Distilling Option Premium Information into Simple Decision Rules

by

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Market agents continue to search for marketing decision aids that will deliver profitable trades yet that are easy to understand and simple enough to use. The market tool that signals buy or sell decisions should also have a low transaction cost so as to not eat into the profits generated by the trade. Agricultural producers are particularly sensitive to the time involved in operating a marketing system or tool. The opportunity cost of their time away from producing, where their comparative advantage lies, and spent on marketing is typically of concern. Decision makers may also have objectives other than simply receiving the highest price as managing price risk to an acceptable level is also important to many producers.

Researchers have long studied futures markets with varying degrees of success to find trading rules that can be use to make profitable hedging decisions. The procedures typically compared current futures prices for delivery at time t a forecast of prices at t. While "expert" forecasts from private and public sources have been considered, much of the work relied upon statistical forecasts that are regularly updated. These models do generate additional information for the decision maker and often produce encouraging results, but are typically not practical for many agricultural decision makers to use because of the data requirements and the continuous updating.

Decision makers require readily available market data that can provide "user-friendly" information to assist them in marketing and risk management decisions. The options market may provide this information. With the advent of the options contracts on futures came an interesting residual known as implied volatility. Now, in addition to a point estimate of where "the market" thinks prices will in the future, i.e., the futures price, there is an estimate of the distribution around the point estimate. The probability distribution can be calculated explicitly from the implied volatility or implicitly from the size of the observed option premiums. The question then becomes, "How can decision makers use this additional information to fine-tune their marketing and risk management decisions?" This paper explores simple decision rules based on information derived from the option premiums observed in the market. Following a brief review of related research is a comparison of alternative thumb-rules using Live Cattle and Live Hog option contracts to trigger futures market trades.

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Related research

Much of the research to date on futures markets has compared the forecasting ability of the futures market to other forecasting methods (Just and Rausser and Leuthold and Hartmann). While some of this work used statistical forecast of prices to test for market efficiency, others were searching for profitable trading rules based on the relationship between forecast prices and current futures prices. In some of the more recent literature Doehring, Garcia, and Sherrick, developed trading rules based on updated time series models that generated positive returns in the Live Hog contract. They found that contract returns were positively related to the size of the signal, or filter, because it eliminated unprofitable trades caused by noise in the market that triggered a market position different from the general market trend.

Adding to the information about the futures market, however, is the market for options on futures contracts. Well before options were available for agricultural commodities Gardner discussed how information about the variability of a commodity's price could be derived from the option market. Black and Scholes developed the original option pricing model that was later extended by Merton. Black adapted the model to price options on futures contracts.

Previous work with options has focused on developing a probability based forecast of future prices and the characteristics of the distribution. Fackler and King examined calibration of option-based probability distributions. The evaluated distributions for Live Cattle, Live Hogs, Corn and Soybean contracts and found no significant calibration problems with Live Cattle or Corn distributions. However, they found problems with the Live Hogs and Soybean contracts. Frank and Kaylen comparing an option-based price forecast to an expert forecast found that the option-based forecast performed better in that it had smaller root-mean-squared-errors, but it was subject to bias. Irwin, Zulauf, and Pelly examining market timing test of options found that the market timing ability of options dissipated quickly in that profitable one-day trades were found, but returns declined after the first day.

King and Fackler Model

King and Fackler starting with the Black and Scholes model derived an option-based non-parametric price forecast by identifying points on the cumulative distribution function (CDF). Their model is quite simple to construct, the necessary inputs are readily observed, and the output is in a form that is easily understood by decision makers.

The standard option model assumptions of frictionless transactions and borrowing and lending at the risk-free interest rate are invoked. Following King and Fackler, define a point on $F(P_t)$, the CDF of commodity a price on option expiration date, P_t. The point on $F(P_t)$ half way between strike prices SP_1 and SP_2 is defined as:

(1) $$F((SP_1+SP_2)/2) = 1 - \{(V_c(SP_{1,t}) - V_c(SP_{2,t}))/e^{-rT}(SP_2-SP_1)\}$$

where $V_c(SP_{x,t})$ is the premium of the call option at strike price x that expires at time t, r is the risk-free interest rate, and T is time to maturity measured as a fraction of a year.

A point on the CDF derived from put premiums is given by:

(2) $$F((SP_1+SP_2)/2) = e^{-rT}(V_p(SP_{2,t}) - V_p(SP_{1,t}))/(SP_2-SP_1)$$

where $V_p(SP_{x,t})$ is the premium of the put option at strike price x that expires at time t. Solving either equation (1) or (2) for different strike prices traces out the CDF of P_t. Where points estimated from both put and call premiums are available the values can be averaged to from a composite estimate.

King and Fackler made this procedure operational by developing a user-friendly computer software program called OPTIONS[2]. Decision makers enter the easily observed required information (i.e., contract name and month, risk-free interest rate, current date and option expiration date, current futures price and strike prices and their associated option premiums) and the program generates the CDF of futures prices. While decision makers have additional information from the CDF, they may still be unsure how to interpret probability distribution. This research will explore alternative thumb rules based on the CDF of futures prices.

Data and Methods

Research using option data can quickly become overwhelming due to its sheer volume; that is where "distilling" becomes important. The work reported here used daily closing quotations for April and October Live Cattle and April, July, and October Live Hog futures and options for 1989-1992 (Chicago Mercantile Exchange). These contract months represent the typical seasonal price extremes in both markets. Put and call premiums for five strike prices (at-the-money, one and two strikes in-the-money, and one and two strikes out-of-the-money) were used. The yield for Treasury Bill futures that expire in the same month as the options expire were used as a proxy for the risk-free interest rate. The T-bill futures yield tracked the cash market for treasury bills closely and equations (1) and (2) are not particularly sensitive to small differences in the risk-free interest rate.

The decisions rules described below were compared over a six month period prior to the delivery month of the contract (e.g., begin April 1 for the October contract). This length of time encompasses the feeding period of hogs, heavy calves and yearling cattle. In addition, the deep in- or out- of the money options are often thinly traded further from

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[2] OPTIONS is available from Extension Distribution, University of Minnesota, Room 3 Coffey Hall, Eckles Ave., St. Paul, Minnesota 55108.

expiration. The April 1989 contracts were considered beginning January 4, 1989 due to lack of data. The data for the five contract months and four years were distilled down to only Wednesday observations. This assumes that decision makers re-evaluate and, if necessary, change their market position each week. The October Live Cattle contract was also evaluated daily for comparison purposes.

Points on the CDF were calculated for both put and call premiums using equations (1) and (2) where data permitted. The point on the CDF, $F(P_t)$, was calculated as the average of the value derived from call information, equation (1), and put information, equation (2) when both values existed. When only one of the estimated values for $F(P_t)$ was available, it was used in place of the average. Points on the CDF for prices between the strike price mid-points were found by linear interpolation.

Probability Based Trading Rules

Simple trading rules described below uses the probability information generated from option premiums to make buy and sell decisions in the futures market. There was no attempt to optimize the trading rules examined, nor was the search exhaustive to find the most profitable parameters. They only represent simple trading strategies to begin to explore if option premiums hold additional useful information.

Futures Contract Trading Rules:

(1) Buy a futures contract at the closing price if the probability of futures prices increasing is greater than X. That is, buy futures if $F(FP_t) < (1 - X)$.

(2) Sell a futures contract at the closing price if the probability of futures prices decreasing is greater than X, or sell futures if $F(FP_t) > X$.

Define $F(FP_t)$ as the point on the CDF associated with the current futures price and X is 0.51, 0.52, 0.53, or 0.54. The market position is held until trading rules (1) or (2) trigger a change in market decision or the contract expires, and no position is taken until rules (1) or (2) are met. If a change is triggered the opposite position is taken. That is, if the rules signal getting out of a short position two contracts are bought. One to offset the short position and one to establish a long position.

Results

The results from the trading rules described above are shown in Tables 1-4. The returns to futures trades are reported prior to commissions and interest which will typically be \$0.15 to \$0.25 per hundredweight. In general, the returns are relatively small and negative in some cases after adjusting for transaction cost. While there are some similarities between the contract months and the two commodities, too few observations were made to make robust claims about preferred trading rules.

As would be expected, as the value of X increases the number of trades decrease and, in general, returns per trade increases as X increase. Increasing the value of X filters the trades and tends to eliminate the unprofitable ones due to overreaction to noise in the market. These results are similar to the Doehring, Garcia, and Sherrick findings.

Applying the trading rules on a weekly basis (i.e., every Wednesday) produced higher returns in Live Cattle futures than Live hogs. Returns in the cattle market were in excess of transaction costs in both contracts and across the four values of X (Table 1). In particular, the six to ten trades in the April contract over the four years generated returns of $1.13 to $1.63 per hundredweight before commissions. Put another way, they returned $372 to $572 per 40,000 pound contract after $80 worth of commissions and interest. Following the same procedures in the hog market resulted in more trades for all values of X and lower returns (Table 2). The increased number of trades suggests that either the Live Hog contract is more volatile than the Live Cattle contract, or the option traders perceive it to be. Trades in the July contract produced higher returns than the other contract months, but a negative return for the tightest filter, X = 0.54. Of the twelve possible contract and filter combinations, one third had returns below transaction costs. The difference is results between the cattle and hogs returns may be related to calibration problems in the hog market reported by Fackler and King. The Live Cattle distribution showed no significant calibration problem while the option-based probability assessment tended to under estimate the location of the Live Hogs distribution.

The October Live Cattle contract was examined using the same trading rules but the market position was evaluated each day of the seven month time horizon rather than once a week. The results of daily trading rules, for the most part, follow the weekly findings (Table 3). As would be expected, the number of trades increased with the increased opportunity to reevaluate the market position. Although the returns appear to be higher, particularly at higher X values, on average they are not due to the large number of negative trades in 1991 (Table 4). The average return over the four years does not cover commissions and interest with the exception of X = 0.54. Note the number of trades and trading returns in 1991, a turbulent year in the fed cattle market. Record cash prices in were set March followed by a steady price decline of over $16/cwt into September producing greater than normal volatility in the futures market. Even the tightest filter, X = 0.54 resulted in 34 trades. The four filters produced negative returns suggesting that the trading rules over reacted to new information in the option market. The average of the three years without 1991, are greater than commissions and comparable to or higher than the weekly trading rules.

Summary

The option market provides decisions makers additional information, but, this information is often difficult and costly to interpret. The King and Fackler model can extract a probability distribution of futures prices from option premiums and presents it in a user-friendly format for decision makers to use. However, questions still remain about how to use this additional information to make profitable, or less risky, marketing decisions. The work reported here attempts to develop recommendations for decision makers by comparing alternative simple trading rules on Live Cattle and Live Hog future markets and reports the results.

Using the selected trading rules to evaluate market positions once a week produced positive returns over the 1989-1992 period in the two Live Cattle contract months considered. However, the same rules produced lower and often negative returns in the Live Hog contract. These differing results may be linked to the option-based calibration problem in the Live Hog contract noted by Fackler and King. Applying the trading rules each day in the October Live Cattle contract over the same time horizon produced generally positive returns with the exception of 1991 in which the returns were consistently negative. The hog contracts and 1991 October cattle contract were both more volatile than the other cattle contracts as seen in the higher number of trades. The trading rules selected appear to perform better in a more stable market where they are less likely to over react to new information. Volatile markets will likely require a tighter filter, a higher value for X, to reduce the number of trades and the tendency to over react.

Obviously, more work is needed before decision makers can feel confident is relying on a given set of trading rules. First, additional contract months and additional years of data should be examined before recommendations can be made. Second, trading rules for a short (or long) hedger should be explored. The results reported here allowed the decision maker to be either long or short in the futures market and do not consider the hedger's view. Third, the size of the filter relative to the volatility of the market should be examined. Tighter filters, higher values of X, may improve the results in volatile markets. Fourth, questions about calibration of option-based distributions should be examined and procedures identified to correct significant problems. Finally, decision rules that use puts and calls rather than strictly futures should be considered. Such strategies evaluating pricing decisions further from the center of the distribution are particularly important as it pertains to decision makers who want down-side risk protection and greater profit potential should the market move in their favor.

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Table 1. Number of Trades and Trading Returns Following Weekly Probability-Based Trading Rules for Two Live Cattle Contracts, 1989-92.

	April		October	
X	No. of Trades	$/cwt/ Trade[1]	No. of Trades	$/cwt/ Trade
0.51	10	1.16	16	0.41
0.52	10	1.13	8	1.68
0.53	8	1.16	6	1.85
0.54	6	1.63	6	0.74

1) Returns per trade are not adjusted for commissions and interest.

Table 2. Number of Trades and Trading Returns Following Weekly Probability-Based Trading Rules for Three Live Hog Contracts, 1989-92.

	April		July		October	
X	No. of Trades	$/cwt/ Trade[1]	No. of Trades	$/cwt/ Trade	No. of Trades	$/cwt/ Trade
0.51	31	0.32	34	0.32	34	0.26
0.52	19	0.29	21	1.12	22	0.04
0.53	15	-0.42	13	0.97	14	0.71
0.54	12	0.38	6	-0.01	11	-0.06

1) Returns per trade are not adjusted for commissions and interest.

Table 3. Number of Trades and Trading Returns Following Daily Probability-Based Trading Rules for October Live Cattle Contracts, 1989-92.

1989 X	Number of Trades / Year	$/cwt/ Trade[1]
0.51	8	0.13
0.52	7	-0.73
0.53	2	2.14
0.54	2	2.29

1990 X	Number of Trades / Year	$/cwt/ Trade
0.51	5	0.44
0.52	2	1.83
0.53	2	2.03
0.54	2	2.03

1991 X	Number of Trades / Year	$/cwt/ Trade
0.51	41	-0.24
0.52	39	-0.30
0.53	39	-0.17
0.54	34	-0.09

1992 X	Number of Trades / Year	$/cwt/ Trade
0.51	9	0.80
0.52	4	1.72
0.53	2	3.23
0.54	2	2.90

1) Returns per trade are not adjusted for commissions and interest.

Table 4. Number of Trades and Trading Returns Following Probability-Based Trading Rules for October Live Cattle Contracts, 1989-92: Four Year Weight Average of Daily Trades

With 1991 X	Total Number of Trades	$/cwt/ Trade[1]
0.51	63	0.01
0.52	52	-0.12
0.53	45	0.18
0.54	40	0.28
Without 1991 X	**Total Number of Trades**	**$/cwt/ Trade[1]**
0.51	22	0.47
0.52	13	0.41
0.53	6	2.47
0.54	6	2.41

1) Returns per trade are not adjusted for commissions and interest.