USING A COTTON OPTIONS STRATEGY TO INCREASE REVENUES

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Abstract

Changes in government programs and increased price volatility are causing cotton farmers to manage more price risks. A "Harvest Strategy" is suggested, which sells cotton at harvest, purchases an at-the-money July options contract and exercises this contract at expiration. The results of the analysis demonstrate that this strategy yields higher returns than the naive strategy of selling at harvest or storing and selling at a later date. The proposed strategy also limits the exposure to the downside price risk.

Introduction

U.S. farm commodity programs were changed with the passage of the 1996 Federal Agriculture Improvement and Reform (FAIR) Act. The FAIR Act appears to be causing dramatic changes in American agriculture. With support payments being reduced and decoupled from production decisions, farmers in the U.S. are attempting to manage production and price risks as these factors affect farm level profits. Efforts to provide revenue assurance to farmers have been attempted through different forms of crop insurance, however cotton growers have not made extensive use of revenue insurance. This analysis suggests using an options technique, described in this study as a "Harvest Strategy," that can limit the exposure to the downside price risk (relative to holding the cash crop in storage) and increase farm revenues.

Nature of the Problem

Abundant research has been conducted on the subject of using futures and options markets to reduce price risk and enhance income. Most of these analyses focus on strategies that are used prior to harvest (Monson and Hayenga; Pfeiffer, Sandall, and Kendrick; Stevenson and Bear; Wisner, Blue, and Baldwin; Zulauf and Irwin), while some studies examine post-harvest strategies (Working and Telser). In this study, a post-harvest strategy involving options markets is examined. Due to a potential asymmetry in returns to options contracts, this strategy allows users to take advantage of anticipated changes in the price of cotton after harvest.

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Previous research does not agree on the issue of whether premiums exist in futures markets. Some studies reported evidence of price premiums in certain commodity futures markets (Carter, Rausser, and Schmitz; Cootner; Monson and Hayenga; Pfeiffer, Sandall, and Kendrick; Stevenson and Bear), while others rejected the presence of price premiums in futures markets (Zulauf and Irwin; Working and Telser). Wisner, Blue, and Baldwin found that premiums exist for some strategies that included options, but not for "futures only" strategies. This study is an attempt to analyze the issue of the existence of price premiums when using marketing strategies, in particular those involving the use of options contracts.

Theoretical Framework

Futures and options premiums are usually analyzed within a framework of the Efficient Market Hypothesis (EMH). EMH was first developed by Fama, who suggested that strongly efficient markets reflect all available information in trading prices. 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 (Zulauf and Irwin). According to EMH,

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

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 that is independently and identically distributed with mean 0 and constant variance σ^2. If EMH holds, $\alpha = 0$ and $\beta = 1$, or

$$E_t (P_{t+1} - P_t) = 0 \quad (2)$$

which means that prices follow a random walk (or the expected average change in prices is zero) (Tomek and Querin).

However, a fundamental principle of modern finance is that higher risk should be compensated with a higher return. Furthermore, if a risk exists that cannot be diversified, an activity associated with that risk should earn a return that exceeds the risk-free rate of return. Thus, if buying or selling futures and/or options of a specific commodity incurs a risk that cannot be diversified, that commodity's futures or options market could be efficient in terms of Fama's definition, yet have a price bias; that is, $E_t (P_{t+1} - P_t) \neq 0$, provided that the bias is a compensation for risk (Zulauf and Irwin). 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 biases was introduced by Keynes. This approach divides 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. Thus, a short futures position will earn positive trading returns.

This study examined futures markets for price biases based on Fama's definition that if the price biases are present, then $E_t (P_{t+1} - P_t) \neq 0$. The time period from 1984 to 1999 was chosen and represents the period for which options contracts were available. The data for the analysis are presented in Table 1. The first column of Table 1 lists P_t, which is a price of July futures contract on November 1 of the previous year, the date of initiation of the "harvest strategy" described below. The second column lists P_{t+1}, which is a price of July futures contract at the expiration date of the option on that contract (early June). The third column lists the price difference $(P_{t+1} - P_t)$ for the period of study.

Table 2 summarizes the results of the test of hypothesis that $E_t (P_{t+1} - P_t) = 0$. The t-test reported in parentheses is a paired two-sample t-test with the hypothesized mean difference equal to zero. The results reported in Table 2 demonstrate that $(P_{t+1} - P_t)$ is significantly greater than zero for the entire period of study at 15% significance level. The period of study was then divided into two sub-periods: 1984-1995, when $(P_{t+1} - P_t)$ is typically positive; and 1995-1999, when $(P_{t+1} - P_t)$ is consistently negative. Table 2 shows that during the first period, $(P_{t+1} - P_t)$ is significantly greater than zero at the 5% level, which indicates the presence of normal backwardation. However, for the 1995-1999 period, there was a negative price difference, which suggests that futures prices followed contango. Given these results, a market strategy may be designed that could help traders to take advantage of price changes in the cotton market after harvest. This strategy is described in the following section.

The Harvest Strategy

The "Harvest Strategy" consists of selling cotton at harvest on the cash market and simultaneously buying an options contract. If markets follow normal backwardation, a long position in futures results in positive net returns. Similarly, if markets follow contango, a short futures position will earn positive trading returns. However, it is difficult to forecast what direction prices are going to follow in the upcoming year. In this study, we use an arbitrary decision rule of adjusting a position in the options markets if the trend in the futures prices reversed in the last two years. In order to track down the trend in prices we observe changes in the price of July futures contract over the life of the contract (or from November 1 to expiration), as demonstrated in the last column of Table 1. According to the data presented in this table July futures prices have consistently reversed trend in 1995 and 1996. Therefore, according to our simple decision rule, in 1997 we should have adjusted our position in the options market from long to short. Thus, for this illustration, the "Harvest Strategy" will simulate buying a call option on July futures for the period 1984-1996, and a put option on July futures for the period 1997-1998.

In order to simulate the Harvest Strategy for the period from 1984 to 1999, data were gathered on spot, futures, and option prices in November and June of the following year to reflect price changes in the beginning and the end of the crop year. The cash or spot prices for the North Delta SLM (41) staple 34 cotton were collected from "Daily Spot Cotton Quotations" published by the USDA, Agricultural Marketing Service, Cotton Division (various issues). The cotton options and futures prices were collected from "Cotton Options, Daily Market Report" published by the New York Cotton Exchange (various issues).

Estimated cash flows resulting from the use of the Harvest Strategy were analyzed using a spreadsheet program. In order to simulate the use of the Harvest Strategy, it was assumed that cotton was sold on the spot market on November 1 (to correspond to the conclusion of harvest). Receipts from this cash market sale were the first cash inflows from using the Harvest Strategy and are recorded in the first column of Table 3. The second step of this strategy was to determine the strike price of the option contract that would be purchased in order to take advantage of any possible future price changes. The procedure of selecting this strike price is described in Table 4. First, the prices of July futures contract on the day of the sale (November 1) of the "cash" cotton was recorded and then a strike price was selected that would provide an "at-the-money" contract, which means that the options contract strike price had to be equal or slightly higher than the futures contract price for the call and equal or slightly lower than the futures contract price for the put.

The next step of the Harvest Strategy was to purchase an "at-the-money" July call/put options contract at the pre-determined strike price. The cost of purchasing an options contract, which is called the options premium, resulted in a negative cash flow that is reflected in column 2 of Table 3. (No contracts with 78 strike price were available for trading on November 1, 1994; therefore the call options premium was inferred on the basis of available contracts.) At this point, the minimum net return from using the Harvest Strategy is equal to the sale price of cotton on the spot market less the options contract premium. The net return or cotton price using the Harvest Strategy could not be any lower than column 3 of Table 3, because when and if market prices fell after the call options contract was purchased, the grower would simply choose not to exercise the option. In the years when cotton prices did increase after November 1, the call

options contract could be sold at any time before expiration if the grower believed that market prices had reached a peak or market prices have reached a target level set by the grower (reverse for the puts). Otherwise, options could be exercised on expiration date. One of the advantages of the harvest strategy is that cotton is sold soon after harvest, thereby increasing financial liquidity and reducing interest payments on borrowed operating capital. The interest gain is listed in column 4 of Table 3 in order to adequately include the opportunity cost of capital. (For the interest gain was assumed to be $2.25 per bale, which corresponds to the CCC loan rate for this period, divided by 500 pounds and multiplied by eight month, which results in 3.60 cents per pound).

The Harvest Strategy was simplified to avoid the subjectivity of choosing a date to sell the option contract by assuming that each July options contract was to be held until its expiration date. If cotton prices increase above the options strike price between November 1 and the July call options contract expiration date, the value of the call options will increase and the options contract can be sold at a premium. Similarly, if prices fall during this period, the put option appreciates in value. Conversely, a decrease/increase in cotton prices with respect to the strike price during this eight-month time span will cause the value of the call/put options contract to fall to zero. The options value on the contract's expiration date is shown in Table 3 and demonstrates that the Harvest Strategy options contract appreciated in value in nine out of fifteen years examined in this study. The net change in the options contract value is listed in column 6 of Table 3 and is equal to the appreciation in the options contract value minus the options premium, which amounted to a total of 86.42 cents or an average of 5.76 cents per pound over the selected study period. Adding the options gain and interest gain to the minimum net return results in a net return with Harvest Strategy that is illustrated in column 7 of Table 3. It shows that the consequences of utilizing this options strategy generated an average net return of 71.86 cents per pound. If a grower used this Harvest Strategy, gross revenues would have been 14.99 percent greater (or 9.37 cents per pound) than the average November 1 spot market cotton price of 62.49 cents per pound.

Alternative Marketing Strategies

The Harvest Strategy was compared to a naive strategy of selling cotton on the cash market right after harvest and an alternative strategy of storing cotton and selling it on the cash market at a later date. To make sure that these marketing alternatives were comparable, the selling at harvest strategy includes the cash price at harvest plus $3.60 of interest gain that would be collected until July. Similarly, the "Store and Sell Later" strategy assumes that the cotton crop will be stored until the expiration date of the July call options contract and then sold on the spot or cash market (Table 5). In the case of the "Store and Sell Later" strategy, the farmer will incur storage and other carrying charges for the eight months between November and July.

Storage and carrying charges were estimated at 80 points (where 100 points represents one cent), or 0.8 cents, per pound per month for the purposes of this study. Carrying charges include $2.25 per bale for interest and $1.75 per bale for storage that leads to a $4.00 per bale per month of total holding costs. This $4.00 per bale cost is then divided by 500 pounds (which is the amount of cotton in an average bale), which yields the 80 points per pound per month carrying charges used in this analysis. The net cotton price resulting from a June spot market sale is estimated by subtracting the carrying charges of 6.4 cents per pound (0.8 cents per month times eight months) from the gross June cash sale price. Estimated net cotton prices and revenues resulting from the "store and sell later" strategy are illustrated in the last column of Table 5 and demonstrate that the average net cotton price was 65.22 cents per pound during the study period.

The results of the comparison of three strategies are presented in Table 6. Summary statistics in Table 6 demonstrate that the Harvest Strategy has the highest mean return of 71.86 cents per pound compared to 65.15 cents per pound using Store and Sell Later strategy and 66.09 cents per pound using the naive strategy of selling at harvest. Also, the results of a two-sample t-test assuming unequal variances demonstrate that at the 10% level of probability, net returns from the Harvest Strategy are significantly greater than net returns from other strategies analyzed here. The average net returns from the Harvest Strategy exceeded returns from the naive strategy of selling at harvest by 5.77 cents per pound and returns from Store and Sell Later strategy returns by 6.71 cents per pound. Thus, the results of this analysis support the hypothesis that harvest strategy can be used to increase revenues.

Another important characteristic of the Harvest Strategy is that it limits the downside price risk. According to the descriptive statistics presented in Table 6, Harvest Strategy has higher variance than Sale at Harvest strategy, but lower variance than Store and Sell strategy. However, the skewness of the distribution moves closer to the right for harvest strategy compared to other strategies. Skewness is -0.08 for Sale at Harvest strategy, 1.23 for Store and Sell Later strategy, and 1.46 for Harvest Strategy. This means that for the Harvest Strategy, there is a greater probability that net returns will be greater than expected net returns, compared to other strategies. Thus, the Harvest Strategy helps reduce downside price risk. In fact, using a Harvest Strategy, the maximum amount of loss after the sale of cotton is equal to the amount of premium on the options contract. Therefore, due to asymmetric returns from options trading, users can

limit downside price risk and profit from anticipated after harvest price movements.

Summary and Conclusions

Government program changes and increased price volatility are causing farmers to manage more price risks. This study suggests using a futures options technique, described as a "Harvest Strategy" that limits the downside price risk and gives a potential to increase farm revenues. This strategy is based on the notion that even if markets are efficient, they may still have price biases, such as normal backwardation and contango. The cotton futures market during the period 1984 to 1999 was tested for the presence of these price biases. Normal backwardation was observed in the 1984-1995 time period, while in 1995-1999 prices followed contango. Based on these findings, the "Harvest Strategy" was suggested that included selling cotton at harvest and buying a July call option in the time of normal backwardation and a put option in the time of contango. Utilization of this strategy was simulated and compared to the naive strategy of selling cotton at harvest and storing cotton and selling it at a later date. The results of this analysis demonstrate that the Harvest Strategy had the highest mean return of 71.86 cents per pound compared to 65.15 cents per pound using Store and Sell Later strategy and 66.09 cents per pound using the naive strategy of selling at harvest. Also, the results of statistical testing demonstrated that at the 10% level of probability, net returns from the Harvest Strategy were significantly greater than net returns from other strategies considered in this analysis. Another important finding is that Harvest Strategy had higher variance than Sale at Harvest strategy, but lower variance than Store and Sell strategy and the skewness of the distribution of the Harvest Strategy is skewed to the right compared to other strategies. Skewness is -0.08 for Sale at Harvest strategy, 1.24 for Store and Sell Later strategy, and 1.46 for Harvest Strategy. This means that for the Harvest Strategy, there is a greater probability that net returns will be greater than expected net returns, compared to other strategies. Thus, the results of this analysis suggest that Harvest Strategy is superior to the alternative strategies in terms of higher revenues and lower downside price risk.

In addition to potential gains in revenues, Harvest Strategy possesses several other advantages: (1) this technique reduces price risks by limiting the downside potential of lower prices (the maximum amount of loss after selling cotton is equal to the amount of option premium), (2) this marketing technique eliminates storage costs of cotton after harvest, (3) it provides the grower with crop revenues soon after harvest which increases financial liquidity and reduces interest payments on borrowed operating capital, (4) options contracts can be "rolled over" to a more distant futures options month contract and provide the grower with the flexibility of exercising, or terminating the options contract, any time on or before the expiration date, (5) options contracts have several strike prices and related premiums that allow growers to select the combination of these factors which correspond to their marketing goals and revenue needs, (6) options are not subject to margin calls when prices move against a trader market position as are futures contacts. This analysis was preformed to illustrate that options allow growers to benefit in the form of increased revenues from anticipated movements in cotton prices after harvest.

Options trading also has several disadvantages that must be considered by growers. First, the costs of option premiums and brokerage fees must be incurred when buying an options contract. Second, cotton options have fixed dates for a call option to expire and a fixed size of options contracts (100 bales). Third, a multitude of fundamental and technical market forces directly and indirectly influence daily futures and options contract prices which often cause volatile and wide swings in the cotton market. Last, a drawback of this analysis is that it is difficult to forecast whether the market is going to follow normal backwardation or contango. Therefore, forces that affect directions in price changes should be examined in the future research.

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Table 1. Changes in Futures Prices of July Contract Over the Life of the Contract, 1984/85 through 1998/99.

Year	P_t	P_{t+1}	$(P_{t+1} - P_t)$
1984/85	71.67	63.12	-8.55
1985/86	59.20	68.18	8.98
1986/87	47.45	74.50	27.05
1987/88	70.50	66.38	-4.12
1988/89	55.82	67.36	11.54
1989/90	77.10	81.02	3.92
1990/91	75.01	86.81	11.80
1991/92	64.50	58.57	-5.93
1992/93	54.10	60.33	6.23
1993/94	60.90	79.80	18.90
1994/95	75.50	113.40	37.90
1995/96	84.62	76.29	-8.33
1996/97	76.05	73.15	-2.90
1997/98	74.68	74.30	-0.38
1998/99	68.25	55.58	-12.67

Table 2. Analysis of Price Biases in Cotton Futures Markets, 1984/85 to 1998/99.

Year	Average Price at P_t	Average Price at P_{t+1}	Mean Price Difference
1984-1998	67.69	73.25	5.563 (1.515)*
1984-1994	64.70	74.50	9.793 (2.295)**
1995-1998	75.90	69.83	-6.070 (-2.203)*

Numbers in parentheses are t-statistics.
*indicates significance at 15% test level using a two-tailed test
**indicates significance at 5% test level using a two-tailed test

Table 3. Cash Cotton Prices and Harvest Strategy Option Premiums, Values and Net Returns, in cents per pound, 1984/85 through 1998/99.

	Col. 1	Col.2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7
Year	Cash Sale at Harvest	Options Premium	Options Minimum Net Ret.	Interest Gain	Option Value at Expir-ation	Change in Option Value	Net Return with Strategy
1984	63.17	2.00	61.17	3.60	0.00	-2.00	64.77
1985	56.72	1.30	55.42	3.60	7.90	6.60	66.92
1986	43.30	4.95	38.35	3.60	24.50	19.55	66.45
1987	63.47	3.55	59.92	3.60	0.00	-3.55	63.52
1988	52.75	3.50	49.25	3.60	11.36	7.86	64.21
1989	70.07	2.40	67.67	3.60	3.02	0.62	74.29
1990	68.29	1.95	66.34	3.60	11.82	9.87	81.76
1991	55.83	2.70	53.13	3.60	0.00	-2.70	56.73
1992	49.93	3.90	46.03	3.60	6.34	2.44	55.97
1993	56.67	2.65	54.02	3.60	17.80	15.15	75.42
1994	68.94	1.62	67.32	3.60	35.41	33.79	106.3
1995	82.33	3.60	78.73	3.60	0.00	-3.60	82.33
1996	70.22	3.69	66.53	3.60	0.00	-3.69	70.13
1997	70.27	2.71	67.56	3.60	0.00	-2.71	71.16
1998	65.46	3.64	61.82	3.60	12.43	8.79	77.85
Avg	62.49	2.94	59.55	3.60	8.71	5.76	71.86

Table 4. July Futures Contract Prices on November 1 and the Corresponding At-The-Money Options Contract Strike Prices, in cents per pound, 1984/85 - 1998/99.

Year	July Futures Contract Price on November 1	Selected Harvest Strategy At-the-Money Strike Price
1984/85	71.67	72.00
1985/86	59.20	60.00
1986/87	47.45	48.00
1987/88	70.50	72.00
1988/89	55.82	56.00
1989/90	77.10	78.00
1990/91	75.01	75.00
1991/92	64.50	65.00
1992/93	54.10	54.00
1993/94	60.90	62.00
1994/95	75.50	78.00
1995/96	84.62	88.00
1996/97	76.05	77.00
1997/98	74.68	74.00
1998/99	68.25	68.00

Table 5. Estimated Cotton Prices and Carrying Charges of a "Store and Sell Later" Marketing Strategy, in cents per pound, 1990/91 through 1997/98

Year	Cash Price on Expiration Date of July Call Options	Cotton Carrying Charges	Net Cotton Price of a Store and Sell Later Strategy
1984/85	60.12	6.40	53.72
1985/86	65.50	6.40	59.10
1986/87	70.00	6.40	63.60
1987/88	63.88	6.40	57.48
1988/89	63.11	6.40	56.71
1989/90	79.52	6.40	73.12
1990/91	85.31	6.40	78.91
1991/92	56.07	6.40	49.67
1992/93	57.08	6.40	50.68
1993/94	79.30	6.40	72.90
1994/95	108.40	6.40	102.00
1995/96	84.29	6.40	77.89
1996/97	72.15	6.40	65.75
1997/98	72.94	6.40	66.54
1998/99	56.58	6.40	50.18
Average	71.62	6.40	65.22

Table 6. Comparison of the "Sale at Harvest", "Store and Sell Later" and "Harvest Strategy" Cotton Marketing Alternatives, in cents per pounds, 1984/85 through 1998/99.

Year	Sale at Harvest[1]	Store and Sell Later	Harvest Strategy
1984/85	66.77	3.72	64.77
1985/86	60.32	59.10	66.92
1986/87	46.90	63.60	66.45
1987/88	67.07	57.48	63.52
1988/89	56.35	56.71	64.21
1989/90	73.67	73.12	74.29
1990/91	71.89	78.91	81.76
1991/92	59.43	49.67	56.73
1992/93	53.53	50.68	55.97
1993/94	60.27	72.90	75.42
1994/95	72.54	102.00	106.33
1995/96	85.93	77.89	82.33
1996/97	73.82	64.75	70.13
1997/98	73.87	66.54	71.16
1998/99	69.06	50.18	77.85
Mean	66.09	65.15	71.86
Standard Deviation	9.96	14.16	12.44
Coef. of Variation (%)	0.16	0.22	0.17
Skewness	-0.08	1.24	1.46
t-test wrt. Sale at Harvest			1.40*
t-test wrt. Store and Sell			1.38*

[1] Includes cash price at harvest plus $3.60 of interest gain.
* significant at a 10% level of one-tail test.