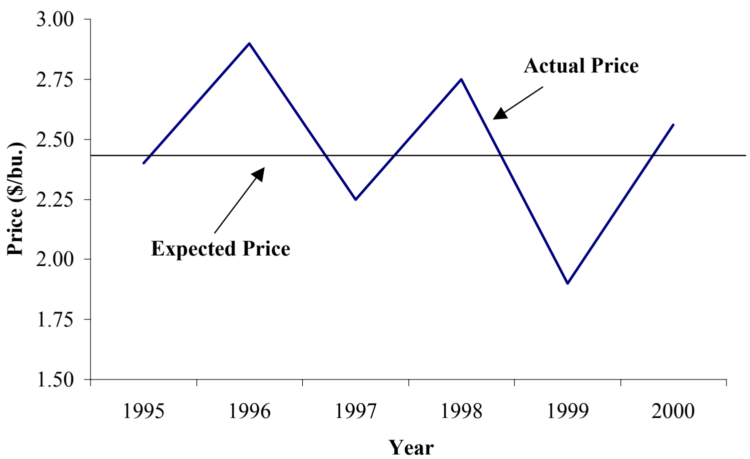
Table 7. Cost of Holding Portfolios of Market Advisory Services of Different Size

Number of Programs in the Portfolio	Total Subscription Cost	500 Acre Farm		1,000 Acre Farm	
		Cost	Expected Net 50/50 Revenue	Cost	Expected Net 50/50 Revenue
	---$/year---	---$/acre---	---$/acre---	---$/acre---	---$/acre---
1	304	0.61	315.39	0.30	315.70
2	608	1.22	314.78	0.61	315.39
3	912	1.82	314.18	0.91	315.09
4	1,216	2.43	313.57	1.22	314.78
5	1,520	3.04	312.96	1.52	314.48
6	1,824	3.65	312.35	1.82	314.18
7	2,128	4.26	311.74	2.13	313.87
8	2,432	4.86	311.14	2.43	313.57
9	2,736	5.47	310.53	2.74	313.26
10	3,040	6.08	309.92	3.04	312.96
11	3,344	6.69	309.31	3.34	312.66
12	3,648	7.30	308.70	3.65	312.35
13	3,952	7.90	308.10	3.95	312.05
14	4,256	8.51	307.49	4.26	311.74
15	4,560	9.12	306.88	4.56	311.44
16	4,864	9.73	306.27	4.86	311.14
17	5,168	10.34	305.66	5.17	310.83

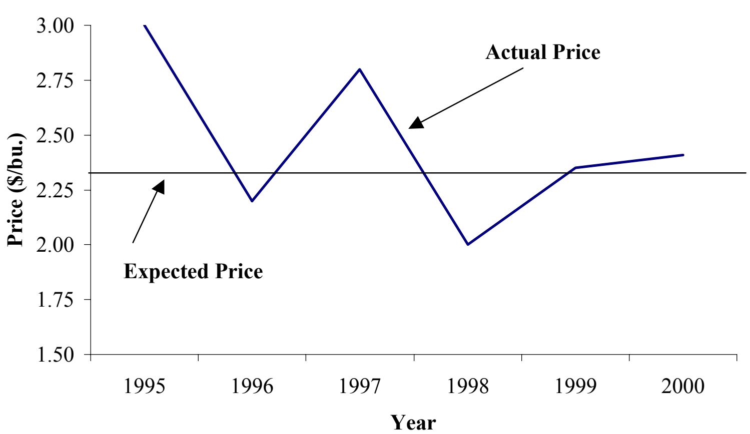
Note: The expected net revenue is computed by sustracting the subscription costs from the average 50/50 revenue presented in Table 2.

Figure 1. Hypothetical Comparison of Price Variability of Individual Advisory Services Versus a Portfolio of Services

Panel A: Net Price for Advisory Service A



Panel B: Net Price for Advisory Service B



Panel C: Net Price for a Portfolio of Advisory Services A and B

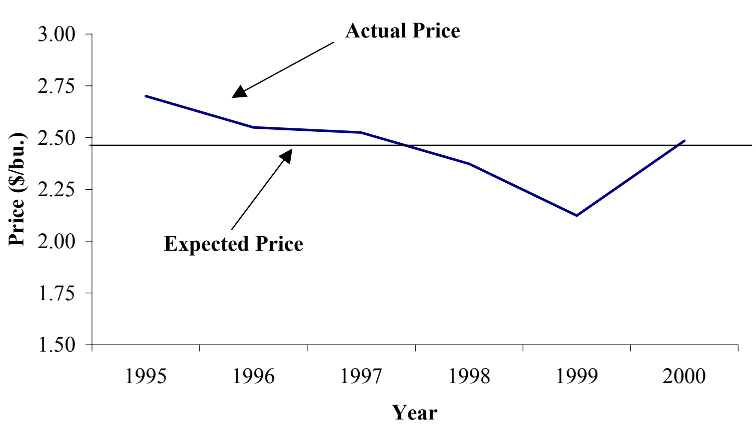
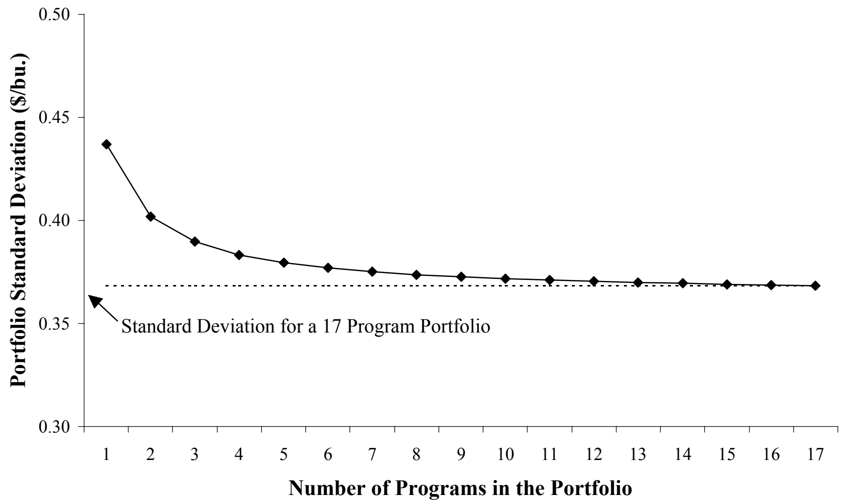
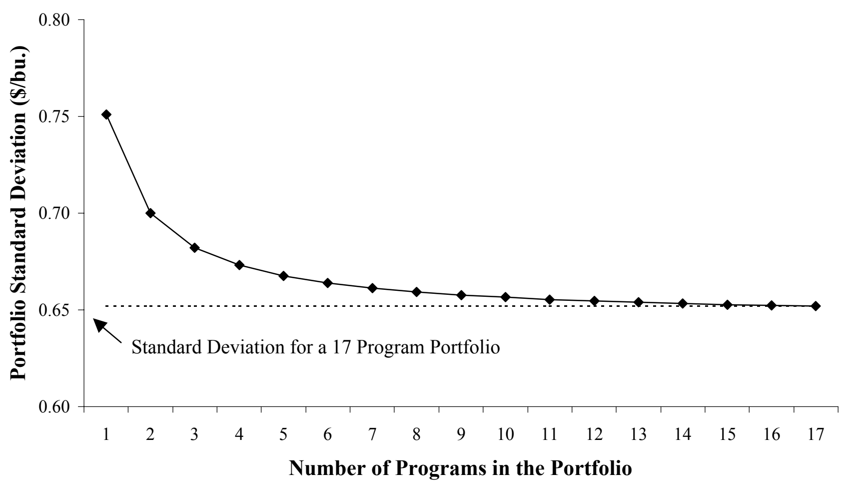


Figure 2. Expected Standard Deviation of Equally Weighted Portfolios of Marketing Advisory Programs Versus the Number of Programs in the Portfolio

Panel A: Corn Net Advisory Price



Panel B: Soybeans Net Advisory Price



Panel C: 50/50 Advisory Revenue

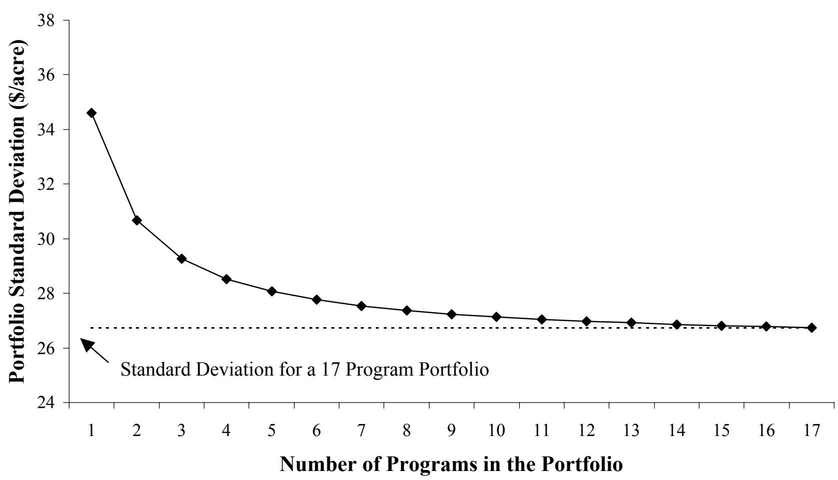
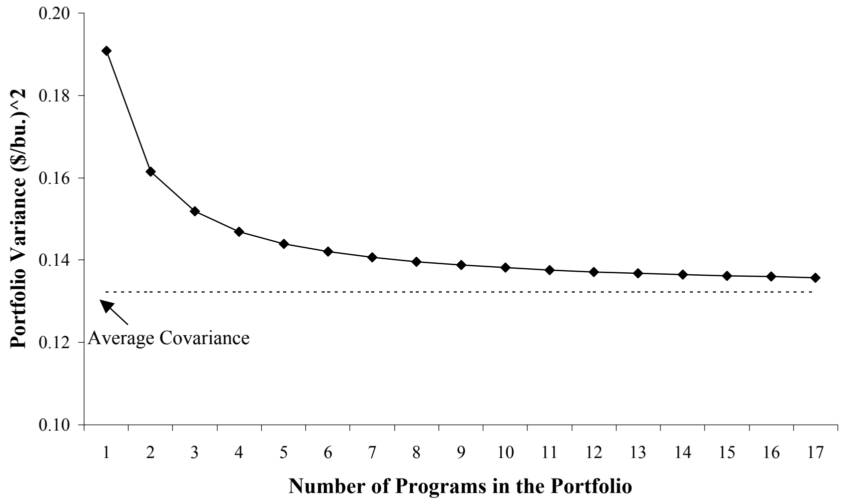
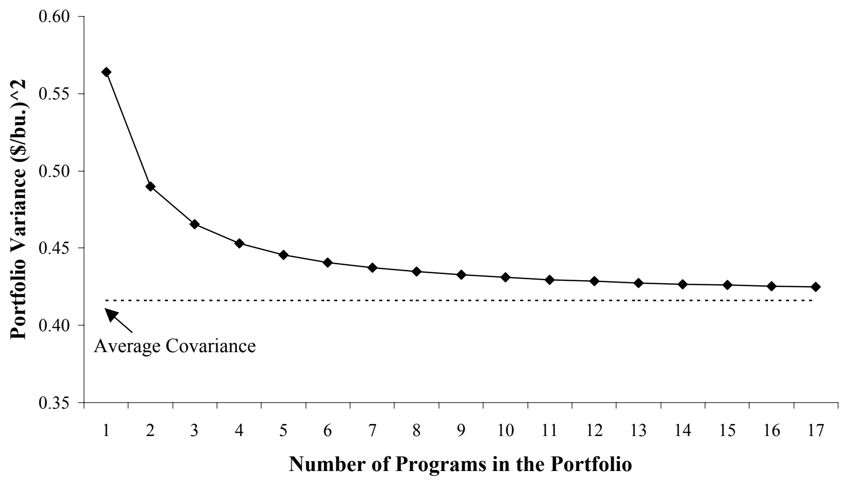


Figure 3. Expected Variance of Equally Weighted Portfolios of Marketing Advisory Services Versus the Number of Programs in the Portfolio

Panel A: Corn Net Advisory Price



Panel B: Soybeans Net Advisory Price



Panel C: 50/50 Advisory Revenue