RISK-EFFICIENT MARKETING OF COTTON: A PRELIMINARY SOUTH CAROLINA ANALYSIS

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Abstract

The volatility of cotton prices the past two decades has seen the need for many farmers to adopt marketing strategies designed to reduce risk in an attempt to produce returns necessary for firm survival. This paper looks at the expected returns and variation in returns of 31 common cotton marketing strategies used by South Carolina farmers from the 1988 through the 1994 crop years. The linear programming risk analysis model, target MOTAD (minimization of total absolute deviations), was employed to determine efficient cotton marketing strategies during the study period from the set of alter-natives examined. Risk-efficient portfolios were generated by minimizing absolute negative deviations below a target return level.

Introduction

Volatile prices have been faced by cotton producers for decades, with prices fluctuating within and between marketing years. These price fluctuations play havoc with producers trying to receive sufficient income to cover their costs. It is the purpose of this study to present a set of risk-efficient cotton marketing strategies that can easily be implemented by cotton producers. The time frame considered is the 1988 crop year through the 1994 crop year. This period encompasses the 1985 and 1990 farm bills, plus it includes the trading of commodity options on futures contracts that started in the 1980s. The objectives set forth for this paper are to 1) identify and calculate revenues from a representative set of cotton marketing strategies and 2) examine these strategies for income abilities and risk abatement attributes to generate risk-efficient portfolios. In order to calculate these risk-efficient portfolios, target MOTAD will be implemented. Target MOTAD is a linear programming risk analysis model which measure risk as the sum of deviations below a set target.

Methods

Early investment analysis studies assumed that investors attempted only to maximize profits. However, empirical evidence suggested investors diversi-fied their portfolios to lower risk. Thus we have come to expect a positive relationship between expected risk and expected income, or an investor will accept higher expected risk only if accompanied by higher expected profit.

Markowitz used a mean-variance (E-V) model to rank portfolios where the mean is used as expected revenue and variance as risk. The trade-off between mean revenues and variance of revenues enables the development of a risk-efficient portfolio frontier. Markowitz stated that a risk efficient portfolio has the properties, 1) no other feasible portfolio has the same expected revenue and lower risk, and 2) no other feasible portfolio has the same risk level and higher expected revenues.

Markowitz (1959) developed the mean-variance model and it has been used in many risk analysis studies such as Purcell and Hague (1972), Cornelius and Dickens (1983) and Hauser and Fortenbery (1985). Markowitz's model expresses an individual's utility as a function of mean revenues and variance of revenues, i.e., $U = f(E,V)$. The E-V model assumes than investors either minimize the variance of revenues for a given level of expected revenue or maximize expected revenues to a given risk level.

The E-V model has received criticism because it measures not just negative, but also positive deviations from the average return. This means that a strategy that performs strongly will be penalized and considered risky. Tronstad and McNeil (1989) provide evidence to suggest that asymmetric (unfavorable deviations only) form of risk analysis as preferred to a symmetric (favorable and unfavorable deviations) form. Also Curtis, Pfeiffer, Lutgen and Frank (1987) found that measuring risk as a deviation below a survival target imposes a more appropriate definition of market risk as compared to E-V and mean-absolute deviation (MAD). With price risk defined as deviations from an expected price, these two studies suggest that only negative deviations, i.e., actual prices below expected price, be considered as price risk, and 0 otherwise.

if $CP_H < E(CP_H)$
 $risk = [CP_H - E(CP_H)]^2$
else
 $risk = 0$

where CP_H is the average harvest cash price and $E(CP_H)$ is the expected cash price at harvest.

Target MOTAD

The target MOTAD model has been described by Tauer (1983) and Watts, Held, and Helmers (1984). Risk is defined as the absolute value of negative deviations of actual revenues below a fixed target. The target MOTAD model assumes that an individual's utility is a function of average revenues and the risk of receiving deviations below a set target.

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The target MOTAD model used in this study is specified from Curtis, Pfeiffer, Lutgen and Frank (1987):

maximize: yx

Subject to: $Ax \geq$ or $\leq b$
$(Y - T)x + Id^- \leq 0$
$vd^- = D$
$x, d^- \leq 0$

where:

v = a 1 by s vector in which each element is "1/s" where s is the number of states of the world considered;

A = an m by n matrix of technical coefficients, where m is the number of constraints and n is the number of activities considered;

x = an n by 1 vector of activities;

b = an m by 1 vector of resource constraints;

d- =an s by 1 vector of income deviations below the fixed income target;

D = A scalar representing average deviations below the fixed income target;

y = a 1 by n vector of expected income for each activity;

T = as s by n matrix in which all elements are the fixed income target;

Y = an s by n matrix of actual income for all activities for the s states of the world considered;

I = an s by s identity matrix;

O = a column vector of appropriate length (s or n), composed of zeros.

The risk-efficient frontier is developed by parametrically varying expected revenues and re-running the model to find the portfolio with the minimum negative deviations from the given target. From this risk-efficient frontier, any portfolio selected will depend on the person's income and risk prefer-ences.

Marketing Strategies

This study examined four main marketing strategies. Among them are cash market speculative strategies, selective pricing in the futures market strategies, multiple-selective pricing in the futures market strategies, and options market speculative strategies. The study included two types of crop storage, conventional stored crop and cotton stored in modules. In total, thirty-one common strategies were examined.

The use of the futures and options markets were used in all but the cash market speculative strategies. In the Routine Hedge strategies, a short position is taken in the futures market at a predetermined time each year regardless of the current market conditions. Pre-harvest hedging is limited to sixty percent of expected production to avoid over selling in the futures market when actual production is less than expected production. Broker transaction costs are included in these strategies.

Producers attempt to lock-in a minimum selling price when using a routine near-the-money put option purchase. A put option gives a producer the right but not the obligation to be short in the futures market at some future date at a certain strike price. In this study, the strike price chosen is the nearest to the futures price for a particular contract when the put is obtained. Again a predetermined date is used each year. In this study, at the time of the cash market sale, the producer would enter the futures market only if the strike price of the option is higher than the current futures price. The purchaser of the put option always incurs the cost of the option, called the premium and any commission fees.

The selective 10 and 21 day moving average hedge is a strategy that is used to help enter the futures market at a preferred time. It uses technical analysis which suggests that when the 10 day moving average crosses the 21 day moving average from above going down, a period of price decline is starting. Using this strategy, the producer begins monitoring the futures market at a predetermined time each year, and upon the first signal of price decline, he takes a short position in the futures market. The selective 10 and 21 day moving average near-the-money put option purchase works the same except put options are purchased instead of taking a short position in the futures market. It should be noted that for this study, it is assumed that futures and options contracts are perfectly divisible in per-acre allotments, when in fact they are in 50,000 pound quantities.

The multiple selective 10 and 21 day moving average hedge strategies use technical signals to enter and exit the futures market multiple times. A sell signal is generated when the 10 day moving average crosses the 21 day moving average from above going down. An alternate buy signal is generated when the 10 day moving average crosses the 21 day moving average from below going up. The idea behind these strategies is to protect the producer when prices are falling with a short position and allow the producer to enjoy rising prices by exiting the futures market. Ideally, the producer is unhedged only while prices are rising, and he will take a short position when prices fall.

A final strategy considered is an options market speculative strategy. Here the producer sells his crop in the cash market at harvest and buys a near-the-money call option on a future contract. A call gives the producer the right, but not the obligation to be long in the futures market at a purchased strike price. If prices rise, the producers call option becomes valuable, and he takes advantage of rising prices. If prices fall, however, the producer is out the premium and brokerage charges for the call option.

The thirty one strategies included in this study comprise five major areas. Included are cash market speculative strategies, pre-harvest strategies, post-harvest strategies (storage of ginned cotton), pre and post harvest strategies (storage of unginned cotton in modules), and an options market speculative strategy. For this study, all revenues and expenses are on a per-acre basis. The target selected was the average variable cost faced by members of the Central South Carolina Farm Management Association. Cash price data were obtained from the Clemson University Extension Service's *Marketing Highlights*. Futures data was purchased from CSI, Boca Raton, FL. Options data was recorded from **The Wall Street Journal**.

In this study, producers are restricted to transacting in the market or to begin analyzing the market for a signal to transact at only the following times: the second week in April (representative of pricing prior to planting), the second week in July (representative of pricing during the growing season), the second week in November (pricing at harvest), the second week in February (representative of sale from stored modules), and the second week in April again (representative of sale from storage).

All prices are deflated using the prices paid by farmers index (1994 = 100). The average variable cost target is also deflated. Data was collected on the actual returns generated by each strategy for the years 1988 to 1994. The selected strategies are far from an exhaustive list of possible alternatives, but were chosen for their simplicity and representation of what South Carolina farmers are using. All pre-harvest hedging strategies were limited to no more than 60 percent of expected yields. Storage strategies were adjusted for storage costs and opportunity cost, with opportunity cost being the foregone interest that could have been earned on money received at harvest. This opportunity costs were calculated using the average of the monthly average Treasury Bill rates during the storage period. With module storage strategies, no physical storage costs were assumed, only opportunity costs.

In this study, no consideration is given to government programs. Cotton is considered wildcat cotton throughout. The reason this approach was taken is the belief that cotton farmers will still want to maximize revenue for a given risk or reduce risk for a given target revenue despite government programs. Government programs do help reduce risk, but each producer will still be trying to maximize his particular crop.

Model Farm

The model farm for this study has 450 acres planted in cotton. Yield has averaged 695 pounds per acre during the study period. The average revenue per acre in selling in the cash market with no other strategies used is $438.48 per acre over the period. Average variable costs for the farm over the study period (1994 = 100) break down as follows:

Seed	5.97
Fertilizer	51.24
Pesticides	113.09
Machine Repair	49.42
Fuel & Oil	13.58
Hired Labor	44.00
Sm. Tools/Supplies	10.31
Fees/Scouting	11.73
Ginning	27.06
Crop Insurance	4.91
Int. - Oper. Capital	16.30
Machine Hire	24.63
Total Variable Cost	372.24

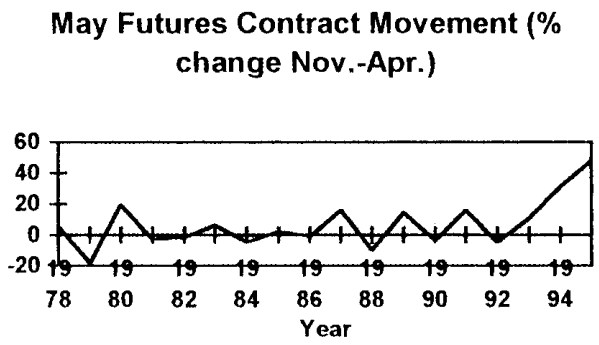
Empirical Results

Target MOTAD was run twice on the thirty-one strategies with a target of $372.24 per acre revenue to cover average variable costs through the study period. The model was run once to maximize revenues without regard to risk. The second run was to minimize risk from our target. The two points obtained will then provide a risk-efficient frontier. The following results were obtained.

Portfolio	Average Income ($/Acre)	Average Risk ($/Acre)	Strategy number as percentage of portfolio 1.2
A	$510.09	$5.702	100%
B	$510.09	$5.702	100%

Strategy 1.2, store ginned cotton unpriced and sell in the cash market in April, was chosen by our model 100% to both maximize revenue and minimize risk. This was a surprising result in that unpriced marketing strategies usually do not perform as well as more sophisticated strategies involving the futures and/or options market. However, the reason for this result becomes more clear as one examines the movement of the May Cotton Futures contract over the study period from November till April. The price of this contract appreciated in 5 of the 7 years of this study. The price of the May futures contract in the five years of appreciation averaged an increase of 24% including a large 48% increase for the 1994 crop. In the two years the price depreciated (1990 and 1992), the average fall was 4.5%. Looking at the May contract since 1978, the price has appreciated between November and April in 10 years and depreciated in 8 years. Between 1978

and 1993, the May contract appreciated, on average, 2.56 percent between November and April. The 31 percent increase in 1994 and the 48 percent increase in 1995 are exceptional price movements looking historically back to 1978. Below is a graph depicting the percent change in the May futures contract price between November and April for the years 1978 through 1994.



Between 1978 and 1993, every year that saw an appreciation in price was followed by a depreciating year. The only exception was 1982 and 1983 that saw two years of small depreciation. Our study period, between the 1989 and 1995 contracts, show much more price appreciation, and thus the good performance of storage strategies.

Does this mean that unpriced storage should be recommended exclusively to cotton producers? In our opinion no. Our study period covering the 1988-89 crop year through the 1994-95 crop year, unpriced storage performed well, but such appreciations in price cannot be expected to always occur. Storage strategies are often recommended strategies depending on market conditions, but if a farmer can lock-in on an approximate price that promises a profitable year, that alternative should be strongly considered. Failure to do so could result in price erosion and a possible loss. With this in mind, another target MOTAD was run without the unpriced storage strategy to see what other strategies have worked well over this period.. Our frontier is described in the following table.

Portfolio	Average Revenues ($/Acre)	Average Risk ($/Acre)	Strategy Number as Percentage of Portfolio 10.17	11.18
1	$500.42	$7.29	100%	
2	$487.82	$7.23	55%	45%

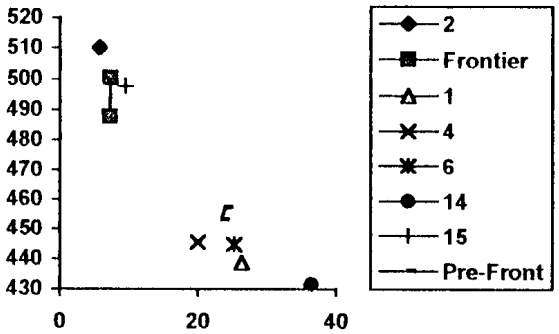
In this model, strategy 10.17, a selective 10 and 21 day moving average near-the-money put option purchase, start monitoring moving average in November and buy a put option on the May contract and offset in April, maximized revenue. A combination of 10.17 and 11.18, a multiple selective 10 and 21 day moving average hedge, with monitoring starting in November and continue selling and offsetting hedges on May contract based on signals generated until April reduced risk. Compared to the unpriced storage frontier, revenues are a little smaller and risk a little higher. These strategies would normally be expected to perform better than unpriced storage because they are designed to allow the producer to take advantage of increasing prices but provide protection in the case of falling prices.

A final consideration is the case when selling the crop at harvest is chosen due to market conditions that make storage look less attractive. This was often the case before 1993 and was more profitable during the 1990 and 1992 crop years of our study. To determine the best performing pre-harvest strategies during our study period, all post harvest strategies were eliminated. The results of this target MOTAD are as follows.

Portfolio	Average Revenues ($/Acre)	Average Risk ($/Acre)	Strategy Number as Percentage of Portfolio 1.1	4.8	5.10
1	$457.31	$23.86		60%	40%
2	$453.14	$23.43	40%	60%	

Pre-harvest strategies that maximized revenue include 60% of strategy 4.8, a selective 10 and 21 day moving average hedge where monitoring signals begin in April, sell the December contract, offset in November. Also 40% of strategy 5.10, a selective 10 and 21 day moving average near-the-money put option purchase using the same dates as the 4.8 hedge above, was included. Using only pre-harvest strategies, average revenues are significantly lower and risk is significantly higher. However, these strategies should not be ignored when market conditions indicate selling no later than at harvest.

The graph below shows our three calculated efficiency frontiers as well as five other common marketing strategies.



Where:

2 - The store ginned cotton unpriced and sell in the cash market in April frontier point.

Frontier - Efficiency frontier where unpriced storage is not considered.

Pre-Front - Efficiency frontier where only pre-harvest non-storage strategies are considered.

1 - Unpriced sell in the cash market in November.

4 - Routine hedge, in April sell December contract and offset in November.

6 - Routine near-the-money put option purchase. In April buy a put option on the December contract and offset in November.

14 - Routine hedge for stored crop. In November sell May contract, offset in April.

15 - Routine near-the-money put option purchase for stored crop. In November buy a put option on the May contract and offset in April.

Conclusions

Target MOTAD was run on thirty-one common cotton marketing strategies used by farmers in South Carolina to discover a risk efficiency frontier based on data from the 1988-89 through the 1994-95 crop years. The risk efficient point calculated saw an average revenue of $510.09 per acre and an average risk of $5.70 per acre. The only strategy selected by target MOTAD was unpriced storage with sale in April. This was a surprising result, but looking at the price movement of cotton from November to April during the study period helped explain this unexpected result. From the 1977-78 crop year to the 1992-93 crop year, prices movements between November and April each year formed a sawtooth pattern with price appreciation one year followed by price depreciation in the following year. However, during the period of study for this paper, prices appreciated in five of seven years including historically high 31% and 48% appreciation in the 1993-94 and the 1994-95 crop years respectively. This has left us to speculate if the past sawtooth pattern will return or a new pattern has emerged that will see more producers storing crop for sale later in the crop year.

Target MOTAD was run again without the unpriced storage to see what other strategies provide good revenue return and low risk. A selective 10 and 21 day moving average near-the-money put option purchase for stored crop maximized revenue and a combination of this strategy and a multiple selective 10 and 21 day moving average hedge for stored crop minimized risk. The results from this risk efficient frontier lagged only a small amount in revenue and risk compared to the unpriced storage strategy.

Also a target MOTAD was run to see which pre-harvest strategies performed the best. A combination of a selective 10 and 21 day moving average hedge and a selective 10 and 21 day moving average near-the-money put option purchase performed the best. However, over this study period, these results lagged substantially behind the storage strategies. They are still important strategies, however, as more farmers decide to store their crop, the strong price appreciation the past three years could deteriorate.

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