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Optimal Marketing Decisions for Cattle under Price Risk

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Optimal marketing decisions for cattle in Georgia are of critical importance to the profitability and continued economic survival of producers because of the low profit margins common to cattle production in the Southeast. Many Georgia producers sell calves in November rather than retaining ownership, feeding until May, and selling as stocker cattle. This allows producers to avoid price risk, but may cause them to miss profit opportunities. We examine five different marketing strategies and assess their expected profitability and riskiness. These expectations are employed to compute the expected utility of profit and allow a producer to choose an optimal marketing strategy for a specific level of risk aversion. Empirical results for a representative Georgia cattle operation of 130 calves show that optimal decisions in the last three years have been either selling in November or feeding until May while using a futures hedge. For example, in 1996 the technique recommends feeding until May while selling two futures contracts as a hedge to reduce risk; following this advice would have earned a producer an extra $1594 (or $12 per head). Given that Georgia producers commonly earn about $30 per head if they sell in November, these extra profits are economically significant.

Introduction

One of the most significant sectors of Georgia's agricultural economy is beef cattle. In 1994, farm cash receipts for cattle totaled $269 million, ranking fifth in agricultural income behind broilers, peanuts, cotton, and eggs. There are three phases in the cattle industry: cow-calf, stocking and feedlot operations. Cattle producers face decisions at several points in time when they must either sell the cattle or continue to feed them until they reach the next size class. Of the calves in Georgia, only 25 percent are retained for stockering. So there is a great potential for enterprises to increase their farm income by carrying a larger portion of the state's calf crop to heavier weights by stockering.

There are two kinds of risk for a Georgia stocker cattle producer. One source is the market, which produces price variability, and the other one is production variability resulting from environmental conditions and production practices. The cattle industry is characterized by highly variable returns. According to McKissick and Ikerd (1996), during 1950 to 1996 the net returns of winter stockering in Georgia ranged from -$9.28/cwt to $27.89/cwt, the net returns of the cow-calf plus winter stockering and yearling feeding ranged from -$47.14/cwt to $33.19/cwt. They also show that stocker operations seem to show an essentially random pattern of profit and loss

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between sharp market breaks regardless of whether cow-calf operations are in the profit or loss phase of the cycle.

Abstracting from production risk in this paper, we examine a set of five marketing strategies in a search for optimal marketing decisions that balance the producer's desire for higher profits with an aversion for decisions that produce too much risk. The first strategy is to sell the calves in November (assumedly to someone who will stocker the cattle at another location). Because the marketing decision is made in November with observable cash prices, this decision is risk-free and can serve as a basis for comparison for the four other strategies. The second strategy is to stocker the cattle from November to May and then sell for the current cash price. The third through fifth strategies all include stockering the calves until May and selling for cash, but add a selection of hedging strategies. In the third strategy the producer employs a futures hedge (selling two futures contracts); in the fourth strategy the producer buys two puts; in the fifth, the producer buys two puts and sells two calls, using a straddle to reduce risk.

These strategies are evaluated here for a representative Georgia cow-calf operation for the years 1994 through 1996 and shown to be reasonably effective at assisting producers in choosing optimal marketing strategies that can raise their profits without unduly burdening them with returns risk.

The Representative Producer

For the purposes of evaluating the five marketing strategies considered here, a representative Georgia cattle operation is created. The farm is assumed to have 100 acres available for pasture and other cattle-related operations. The producer starts with 131 calves at the beginning of the annual operation, only has one death, therefore having 130 calves to market in November. Weight in November is taken to be 450 pounds per head, or 58,500 pounds total. The feeding period if ownership is retained past November is taken to be 180 days, with the stockered cattle then being sold on May 1. Total selling weight is assumed to be 97,110 pounds on May 1, implying average weight of 747 pounds per head. Marketing shrink is assumed to be 3 percent. Because the size of this operation would entail about 2.4 contracts to fully hedge, two contracts are assumed to be used in all positions in the futures and options markets. This keeps the example more realistic than if we allowed for partial contracts which are not possible for real world producers.

For assessing the five marketing strategies under conditions experienced in 1994, 1995, and 1996, variable costs of production are defined to include the cost of raising the calves until November, the foregone revenue that could have been realized by selling in the cash market on November 1, and, for the strategies where the cattle are retained until May, the cost of feeding/grazing the calves until May 1. This definition of variable costs results in profit always being equal to zero for the strategy of selling in November.

Evaluation of the Five Strategies: The Methodology

To evaluate the five marketing strategies, the representative Georgia cattle producer is assumed to choose a strategy that maximizes his expected utility of profit, where utility of profit is defined as

$$(1) \qquad U(\pi) = \pi - (\phi/2)\text{var}(\pi).$$

In the above utility function ϕ is a constant absolute risk aversion coefficient. Smaller values of ϕ imply less aversion to risk, with values generally being between 0.001 and 0.000001, and with $\phi = 0$ equating to the risk-neutral case. For this analysis of cattle marketing options, we set $\phi = 0.0001$ which implies a fair amount of risk aversion fitting for Georgia cattle producers who operate on such thin profit margins. The expected utility of profit is simply the expected value of the expression in equation (1),

$$(2) \qquad E[U(\pi)] = E(\pi) - (\phi/2)\text{var}(\pi).$$

Because the profit of the first strategy, selling the calves for cash in November, is defined to be zero in all years, the expected utility of profit for that strategy is also zero ($E(\pi) = 0$ and $\text{var}(\pi) = 0$). To compute the expected utility of the other four strategies is somewhat more complicated because the profits are random. To compute the variances and expected profits for these strategies, we must make assumptions about the distribution of returns associated with each of them.

For the second strategy (feeding until May and selling in the cash market), the random variable whose distribution must be accounted for is the cash price on May 1. For the third strategy (feeding until May, selling in the cash market, and selling two futures contracts as a hedge against falling prices), the random variable is the basis. In each case a simple linear regression model was built to predict cash price or basis on May 1. The May 1 cash price model has a constant and cash prices from November (current) and the most recent May as regressors; the basis model consisted of a constant, November cash price, and the basis in the previous May. Data from 1973 to 1996 were used to estimate the models, with only data that was observable at the time of a decision used in estimation when computing the expected values that are used in evaluating the strategies (that is, the model is re-estimated with one additional year of data before evaluating the strategies for the next year). To compute the expected utility of profit from these strategies, Monte Carlo integration was used (Geweke, 1989, 1995). This consisted of generating 10,000 random values of May cash price or May basis from the distribution implied by the fitted regression models (and assumed to be multivariate normal). These random values are then used to compute 10,000 random values of profit for each strategy accounting for the variable cost of production and the cost of selling futures contracts for the third strategy. The 10,000 values of profit under each of these two strategies are then used to calculate the expected value of profit and the variance of profit. Because these empirical values of profits are randomly generated from

their distributions, the expected value and variance of profit can be calculated using the standard formulas for random samples (e.g., the expected value is the simple arithmetic average of the 10,000 random values).

The computation of expected utility for the fourth and fifth strategies is different due to the much shorter time period of available data on cattle options. Nine years of data are available on the returns from puts and calls (including all premia and transaction costs); these historical returns are treated as an empirical distribution of these random variables with equal weight placed on each sample point. These nine points are used to compute the expected value and variance of these two strategies.

Evaluation of the Strategies: Three Years of Experience

Using the methodology described above, the five strategies were evaluated for the years 1994, 1995, and 1996 using only information available on November 1 of the respective year. The expected utilities of each strategy for each year are shown in table 1. A producer should choose the strategy that has the maximum expected utility in a given year. The empirical results suggest that a Georgia cattle producer should choose strategy three in 1994 and 1996 and strategy one in 1995. Recall that strategy three is to feed through May 1 while selling two futures contracts and strategy one is to sell in November.

Table 1. Expected Utilities of the Five Strategies

	1994	1995	1996
d1	0	0	0
d2	-5269	-6842	-2347
d3	1312	-2064	10390
d4	-8504	-9821	-4603
d5	-9271	-10203	-4608

Note: d1 is the first strategy, d2 is the second, and so on. Strategies are as described in the text.

To evaluate the effectiveness of this method, ex post, the actual profits that would have been earned by the representative producer under each of the strategies for these three years are shown in table 2 along with the expected profits that would have been computed ex ante. This table shows that the suggested strategies performed reasonably well. In 1994, the futures hedging strategy turned out to be second best (to selling in November). Because the strategy of selling in November has no risk and higher ex post profit, it must be superior to the futures hedging strategy. In 1995, the recommended strategy of selling in November turned out to be optimal ex post. In 1996, the results are disappointing. The two strategies utilizing options have higher ex post profits and lower variances of profit (not shown) than the recommended strategy of futures hedging. Thus, the producer would have accepted more risk in choosing strategy three and not received the hoped for payoff in higher profit. However, even though the recommended 1996 strategy of futures hedging was not optimal ex post, if followed it still would have produced an additional $1594 of profit over choosing the common strategy of selling the cattle in November.

Conclusions

We have demonstrated a method for evaluating a variety of cattle marketing strategies that are especially relevant to producers in Georgia and the Southeastern United States. In a three year demonstration, the method recommended the best strategy considered in 1995, the second best in 1994, and the third best in 1996. While the method is obviously not perfect, it shows promise in helping producers boost their thin profit margins. Future plans are to add production risk related to the uncertainty of weight gain and to investigate incorporating such measures as the probability of suffering a loss into the utility function.

Table 2. Expected and Actual Ex Post Profit

	1994		1995		1996	
	expected	actual	expected	actual	expected	actual
d1	0	0	0	0	0	0
d2	-3384	-6890	-4653	-9971	4488	-8535
d3	2267	-3278	-312	-5155	17764	1594
d4	-7046	-5162	-7393	-5650	2240	1845
d5	-7733	-3368	-8012	-1076	2225	5904

Note: All figures are in dollars.

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