Pre-Harvest Pricing Strategies in Ohio Corn Markets: Their Effect on Returns and Cash Flow

Carl R. Zalauf, Donald W. Larson, Christopher K. Alexander, and Scott H. Irwin

ABSTRACT

This paper contributes to the debate on whether pre-harvest pricing strategies can improve returns over cash sales at harvest. It also examines cash flow needs of such strategies. The analysis is conducted for Ohio cash produced from 1996 through 1999. The pre-harvest strategies evaluated (cluster fences, long put, synthetic long put, price-off fences) did not statistically improve returns over cash sales at harvest. However, if implemented during or before planting, these active strategies reduced the standard deviation of annual gross returns. Substantial cash flow may be incurred, either to establish the strength of crop margin caps. Therefore, assessment of pre-harvest pricing strategies should include cash flow needs, along with return results.

Key Words: cash flow risk, pre-harvest pricing strategies, price risk.

Grain farmers are continually searching for ways to improve returns and manage the risks associated with grain production. Government farm programs traditionally have been important instruments in managing risk. However, the free market orientation of the 1996 farm bill strongly suggests that producers will have to rely more on private markets to manage risk.

Evaluations of pricing strategies have relied on mean-variance analysis to identify an optimal hedging strategy for, for example, Greenhall et al., 1984; Grant, 1987 and 1989, and Lei et al., 1993. While mean-variance analysis of historical data has improved our understanding of pricing returns and risk, it does not recognize the potential impact of another source of risk: cash flow constraints. Limited borrowing capacity, need to borrow to satisfy margin calls when prices move against a position, and/or increased costs of borrowing as credit limits are approached may influence the selection and even prevent the use of pricing strategies.

The objectives of this paper are to determine how the returns from pre-harvest pricing strategies compare to a cash sale at harvest strategy, and to evaluate daily cash flow re-
requirements necessary to maintain pre-harvest pricing strategies for Ohio corn produced during the 1986 through 1999 crop years. One reason for selecting corn is that weather-related problems, in particular drought, can cause major changes in price. Thus, cash flow need is an important consideration when pre-harvest pricing corn. Second, corn is the largest U.S. crop in terms of acreage and gross value and is a farm program crop affected by farm policy. Third, pre-harvest pricing strategies based on a perceived premium built into futures and options prices during the planting and early growing season have gained increasing acceptance among corn farmers and their marketing advisors. The premium is usually attributed to production uncertainty resulting from unpredictable risks, such as the threat of drought (Wisser, Blue, and Baldwin, 1998).

The fact that droughts do not usually happen leads to a strategy of selling part of the crop before harvest. Existence of a pre-harvest premium is a source of considerable debate (see the debate between Wisser et al., 1998, and Zulauf and Irwin, 1998).

The pre-harvest pricing strategies evaluated in this study are short futures, long put, synthetic long put, and put-call fence. The procedures and data used to evaluate the performance of these strategies within the context of the efficient market hypothesis are discussed below, followed by a discussion of the results and their implications.

The Efficient Market Hypothesis

A market is described as efficient if it incorporates all known information in determining price. This definition is usually attributed to Fama (1970, updated 1991), and has come to be known as the efficient market hypothesis. Fama’s model assumes no transaction costs and costless information, both of which are costs for traders in real-world markets. Grossman and Stiglitz (1980) incorporate the cost of information into a model of price determination and show that it is impossible for prices to reflect all available information perfectly. The implication is that those who have superior access to information and/or superior analytical ability in using information can earn trading profits.

Since Fama’s original article, numerous empirical studies have examined the efficient market hypothesis in the context of agricultural futures markets. Zulauf and Irwin (1998) review the literature on the profitability of hedging strategies and conclude that returns to trading strategies generally do not exceed the costs of trading. This conclusion is consistent with Grosman and Stiglitz’s model, and leads Zulauf and Irwin to conclude that individual traders in agricultural markets can beat the market only if they have superior access to information and/or possess superior analytical ability. They suggest that few crop farmers are likely to possess these characteristics (Zulauf and Irwin, p. 327).

Pricing Strategies

The following frequently used grain pricing strategies were evaluated:

1. Cash sale of the crop at harvest (no pre-harvest selling).
2. Pre-harvest selling of harvest futures, i.e. December futures, to establish a price level.
3. Pre-harvest purchase of December put options to set a minimum price while retaining upward price flexibility. The strike price nearest to the underlying futures price is used. It will be referred to as the in-the-money strike price.
4. A pre-harvest synthetic long put established by selling harvest futures and buying harvest call options at one strike price out-of-the-money.
5. A pre-harvest fence established by purchasing at-the-money harvest put options and selling one strike price out-of-the-money harvest call options. Selling calls generates cash for purchasing the puts.

Because of yield risk, the optimal amount of expected production to hedge (i.e., optimal hedge ratio) is less than one. The most commonly investigated pre-harvest crop production hedge when prices and yields are uncertain.
tain uses short futures as the hedging instrument. For corn, estimates of pre-harvest optimal short futures hedge ratios are 0.17 for western New York and Central Illinois over 1972-1982 (Greenhalah et al., 1984), 0.67 for counties principally in Iowa and Nebraska over 1964-1983 (Grant, 1987 and 1989), and 0.51 to 0.70 for Iowa over 1990-1992 (Lai et al., 1995). The average of these studies, all involving non-Ohio locations, is 0.44 or 0.54 depending on whether the low or high value from Lai et al. is used. For the Ohio counties of Clinton and Henry, Martinez-Padro (1996) estimated an optimal short corn futures hedge ratio of 0.43 and 0.36, respectively, over the 1991-1996 period.

Based on these studies, an optimal hedge ratio for short future soybean futures, 0.50 was used in the study. The optimal hedge ratio is likely vary by hedging instrument. However, to improve the ability to compare returns and cash flow characteristics, the 0.50 hedge ratio was used for all four pre-harvest pricing strategies. In contrast to a 1.00 hedge ratio, a 0.50 hedge ratio reduces substantially the probability that more corn will be sold before harvest that is ultimately harvested. For this reason, the analysis does not include strategies that incorporate crop insurance. Furthermore, for the county-level observational units used in this study, the largest shortfall in actual yield relative to expected yield was 23 percent during the 1998 drought. No indemnity would have been collected using the crop yield insurance programs consistently available throughout the analytical period. Peace, including the premium to buy yield insurance would reduce the returns to pre-harvest pricing strategies.

Expected production equaled expected yield times 500 acres, where expected yield was the average of the county's yield for the five previous years. To determine the number of futures and options contracts, expected production was divided by 5000 bushels, multiplied by the 0.50 hedge ratio, then rounded to the nearest whole number. Six contracts were used for the 1987 crop year. Seven contracts were used for the 1987 and 1991-1999 crop years. The pre-harvest pricing strategies were implemented midway by following the same trading rules every year. To evaluate the potential importance of time of initiation of a strategy, the pre-harvest strategies were initiated on four dates: the second Thursday of November during the year before harvest and the second Thursday of February, May, and July during the year of harvest. December of the year before harvest represents a time immediately following the previous harvest, when a few farmers may be developing pricing plans for the next crop year. The second Thursday in February occurs when farmers are making planting decisions. Mid-March and mid-July represent the planning and planting growing seasons, respectively.

Cash sales and pre-harvest strategies were closed out at harvest. Harvest was set at the Thursday of the week during which 50 percent of the Ohio corn crop was reported harvested. This week varied between the third week in October and the second week in November.

Na\textsuperscript{i}ve strategies are important to understand market performance because the efficient market theory predicts a strong null hypothesis that naive strategies should not be profitable. Traders usually employ more complex strategies that involve different combinations of pricing instruments and placement dates, but simpler strategies require analysis as well as time to implement and monitor them. These costs should be included in evaluating returns. In contrast, naive strategies require no analysis and limited monitoring costs.

Calculating Returns and Cash Flow

Because of space constraints, only key parameters used in calculating the gross returns net of futures and options transaction costs and interest costs as well as the cash flow characteristics of each strategy are discussed below. The specific formulas used to make the calculations are available upon request from the authors.

Returns and cash flow were calculated for a hypothetical 500-acre farm that is representative of farms in four major grain-producing counties located in northwestern Ohio crop-
reporting districts (Districts 1, 4, and 7) and one central Ohio crop-reporting district (District 5). The counties are Henry, Pickaway, Champaign, and Clinton. They are generally representative of production in their crop reporting district. Each county also had local cash price data available for the 1986-1989 study period. This study began with the 1986 crop year because premiums of option contracts traded on the Chicago Board of Trade were not available consistently until the 1986 crop year for all pricing strategies and dates analyzed in this study.

Calculation of the daily cash flow requirements included futures and option transaction costs, margin levels, and interest costs. The latter is a measure of opportunity cost foregone when using borrowed funds to finance a pricing strategy. Transaction costs included brokerage fees and liquidity costs. Based on a survey of commodity futures and option brokers, brokerage fees for a 5000-bushel corn contract were established at $50 per round-trip futures trade and $30 per single-option trade. Liquidity costs are payments earned by floor traders (scalers) for filling an order to sell at the market. Brorsen (1989) and Thompson and Waller (1987) estimated them to be one price tick (1/4 and 1/8 cent per bushel for corn futures and options, respectively) for nearby contracts and two price ticks for the more thinly traded contracts that are more than five months away from delivery. Summing the two components, transaction costs were assumed to be $97.50 per futures contract, $78.75 per put contract, $176.25 for a synthetic long put contract, and $157.50 for a fence contract.

The Chicago Board of Trade Clearing Corporation requires margin deposits on long and short positions in futures markets and short positions in option markets to ensure the financial integrity of both the market and individual participants (Board of Trade of the City of Chicago, 1989, and Edwards and Ma, 1992). Although individual brokers may require additional margin money, the initial cash flow for a pricing strategy was calculated using the initial per-contract margin amount established by the Clearing Corporation. When the Clearing Corporation changed the initial margin requirement, the cash flow account for the pricing strategies was adjusted likewise. Because the Clearing Corporation's initial margin maintenance margins were the same for all years over the period of this analysis and a farmer in the situation being investigated would be considered a hedger, daily cash flow updates yield short fall weather events were calculated using the amount marked-to-the-market. For short option positions, the daily cash flow updates were based on whether and how much the option premium at the close of trading for the day exceeded the premium received on the date the option was sold. Farmers are assumed to borrow 100 percent of all costs associated with establishing and maintaining a pre-harvest strategy. Based on telephone interviews with agricultural lenders at major banks and agricultural credit institutions in the four counties, interest costs were calculated using the prime rate plus 0.5 percent.

Borrowing costs are assumed to be linear, so that the interest rate does not change as the amount borrowed increases. This assumption is reasonable during years with normal or above-normal growing conditions because the 50 percent hedge ratio substantially reduces the likelihood that the wealth position of the farmer will be negatively impacted by a short fall in realized production relative to the amount of production hedged. However, when yield-reducing weather events occur, nationally, the assumption of linear borrowing costs may not be appropriate. Even with a 0.50 optimal hedge ratio, price increases may be large enough to result in cash flow yields that substantially exceed borrowing parameters. Bronsen (1995) has shown that when nonlinear borrowing costs are introduced Johnson and Stein's theory of hedging becomes invalid. We acknowledge the important impact of nonlinear borrowing costs during wide-spread weather events that reduce national yield. The response of lending institutions in this situation is hard to predict, in part because it will be conditioned on a multitude of factors including the debt-equity position of the farmer. Thus, we do not include nonlinear borrowing costs in our analysis. However, we ask the
Table 1. Per-Acre Gross Return of Selected Pricing Strategies, 500 Acres of Corn, Henry County, Ohio, 1986-1993, Positioned Established Second Week of December

<table>
<thead>
<tr>
<th>Pricing Strategy</th>
<th>Short Futures</th>
<th>Long Put</th>
<th>Synthetic Long Put</th>
<th>Put/Call</th>
<th>Harvest Cash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Gross Return</td>
<td>$282.18</td>
<td>$281.55</td>
<td>$279.77</td>
<td>$281.25</td>
<td>$270.38</td>
</tr>
<tr>
<td>Standard Deviation (Dollars)</td>
<td>$55.57</td>
<td>$57.90</td>
<td>$57.11</td>
<td>$55.93</td>
<td>$61.85</td>
</tr>
<tr>
<td>Mean/Standard Deviation</td>
<td>4.99</td>
<td>4.86</td>
<td>4.87</td>
<td>5.05</td>
<td>4.82</td>
</tr>
<tr>
<td>Difference from Harvest Cash</td>
<td>(2.93)</td>
<td>2.16</td>
<td>0.39</td>
<td>1.86</td>
<td></td>
</tr>
<tr>
<td>(%)</td>
<td>1.00</td>
<td>0.71</td>
<td>0.14</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>Significance Test (t-statistic)</td>
<td>0.33</td>
<td>0.52</td>
<td>0.08</td>
<td>0.24</td>
<td></td>
</tr>
</tbody>
</table>

1 Non-harvest cash pricing strategies are net of 50% of expected production. The pricing instrument plus the realized production is paid at harvest. Harvested pricing strategies are (1) short futures and put/put harvest; (2) long put and put/put harvest; harvest; (3) long put and put/put harvest; December harvest; (4) long put and put/put harvest; December harvest; December options; and (5) put/put harvest. December harvest call is one strike price higher than the December harvest cash purchase price (i.e., one strike price out of the-money), and December put option is one strike price lower than the December harvest cash purchase price (i.e., one strike price in the-money). Put/put harvest call is one strike price higher than the December harvest cash purchase price (i.e., one strike price out of the-money), and put/put harvest put option is one strike price lower than the December harvest cash purchase price (i.e., one strike price in the-money).

2 Results are based on the risk-free monetary return, and the risk-free rate is 10%.

3 Net harvest cash income from non-harvest pricing strategy minus gross income from harvest cash strategy minus net cost of non-harvest pricing strategy.

Readers are encouraged to keep this issue in mind as they assess the analysis.

Data

The 14-year period of 1986 through 1999 allows the testing of pricing strategies that were market-determined option premiums. This time period also includes a wide range of meteorological, economic, and political conditions that produce uncertainty, such as drought (1988), large price increases driven by upward trends (1985), and changes in government programs (1985, 1992, and 1996 farm bills).

Local cash price data for Henry, Pickaway, Champaign, and Clinton counties were obtained from ongoing research at The Ohio State University. County yields were collected from Ohio Agricultural Statistics Service annual reports for 1986 through 1999. The Weekly Weather and Crop Bulletin, which is jointly published by the U.S. Department of Commerce and Agriculture, was used to establish the harvest data. Daily settlement prices of the December corn futures contracts were obtained from an electronic database maintained by Technical Tools, Inc. Daily estimated premiums were obtained from the Chicago Board of Trade. Margin requirements for hedgers were obtained from the Chicago Board of Trade Clearing Corporation.

Results

Returns

Only the results for Henry County are presented because of space limitations and the similarity of results among the four locations. Over the 1986-1999 crop years, selling all of the annual production on 500 acres of corn in Henry County, Ohio at the local harvest cash price generated an average per-acre gross return of $23.09 (Table 1). Average yield was 132 bushels per acre and average cash price at harvest was $2.15 per bushel. Gross return was highest in 1995 at $436 per acre due to the highest cash price at harvest, $3.03 per bushel, observed over the analysis period. Gross return was lowest in 1987 at $187 per acre, as both yield and price were well below normal.
Table 2. Pre-Acre Gross Return of Selected Pricing Strategies, 500 Acres of Corn, Henry County, Ohio, 1986–1999 Postion Established Second Week of February

<table>
<thead>
<tr>
<th>Measure</th>
<th>Short Futures</th>
<th>Long Put</th>
<th>Synthetic Long Put</th>
<th>Put Call</th>
<th>Harvest Cash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Gross Return ($/acre)</td>
<td>284.37</td>
<td>281.64</td>
<td>280.38</td>
<td>283.02</td>
<td>279.38</td>
</tr>
<tr>
<td>Standard Deviation ($/acre)</td>
<td>60.78</td>
<td>59.89</td>
<td>59.87</td>
<td>60.09</td>
<td>61.85</td>
</tr>
<tr>
<td>Mean/Standard Deviation</td>
<td>4.68</td>
<td>4.70</td>
<td>4.68</td>
<td>4.71</td>
<td>4.52</td>
</tr>
<tr>
<td>Difference from Harvest Cash ($/acre)</td>
<td>4.99</td>
<td>2.25</td>
<td>0.99</td>
<td>3.63</td>
<td>—</td>
</tr>
<tr>
<td>Significance Test (t-ratio)</td>
<td>1.79</td>
<td>0.81</td>
<td>0.35</td>
<td>1.30</td>
<td>—</td>
</tr>
</tbody>
</table>

1 Non-harvest cash pricing strategies are to sell 30% of expected production via the pricing instrument plus sell the realized production for cash at harvest. Non-cash pricing strategies are (1) short futures: sell post-harvest December cash futures, (2) long put: buy post-harvest December put with a strike price nearest to the December futures price, (3) synthetic long put: sell post-harvest December cash futures and buy post-harvest December call at one strike price higher than the at-the-money strike price, and (4) fence: buy at-the-money put and sell one strike price out-of-the-money call.

2 Returns are net of transaction costs and interest costs on margin. They need to establish and maintain the pre-harvest pricing strategy. Transaction costs include brokerage fees for futures and options positions and liquidity costs for initiating and closing out futures and options positions.

3 Null hypothesis: gross returns from pre-harvest pricing strategy minus gross income from harvest cash strategy equals zero.

at 105 bushels per acre and $1.58 per bushel, respectively.

These gross returns do not include any farm program payments (target price deficiency payments, loan rate deficiency payments, market tranisition payments, etc.), nor do they include the impact of announced acreage set aside. Because these farm program considerations would be the same for all pricing strategies analyzed in this study, their inclusion would not alter the relative performance of the different pricing strategies.

All combinations of pre-harvest pricing dates and pricing strategies generated higher average gross income per acre than the harvest cash sale (Tables 1–4). This occurred because the non-cash part of the pricing strategy generated trading returns above transaction and interest costs. The improvement over harvest cash sale ranged from $0.39 per acre for a synthetic long put placed during the middle of December (Table 1) to $7.59 per acre for a short futures position placed during the middle of May (Table 3). The number of years in which the non-cash part of the pricing strategy produced positive returns ranged from 5 of 14 years for the mid-December synthetic long put to 9 of 14 years for the mid-December, mid-February, and mid-May short futures, as well as for the mid-May synthetic long put and fence.

When averaged across all four pre-harvest pricing dates, the improvement over a harvest cash sale was $1.40 per acre for the synthetic long put strategy, $2.74 per acre for the long put strategy, $4.11 per acre for the fence strategy, and $5.16 per acre for the short futures strategy (Tables 1–4). Thus, the short futures strategy improved gross returns the most. When examined by pre-harvest pricing date, mid-May stands out as having the highest return (Table 3), with improvements over cash harvest sales that ranged from $2.90 per acre for the synthetic long put to $7.59 per acre for short futures. One potential explanation for the mid-May findings is that over the 14 crop years included in this study early season drought scares that did not materialize into reduced yields were especially prominent during the planting season.

While the pre-harvest pricing strategies nominally improved returns over a harvest
Table 3. Pre-Acre Gross Return of Selected Pricing Strategies, 500 Acres of Corn, Henry County, Ohio, 1986-1999 Position Established Second Week of May

<table>
<thead>
<tr>
<th>Measure</th>
<th>Short Futures</th>
<th>Long Put</th>
<th>Synthetic</th>
<th>Put/Call</th>
<th>Harvest Cash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Gross Return (Mean)</td>
<td>284.66</td>
<td>282.53</td>
<td>280.79</td>
<td>284.34</td>
<td>278.39</td>
</tr>
<tr>
<td>Standard Deviation (Standard)</td>
<td>63.39</td>
<td>65.69</td>
<td>63.59</td>
<td>63.68</td>
<td>65.65</td>
</tr>
<tr>
<td>Mean/Standard Deviation</td>
<td>4.50</td>
<td>5.39</td>
<td>4.37</td>
<td>4.49</td>
<td>4.52</td>
</tr>
<tr>
<td>Difference from Harvest Cash (Mean)</td>
<td>0.75</td>
<td>2.85</td>
<td>1.32</td>
<td>4.65</td>
<td></td>
</tr>
<tr>
<td>Significance Test (t-values)</td>
<td>1.85</td>
<td>1.02</td>
<td>0.47</td>
<td>1.77</td>
<td></td>
</tr>
</tbody>
</table>

1 Non-hedge and pricing strategies are to sell 80% of expected production via the pricing instrument plus sell the realized production for cash at harvest. Non-hedge strategies are (1) short futures plus harvest delivery (loss); (2) long put; buy post-harvest December put with a strike price equal to the December futures strike (i.e., at-the-money put). Synthetic long put plus harvest December corn futures and buy post-harvest December call at a strike price higher than the December strike price plus the call premium; and (3) put/call. Synthetic long put and sell one strike price out-of-the-money call.

2 Returns are net of financing costs and premiums on money used to establish and maintain the producer pricing strategy. Transactions costs (including brokerage fees for forward and options positions and liquidity costs for financing and closing our futures and options positions).

3 Not hypothetical gross income from pre-harvest pricing strategy minus gross income from harvest cash strategy equals zero.

Table 4. Pre-Acre Gross Return of Selected Pricing Strategies, 500 Acres of Corn, Henry County, Ohio, 1986-1999 Position Established Second Week of July

<table>
<thead>
<tr>
<th>Measure</th>
<th>Short Futures</th>
<th>Long Put</th>
<th>Synthetic</th>
<th>Put/Call</th>
<th>Harvest Cash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Gross Return (Mean)</td>
<td>284.66</td>
<td>282.53</td>
<td>280.79</td>
<td>284.34</td>
<td>278.39</td>
</tr>
<tr>
<td>Standard Deviation (Standard)</td>
<td>63.39</td>
<td>65.69</td>
<td>63.59</td>
<td>63.68</td>
<td>65.65</td>
</tr>
<tr>
<td>Mean/Standard Deviation</td>
<td>4.50</td>
<td>5.39</td>
<td>4.37</td>
<td>4.49</td>
<td>4.52</td>
</tr>
<tr>
<td>Difference from Harvest Sales (Mean)</td>
<td>0.75</td>
<td>2.85</td>
<td>1.32</td>
<td>4.65</td>
<td></td>
</tr>
<tr>
<td>Significance Test (t-values)</td>
<td>1.85</td>
<td>1.02</td>
<td>0.47</td>
<td>1.77</td>
<td></td>
</tr>
</tbody>
</table>

1 Non-hedge and pricing strategies are to sell 80% of expected production via the pricing instrument plus sell the realized production for cash at harvest. Non-hedge strategies are (1) short futures plus harvest delivery (loss); (2) long put; buy post-harvest December put with a strike price equal to the December futures strike (i.e., at-the-money put). Synthetic long put plus harvest December corn futures and buy post-harvest December call at a strike price higher than the December strike price plus the call premium; and (3) put/call. Synthetic long put and sell one strike price out-of-the-money call.

2 Returns are net of financing costs and premiums on money used to establish and maintain the producer pricing strategy. Transactions costs (including brokerage fees for forward and options positions and liquidity costs for financing and closing our futures and options positions).

3 Not hypothetical gross income from pre-harvest pricing strategy minus gross income from harvest cash strategy equals zero.
cash sale, the null hypothesis that the improve-
ment equals zero could not be rejected at the
90 percent confidence level for any combina-
tion of pre-harvest pricing date and strategy.
Thus, from a statistical perspective the pre-
harvest strategies did not generate a per-acre
gross return that differed from selling the crop
for cash at harvest. Furthermore, economic
significance of the improved returns is rela-
tively small. When expressed as a percent of
the $279 per-acre average gross return from
selling corn for cash at harvest, the average
improvement across all four pre-harvest dates
ranged from 0.5 percent for the synthetic long
put strategy to 1.8 percent for the short futures
strategy.

A frequently used measure of risk is stan-
dard deviation. The focus of this analysis is on
the standard deviation of annual per-acre gross
return. It equaled $62 per acre for the harvest
cash strategy over the 15 years analyzed. For
the pre-harvest strategies, this standard devi-
ation ranged from $56 per acre for the mid-
December fence to $66 per acre for the mid-
July long put. The pre-harvest pricing
strategies were superior at reducing the stan-
dard deviation of annual gross return if imple-
mented before or during planting, i.e. mid-
May. The reduction was especially noticeable
for the mid-December pricing date. In con-
trast, for mid-July standard deviation of the
pre-harvest pricing strategies all were higher
than the standard deviation of the harvest cash
strategy. Because of weather’s impact upon
potential yield, futures prices are more vari-
able during the early to middle part of the
growing season, i.e. June and July (Anderson,
1985). Similarly, depending on whether
weather is favorable or unfavorable for yield,
the volatility of corn futures prices and, thus,
the value of corn options can vary substan-
tially from year to year during June and July.
Consequently, returns to pricing strategies in-
volving futures and options are likely to be
more variable when the strategies are imple-
mented during June and July rather than be-
fore or during planting.

A measure that combines return and risk is
the ratio of the average return per acre to the
standard deviation of return. Given the previ-
ous discussion, it is unsurprising that the mid-
December, mid-February, and mid-May pre-
harvest pricing strategies have a higher
mean-to-standard deviation ratio than the har-
est cash sale. For mid-July, the mean-to-stand-
dard deviation ratios are either similar or favor
the harvest cash sale strategy.

As mentioned previously, this analysis uses
naive pre-harvest pricing strategies that have
low transaction, informational, and monitoring
costs. While naive strategies are important
tests of market efficiency, traders usually em-
ploy more complex strategies that involve
combinations of these basic strategies and dif-
f erent placement dates. Of particular note for
this study, Wisner et al. (1998) argued that
different strategies should be employed after
a short crop year than after a normal crop year.
Their findings are statistically significant for
corn over the 1952–1996 crop years for some
pre-harvest strategies involving only futures
and over the 1985–1996 crop years for some
pre-harvest strategies involving options.

We examine their strategies within the
hedging parameters and data period used for
this article. One difference is that Wisner et al.
sold 100 percent of expected production be-
fore harvest, whereas we sold pre-harvest 50
percent of expected production. They used
two strike price out-of-the-money call and put
options; we used at-the-money puts and one
strike price out-of-the-money calls. Last, we
used a different procedure to identify short
crop years. They identified a short crop year
as one with a U.S. average yield that was more
than five percent below the linear trend yield
over the 1990–1994 period. We identified a
short crop year as a year in which U.S. aver-
age yield was five percent lower than the one-
year, out-of-sample forecast from a linear
trend regression of average U.S. corn yields
for the previous 20 years. Our procedure,
which is out-of-sample and thus consistent
with the information available to traders, iden-
crop years. For crop years since 1985, Wisner
et al.’s procedure identified these years plus
1990.

We examine a short futures strategy pro-
posed by Wisner et al. because it was signifi-
ificant.
tient at the 50 percent confidence level and was the strategy most comparable to those used in this study. Winter et al.’s 2, 28, following a short crop year, sell futures in the first week of February; following a normal crop year, sell futures during the first week of July. We implemented their pricing strategy by combining our results from the short futures strategy for the second week of February or July depending on whether the crop year was a short or normal crop year. Average return for the February-July futures strategy was $3.86 per acre higher than the cash sale a harvest strategy. The t-ratio was 0.39, which is not statistically significant at the 90-percent confidence level. The difference in findings underscores how sensitive trading returns can be to a study’s period of analysis, data on which strategies were priced and utilized, and other analytical parameters.

The corn pricing strategy examined by Winter et al. that had the largest t-ratio, 2.8, was following a short crop year, sell futures for 100 percent of the expected crop in the first week of February; following a normal crop year, buy $1.20 out-of-the-money put for 80 percent of expected production in the third week of May and sell the remaining 20 percent of expected production using short futures in the first week of July. We examined this strategy but, to increase comparability with the other strategies examined in the present study, we scaled the proportion hedged to that it totaled 50 not 100 percent, used at-the-money puts, and implemented the positions during the second week of February, May, and July. Average returns above the cash sale at harvest strategy equaled $7.31 per acre with a t-ratio of 1.91, which is significantly different than zero at the 90-percent confidence level.

Moving beyond naive strategies found a strategy that generated significant trading returns. However, it is important to remember that trading returns are sensitive to the analytical parameters used, and it is likely that any analysis of a historical period will find at least one profitable trading strategy. Thus, a trading strategy needs to stand the test of time via substantial out-of-sample testing. It also is desirable for any trading returns that are consistently observed to have an explanation based on an economic principle, such as risk reduction. Without this foundation the returns are more likely to be viewed as spurious.

Cash Flow

Selling at harvest means no cash flow risk relative to pricing before harvest because margin calls, option premiums, brokerage fees, and interest opportunity cost are not incurred. To save space we present the cash flow results only for mid-December and mid-July. The results for mid-February and mid-May generally fall between the results for mid-December and mid-July in large part because the latter two dates are the furthest from and nearest to harvest, respectively.

The focus of this discussion is on the cumulative cash flow from the date the strategy was established, as the day-to-day changes in the cash flow account. Cumulative cash flow reflects brokerage cost, initial margin, and the cumulative change in price or option premium as well as the interest opportunity cost incurred since the strategy was initiated. Cumulative cash flow at the close of trading on a given day can be thought of as the total amount of cash needed to keep the strategy active for the next trading day. It is an amount that funding institutions and traders monitor intensely. To provide a simple illustration, assume one corn futures contract ($500) initially was sold at $20/ton, cash at the close of trading is now $2.20, and brokerage fees were $0/contract, a $500 initial margin was required, and 50 percent of interest cost on borrowed money has been incurred. Cumulative cash flow through the day is ([($2.00 - $2.20) x 500] - 500 - $500 - $50) or $1,610. We specifically examine the maximum cumulative cash outflow that occurred between the opening and close dates of the strategy, and the average of all the daily cumulative cash outflow.

Even though a pre-harvest pricing strategy earns positive trading returns, its average cumulative cash flow between the initial pricing date and harvest can be negative. This can occur because of the initial cash outflow associ-
Table 5. Average and Maximum Cumulative Per-Acre Cash Flow Requirements for Selected Pre-Harvest Pricing Strategies Entered the Second Week of December, by Crop Year, Henry County Ohio Yields, 500 Acres of Corn, 1986-1999 ($/acre)

<table>
<thead>
<tr>
<th>Crop Year</th>
<th>Average Cumulative Cash Flow</th>
<th>Average Cumulative Cash Flow</th>
<th>Average Cumulative Cash Flow</th>
<th>Average Cumulative Cash Flow</th>
<th>Average Cumulative Cash Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short Futures</td>
<td>Long Put</td>
<td>Synthetic Long Put</td>
<td>Put/Call Fence</td>
<td></td>
</tr>
<tr>
<td>1986</td>
<td>17.12 (4.93)</td>
<td>(7.23) (7.49)</td>
<td>12.70 (9.20)</td>
<td>(5.78) (6.89)</td>
<td></td>
</tr>
<tr>
<td>1987</td>
<td>(2.54) (26.87)</td>
<td>(7.96) (8.23)</td>
<td>(9.50) (33.88)</td>
<td>(5.92) (20.42)</td>
<td></td>
</tr>
<tr>
<td>1988</td>
<td>(44.64) (14.39)</td>
<td>(11.79) (12.30)</td>
<td>(55.03) (125.08)</td>
<td>(28.42) (91.32)</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>(4.72) (21.35)</td>
<td>(14.30) (15.11)</td>
<td>(15.96) (32.22)</td>
<td>(8.31) (13.70)</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>(1.37) (19.08)</td>
<td>(11.64) (11.37)</td>
<td>(11.79) (29.35)</td>
<td>(5.62) (13.84)</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>(23.42) (61.88)</td>
<td>(11.70) (12.15)</td>
<td>(31.85) (70.62)</td>
<td>(16.69) (47.54)</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>(31.00) (81.19)</td>
<td>(15.18) (15.77)</td>
<td>(43.85) (93.75)</td>
<td>(21.51) (58.83)</td>
<td></td>
</tr>
<tr>
<td>1997</td>
<td>(11.07) (29.95)</td>
<td>(13.89) (14.43)</td>
<td>(23.50) (42.60)</td>
<td>(10.47) (21.59)</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>18.40 (6.79)</td>
<td>(17.82) (18.70)</td>
<td>4.36 (20.34)</td>
<td>(10.96) (13.90)</td>
<td></td>
</tr>
<tr>
<td>1999</td>
<td>5.98 (7.34)</td>
<td>(14.57) (15.07)</td>
<td>(4.43) (57.61)</td>
<td>(10.78) (14.26)</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>(6.45) (30.57)</td>
<td>(12.41) (12.90)</td>
<td>(16.34) (42.18)</td>
<td>(10.77) (25.98)</td>
<td></td>
</tr>
<tr>
<td>Stan. Dev.</td>
<td>17.35 (31.49)</td>
<td>2.93 (3.10)</td>
<td>18.06 (32.62)</td>
<td>7.00 (24.30)</td>
<td></td>
</tr>
</tbody>
</table>

1 Negative cash balances are reported in parentheses.

Exercised with the initial futures margin or option premium and brokerage costs, the cumulative nature of interest expense, the fact that usually prices do not change much until spring, and the random walk nature of price changes unless a major news event occurs.

Examining the results by pricing strategy reveals that either the long put or the synthetic long put had the highest average cumulative cash outflow, except for the mid-July 1994 pricing date (Tables 3 and 6). The short futures strategy never had the smallest average cumulative cash flow for a pricing date because the synthetic long put strategy required the purchase of a call in combination with a short futures position.

For the synthetic long put, short futures, and fomce, maximum cumulative cash flow needed on June 27, 1988 during the worst growing season drought in the U.S. since the 1930s. It totaled $125 per acre for the synthetic put, $114 per acre for short futures, and $91 per acre for the fomce (Table 5). Among these pre-harvest pricing strategies, the synthetic long put consistently had the highest maximum cumulative cash flow need because cash is paid to purchase call options on the initial day of the strategy. The fomce's maximum cumulative cash flow need is usually, but not always, the lowest among these three strategies because income is received from selling calls.

For the long put strategy, maximum cumulative cash flow need occurs just before harvest, i.e., at the end of the trading period. The reason is that interest expense is highest at that time, reflecting its cumulative nature. Unlike the other three strategies, no margin calls occur with this strategy. Thus, maximum cumulative cash flow for the long put strategy was substantially lower.

Maximum and average cumulative cash
flow need was lower for mid-July than for mid-December (Tables 3 and 6). This result was expected because interest expense is smaller since the strategy is active for a shorter period. In addition, part of the uncertainty surrounding corn yields is resolved by mid-July and time to expiration is less, resulting in a lower put and call premiums. Nevertheless, maximum cumulative cash flow needs approached or exceeded $4 per acre for a mid-July synthetic put, short futures, and fence.

The discussion has focused on cumulative cash flow, not the economic value of the strategy. Specifically, it has not considered that the value of a long call increases as price increases. For example, on June 27, 1998, the premium for the long call used in part of the synthetic put established in mid-December 1997 ($2.16 strike price) was $1.555 per bushel, compared with a purchase premium of $0.16 per bushel. The positive value for a long call does not yield a flow of cash until the long call is sold, but a lengthy limitation only recognizes the long call as an asset that can be borrowed against. Thus, they may change a lower interest rate on loans to cover a larger exposure resulting from margin calls or short futures. In this situation the increasing value of corn due to its increasing price may serve as potential collateral for margin calls. Therefore, it is not clear why a long-call would be a superior hedge against cash flow risk, provided the amount of corn contracts does not exceed expected production.

One measure of cash flow risk is the additional cash flow that may be needed to maintain a position after it is established. One indicator of this risk is the absolute difference between the maximum cumulative cash flow and the average cumulative cash flow. Over the 1986-1995 crop years, this average differ-
ence was much smaller for the long put strategy than for the other pre-harvest pricing strategies. To illustrate, for the mid-December pricing date, per-acre average absolute difference between the maximum cumulative cash flow and the average cumulative cash flow was $26 for the synthetic long put strategy, $24 for the short futures strategy, $14 for the fence strategy, and less than $1 for the long put strategy.

Standard deviation of the maximum cumulative cash flow, a measure of cash flow risk across crop years, was also substantially smaller for the long put. To illustrate, using the pricing date with the smallest range, mid-July, standard deviation of the maximum cumulative cash flow was $15 per acre for the synthetic long put, $14 per acre for short futures, $10 per acre for the fence, and $5 per acre for the long put.

The lower cash flow risk of the long put strategy occurred because it was the only pre-harvest pricing strategy not subject to margin calls. However, to obtain this lower cash flow risk, the full purchase price of the put must be paid up front.

Conclusions

For the 1986-1999 corn crops in the four Ohio counties analyzed in this study, naive pre-harvest short futures, long put, synthetic put, and put/call fence pricing strategies improved average gross income per acre compared with the strategy of selling in the cash market at harvest. For Henry County, the county discussed in this article, the largest average improvement was $7.59 per acre for a short futures position placed during the middle of May. The smallest average improvement was $0.39 per acre for a synthetic long put position placed during the middle of December. You must pre-harvest pricing dates and strategies, return increased by $5.00 per acre or less. As a comparison, average gross return from selling corn for cash at harvest was $279 per acre. Thus, economic magnitude of the increased return was relatively small. Furthermore, the increased returns were not different statistically from zero at the 90-percent confidence level.

Thus, from a statistical perspective, the pre-harvest strategies did not generate a pre-acre gross return that differed from selling for cash at harvest.

The cash outflow incurred by pre-harvest pricing strategies can be substantial, especially when invested in a short crop year. For example, even when using an optimal hedge ratio of 50 percent of expected production, cash outflow during the drought of 1988 approached and exceeded $100 per acre for the short futures, long synthetic put, and put/call fence due to margin calls on futures and short option positions. The long put strategy substantially reduces cash flow risk resulting from pre-harvest pricing, but to obtain the lower cash flow risk the full premium of the long put must be paid up front.

The naive pre-harvest pricing strategies did reduce the standard deviation of annual returns provided the strategies were implemented before or during planting. The use of futures markets by short hedgers to reduce the risk of return is conventionally associated with a market situation referred to as normal backwardation (Keynes, 1930). In normal backwardation, prices tend to rise over the life of a futures contract, leading on average to trading losses for short hedgers as they pay long speculators for assuming their price risk. Even though the returns to the naive pre-harvest pricing strategies investigated in this study are not economically large nor statistically different from zero, the existence of positive returns in the presence of a lower risk of return for short hedges implemented before and during planting is interesting and calls for additional research. It is possible that the increased cash flow risk associated with pre-harvest pricing strategies compared with the sale cash at harvest strategy may explain the observed positive return in the presence of a lower risk of return.

Two strategies proposed by Wise et al. (1998) were investigated to examine their argument that different strategies should be used after a short crop year than after a normal crop year. Wise et al. (1998) found that both strategies produced significantly higher returns than selling for cash at harvest, but only one
of the strategies produced significantly higher returns in this study despite a substantial overlap in analytical metrics. While additional analysis of the strategies proposed by Weisser et al. (1998) is warranted, the findings of this study raise caution. Thus, in general, the results of this study support the traditional implication from the market efficiency literature that pre-harvest pricing is unlikely to increase returns without the ability to time the market successfully. Few farmers are likely to possess this skill.

In summary, the findings of this study suggest that reducing the risk of return is probably a greater incentive for pre-harvest pricing than in revenue enhancement. However, the potential magnitude of the cash outflow needed to maintain a pre-harvest pricing strategy suggests that, along with measures of return and risk of return, measures of cash flow risk should be explicitly incorporated into assessments of pricing strategies being considered by producers and analyzed by academics.

References


751, 1989.


