Market Efficiency and Marketing to Enhance Income of Crop Producers

Carl R. Zulauf and Scott H. Irwin

Carl R. Zulauf
Department of Agricultural Economics and Rural Sociology
The Ohio State University

Scott H. Irwin
Department of Agricultural and Consumer Economics
University of Illinois at Urbana-Champaign

OFOR Paper Number 97-04
October 1997

MARKET EFFICIENCY AND MARKETING TO ENHANCE INCOME OF CROP PRODUCERS

Carl R. Zulauf and Scott H. Irwin*

October 1997

* McCormick Professor of Agricultural Marketing and Policy, Ohio State University, and Professor, University of Illinois at Champaign-Urbana, respectively.

The authors thank Bill Tomek for his comments, Jeff Goodbar for his assistance with the data analysis, Sharon Thayer Baxter for her assistance with preparing the manuscript, and Phil Colling and Denny Gehrt for their assistance in obtaining data.

MARKET EFFICIENCY AND MARKETING TO ENHANCE INCOME OF CROP PRODUCERS

ABSTRACT

Recent changes in farm policy have renewed interest in using marketing strategies based on futures and options markets to enhance the income of field crop producers. This article reviews the literature surrounding the dominant academic theory of the behavior of futures and options markets, the efficient market hypothesis. The following conclusion is reached: while individuals can beat the market, few can consistently do so. This conclusion is consistent with Grossman and Stiglitz's model of market efficiency in which individuals who consistently earn trading returns have superior access to information or superior analytical ability. One implication is that, with few exceptions, the crop producers who survive will be those with the lowest cost of production since efforts to improve revenue through better marketing will have limited success. There do appear to be some successful marketing strategies. One is to base storage decisions on when a producer harvests the crop relative to the national harvest of the crop. Another is to base storage decisions on whether the current basis exceeds the cost of storage, and then to use hedging to assure an expected positive return.

MARKET EFFICIENCY AND MARKETING TO ENHANCE INCOME OF CROP PRODUCERS

INTRODUCTION

The use of futures and, more recently, option markets to enhance income long has been a topic of interest to agricultural producers and others, as well as the subject of many academic investigations (Tomek, 1987). This topic has taken on new importance because of recent changes in farm policy. These changes reduce the role of government in determining prices and incomes earned by producing the major field crops (Nelson and Schertz, 1996). Given this new context, we review the main concepts of the dominant academic theory concerning the behavior of futures and options markets, the efficient market hypothesis. This rich conceptual base and associated empirical research has several, important insights regarding who should be able to profit from futures and options trading, and what strategies should be profitable.

MAJOR CONCEPTS OF EFFICIENT MARKET HYPOTHESIS

According to Fama (1970, updated 1991) an efficient market is one that accurately incorporates all known information in determining price[1]. Fama's original definition came to be known as the efficient market hypothesis (EMH). It is essentially an extension of the zero profit equilibrium of a competitive market in a certain world to an uncertain world of price dynamics. Although considerable disagreement exists about the degree to which EMH holds, it has become the dominant paradigm used by economists to understand and investigate the behavior of financial and commodity markets[2].

The following equation allows a simple discussion of the major concepts underlying the EMH:

(1) $P_{t+1} = \alpha + \beta P_t + \epsilon_t$,

where P_{t+1} is the price at time t + 1, P_t is the current price, α and β are parameters, and ϵ_t is a random error term which is independently and identically distributed with mean 0 and constant variance σ^2. To aid in understanding EMH, equation (1) is rearranged as follows:

(2) $P_{t+1} - \beta P_t = \alpha + \epsilon_t$

If $\alpha = 0$ and $\beta = 1$, then

(3) $P_{t+1} - P_t = \epsilon_t$

Last, taking the expectation of equation (3) yields:

(4) $E_t(P_{t+1} - P_t) = 0$

The price process described above is usually referred to as a random walk[3] (Campbell, Lo, and MacKinlay, 1997; Tomek and Querin, 1984). The expected average change in price is zero. Furthermore, since the ϵ_t's are uncorrelated, changes in prices are uncorrelated. A commonly used analogy of a random walk is the flipping of a fair coin.

Campbell, Lo, and MacKinlay (1997) point out that two other versions of the random walk hypothesis exist. One version relaxes the assumptions on ϵ_t so that it is independent but not identically distributed. This version allows for heteroskedasticity, a condition often found in commodity futures prices. The second and most general version relaxes the independence assumption, so that the ϵ_t's may be dependent, but uncorrelated.

It is common for individuals to visualize the random walk as a jagged line around some initial value, with the high and low values of this line not far from the initial value. Stated alternatively, the random walk does not deviate much from its initial value, and returns to its initial value after relatively few observations (for a general discussion of this small-number phenomenon see Tversky and Kahneman (1971)). In contrast, a well-accepted finding from random walk experiments is that a random walk can deviate substantially from its initial value. Furthermore, a large number of observations may occur before the random walk returns to its initial value. Thus, long periods of "trends" and even longer periods of deviation from its initial value are consistent with a random walk.

A fundamental principle of modern finance is that higher risk should be compensated with a higher return. Furthermore, if a risk exists that can not be diversified, an activity associated with that risk should earn a return which exceeds the risk-free rate of return. Thus, if buying or selling futures and/or options of a specific commodity incurs a risk which can not be diversified, that commodity's futures or option market could be efficient in terms of Fama's definition and have a price bias, i.e., $E_t(P_{t+1} - P_t) \neq 0$, provided the bias is a compensation for risk. Such a price bias is commonly noted as $\alpha \neq 0$, where α is the compensation for risk.

A convenient way of thinking about price bias is to use terminology introduced by Keynes (1930). He divided price biases into normal backwardation and contango. In normal backwardation, the expected price is lower than the realized price. If this situation exists, futures prices should increase over the course of a contract, resulting in positive trading returns to a long position. In a contango, the reverse is true, and the expected price is higher than the realized price. Hence, a short futures position will earn positive trading returns.

To summarize this discussion, there are two versions of Fama efficiency. In the first, $\alpha = 0$ and $\beta = 1$. In the second, $\alpha \neq 0$ and $\beta = 1$, provided a non-zero α is a return to risk. The second situation is commonly referred to as a random walk with drift. Normal backwardation implies that $\alpha > 0$, while contango implies that $\alpha < 0$. These price biases may be constant over time or may vary over time. The existence of price biases is extremely controversial, but, whatever the investigator's belief, their existence is an empirical, not conceptual, question.

Violations of Fama's Assumptions

Fama assumed no transaction costs, costless information, and that the implications of current information for both current price and the distributions of future prices are generally accepted by all market participants. At least two assumptions are unrealistic. First, transaction costs, such as brokerage fees, exist. The existence of transaction costs changes the criteria by which market efficiency is evaluated: a market is efficient if gross trading returns do not exceed transaction costs. Second, information is costly to acquire and analyze.

Grossman and Stiglitz (1980) show that, if information is costly, it is impossible for prices to perfectly reflect all available information. Otherwise, those who use resources to obtain information would earn no compensation to cover their costs of acquiring and analyzing it. This insight introduces a potential avenue for profitable trading. Profit can be earned by using information and analysis to take a position in anticipation of price changes which will occur as the rest of the market learns about the information. These trading returns represent a return to the costs incurred in acquiring and analyzing information.

Grossman and Stiglitz's model has come to be known as noisy rational expectations[4]. Relative to Fama's model of market efficiency, it implies that β may not equal 1 because the market acquires and analyzes information (i.e., learns) slowly, with traders possessing superior access to information and/or analytical ability acquiring information first. It also implies an alternative statement of market efficiency: a market is efficient with respect to the information set available at time t provided economic returns generated by trading on this information set do not exceed transaction and information costs (Jensen, 1978).

IMPLICATIONS OF MARKET EFFICIENCY FOR MARKETING STRATEGIES

For pedagogical purposes, we classify the different strategies employed in the marketing of commodities[5], including field crops, into four categories: routine strategies, systematic strategies, strategies based on individual-generated forecasts, and strategies based on market-generated forecasts of profits from engaging in a production activity. These four categories are discussed below.

Routine Strategies

A routine strategy is one that involves buying or selling at the same time during each production cycle. Because of their passive and unconditional nature, routine strategies represent minimal input strategies. These attributes make the evaluation of routine strategies important because the routine strategy which yields the highest return becomes the benchmark against which active and conditional marketing strategies should be measured.

One obvious routine strategy is to sell 100 percent of production at the end of the production period (i.e., harvest). Another routine strategy that has received significant attention is to always sell a share of expected production before harvest. Such a strategy will enhance income if a contango exists ($\alpha < 0$ and $\beta = 1$). On the other hand, if the futures or options market provides an unbiased forecast of subsequent prices (i.e., $\alpha = 0$ and $\beta = 1$), then the expected return from selling before harvest is zero. Hence, the success of routine selling before harvest depends on whether a routine price bias exists.

A particular type of contango price bias, known as the drought risk premium (Wisner, 1991), has been much discussed in recent years. This strategy is based on the argument that, during the period before harvest, crop futures and option prices will be priced in anticipation of a drought. Because a drought does not normally occur, futures prices will decline. By extension, routinely selling a futures or option contract before harvest should be profitable.

We examine the drought risk premium for the pre-harvest quotes of corn and soybean new crop futures over the 1952-1996 period. Table 1 presents the difference between the November soybean and December corn futures quote on March 1, May 1, July 1, and September 1 and the quote on the following November 1 or December 1. November 1 and December 1 represent harvest, March 1 represents pre-planting, May 1 represents planting, July 1 represents the middle of the growing season, and September 1 represents the late growing season. A positive difference means the pre-harvest quote on average was greater than the harvest quote, while a negative number means the pre-harvest quote on average was less than the harvest quote. The differences are tested for statistical significance at the five percent level using a two-tailed test. Note that these comparisons do not account for transactions costs incurred when trading[6].

Over the entire 1952-1996 observation period, none of the pre-harvest quotes for corn and soybeans differed significantly from the harvest quote. Furthermore, none of the eight t-statistics have a p-value which is less than 20 percent. When the observation period is divided in half, one t-statistic is significant at the five percent test level: soybeans, May 1, 1952-1973 (-2.59). Over this period, November soybean futures prices increased significantly between May 1 and November 1. When the observation period is split into fourths, three t-statistics are significant: corn, March 1, 1952-1962 (2.49); soybeans, May 1, 1963-1973 (-2.64); and soybeans, July 1, 1985-1996 (2.28). Two of these significant observations are consistent with contango, while the other is consistent with normal backwardation.

The number of significant coefficients do not deviate by much from the laws of chance. For example, random chance implies that approximately 0.9 observations (16 times 0.05) over the two equally divided sub-periods should be significant at the five percent test level. One significant coefficient is observed. Similar results are obtained for the 32 cases when four sub-periods are used. Furthermore, among the significant coefficients, there is no consistent pattern of normal backwardation or contango. In summary, there is little evidence that a consistent price bias exists in pre-harvest futures quotes. Thus, an annual short (or long) routine hedging strategy will not enhance the price received.

Table 2 presents the gross trading returns from buying September and November (December) soybean (corn) put options at the same four pre-harvest dates evaluated for futures. Because options expire during the month before the underlying futures contract expires, a September put option is not available on September 1. The put position was closed on the 15th day of the month before the underlying futures contract expires or the last day of trading, whichever came first. Again, trading costs were not included in the calculations.

The current option contracts did not begin trading until 1985 for corn and soybeans. Along with the 1985-1996 period, the 1990-1996 period is included because, following Grossman and Stiglitz, markets must learn how to price new contracts. Thus, reasons exist for believing that any new market can generate inaccurate pricing.

Only one average gross trading return is significant at the 5 percent level: corn, July 1, September put, 1985-1996 (2.66). However, the comparable t-statistic for 1990-1996 is insignificant (1.27). In total, there is no consistent evidence of significant trading returns to the routine buying of a put before harvest.

An issue is whether the results for the price bias analyses translates to the farm level decision making environment. This issue exists because yield, as well as price, varies at the farm level. Hence, a marketing strategy should be evaluated in terms of its impact on farm income. To evaluate the transferability of price bias analyses to the farm level, yields were collected for 21 farms operated by the University of Illinois over the 1985-1995 period. Thursday cash prices are available for regions of the state (Good). The same strategies as discussed above were evaluated, but the only pre-harvest date used was May 1. The futures and harvest put strategies are lifted at harvest, while the September put strategy is closed out on the last day of trading but no later than August 15. Harvest is defined as the week in which 50 percent of the Illinois corn or soybean harvest was completed.

The average gross return for all 21 farms from selling at harvest are presented in Table 3. Also presented is the average gross return associated with each pre-harvest marketing strategy, as well as the average t-statistic used to test the difference between gross returns from using the pre-harvest strategy and the gross return from selling at harvest. The average gross return is higher when the pre-harvest marketing strategies are used. However, using a five percent test level, none of the pre-harvest strategies yield a significantly higher return than selling at harvest. Larson, Alexander, Zulauf, and Irwin (1997) found similar results for Ohio corn farm situations examined over the 1985-1996 period.

For comparative purposes, the per bushel gross returns generated by selling a futures contract or buying a put option on May 1 for the 1985-1995 period are presented. As expected, the results for these price bias tests are similar to the results for the farm level tests: the pre-harvest marketing strategies yield a higher return than selling at harvest, but the return is not significantly higher.

The lack of a routine price bias in pre-harvest quotes of the corn and soybean harvest futures and options contracts without adjusting for transaction costs is consistent with Fama efficiency and with the view that over the preharvest period $\alpha = 0$ and $\beta = 1$. Thus, from the view of enhancing income, routinely selling before harvest is no better than simply selling at harvest. Conversely, selling at harvest is no better than selling before harvest, if done routinely[7].

Relative to the routine drought premium argument, our findings suggest that the corn and soybean futures and options markets incorporate the average economic value of a growing-season drought into their pre-harvest estimate of the harvest price. Because a drought usually does not happen, it is not surprising that over the 1974-1996 period corn and soybean new crop futures declined two-thirds of the time between May 1 and November 1 (December 1) (Figures 1 and 2). However, the average price increase was much greater than the average price decrease (Figures 1 and 2). Thus, the price reaction to a drought is much larger than the price reaction to the lack of a drought. Putting these two observations together results in futures and options prices being unbiased predictors {i.e., (average price increase times the probability that price increased) minus (average price decrease times the probability that price decreased) is not statistically different from zero}. Hence, while a trader can predict that corn and soybean prices will normally decline over the growing season, this information can not be used to trade profitably unless the trader can predict in which years price will increase (decrease). In other words, a trader must be able to predict a drought before it occurs.

One last point: the observed bias in futures prices varied substantially from subperiod to subperiod. For example, over 1974-1984 the May 1 quote of the November soybean contract averaged 25 cents lower than the November 1 quote of the November contract (Table 1). In contrast, over 1985-1996, the May 1 quote averaged 40 cents higher than the November 1 quote. Thus, a routine sell strategy would have generated substantial profits over 1985-1996, but substantial loses over 1974-1984. This discussion emphasizes the importance of having an adequate sample size before projecting past price behavior into the future. It also urges extreme caution in drawing any conclusions regarding the performance of option-based strategies, given that only 12 years of data exist.

While routine pre-harvest strategies do not appear to enhance the income of crop farmers, other routine strategies may be profitable. Numerous studies have investigated whether normal backwardation or contango is a general feature of futures prices for different commodities. In contrast to the above analysis which focused only on the pre-harvest period of the harvest contract, these studies have included all contracts and contract trading periods. The most extensive study is by Kolb (1992). He investigated the existence of normal backwardation in daily prices of 29 futures markets from 1959 (or first year of trading) through 1988. For the commodities of interest in this study, he found no evidence of normal backwardation or contango in corn, oats, or wheat futures contracts, but did find some evidence of normal backwardation in cotton and soybeans[8]. A buy-and-hold strategy produced mean annual gross trading returns between 4.5 and 5.0 percent for cotton and soybeans. The returns were statistically significant at the five percent test level (Kolb, p. 81). These findings suggest that a producer should wait to sell cotton and soybeans as long as possible.

Kolb's review of the literature reveals that the existence of a routine normal backwardation is sensitive to the time period analyzed. Also, Kolb does not account for the effect of overlapping sample periods or trading costs. Both of these considerations will reduce the confidence level associated with his results. Nevertheless, especially in regard to cotton and soybeans, Kolb's findings suggest that routine strategies need further investigation.

If a farmer has not already sold the crop for delivery at harvest, the farmer must confront the issue of storage when the crop is harvested. Many farmers routinely store, but it is uncertain whether this makes sense given the well-known “j” shaped pattern of cash prices over the harvest period. Cash prices are high at the beginning of harvest, reach a low around the middle of harvest, then begin to climb as harvest winds down. This pattern suggests that returns to storage may depend on the time of harvest, and, thus, routine storage will not necessarily enhance income.

Returns to routine storage are presented in Figures 3 and 4 for corn produced in Ohio during the 1964-1996 crop years. Returns to storage are evaluated for the week in which 10, 50, and 90 percent of Ohio’s corn crop is normally harvested. The pace of the Ohio corn harvest generally follows the national harvest rate. Thus, the use of the Ohio rate of harvest allows us to jointly capture the effect of the national harvest rate. The 10, 50, and 90 percent completion rates vary by crop year, but usually fall during the first week of October, first week of November, and last week of November. These usual dates are used for the analysis presented below because (1) the results are similar to those generated using the year-specific completion dates and (2) the presentation and interpretation of the results are simpler.

Returns, net of interest and physical storage costs, are computed for both hedged and unhedged corn. Transaction costs for futures trading are also subtracted when calculating returns to hedged storage. The storage hedge was placed in the July futures contract[9]. Because physical storage costs are included, the calculated storage returns can be thought of as returns to (1) corn stored off the farm with storage cost being measured as variable costs or (2) corn stored on the farm with storage costs measured as their opportunity cost.

Average net return to storage, whether hedged or unhedged, are not significantly different from zero at the five percent test level for corn harvest at the 10 and 90 percent completion dates except for unhedged storage held one week after the 90 percent harvest date. Furthermore, average net returns generally were negative for hedged storage at the 10 and 90 percent completion dates and for unhedged storage at the 10 percent harvest date. Thus, over the analysis period, the most favorable conclusion which can be drawn is that routine storage of corn at the 10 and 90 percent completion dates is a break-even proposition.

Net returns to both hedged and unhedged storage are greatest for corn harvested at the 50 percent completion date. Net returns were positive over most storage periods, generally falling between five and seven cents per bushel for unhedged storage and two and four cents per bushel for hedged storage. The lower returns for hedged storage in part reflect its higher cost due to the transactions costs associated with futures trading. Net storage returns are significantly greater than zero at the five percent test level for storage between December 1 and January 15th for unhedged storage and between December 1 and February 15th for hedged storage.

Despite its lower average return, net returns are significant for hedged storage because the risk associated with hedged storage returns is substantially smaller than the risk associated with unhedged storage returns. A common measure of this risk, standard deviation of returns, is presented in Figures 5 and 6 for unhedged and hedged storage, respectively. The difference in risk becomes more pronounced as the length of the storage period increases.

The routine strategy which generates the highest income should be used as the benchmark against which marketing programs are evaluated. For producers of field crops, the benchmark appears to be harvest-time sales for those who harvest early or late. For those harvesting during the middle of the harvest season, the appropriate benchmark appears to include the return from short-to-intermediate routine storage.

Systematic Strategies

Systematic strategies base the buy/sell decision on the status of an indicator variable. The indicator variable can take on different values over time. Depending on the value of the indicator variable, the strategy may involve taking a long, short, or no position, with the exact position changing as the value of the indicator variable changes. In terms of the discussion of price bias in an efficient market, these strategies are consistent with a situation in which α can take on any value, but $\beta = 1$, and the relationship between α and the indicator variable is caused by a risk factor. Thus, for successful systematic strategies in an efficient market, the risk factor must vary over time.

A systematic strategy which has received considerable attention in the literature is based on the argument that a hedging pressure risk premium exists. This argument was first stated by Keynes (1930) and Hicks (1946). It is based on the assumption that producers engage in hedging to reduce risk. Assuming that speculators are risk-averse, they will assume the risk which hedgers want to transfer only if they are paid for accepting it. Normal backwardation is a mechanism by which hedgers of cash commodities (i.e., short hedgers) pay speculators to assume the price risk avoided by hedging. By analogy, a contango is the mechanism by which long hedgers pay speculators to assume the price risk avoided by hedging (Cootner, 1960). These arguments imply that a long position will be profitable if hedgers are net short, while a short position will be profitable if hedgers are net long.

Bessembinder (1992) provides a recent, comprehensive analysis of this issue. He evaluates all contracts traded on 22 futures markets, including corn, cotton, soybeans, and wheat, over the period January 1967 through December 1989. He finds no relationship for soybeans and wheat between the net short and net long position of hedgers and mean gross trading returns. On the other hand, a statistically significant relationship at the five percent test level is found for corn and cotton. For corn, net trading returns to a long (short) position when hedgers are net short (long) for the entire month prior to taking the position is 16 percent (20 percent) expressed on an annual basis. For cotton, significant returns are found only when hedgers are net short for the entire month prior to the position being taken. Returns to a long position are 28 percent expressed on an annual basis[10].

A second systematic strategy is to condition trading positions on the state of the economy. In the academic literature, this is frequently referred to as a time-varying macro-economic risk premium. At present, the most comprehensive evaluation is by Bessembinder and Chan (1992). They investigated 12 futures markets over the period January 1975 to December 1989, including cotton, soybeans, and wheat. Returns to trading wheat and soybean futures were not significantly related at the five percent test level to the three macro-economic variables examined: three-month Treasury bill yield, dividend yield on a value-weighted equity index, and a measure of the ‘junk bond” premium. For cotton, the three-month Treasury bill yield was significant at the five percent test level, as was the explanatory power of all three variables as a group. The sign on the Treasury bill variable was negative, implying that a reduction in Treasury bill yields was associated with a positive return to a long position in cotton futures. On an annual basis, this return was approximately five percent for each unit change in Treasury bill yield. These results suggest that a time-varying macro-economic risk factor could exist for cotton, and, thus, could provide a basis for a systematic hedging strategy[11].

It is possible that other systematic strategies may be valid. A number of systematic price biases have been presented in the stock market literature. These include, among others, the firm size effect, the January effect, the weekend effect, and the Value-Line effect. For a more complete listing and discussion, see Gallinger and Poe (1995) and for a discussion of the evidence see Ball (1996) and Fama (1991). These systematic price biases lead to systematic trading strategies[12], such as always being long in the stock market during January. We would not be surprised if similar pricing biases exist in agricultural futures market; however, as of this time there is no convincing body of evidence that systematic biases of the kind found in the stock markets exist in the futures markets for crops.

In summary, evidence exists that for some field crop futures markets a hedging pressure risk premium and/or a time-varying risk premium tied to macro-economic variables may exist. In these instances, systematic hedging strategies could be timed to coincide with the values of these systematic risk factors. However, the evidence is not consistent across all field crop futures markets, implying that the usefulness of such strategies vary by crop.

Marketing Strategies Using Individual-Generated Forecasts

Grossman and Stiglitz's model of market efficiency implies that positive trading returns can be earned by those who are the first to acquire new information or who possess superior analytical ability. As discussed earlier, positive returns can be earned because information is costly and because markets are human institutions and, thus, need to learn (i.e., analyze) new information. Hence, β in the price bias equation may not equal 1.

Large traders, especially those involved in producing or transforming commodities, are immersed in national and international information flows. They also have access to more resources than small traders. Because of these advantages, Grossman and Stiglitz's model implies that large traders should make most of the money from trading on futures and options markets. In contrast, because of their limited ability to be among the first to acquire new information, small traders should lose money as a group.

These implications are supported by several studies of traders' returns. Hartzmark (1987) analyzed the Commodity Futures Trading Commission's data on the position of large traders in nine markets over the period 1977-1981. Large hedgers had gross trading profits of $728 million, large speculators made $125 million, while small traders lost $853 million (Table 4). Leuthold, Garcia, and Lu (1994) found that large traders in frozen pork bellies were able to generate significant profits over the period 1982-1990, while Phillips and Weiner (1994) found that major oil companies earned significant profits from forward trades of Brent Blend crude oil over the 1983-1989 period. Both of these studies attribute the significant profits of larger traders to superior information and/or forecasting ability. Last, Irwin, Krukemyer, and Zulauf (1993) found that public commodity pools earned significant gross trading returns[13]. The findings of each of these studies of traders' returns are inconsistent with Fama's definition of efficiency, but are consistent with Grossman and Stiglitz's model of market performance[14].

While the above results seem to suggest that traders with superior forecasting ability can earn trading returns, the more pertinent question for most agricultural producers, including crop farmers, is whether small traders can "out-forecast" the market. Hartzmark's (1987) analysis implies that small traders lose money as a group. However, it is possible that these small traders were not using the best forecasting methods.

A review of the pricing efficiency of agricultural futures markets by Garcia, Hudson, and Waller (1988) found mixed evidence in regard to whether forecasting models can improve upon the forecast performance of futures markets. The percent of studies in which forecast models performed better than futures markets varied by commodity (inefficiency was more common in livestock than crops), by period of analysis, by forecast horizon, and by method of analysis (inefficiency was more common with tests involving past prices than public information). A review of economic forecasting in agriculture by Allen (1994, p. 105) found that econometric and other multivariate models do slightly worse than the naïve no change forecast. Trend extrapolation and exponential smoothing perform the worst. Vector autocorrelation was the best performing forecast method, although Allen argues that it has generally been compared with relatively weak alternatives. In his overview of commodity futures prices as forecasts, Tomek (1997) argues that futures markets may have low forecast ability, but model-based forecasts will generally do no better because markets are efficient.

Irwin, Gerlow, and Liu (1994) found no significant difference between the forecast accuracy of live hog and live cattle futures prices and U.S. Department of Agriculture expert predictions over the period 1980-1991. Bessler and Brandt (1992) found that the forecast of cattle prices by the expert they evaluated outperformed the live cattle futures market over the period 1972-1986; however, the expert's forecasts regarding hog prices did not outperform the live hog futures markets. Kastens and Schroeder (1996) found that Kansas City wheat futures outperformed econometric forecasting over the 1947 to 1995 period. Lukac, Brorsen, and Irwin (1988) and Lukac and Brorsen (1990) found that several technical trading systems earned significant risk-adjusted profits above transaction costs. However, it appear that to earn consistent profits, technical trading systems must be used with a portfolio of markets, not just a single market. Last, in a recent study, Conley, Khan, and Almonte-Alvarez (1997) evaluated a two-year hedge for corn triggered by a probability density function determination that price was in the highest 10 percent category of historical prices over the last four years. This strategy is a variation of technical trading systems. They found that, over the 1973-1995 crop years, the two-year hedge did no better than annually selling corn at harvest.

In evaluating these mixed findings with respect to the performance of publicly available forecasts, it is useful to keep in mind an article by Tomek and Querin (1984). They show through a simulation exercise that, even if prices are generated by a random walk process, price trends (after the fact) will exist. Therefore, it is likely that historical analysis will discover some technical trading rule that was profitable over the period analyzed. The same conclusion can be reached with regard to any type of forecasting model. Hence, the expectation is that forecasting studies will find mixed evidence regarding market efficiency and trading profitability. What is more important is whether consistent results are found repeatedly for a given forecasting model. On this score, the evidence is fairly clear: no publicly available forecasting model has been found to generate consistent trading profits when applied to a single market.

Another area of investigation recently has emerged that falls somewhere between the large trader return studies and the public price forecasting studies. This area focuses on evaluating the performance of advisory services who provide marketing assistance to farmers. Because of their on-going collection and evaluation of information, it is possible that these services may be able to enhance farmer income. The available studies have focused on corn and soybeans. They include Gehrt and Good (1993); Martines-Filho (1996), and Good, Irwin, Jackson, and Price (1997). When viewed as a group, these studies hint that market advisory services may be able to enhance income relative to the returns obtained from selling at harvest. Robustness of the results is limited by extremely small samples and by the considerable variance in performance by advisory service and crop. Nevertheless, the early evidence indicates that additional investigation is warranted.

In summary, the available evidence on individual-generated forecasts is largely consistent with an efficient market at least in the Grossman and Stiglitz's sense. This finding should not come as a surprise. According to Patel, Zeckhauser, and Hendricks (1991), market efficiency is expected when investors play for significant stakes, investors have sustained opportunities for practice, economic selection eliminates non-rational traders, and poaching (i.e., arbitrage) opportunities can be seized readily. These characteristics describe futures and options markets, where entry is easy, trading opportunities exist daily, loses are visible daily, and loses are magnified through the leverage provided by margin money.

Marketing Strategies Based on Market-Generated Forecasts of Production Profits

The discussion in the previous section leads to the conclusion that the only individuals who can beat the market are those with superior access to information and/or those who possess superior analytical ability. However, we contend that the marketing situation in competitive markets may not be this bleak for the average farmer. A fourth category of marketing strategies exists which we think offers marketing opportunities to most producers. These marketing strategies use the currently-quoted futures and options prices to forecast the expected profit from engaging in a production activity. The expected profit is used to determine a production and associated hedging (i.e., marketing) strategy. This category of strategies is derived from viewing the futures and options prices as forecasts which carry signals regarding production activities the market wants to encourage or discourage. Stated alternatively, these strategies are derived from using the collective wisdom of the market to guide activities, rather than trying to increase price by outguessing the market's wisdom. We illustrate these strategies by discussing two of them: storage arbitrage and farm production response strategies.

Storage strategies were first discussed by Working (1953). In particular, he argued that the current futures-cash basis provides a market determined estimate of the expected return to storage. Working discussed this strategy in the context of storage at the futures market delivery point. This allowed him to use the convergence of futures and cash markets during the futures delivery month, i.e., the basis becomes nearly zero. His storage strategy was to store until the delivery month only when the current futures-cash basis exceeds the cost of storing to the delivery month. Working also advocated the use of a hedge to assure that the expected storage return was earned.

At non-delivery points or during non-delivery months, the storage agent can no longer rely on convergence to provide a near-certain expectation of the basis at the end of the storage period (i.e, zero). Hence, uncertainty is introduced into storage returns. One technique for estimating the expected basis at the end of the desired storage period is to use an average of past bases on the expected storage ending date. Working's basis strategy is then transformed into: store only when the current basis minus the historical average basis on the projected sell date exceeds the cost of storage[15].

To examine Working's basis strategy over a long period of time at a non-delivery point, we evaluated the returns to corn storage in Ohio over the 1964-1996 crop years. The parameters of the analysis were the same as those described above for the time of harvest analysis[16]. Figure 7 contains the net returns for unhedged storage of corn harvested at the 50% harvest completion date separated out by basis storage signal: i.e., store or not store. The net returns to these two different signals do not differ statistically from each other at the five percent test level. The same result was found for corn harvested at the 10% and 90% harvest completion date. In short, Working's basis strategy offered little discernible ability to enhance returns to unhedged storage.

This result is not surprising because returns to unhedged storage are generated by changes in cash prices. In contrast, the basis measures the difference between cash and futures prices. Hence, the information it contains relates to changes in the difference between cash and futures prices, not changes in cash prices.

The returns presented in Figure 8 for hedged storage stand in sharp contrast to the returns presented in Figure 7 for unhedged storage. For hedged storage at the 50% completion date, average net returns were twice as large for years in which Working's basis strategy indicated that corn should be stored than for the years in which the basis strategy indicated that corn should not be stored. Furthermore, the strategy was statistically able at the five percent test level to discriminate among which years to store. The same general statistical relationship was found for the 10% and 90% harvest completion dates. Using shorter periods of analysis, Heifner (1966) and Tomek (1987) also found that the basis strategy increased returns to hedged storage.

Compared with storage arbitrage strategies, the evidence regarding farm production response hedging is less definitive. The farm production response hedging strategy involves placing a hedge in output and/or input futures whenever the expected profit from production based on expected expenses and current futures prices (adjusted via the basis to local conditions) exceed some specified level. In essence, the market is signaling farmers to increase production. Hedging is a way to lock in this expected profit. It is analogous to locking in a storage return through hedging. The existence of a farm production response incentive is controversial because rational expectation theory suggests that the market should incorporate expected producer response to current prices. Thus, given rational expectations, this incentive should not exist.

As a group, studies of farm production response hedging have found that this market forecast based strategy may enhance returns and/or reduce risk, although it is important to emphasize that it is not uncommon for studies to find that the strategy does not increase income or reduce risk. This literature is summarized in Johnson, Zulauf, Irwin, and Gerlow (1991).

The existing farm production response hedging studies were conducted using extremely small samples and did not use appropriate statistical techniques. In a recent study, Irwin, Zulauf, and Jackson (1996) found no statistically significant evidence of mean reversion in agricultural futures prices when appropriate statistical techniques were used. Mean reversion is probably a needed attribute of price behavior for profit-margin hedging to be a successful strategy[17]. Nevertheless, the existing literature regarding farm production response hedging suggests the need for further research using appropriate statistical techniques. If such a hedging strategy is found to enhance income (or reduce risk), it would be a valuable tool for field crop producers who no longer have acreage decisions dictated by government programs.

Conclusions and Implications for Farmer Marketing Strategies

The available evidence regarding returns to routine strategies using crop futures and options is generally pessimistic. In particular, there is no evidence that a routine drought premium exists in pre-harvest quotes of new crop futures. The available evidence regarding returns to systematic strategies is mixed at best and the performance of systematic strategies appear to vary by crop. These conclusion are of seminal importance because routine and systematic strategies can be used by anybody. In contrast, there is evidence that individuals can beat the market, although the number who can consistently do so is small. The primary attributes of these individuals are that they have superior access to information and/or possess superior analytical ability. These conclusions are consistent with Grossman and Stiglitz's model of market efficiency. Hence, for most field crop producers marketing strategies have limited ability to enhance income. In a sense, this conclusion reaffirms the "no-free-lunch" rule.

On its surface the preceding paragraph seems to drip with pessimism, but we suggest that in fact in contains a powerful directive for producers: a Grossman and Stiglitz's world of market efficiency underscores the importance of cost of production relative to marketing when it comes to long term survival in a commodity market. With few exceptions, the field crop producers who survive will be those who have the lowest cost of production since efforts to improve revenue through better marketing of the commodity produced will meet with limited success over time. Producers will increase their probability of long-term survival by using their scarce resources to first maximize their production efficiency before chasing the allure of marketing profits. In other words, a good marketing program starts with a good program for managing and controlling cost of production. This axiom needs to be incorporated into every marketing program.

Furthermore, we suggest that all is not lost for individual producers when it comes to enhancing income through prudent marketing. One example is to base storage decisions on when a producer harvests the crop relative to the national harvest of the crop. Stated more broadly, an effective marketing program begins with first learning and practicing effective cash marketing. Another example is to base storage decisions on whether the current basis exceeds the cost of storage, and then to use hedging to assure an expected positive return. This strategy involves using futures markets as an information input. Stated more broadly, producers need to begin using futures and option markets as a source of marketing information, rather than just as a pricing and trading medium.

We end by noting the rather poor performance of econometric and other economic models in predicting future prices. This is not to say that such models are useless. In a world where information is costly, learning is not instantaneous, and the economic system is in a constant state of change; economic model building is likely to be an important part of improving our understanding of the economic world. The value of economic model building is not in forecasting prices better than the futures markets, but in helping us understand market parameters and in devising less costly means to analyze and collect information.

ENDNOTES

1. Fama (1970) referred to the definition used here as strong-form efficient in his 1970 article and as tests for private information in his 1991 update article.

2. For an excellent discussion of the impacts and controversies surrounding the Efficient Market Theory in the context of the stock market see Ball (1996).

3. While the random walk price process is a useful pedagogical tool, the martingale price process has supplanted it within the efficient market literature. An excellent discussion of the efficient market theory and its relationship to the random walk and martingale price processes is provided by LeRoy (1989). Both the martingale and random walk imply that, given the information set available at time t, the best guess of price at time $t+1$ is the price at time t and that the expected change in price is zero. The difference between the two price processes is that a martingale rules out a relationship between the expected mean price change and the information set available at time t, whereas the random walk rules out this relationship and any other relationship involving higher conditional moments of price changes and the information set at time t.

4. See Brorsen and Irwin (1996) for a more thorough discussion of Grossman and Stiglitz's model of noisy rational expectations and its relationship to Fama's model, which is similar to Muth's rational expectation model (1961).

5. It is worth emphasizing that this discussion of marketing strategies occurs within the context of a competitive market with homogenous products. In a market with differentiated products, a different and more diverse set of marketing strategies are available. These strategies are categorized in various ways. One typology is

strategies involving product positioning, price, distribution, and promotion (Bovee, Houston, and Thill, 1995).

6. Transaction costs include brokerage fees and liquidity costs. Currently, brokerage fees for a 5,000 bushel corn and soybean contract are commonly cited as $50 for a round-trip futures trade and $30 per single option trade (Good, Irwin, Jackson, and Price, 1997). Liquidity costs are payments earned by floor traders (scalpers) for filling an order to sell at the market. They have been estimated to be one price tick (1/4 cent per bushel for grain futures and 1/8 cent per bushel for grain options) for the more heavily traded nearby contracts and two price ticks for the more lightly traded contracts that are more than 5 months from delivery (Brorsen and Nielsen, 1986, and Thompson and Waller, 1987). Summing these two components, transaction costs are at least $75 for a round-trip futures trade and $36.25 for a single option trade.

7. If futures are used for pre-harvest selling, cash flow requirements may become significant due to margin calls resulting from adverse price moves (Larson, Alexander, Zulauf, and Irwin, 1997). When purchasing put options, a known premium must be paid at the time of purchase; however, the buyer is not exposed to additional cash flow requirements due to adverse price moves.

8. Among the other agricultural commodities examined, Kolb found strong evidence of normal backwardation in feeder cattle, live cattle, live hogs, and frozen concentrated orange juice futures contracts. Some evidence in support of normal backwardation was found for soy oil and soy meal futures contracts.

9. For a complete discussion of the procedures, see Leeds, Zulauf, and Irwin (1992b).

10. Bessembinder (1992) also investigated live cattle, world sugar, and a portfolio of the five agricultural commodities. Trading returns on futures were significant only when hedgers were net short for the portfolio. Returns averaged 11 percent expressed on an annual basis.

11. Bessembinder and Chan (1992) also investigated live cattle. A significant relationship was found between trading returns on live cattle futures and both the three-month Treasury bill yield and the dividend yield on the equity index. They also found that the macro-economic variables possessed statistically significant power to predict futures trading returns when the four agricultural commodities were evaluated as a group.

12. There is considerable disagreement about whether these pricing anomalies generate trading returns which are consistent with a time-varying risk premium or whether they generate abnormal trading returns (i.e., they are price anomalies).

13. Irwin, Krukemyer, and Zulauf (1993) found that, after adjusting for costs and risk, public commodity pools do not earn abnormal profits despite their large and significant gross trading returns.

14. Fama (1991) reached the same conclusion with respect to the literature on private information in the stock market, i.e., private information exists which generates abnormal trading returns. An example is information possessed by corporate insiders.

15. For a more detailed discussion of basis forecast procedures see Tomek (1997).

16. For a complete discussion of the calculation procedures, see Leeds, Zulauf, and Irwin (1992a).

17. This observation is based on the argument that over time prices should equal the cost of production in a competitive market. If the output price offers a profit for production and producers respond to this profit, then price will decline toward the cost of production as production expands. The reverse should happen if output price signals a loss. Hence, price reverts to the cost of production, or its mean value in a competitive market.

References

Allen, P. G. "Economic Forecasting in Agriculture." *International Journal of Forecasting*. 10 (1994): 81-135.

Ball, R. "The Theory of Stock Market Efficiency: Accomplishments and Limitations." *Journal of Financial Education*. 22(Spring 1996): 1-13.

Bessembinder, H. "Systematic Risk, Hedging Pressure, and Risk Premiums in Futures Markets." *The Review of Financial Studies*. 5(1992): 637-667.

Bessembinder, H. and Chan, K. "Time-Varying Risk Premia and Forecastable Return in Futures Markets." *Journal of Financial Economics*. 32(1992): 169-193.

Bovee, C. L., Houston, M. J., and Thill, J. V. *Marketing*. McGraw-Hill, Inc., 2nd edition, 1995.

Bessler, D. A. and Brandt, J. A. "An Analysis of Forecasts of Livestock Prices." *Journal of Economic Behavior and Organization*. 18(1992): 249-263.

Brorsen, B. W. and Irwin, S. H. "Improving the Relevance of Research on Price Forecasting and Marketing Strategies." *Agricultural and Resource Economics Review*. 25(April 1996): 68-75.

Brorsen, B. W. and Nielsen, R. J. "Liquidity Costs in the Corn Futures Market." Selected paper presented at the annual meeting of the American Agricultural Economics Association, Reno, Nevada. 1986.

Campbell, J. Y., Lo, A. W., and MacKinlay, A. C. *The Econometrics of Financial Markets*. Princeton University Press, 1997.

Cootner, P. "Returns to Speculators: Telser Versus Keynes." *Journal of Political Economy*. 68 (August 1960): 398-404.

Conley, D., Khan, A., and Almonte-Alvarez, J. "Multi-Year Hedging Analysis for Corn, 1973-1995." Selected paper presented at the annual meeting of the American Agricultural Economics Association, Toronto, Canada. July 1997.

Fama, E. "Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance.* 25(1970): 1043-1053.

Fama, E. "Efficient Capital Markets: II." *Journal of Finance.* 46(December 1991): 1575-1617.

Gallinger, G. W. and Poe, J. B. *Essentials of Finance: An Integrated Approach*. Prentice-Hall, Inc. 1995.

Garcia, P., Hudson, M. A., and Waller, M. L. "The Pricing Efficiency of Agricultural Futures Markets: An Analysis of Previous Research Results." *Southern Journal of Agricultural Economics*. 20(July 1988): 119-130.

Gehrt, D. W. and Good, D. L. "Evaluation of Market Advisory Services for Corn and Soybeans." *Journal of the American Society of Farm Managers and Rural Appraisers*. 57(May 1993): 75-81.

Good, D. "Illinois Regional Basis: Corn and Soybeans." University of Illinois Department of Agricultural Economics. (no date or publication number)

Good, D. L., Irwin, S. H., Jackson, T. E., and Price, G. K. *1995 Pricing Performance of Market Advisory Services for Corn and Soybeans*. AgMAS Project Research Report 1997-01. University of Illinois at Urbana-Champaign and The Ohio State University. March 1997.

Grossman, S. J. and Stiglitz, J. E. "On the Impossibility of Informationally Efficient Markets." *American Economic Review*. 70(June 1980): 393-408.

Hartzmark, M. L. "Returns to Individual Traders of Futures: Aggregate Results." *Journal of Political Economy*. 95(December 1987): 1292-1306.

Heifner, R. G. "The Gains from Basing Grain Storage Decisions on Cash-Futures Spreads." *Journal of Farm Economics*. 48(December 1966): 1490-1495.

Hicks, J. R. *Value and Capital: An Inquiry into Some Fundamental Principles of Economic Theory*. 2nd Edition. Oxford University Press: London. 1946. Reprint, 1978.

Irwin, S. H., Gerlow, M. E., and Liu, T. "The Forecasting Performance of Livestock Futures Prices: A Comparison to USDA Expert Predictions." *The Journal of Futures Markets*. 14(October 1994): 861-875.

Irwin, S. H., Krukemyer, T. R., and Zulauf, C. R. "Investment Performance of Public Commodity Pools: 1979-1990." *The Journal of Futures Markets*. 13(October 1993): 799-820.

Irwin, S. H., Zulauf, C. R., and Jackson, T. E. "Monte Carlo Analysis of Mean Reversion in Commodity Futures Prices." *American Journal of Agricultural Economics*. 78(May 1996): 387-399.

Jensen, M. C. "Some Anomalous Evidence Regarding Market Efficiency." *Journal of Financial Economics*. 6(June/September 1978): 95-101.

Johnson, R., Zulauf, C. R., Irwin, S. H., and Gerlow, M. E. "The Soybean Complex Spread: An Examination of Market Efficiency from the Viewpoint of a Production Process." *The Journal of Futures Markets.* 11(February 1991): 25-37.

Kastens, T. L. and Schroeder, T. C. "Efficiency Tests of Kansas City Wheat Futures." *Journal of Agricultural and Resource Economics*. 21(December 1996): 187-198.

Keynes, J. M. *A Treatise on Money*, Volume II, *The Applied Theory of Money*. Macmillan & Co.: London. 1930.

Kolb, R. W. "Is Normal Backwardation Normal?" *The Journal of Futures Markets*. 12(February 1992): 75-91.

Larson, D.W., Alexander, C. K., Zulauf, C.R., and Irwin, S. H. "Performance of Pre-Harvest Pricing Strategies in Ohio Corn Markets: The Role of Cash Flow Risk." Selected paper presented at the annual meeting of the American Agricultural Economics Association, Toronto, Canada. July 1997.

Leeds, R., Zulauf, C., and Irwin, S. "Basis and Large Crop Storage Strategies for Corn, Ohio, 1964-1989." Ohio State University Department of Agricultural Economics ESO Number 1975. October 1992a.

Leeds, R., Zulauf, C., and Irwin, S. "Return and Risk to Storing Corn by Time of Harvest, Ohio, 1964-1989." Ohio State University Department of Agricultural Economics ESO Number 1977. October 1992b.

Leroy, S. F. "Efficient Capital Markets and Martingales." *Journal of Economic Literature*. 27(December 1989): 1583-1621.

Leuthold, R. M., Garcia, P., and Liu, R. "The Returns and Forecasting Ability of Large Traders in the Frozen Pork Bellies Futures Markets." *Journal of Business*. 67(July 1994): 459-473.

Lukac, L. P. and Brorsen, B. W. "A Comprehensive Test of Futures Market Disequilibrium." *Financial Review*. 25(November 1990): 593-622.

Lukac, L. P. , Brorsen, B. W., and Irwin, S. H. "A Test of Futures Market Disequilibrium Using Twelve Different Technical Trading Systems." *Applied Economics.* 20(May 1988): 623-639.

Martines-Filho, J. G. *Pre-Harvest Marketing Strategies for Corn and Soybeans: A Comparison of Optimal Hedging Models and Market Advisory Service Recommendations*. Unpublished Ph.D. dissertation. The Ohio State University. 1996.

Muth, J. "Rational Expectations and the Theory of Price Movements." *Econometrica*. 29(April 1961): 315-335.

Nelson, F. J. and Schertz, L. P., editors. *Provisions of the Federal Agriculture Improvement and Reform Act of 1996*. U.S. Department of Agriculture, Economic Research Service Agriculture Information Bulletin No. 729. September 1996.

Patel, J., Zeckhauser, R., and Hendricks, D. "The Rationality Struggle: Illustrations from Financial Markets." *The American Economic Review*. 81(May 1991): 232-236.

Phillips, G. M. and Weiner, R. J. "Information and Normal Backwardation as Determinants of Trading Performance: Evidence from the North Sea Oil Forward Market." *Economic Journal*. 104 (January 1994): 76-95.

Thompson, S. R. and Waller, M. L. "The Execution Cost of Trading In Commodity Markets." *Food Research Institute Studies*. 10(No. 2, 1987): 141-163.

Tomek, W. "Commodity Futures Prices as Forecasts." *Review of Agricultural Economics*. 19(Spring/Summer 1997): 23-44.

Tomek, W. "Effects of Futures and Options Trading on Farm Incomes." Cornell University, Department of Agricultural Economics Staff Paper No. 87-9. May 1987.

Tomek, W. G. and Querin, S. F. "Random Processes in Prices and Technical Analysis." *The Journal of Futures Markets*. 4(Spring 1984): 15-23.

Tversky, A. and Kahneman, D. "Belief in the Law of Small Numbers." *Psychological Bulletin*. 76(1971, part 2): 105 - 110.

Wisner, R. N. "An Evaluation of Pre-Harvest Corn Futures and Option Marketing Strategies in Selected Iowa and Nebraska Locations." University of Nebraska-Lincoln, Agricultural Research Division Working Paper 167. June 1991.

Working, H. "Futures Trading and Hedging." *American Economic Review*. 43(June 1953): 314-343.

TABLE 1. Price of Harvest Futures at Selected Times before Harvest Minus Harvest-time Price of Harvest Futures, December Corn and November Soybean Futures, 1952 -1996.

Year	Average Price of Harvest Futures at Harvest [a]	Price Difference by Date Before Harvest			
		September 1	July 1	May 1	March 1
		Corn (¢/bushel) [b]			
1952 - 1996	197	1.19 (0.37)	7.21 (1.21)	2.65 (0.44)	2.79 (0.47)
1952 - 1973	133	-0.47 (-0.31)	0.28 (0.08)	-2.07 (-0.42)	-2.35 (-0.40)
1974 - 1996	259	2.78 (0.44)	13.83 (1.25)	7.16 (0.65)	7.72 (0.76)
1952 - 1962	127	2.34 (1.55)	3.91 (1.47)	4.95 (1.96)	5.18 (2.49*)
1963 - 1973	138	-3.28 (-1.34)	-3.34 (-0.50)	-9.09 (-0.97)	-9.88 (-0.86)
1974 - 1984	280	4.89 (0.61)	2.05 (0.12)	1.11 (0.06)	4.02 (0.24)
1985 - 1996	239	0.85 (0.09)	24.63 (1.79)	12.71 (1.12)	11.10 (0.90)
		Soybeans (¢/bushel)			
1952 - 1996	458	5.07 (0.73)	9.66 (0.83)	-2.13 (-0.15)	-5.40 (-0.41)
1952 - 1973	277	0.84 (0.12)	2.95 (0.54)	-13.36 (-2.59*)	-13.34 (-1.81)
1974 - 1996	632	9.12 (0.77)	16.09 (0.72)	8.62 (0.32)	2.20 (0.09)
1952 - 1962	246	-5.17 (-1.41)	3.11 (0.45)	-4.66 (-0.90)	-0.65 (-0.10)
1963 - 1973	307	6.85 (0.49)	2.79 (0.32)	-22.06 (-2.64*)	-26.02 (-2.09)
1974 - 1984	675	-2.39 (-0.13)	-19.30 (-0.50)	-25.11 (-0.49)	-19.30 (-0.43)
1985 - 1996	592	19.67 (1.25)	48.52 (2.28*)	39.54 (1.91)	21.90 (0.89)

[a] Harvest is defined as November 1 for soybeans and December 1 for corn.

[b] The t-test is reported in the parenthesis for the null hypothesis: Price of Harvest Futures before Harvest Minus Price of Harvest Futures at Harvest = 0. * - indicates significance at 5 percent test level using a two-tailed test.

SOURCE: original calculations

TABLE 2. Average Return to Selling Put Options at Selected Times before Harvest [a], Corn and Soybean September and Harvest Futures Options, 1985 - 1996.

Year	Return to Selling Put Option by Date Before Harvest [b]			
	September 1	July 1	May 1	March 1
		Corn September Option (¢/bushel)		
1985 - 1996	NA	9.98	7.67	9.01
		(2.66*)	(1.40)	(1.22)
1990 - 1996	NA	8.25	1.70	4.64
		(1.27)	(0.22)	(0.45)
		Corn December Option (¢/bushel)		
1985 - 1996	2.32	12.78	8.00	8.08
	(0.49)	(1.51)	(1.39)	(1.45)
1990 - 1996	5.70	16.09	10.41	11.11
	(0.78)	(1.23)	(1.19)	(1.35)
		Soybean September Option (¢/bushel)		
1985 - 1996	NA	7.26	10.31	8.52 [c]
		(0.88)	(0.89)	(0.64)
1990 - 1996	NA	-0.10	-0.45	1.66
		(-0.10)	(-0.04)	(0.11)
		Soybean November Option (¢/bushel)		
1985 - 1996	9.68	15.79	18.29	20.47
	(1.21)	(1.26)	(1.29)	(1.40)
1990 - 1996	10.71	4.45	11.45	14.34
	(0.87)	(0.32)	(0.90)	(0.95)

NA - not applicable

[a] The put option position is closed on the 15th day of the month before the delivery month of the futures contract or the last day of trading, whichever came first.

[b] The t-test is reported in the parenthesis for the null hypothesis: return to option position = 0. * - indicates significance at 5 percent test level using a two-tailed test.

[c] The soybean September option price was not available for March 1, 1985.

SOURCE: original calculations

TABLE 3. Average Return to Various Marketing Strategies, 21 Illinois Farms, Corn and Soybeans, 1985 -1995.

Strategy	Corn		Soybeans	
	Mean	t-statistic [a]	Mean	t-statistic [a]
	Gross Production Returns [b] ($/acre)			
Sell at Harvest	303	NA	251	NA
Sell Futures on May 1 [c]	319	0.82	266	1.56
Buy Sept. Put on May 1 [d]	319	2.04	260	1.30
Buy Harvest Put on May 1 [c]	310	0.93	259	0.97
	Gross Trading Returns to Futures or Option Position (¢/ bushel)			
Sell Futures on May 1 [c]	11.0	0.90	33.8	1.66
Buy Sept. Put on May 1 [d]	10.6	2.07	15.4	1.35
Buy Harvest Put on May 1 [c]	4.9	0.85	14.6	1.02

[a] The t-statistic for gross production returns per acre is for the null hypothesis: gross returns with pre-harvest strategy - gross returns from selling at harvest = 0. The t-statistic for gross trading returns is for the null hypothesis: gross trading return = 0.

[b] Gross return for selling at harvest equals cash price during the week in which 50 percent of the Illinois crop is harvested times the farm's yield. Gross return for the other marketing strategies includes the return from selling futures or buying the put. It is assumed that 100 percent of expected production (five-year moving average of yield minus high and low yield) is sold before harvest.

[c] Futures and harvest put positions are closed out on the same date the cash sale is made, i.e. the week in which 50 percent of the Illinois crop is harvested.

[d] September put option position is closed on the 15th day of August or the last day of trading, whichever came first.

SOURCE: original calculations

TABLE 4. Gross Trading Returns Earned by Traders Grouped According to Commodity Futures Trading Commission Data on Position of Large Traders, Selected Commodities, 1977-1981.

	Gross Trading Returns (Million $)		
Commodity	Large Hedger	Large Speculator	Small Trader
Oats	9.63	0.64	-10.28
Wheat [a]	66.73	13.53	-80.30
Pork Bellies	79.05	1.48	-80.56
Live Cattle	-130.27	197.12	-66.85
Feeder Cattle	29.13	75.42	-104.55
T-bonds	559.09	-169.07	-390.02
T-bills	114.96	5.48	-120.44
TOTAL	728.00	125.00	-853.00

[a] This includes the Chicago, Kansas City, and Minneapolis wheat futures markets.

SOURCE: Hartzmark, pages 1298-1299.

Figure 1. Observed Probability of a Price Increase and Decline Between May 1 and November 1 on November Soybean Contract and May 1 and December 1 on December Corn Contract, 1974-96

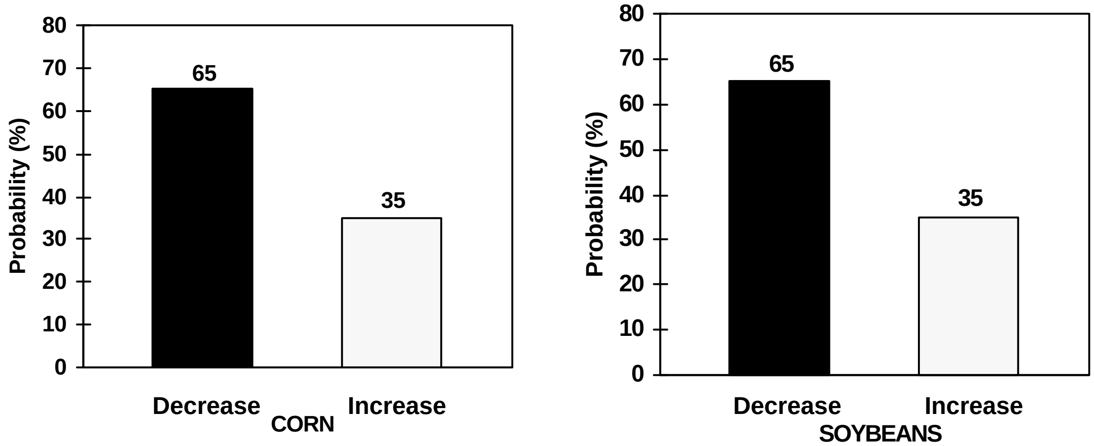

Figure 2. Average Price Increase and Average Price Decline Between May 1 and November 1 on November Soybean Contract and May 1 and December 1 on December Corn Contract, 1974-96

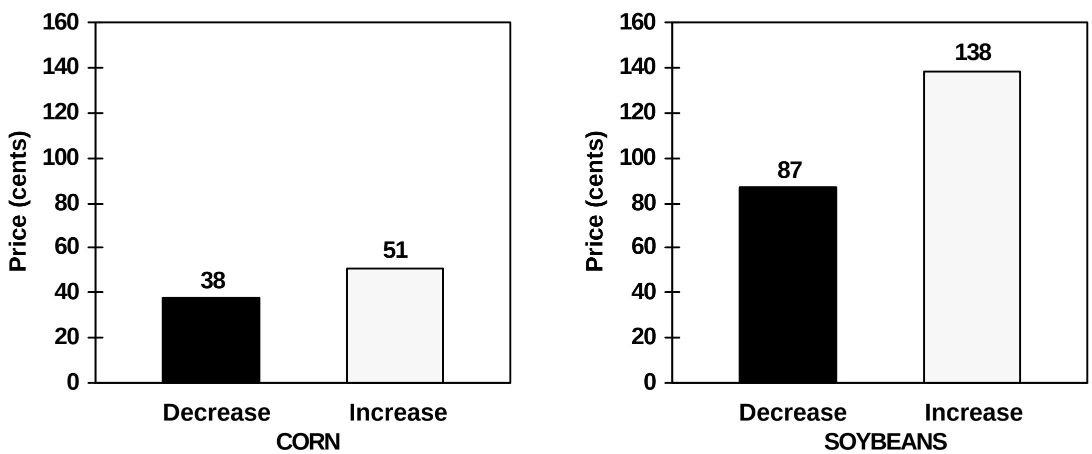

Figure 3. Net Return to Unhedged Storage by Time of Harvest and Week Sold After Harvest, Ohio Corn, 1964-1996 Crop Years

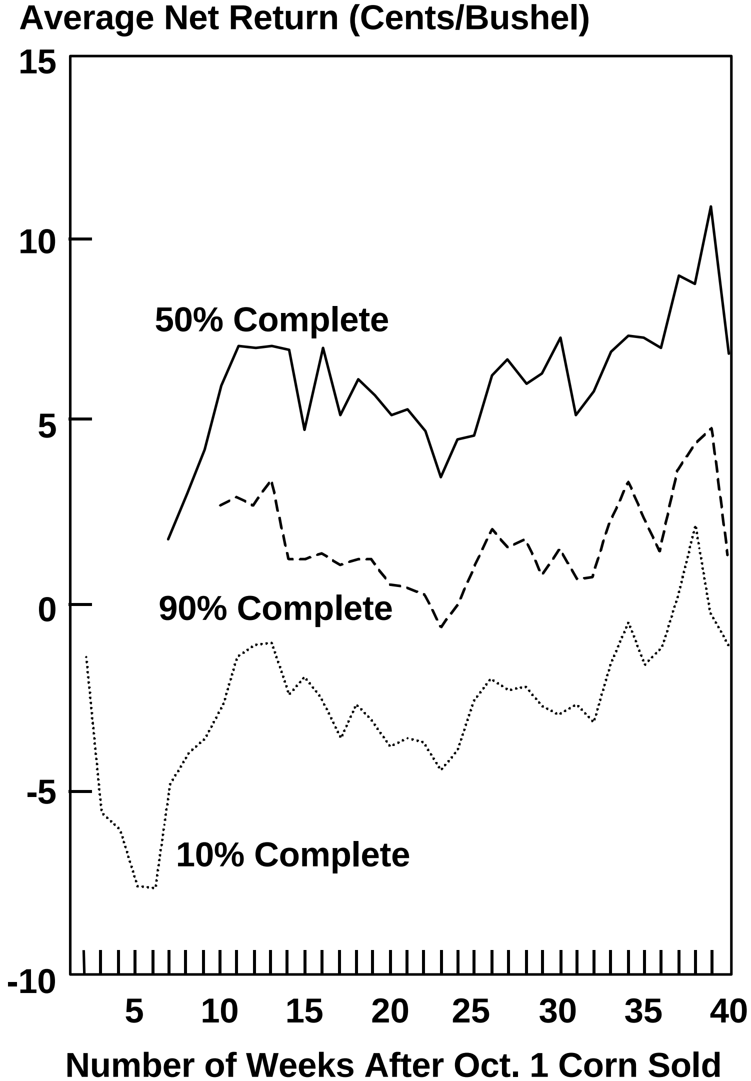

Figure 4. Net Return to Hedged Storage by Time of Harvest and Week Sold After Harvest, Ohio Corn, 1964-1996 Crop Years

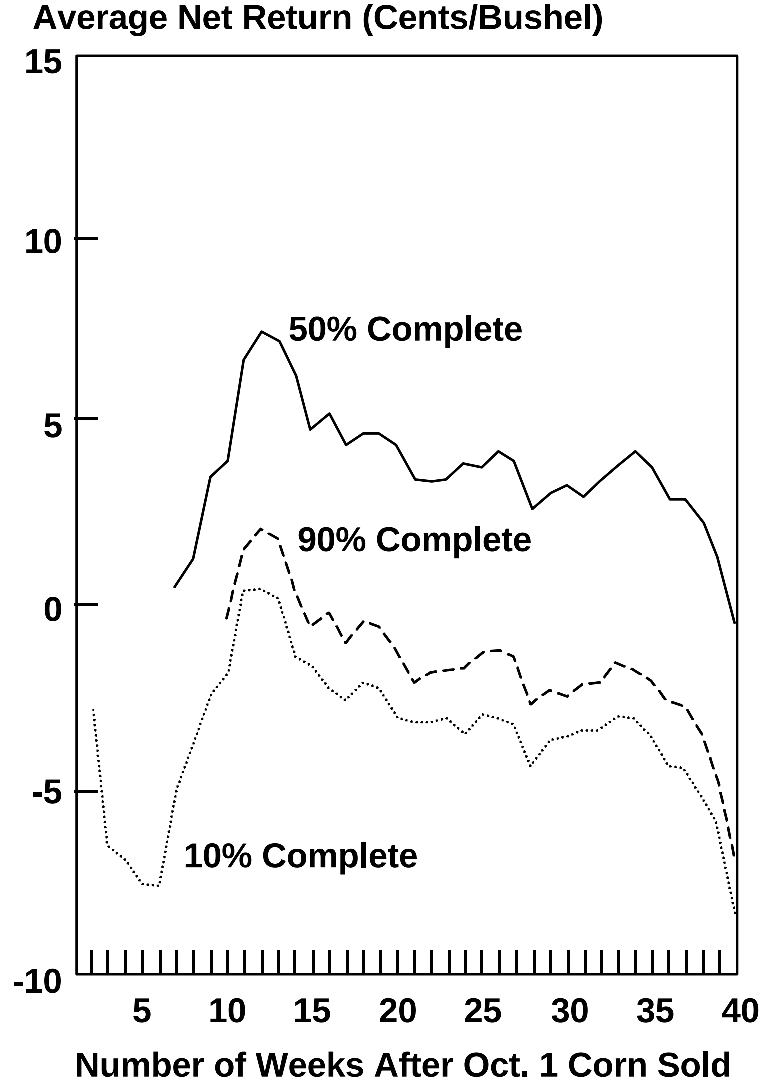

Figure 5. Return Risk of Unhedged Storage by Time of Harvest and Week Sold After Harvest, Ohio Corn, 1964-1996 Crop Years

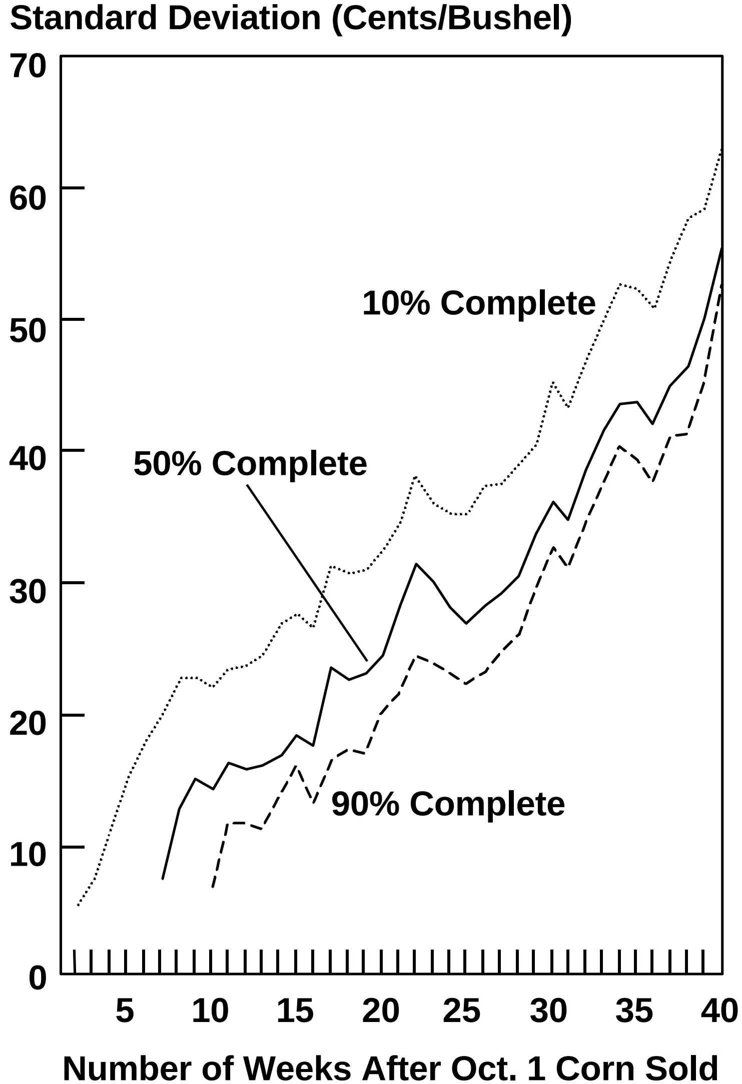

Figure 6. Return Risk of Hedged Storage by Time of Harvest and Week Sold After Harvest, Ohio Corn, 1964-1996 Crop Years

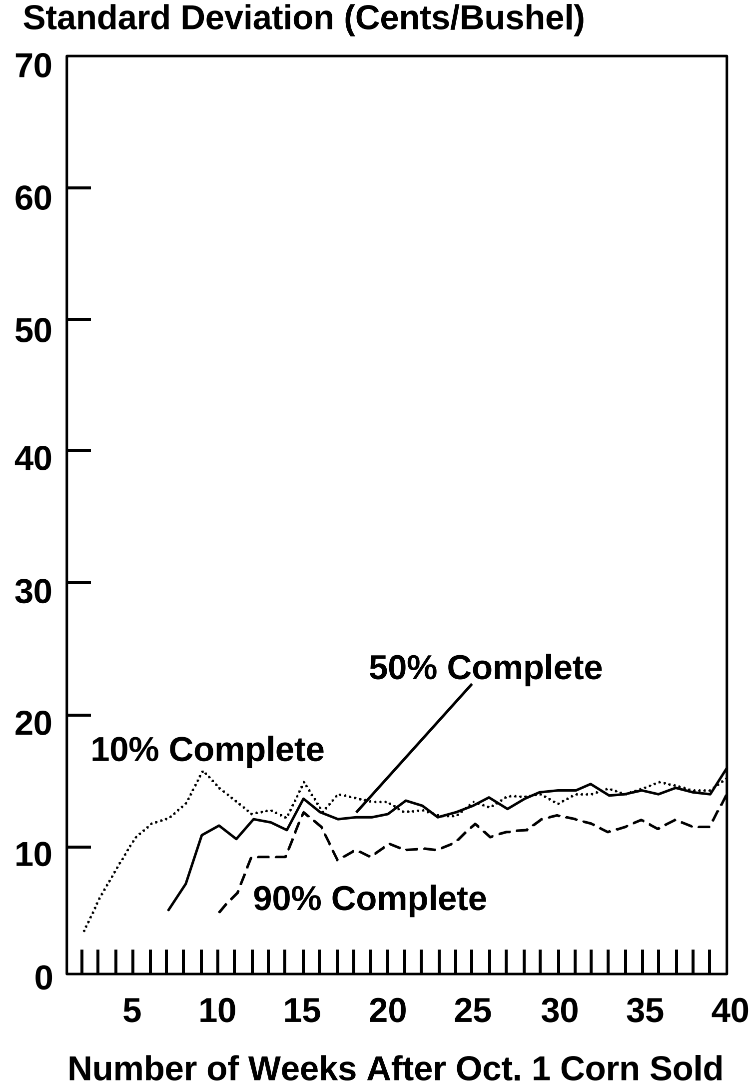

Figure 7. Net Return to Unhedged Storage by Basis Storage Signal and Week Sold After Harvest, 50% Harvest, Ohio Corn, 1967-1996 Crop Years

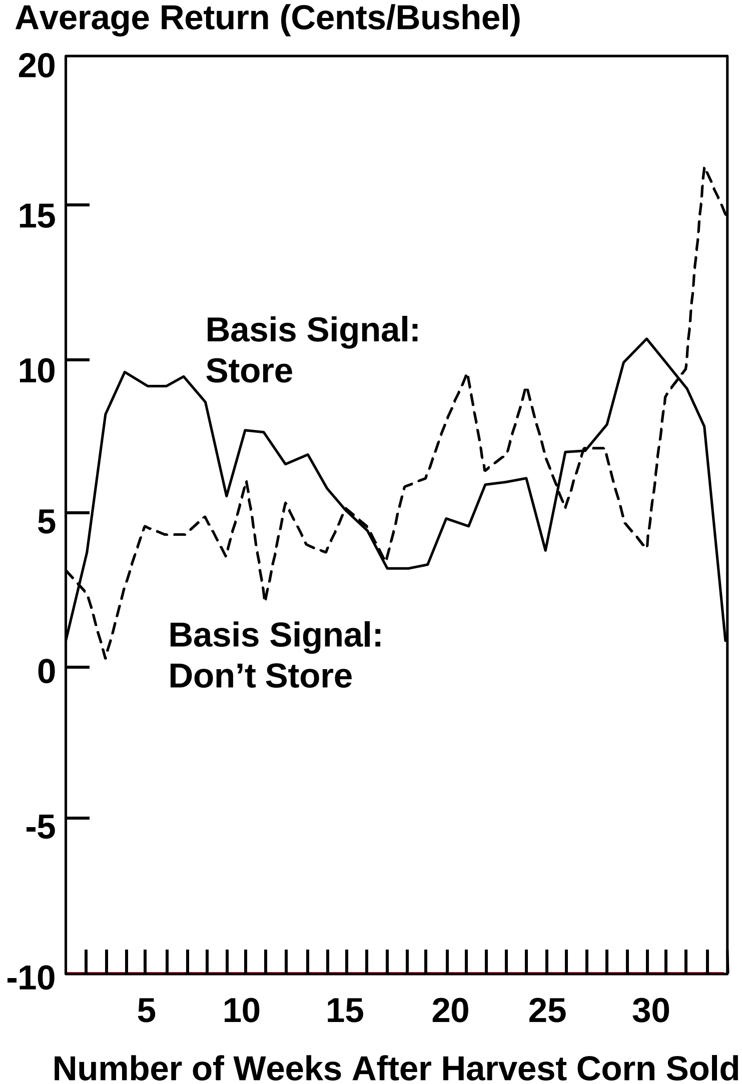

Figure 8. Net Return to Hedged Storage by Basis Storage Signal and Week Sold After Harvest, 50% Harvest, Ohio Corn, 1967-1996 Crop Years