MULTIPLE HEDGING SLAUGHTER CATTLE USING MOVING AVERAGES

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Multiple Hedging Slaughter Cattle Using Moving Averages

John R. Franzmann and Mike E. Shields*

Most feedlot operators have learned to deal with the production risks associated with their business. However, many have found difficulty in dealing with the price or marketing risks that are commonplace in the cattle industry. During the early Spring of 1979, for example, Oklahoma stockmen saw record prices for both feeder cattle and slaughter cattle. Futures prices for feeder cattle reached $95 per hundredweight and live cattle futures prices neared $80 per hundredweight. Yet by late Summer feeder cattle and live cattle prices had declined by 20 percent and losses of $100 per head or more were realized on many slaughter steers and heifers. Such volatility emphasizes the need for sound marketing practices that reduce the burden of large price risks, yet maximize monetary returns.

Some operators, realizing this inherent risk, have turned to the futures market for protection against large price risks. By placing sell hedges and lifting them at the appropriate times, the operator can use the futures market to transfer a portion of market risk to other individuals willing to accept such risks.

The conventional approach to hedging is to price cattle when the basis permits some predetermined level of profits to be "locked in". Such a hedge generally is maintained until the physical product is disposed of on the cash market or delivery is made against the futures contract. Significant reductions in risk are possible through the use of the basis hedge. However, should the market rise substantially following the placement of a sell hedge, only a portion of the potential may be realized.

Recent research[1] has indicated that for markets as volatile as the cattle markets, price risk can be reduced and average returns increased through the use of the multiple hedging technique. Multiple hedging, as the name implies, means to hedge the same commodity more than once. For the cattleman this means placing sell hedges when there is a high probability the market will move significantly higher. Timing the placement and removal of the hedges is crucial to the success of the multiple hedging strategy. The use of optimized[2] moving averages has been demonstrated to be profitable for multiple hedging feeder cattle and have the additional advantages of permitting the hedging decisions to be made on an objective basis.

Research reported herein was conducted under Oklahoma Station Project No. 1667.

* Professor, Department of Agricultural Economics, OSU and Agricultural Economist, Frenchmen Valley Farmers Cooperative, Imperial, Nebraska, respectively.

[1]Franzmann, J. R. and Lehenbauer, J. D., Hedging Feeder Cattle with the Aid of Moving Averages, Oklahoma Agricultural Experiment Station Bulletin 746, July 1979, and

Franzmann, J. R. and Shields, M. E., Long Hedging Feeder Cattle with the Aid of Moving Averages, Oklahoma Agricultural Experiment Station Bulletin B754, December, 1980.

[2]Optimized, as used here means a set of averages that generates signals which result in the greatest profit over the selected time horizon.

The Moving Average Technique

Little work has been performed to determine an appropriate set of moving averages to employ in hedging programs for live cattle. Some earlier work employed a 4-day weighted, a 5-day and a 15-day set of averages but no evidence was developed to determine whether this set of averages was optimal. One chart advisory service employs a 4-day, 9-day, and 18-day set of averages but, again, there is no evidence that this set is optimal when used with live cattle futures contracts. One major brokerage firm reported that a 7-day and 13-day set was the best over the period 1970-1979 where two averages were used and a 4-day, 7-day and 13-day set was best when three averages were used. The effectiveness of these latter sets of averages was not demonstrated in hedging programs.

In this study, optimal control theory is used to find the most profitable set of averages. Optimal control theory is a mathematical technique for analyzing systems under different sets of controls. Box[3] has developed a procedure capable of solving for the optimal set of controls in a multi-variable model.

As applied in this study, the objective function is total profit realized by following buy and sell signals generated by a moving average combination. The goal of the Box Complex Procedure is to maximize this objective function. The control variables are the moving average lengths and the amount by which one moving average penetrates another moving average.

Data used to determine the optimal combination of moving averages included the February, April, August, and December live cattle futures contracts over the period 1975-79. In order to make the simulation more realistic, the following trading rules were employed:

1) no trades were transacted on days when the high and low prices were equal
2) no trades were made on days when the closing price was up or down the daily limit
3) because of the threat of delivery, no *new* buy signals were honored after the first of the delivery month.

Analysis of the Optimization Results

Table 1 presents the results of eight sets of moving average combinations. The 3-day and 4-day combinations appear in the majority of the most profitable sets of averages devised by the direct-search technique. Except for the 2W-7-13 day moving average[4] combination with a minimum penetration requirement of 13 cents, all of the combinations are relatively short as measured in terms of length of the longest moving average. The 3-4-7W combination for live cattle is the most profitable moving average combination during the period 1975-79 with a total of $57,325 in net profit.

A systematic search procedure was employed to check the minimum penetration requirement of the four most profitable moving average combinations in an effort to increase total profits. Profits could not be increased beyond those generated by the moving average combinations derived from the Box Complex Procedure.

[3]Richardson, J. W., Ray, D. E. and Trapp, J. N., Illustrative Applications of Optimal Control Theory Techniques to Problems in Agricultural Economics, Oklahoma Agriculture Experiment Station, Bulletin B-739, January, 1979, Stillwater, Okla.

[4]The notion 2W-7-13 refers to a two day linearly weighted average combined with a seven day simple average and a thirteen day simple average. Other sets of averages are interpreted in a similar manner.

Table 1. Net Profit In Dollars Generated From Moving Average Combinations Derived By The Box Complex Procedure Using Live Cattle Futures Market Prices, 1975-1979

Lengths of Moving Averages[a]	Minimum Penetration Required[b]	Total Net Profit	Total Number of Trades	Average Profit per Trade
3-4-7w	.00	57,325	545	105.18
1-3-5w	.09	50,734	216	240.45
3-4-6w	.00	50,220	587	85.56
3-4-6	.09	48,332	354	136.33
3-5w-7	.02	45,131	514	87.80
3-5w-7	.00	44,383	566	78.42
2w-7-13	.13	43,939	175	251.03
3-4-8w	.01	43,451	524	82.92

[a]Length is in days. w denotes a linearly weighted moving average.
[b]Minimum penetration required is in $/cwt.

Live cattle were in a trendless market from 1974 until late 1977 when a bull market began and continued until a sharp drop occurred in May of 1979. Since then the futures markets have been quite volatile in both directions. Table 2 points out that a greater amount of profit was generated from the long side of the market since 1975, yet the most profitable moving average combination (3-4-7W) produced the most profit on both the long and the short sides of the market.

Earlier research results have indicated that moving averages, when optimized over a several years period, produced profits, but did not yield a high percentage of profitable trades. For feeder cattle the most profitable set of averages produced 50.5 percent profitable trades; over the period 1975-79, for live cattle the results of one study[5] covering the period 1970-79 indicate only 41.3 percent profitable trades. For the work reported here the 1-3-5W set of averages achieved 49.8 percent profitable trades (Table 3).

Since cattle feeders are most concerned with a decrease in value of their end product, fat cattle, the futures profits generated from the short side of the market are important. Examining the profits from the short side only for all combinations indicates no clear choice as to the "best" moving average combinations.

The 3-4-7W combination produced the greatest total profits as well as the greatest profits from short trades. However, although the 1-3-5W (and a requirement that the 3-day penetrate the 5-day linearily weighted average by $0.09 or more) moving average combination yield eleven percent less profit than the 3-4-7W, it provides the highest percentage of profitable trades and also provides less annual variation in profits (Table 4) over the five year history. In addition, this combination required the fewest number of trades. Although none of the more profitable sets of averages performed well on the short side during 1979, the 1-3-5W ($0.09) averages produced the smallest losses.

[5]Computerized Trading Techniques, 1980, Commodity Research Report, Merrill Lynch, Pierce, Fenner and Smith, Inc., February 1980.

Table 2. Net Profit in Dollars From Selected Moving Averages Using Live Cattle Futures Market Prices, 1975-1979

Length of Moving Average[a]	Net Profit			Percent Profitable			Total Number of Trades
	Long Trades	Short Trades	Total	Long Trades	Short Trades	Trades	
3-4-7w	43,145	14,180	57,325	45.7	39.5	42.6	545
1-3-5w (.09)	40,319	10,415	50,734	51.9	47.7	49.8	216
3-4-6w	40,437	9,783	50,220	47.0	39.7	43.3	587
3-4-6 (.09)	38,350	9,982	48,332	50.3	41.9	46.0	354
4w-5-15	35,710	1,347	37,057	47.7	37.2	42.3	307

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

Table 3. Net Profit In Dollars From Selected Moving Averages Using Live Cattle Futures Market Prices, 1975-1979

Length of Moving Average[a]	Net Profit			Percent Profitable			Total Number of Trades
	Long Trades	Short Trades	Total	Long Trades	Short Trades	Trades	
3-4-7w	43,145	14,180	57,325	45.7	39.5	42.6	545
1-3-5w (.09)	40,319	10,415	50,734	51.9	47.7	49.8	216
3-4-6w	40,437	9,783	50,220	47.0	39.7	43.3	587
3-4-6 (.09)	38,350	9,982	48,332	50.3	41.9	46.0	354
4w-5-15	35,710	1,347	37,057	47.7	37.2	42.3	307

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

Table 4. Yearly Distribution of Profits in Dollars From Selected Moving Averages Using Live Cattle Futures Market Prices, 1975-1979

Combination[a]		1975	1976	1977	1978	1979	Total
	Long	11,444	5,120	-6,332	12,544	12,934	35,710
4w-5-15	Short	11,056	5,296	-532	-3,002	-11,470	1,347
	Total	22,500	10,416	-6,864	9,542	1,464	37,057
	Long	14,269	4,216	-8,467	13,109	15,221	38,350
3-4-6 (.09)	Short	17,171	3,300	-1,861	-1,870	-6,758	9,982
	Total	31,440	7,516	-10,326	11,239	8,463	48,332
	Long	6,558	1,688	-3,580	17,634	18,019	40,319
1-3-5w (.09)	Short	7,882	162	3,420	3,552	-4,601	10,415
	Total	14,440	1,850	-160	21,186	13,418	50,734
	Long	13,252	3,100	-5,614	16,656	15,750	43,145
3-4-7w	Short	16,600	1,960	1,156	884	-6,420	14,180
	Total	29,852	5,060	-4,458	17,540	9,330	57,325

[a]Length is in days. w denotes a linearly weighted moving average. The number in parentheses is the minimum penetration required.

Hedging Strategies

The hedging strategies examined herein are based on simulated feedlot operations as follows:

Feeder steers are placed on feed beginning the first of January 1975 and appropriate dates thereafter so as to ensure that one lot of cattle is marketed each month through December 1979, resulting in 56 lots of cattle being fed and marketed during the

Table 5. Futures Market Profits from Short Hedging of Live Cattle, 1975-79[a]

Month Marketed	1975	1976	1977	1978	1979
January		2278	1910	– 1048	– 534
February		1918	770	– 1800	268
March		2108	– 480	0	– 2832
April		990	160	– 982	– 1854
May	– 478[B]	1776	– 1942	– 902	– 240
June	– 398	2930	– 282	– 902	– 1762
July	920	– 458	– 172	1922	– 1940
August	– 212	290	– 122	1432	1082
September	– 648	1382	1480	560	784
October	– 418	3102	592	628	342
November	– 684	2390	– 1048	98	1682
December	– 490	1530	– 1170	– 404	162
Total	– 2408	20236	– 304	– 1398	– 4842

[a]Hedging transactions are based on buy and sell signals from the 1-3-5W ($0.09) moving average combination.

[b]Net profits from hedging transactions are in dollars per futures contract including a $50 per round trade commission fee but excluding interest charges on the margin funds.

entire simulation period. The average weight of the feeder cattle at the time they are placed on feed is assumed to be 650 pounds. The animals are fed for 140 days at an assumed daily rate of gain of 2.85 pounds resulting in a slaughter weight of 1050 pounds per steer. A one percent death loss per lot was assumed.

Short hedges were placed and lifted as directed by the 1-3-5W ($0.09) moving average combination. Short hedging of cattle can be initiated on the first day the feeder cattle are placed in the feedlot depending on the moving average signal. Thus, if the moving average signal indicates a downward market on the day the feeders are placed then short hedges are initiated on the close of trading on that day. However, if the moving averages are signalling an upward trend in live cattle futures market, hedges are not placed until a sell signal is generated. The hedges are placed and lifted as dictated by the signals from the moving averages until the finished cattle are sold and the futures positions liquidated.

Returns generated from the sale of the finished cattle were calculated in the following manner

$$NLC_{t+k} = PLC_{t+k} + LCHP_{T,\,T+k} + IM_{lc}$$

where:

NLC_{t+k} = net value of the finished cattle at slaughter time

t = date at which feeders are placed on feed

PLC_{t+k} = weekly average price for slaughter steers at Guymon, Oklahoma at date $t+k$ multipied by the number of feeders placed on feed at time t less on percent death loss

$LHCP_{t,\,t+k}$ = profit loss from futures market transactions on short hedges (less $50 round turn commission)

IM_{lc} = interest accrued on initial margin requirements ($1,200 per contract times annual prime interest rate plus one percent).

The margin between the revenue from the sale of finished cattle and the costs of feeder cattle plus the costs of corn was computed as follows:

$$PM = NLC_{t+k} - (FC_t - CC_t)$$

where:

PM = production margin

NLC_{t+k} = value of the finished cattle at slaughter time

FC_t = cost of feeder cattle at time t

CC_t = cost of corn at time t

Two hedging strategies were examined. Strategy I is a no-hedge strategy representing complete exposure to risks associated with adverse changes in the price of slaughter cattle. Strategy II is a multiple hedging strategy which employs signals from the 1-3-5W ($0.09) set of moving averages to place and lift hedges.

In Figure 1, the points on the graph represent the production margin for each of the 56 lots of 190 head of cattle marketed from May 1975 through December 1979. As Figure 1 indicates, complete exposure to price risk results in both large profits and losses for the producer.

The production margin derived from the simulation where cattle were unhedged on individual pens of cattle varied from a negative $85.23 per head to a positive $225.54 per head. Nine of the 56 lots marketed resulted in feeder cattle plus corn costs greater than the gross value of the slaughter animals. The standard deviation about the mean for Strategy 1 is $14,563 with the coefficient of variation equal to 1.10. The mean production margin is $13,182 per lot.

Figure 1 shows that the production margin for each feeding period during 1975 was greater than the mean over the complete test period. This contrasts with 1976 and 1977 when only one lot of cattle produced a production margin above the mean. The year 1979 is illustrative of the price risk that is associated with feeding cattle. During this year the second most profitable lot and the least profitable occured only four months apart.

Figure 2 presents the production margin when the cattle were multiple hedged. The number of negative production margins, as compared to Strategy 1 was reduced from nine to four lots. The largest single production margin for one lot of cattle was increased to $237,95 per head and the single largest loss was cut to a -$58.39 per head. The mean production margin for this alternative was $13,967 per lot compared to $13,192 for Strategy 1.

The low to negative margins experienced during 1976 due to depressed live cattle prices were improved greatly by the multiple short hedging of the finished cattle on the futures market. The mean production margin for 1976 was only $0.12 per head for Strategy 1. This same margin was increased to $31.73 per head through the use of the 1-3-5W ($0.09) moving average combination to identify times to place and lift short hedges. Thes standard deviation and coefficient of variation was reduced to $12,213 and 0.88 respectively under the multiple hedging strategy.

The multiple hedging technique using moving averages to trigger buy and sell signals does not guarantee futures markets profits with which to increase the returns to finished cattle in each and every production period. Table V shows the profits and

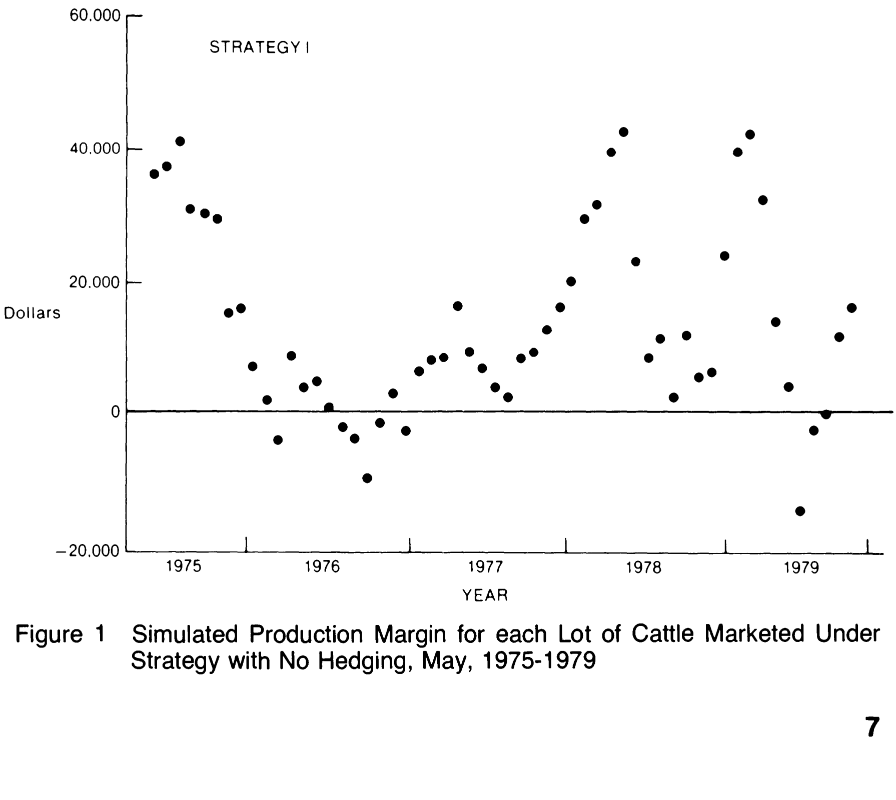

Figure 1 Simulated Production Margin for each Lot of Cattle Marketed Under Strategy with No Hedging, May, 1975-1979

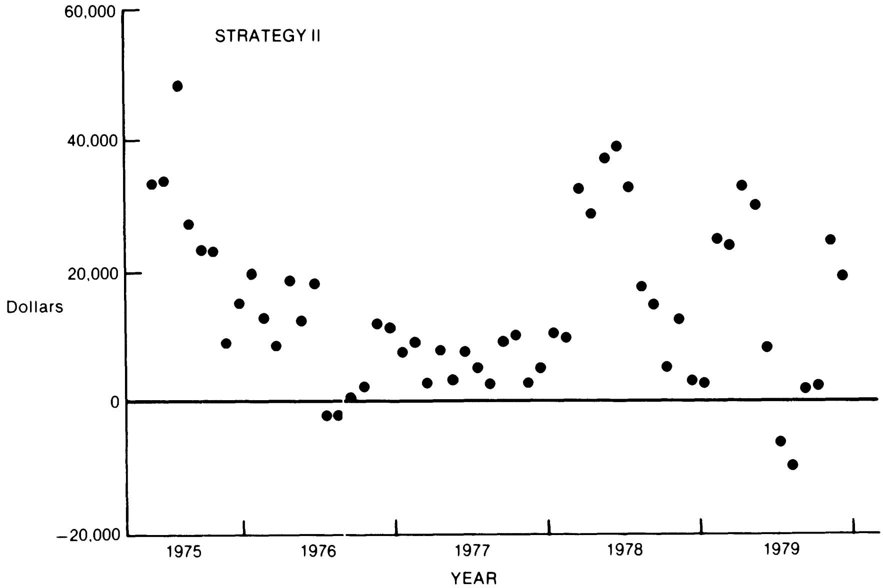

Figure 2. Simulated Production Margin for each Lot of Cattle Marketed Under Strategy II with Live Cattle Multiple Hedged, May, 1975-79

losses generated from short hedging finished cattle over the period 1975-79. Modest losses occurred on individual lots in each years except 1976 during which substantial gains occurred . It is important to note that future losses can occur on at least as many as six consecutive lots of cattle and, consequently, not all cattle feeders will be in a financial position to employ the multiple hedging technique. However, for those in strong financial positions, the historical evidence suggests profits will be enhanced over a period of years.

Summary

The risks associated with feeding cattle include both production risks and market, or price, risks. Generally speaking, cattlemen have learned to deal with the production risks. Price risks have posed more difficult problems for many operators. The wide fluctuations in cattle prices attest to the significance of the issue to the industry.

One time tested method of dealing with price risk is to forward price feedlot output in the futures market. However, while forward pricing protects against serious adverse price movements, it may also limit profits in some cases.

Recent research results have demonstrated that multiple hedging has the potential to reduce price risk and also reduce the average cost of procuring feeder cattle. The current study investigated the applicability of the multiple hedging technique for short hedging fat cattle.

A simulation was developed to correspond with a continuous feedlot operation in NW Oklahoma. Feeder cattle were placed on feed at a rate such as to ensure one lot of cattle were marketed each month. This resulted in 56 lots of cattle being fed and marketed during the simulation.. The difference between the feeder cattle costs plus the corn costs and the return from the sale of the slaughter cattle, called a production margin, was calculated and analyzed for two strategies—a no hedge strategy and a multiple hedging strategy for the finished cattle which employed a 1-3-5W ($0.09) set of moving averages to indicate when to place and lift the short hedges.

The results indicate that over the period 1975-79 a strategy of multiple hedging feedlot cattle with the use of an optimized set of moving averages increased returns to the feedlot and also reduced the risk as compared with a strategy of not hedging.

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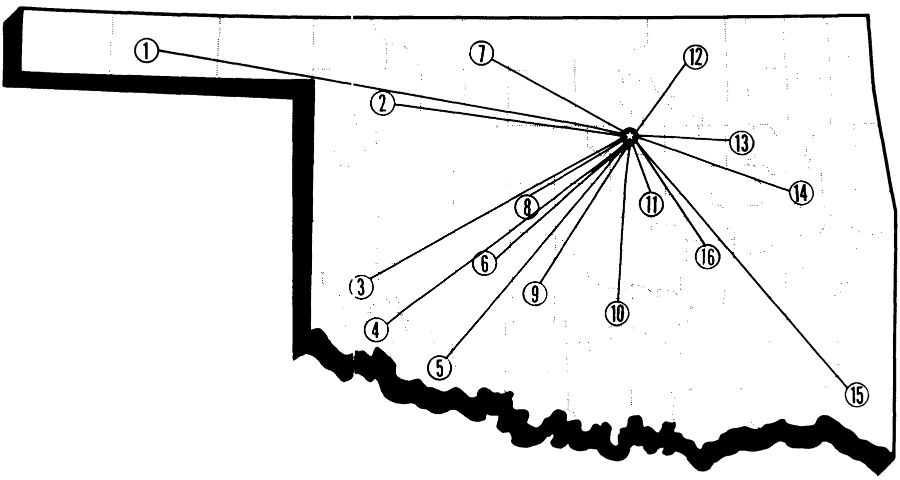

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