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THE SOYCOMPLEX SPREAD CRUSH: A DIFFERENT LOOK AT MARKET EFFICIENCY

by

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ABSTRACT

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Significant profits from trading rules and the existence of models that outforecast futures prices provide conflicting evidence for the efficient market hypothesis. Spread trading in the soycomplex produces significant profits only at distant lengths to maturity indicating the futures market may perform different functions at different times to maturity.

Keywords: Soycomplex crush, reverse crush, market efficiency.

Market efficiency has been a central topic in the futures markets literature. Traditionally, efficiency has meant that markets incorporate all available information when establishing prices (Fama, 1970). This definition has been tested by searching for forecasting models that outperform the futures market or by searching for abnormal returns from trading rules. While results have varied across studies, a growing body of recent literature suggests futures markets are inefficient according to Fama's definition (Garcia, Hudson, and Waller, 1988, and Lukac and Brorsen, 1988).

Even if futures are not efficient, they may still may have a legitimate role in the direction of inventories and production decisions (Working, 1949; Tomek and Gray, 1970). Moreover, Garcia, et al.'s (1988) review of efficiency studies on agricultural futures found that futures prices become better forecasters as maturity approaches. This finding suggests that the role of futures prices may change over the life of the contract.

The purpose of this paper is to test whether efficiency of futures change as time to maturity changes. In contrast to most efficiency studies which have focused on a single commodity market, this study uses intercommodity spreads to test efficiency. This approach will also document spread behavior, an area generally absent from the current academic literature.

The analysis will focus on the intercommodity spread of soybeans, soyoil, and soymeal using a profit margin trading signal. Both normal crush positions (long soybeans, short meal, short oil) and reverse crush positions (short soybeans, long meal, long oil) are examined. Although the reverse crush is believed to be used often by the soybean industry, a review of the academic literature produced no investigation of it. Significant profits are found with both the normal and reverse crush. In addition, profits vary with time to maturity, indicating that futures may perform different functions as maturity approaches.

Relevant Literature

The efficient market hypothesis (EMH) describes an efficient market as one that accurately incorporates all known information in determining prices (Fama, 1970). Fama defined three forms of market efficiency: (a) weak-form efficiency where all information in past prices is incorporated into the current price, (b) semi-strong form efficiency where all publicly available information is incorporated into the current price, and (c) strong-form efficiency where all information, both public and private, is incorporated into the current price. EMH assumes that there are no transaction costs, information is costlessly available to all market participants, and implications of current information for current price and distributions of future prices are generally accepted by all market participants.

At least two of these three assumptions are invalid in a real-world market place. First, transaction costs (brokerage fees, opportunity cost of margin, etc.) exist. Therefore, Jensen (1968) argued that a market is efficient as long as a trading system cannot produce profits greater than transaction costs. Second, information is not costless. Grossman and Stiglitz (1980) argued that the cost of acquiring and interpreting information slows price adjustment and that those who spend resources to become informed are compensated by the market. Furthermore, Fama (1970) argued that information arrives in small random doses, but empirical evidence found by Oldfield et al. (1977) suggests that it arrives in large non-random doses. Black (1976) showed that an uneven flow of information will impede market reaction, thus creating the potential for profitable trading.

Because of institutional factors such as transactions costs, taxes, cost of acquiring and evaluating information, lags in obtaining information, and the uneven flow of information, a market disequilibrium pricing model has been proposed to explain the price adjustment process (Beja and Goldman, 1980; Nawrocki, 1984; Lukac, Brorsen, and Irwin, 1987; Lukac and Brorsen, 1988). Disequilibrium theory argues that prices are in short-run disequilibrium due to information shocks and, therefore, technical trading systems may generate significant profits.

Efficiency of the soycomplex is of specific interest to this study. Rausser and Carter (1983) concluded that the soycomplex was inefficient because both univariate and multivariate models were found to outforecast the futures market based on a mean-squared error criterion. Forecasting studies of other agricultural commodities have also found better forecasting models than futures markets (Oliveira et al., 1979, beef cattle; Spriggs, 1981, corn; Brandt and Bessler, 1981, hogs; and Martin and Garcia, 1981, cattle and hogs;). However, Garcia et al. (1988) have questioned the use of mean-squared error as a criterion for evaluating forecasting ability, and instead prefer evaluating whether trading profits are generated by the forecasts.

Methodology

To test the efficiency of the soycomplex, either a forecasting or profit-from-trading approach could be used. Most forecasting studies have used ARIMA time series models. On the other hand, profit-from-trading generating studies are usually based on a filtering mechanism that may or may not be based in economic theory.

Filtering mechanisms based on cost of production have been used extensively in the profit margin hedging literature (Shafer, Griffin, and Johnston, 1978, fed cattle, feeder cattle, and corn; Holland, Purcell, and Hague 1978, fed cattle; Leuthold and Peterson, 1980, hogs; Spahr and Sawaya, 1981, fed cattle, feeder cattle, and corn; Holt and Brandt, 1985, hogs; Kenyon and Clay, 1987, hogs, corn, and soymeal; Schroeder and Hayenga, 1988, fed cattle, feeder cattle, and corn). In general, profit margin hedging studies use the following decision rule: If the profits implied using futures prices and cost of production estimates exceeds a pre-specified level, a hedge is placed before or during the production period. Average profits for the combined hedged and unhedged positions taken using the profit margin filter are compared with profits from routinely hedged positions and a cash only marketing strategy. Each study has found that profit margin hedging strategies increased mean returns and decreased variance compared to a cash only marketing strategy. Routine hedging strategies were found to reduce variance of returns, but also significantly reduced mean returns as well.

This research employs the concept of profit margin hedging as its basic methodology, but takes it one step further. Trades are triggered not only when positive profit margins exist, but also when negative profit margins exist.

Gross profits margins are computed as:

$$GPM_{t+1} = [((FM_{t+1}*48)/2000 \text{ lbs.}) + ((FO_{t+1}*11)/100 \text{ lbs.})] - FS_{t+1}$$

where,

GPM_{t+1} = Gross profit margin in dollars per bushel of soybeans at time t+1
FM_{t+1} = Futures price of meal in dollars per ton at time t+1
FO_{t+1} = Futures price of oil in dollars per 100 pounds at time t+1
FS_{t+1} = Futures price of soybeans in dollars per bushel at time t+1
t+1 = a time prior to contract maturity

This calculation is based on the long term crushing average of 48 pounds of meal and 11 pounds of oil per bushel of soybeans (United States Department of Agriculture, 1988).

To obtain the profit from crushing that is implied by the futures market at the time the trade is to be placed, cost of crushing must be subtracted from the gross profit margin. Since cost of crushing is proprietary information, it was necessary to estimate this cost. Based on the assumption that an economic activity must cover its total cost of production if it is to continue, a moving average of gross spread margins near futures contract expiration was used to estimate the cost of crush. Spreads were calculated on the first trading day of every month using the contracts nearest expiration. Moving averages of 36, 60, and 120 months were used as the estimated cost of crush to test the sensitivity of results to different moving averages. The first trading day of the month was used to avoid potential erratic trading near expiration of a contract.

This estimated cost of crush was subtracted from the calculated gross profit margin (GPM) to obtain a net profit margin implied by the futures market at the time the trade was placed (hereafter referred to as the implied margin). A reverse crush (short soybeans, long meal, long oil) or normal crush (long soybeans, short meal, short oil) is taken based on whether the implied margin was less than zero (reverse crush) or greater than zero (normal crush). Given the method use to estimate crushing costs and the absence of profits, long term equilibrium would be consistent with an implied margin of zero.

The specific trading strategy used involved placing five trades on the 15th of every month over the period of 1966-1988. These trades were lifted 9.5, 7.5, 5.5, 3.5, and 1.5 months later. Trading did not occur 9.5 months from expiration for oil and meal on a consistent basis prior to 1966. Positions were taken in the soybean, meal, and oil contracts maturing nearest to but later that the calendar month when the trade was to be lifted. All trades were lifted on the first trading day of a month to avoid erratic trading that may occur during a futures contract's delivery month.

One contract of meal and one contract of oil were traded for each soybean contract. Since one bushel of soybeans (60 pounds) normally yields 48 pounds of meal and 11 pounds of oil, the exact trading relationship is 1.2 contracts of meal (100 tons per contract) and 0.915 contracts of oil (60,000 pounds per contract) for every one contract of soybeans (5000 bushels per contract). However, using only one contract of each commodity keeps the number of contracts small while maintaining the essential underlying processing relationship.

Due to the trading strategy being investigated and the method used to calculate net profit, all trades are out-of-sample. This procedure results in a test which more closely approximates real world trading.

If equilibrium forces are at work, significant profits should be generated for profit margin levels further from zero and at times further from maturity. Average profits should be higher at higher absolute implied margins because the market is providing economic incentive for the cash market to react to the potential economic profits (losses) that exist in the future. Average profits should be higher as trade length increases because the market has more time to adjust. This research will use implied margins over different lengths to maturity to see if this behavior does exist. The results will help determine if efficiency exists in the soycomplex and will provide implications for the definition of market efficiency.

Results of the Empirical Analysis

Results of the analysis are presented in tables 1 and 2. Those results used the 60 month moving average to estimate the cost of crush. The 36 and 120 month moving averages did not significantly alter the results, so they are not presented. The last trades included in the results expired on December 1, 1988. This accounts for the different number of trades at different trade lengths.

At all trade lengths, mean profits from the normal crush position were negative. Therefore, a routinely reversed position would have produced profit at all five trade lengths. Profits were statistically different from zero at 1.5, 3.5, and 9.5 months. When transaction costs are considered, only the routine reversal at 9.5 months generated economically significant profits.[1]

The trading strategy based on trading the normal crush if profit margins are above zero and the reverse crush if profit margins are below zero (hereafter referred to as the combination trade) produced profits that were statistically different than zero at trade lengths of 3.5 months and beyond (table 1). When transaction costs are considered, the profits at 5.5 months and beyond are probably economically significant. More importantly, the profits generated by the combination strategy are significantly greater at 5.5 and 7.5 months than the routine reverse crush position. This suggests that the trading strategy has the ability to time when the position should be taken.

Table 2 presents a breakdown of profits for the combination trade by implied margin levels. In general, as length to maturity increased, larger profits were generated as implied margins became more highly positive or more highly negative. This clearly suggests the timing ability of the combination crush trade. At implied margin levels closer to zero, economically significant profits are less prevalent. Statistically significant profits exist at implied margin levels near zero for 1.5 and 3.5 month trade lengths but these profits would not likely cover transaction costs.

The 5.5 month trade length performed the best compared to other trade lengths as all profits were of the expected sign, significantly

[1] A large brokerage firm currently quotes fees for the crush spread at $150 per round trip for public traders. Assuming execution cost is one tick in each market, execution costs per round trip would be between $75 to $100. With the addition of opportunity cost of margin, total transaction costs would exceed $250 per trade.

different than zero at the 10% level, and probably economically significant. Large average profits existed at 7.5 months but the variance was so large that only profits generated at the most extreme negative implied margins were significant. However, almost all trades generated profits in the expected direction for net margin levels above 10 cents or below negative 10 cents. While results for the negative implied margins at 9.5 months were generally consistent with postulated expectations, results for the positive implied margins did not reveal good timing ability.

Variances were high over all trade lengths further showing that futures trading is a risky investment. Variances and profits were higher in general as distance to maturity increased except at 9.5 months.

Conclusions and Implications

This study has shown that statistically significant as well as economically significant trading profits have been present in the soycomplex market at 3.5 to 9.5 months prior to contract maturity. These results are evidence against market efficiency according to both the Fama and Jensen definitions. Grossman and Stiglitz argued that traders are compensated by the market for spending resources (time, money, talent, etc.) to exploit market inefficiencies. Therefore, if profits above transaction costs did exist, it could be argued that they were a return to those resources.

But the ease and simplicity of this trading strategy along with its foundation in economic theory suggest that futures markets may serve different roles over the course of trading on a contract. Close to maturity, the market may perform a role consistent with accurate price forecasting. This role is consistent with the traditional efficiency models of Fama and Jensen.

In contrast, a contract far from maturity may serve a role that could be more closely defined as resource allocation and direction. Profit (price) signals are sent to encourage a certain response from market participants. As market participants respond, the need for the price signal lessens and prices move toward a new equilibrium. The catch is that if futures had priced the response in the first place (which it should according to traditional efficiency concerns), the economic rational response would not be forthcoming and prices would diverge from their desired path to reflect the lack of response. Either way profits are generated, but in the former the desired economic outcome occurs. Thus, efficiency for more distant futures should be judged not on whether significant trading profits are generated but also on whether desired economic response occurs.

Additional research is needed in other markets to confirm or reject the findings of this research. Potential investigations include the hog, corn, soymeal spread and the fed cattle, feeder cattle, corn spread. Both are cost of production driven spreads, and, therefore, results should prove comparable.

Table 1 Average Profits and Implied Profit Margins per Soycomplex Spread Trade, Chicago Board of Trade Futures Prices, 1966 to 1988.

			Trading Strategies ($ per trade)		
Length of Trade (Months)	Number of Trades	Implied Profit Margin[a] (cents)	Normal Crush Position[b]	Routinely Reversed Crush Position[c]	Reverse Crush Below 0, Normal Crush Above 0[d]
1.5	274	3.3***[e] (3.21)	-166*** (-3.04)	166*** (3.04)	51 (0.09)
3.5	272	0.1 (0.937)	-270*** (-3.61)	270*** (3.61)	210*** (2.77)
5.5	270	-1.2 (-1.29)	-39 (-0.169)	39 (0.169)	1072*** (4.87)
7.5	268	-4.1*** (-6.01)	-133 (-0.052)	133 (0.052)	838*** (3.33)
9.5[f]	261	-5.1*** (-7.03)	-557*** (-6.79)	557*** (6.79)	578*** (7.09)

[a] Implied margin is calculated as described in the text. Reported in cents per bushel of soybeans.
[b] The normal crush position is long soybeans, short meal, and short oil.
[c] The reverse crush position is short soybeans, long meal, and long oil.
[d] This strategy takes the reverse crush position at implied margins below zero and the normal position at implied margins above zero.
[e] t statistics are in parentheses.
[f] Five observations were missing because trading did not occur during part of 1967, 1971, and 1972.

*** Significantly different that zero at the 1% level using a two-tailed t test.

SOURCE: Original data calculations

Table 2 **Profits per Crush Trade Under Different Levels of Implied Margins, Normal crush at Implied Margins Above Zero and Reverse Crush at Implied Margins Below Zero, Chicago Board of Trade Futures, 1966-1988.**

Level of Implied Margins (cents)[a]		Trade Length in Months				
		1.5	3.5	5.5	7.5	9.5
<-20	Mean ($)	137[b]	2169**	2910***	2694***	2532***
	SD ($)	377	2128	2236	2131	1932
	Trades	2	5	11	15	22
	% Expected[c]	50%	100%	100%	100%	95%
-20-(-10)	Mean ($)	212*	755***	740**	723*	589***
	SD ($)	655	1437	2438	2993	1398
	Trades	35	33	37	39	53
	% Expected	71%	70%	68%	62%	75%
-10-0	Mean ($)	260***	281***	808**	470*	542***
	SD ($)	740	969	3668	3905	1000
	Trades	85	105	112	131	113
	% Expected	55%	59%	62%	62%	73%
0-10	Mean ($)	-159**	-330***	875**	952*	-68
	SD ($)	677	911	4210	5113	791
	Trades	94	89	80	69	52
	% Expected	47%	36%	57%	54%	50%
10-20	Mean ($)	-195	-51	2025**	1329	118
	SD ($)	1393	1281	2531	5818	1095
	Trades	34	27	19	10	16
	% Expected	41%	48%	63%	70%	62%
>20	Mean ($)	245	1733***	2820***	3853*	834*
	SD ($)	1550	2001	2823	3654	1208
	Trades	8	13	11	4	5
	% Expected	67%	85%	91%	100%	80%

[a] Cents per bushel of soybean futures.
[b] One, two, three asterisks indicate significance from zero at the 10, 5, and 1% significance level using a one-tailed t test. A one-tailed test was used due to a priori expectations of the sign of profits.
[c] Percentage of trades, given the trading rule that produced positive profits.

SOURCE: Original calculations

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