The Soybean Complex Spread: An Examination of Market Efficiency from the Viewpoint of a Production Process

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Market efficiency is an important topic of research in the academic community. Futures market efficiency means that futures prices accurately incorporate all currently known information. Therefore, current futures prices are unbiased forecasts of subsequent cash and/or futures prices. Futhermore, traders cannot earn abnormal returns (see Fama (1970)). Previous studies have examined the efficiency of futures markets from the viewpoint of: whether futures prices follow a random walk; whether futures prices are efficient forecasts of subsequent prices; and whether profits can be generated from trading rules.

This research tests for trading profits by applying a profit margin trading rule to the intercommodity spread of soybeans, soyoil, and soymeal (i.e., the soy complex). The trading rule applied in this study has been tested extensively in hedging studies. The rule calls for initiating trades when a pre-specified level of implied profit exists. Implied profit is derived from currently-quoted futures prices for the output of the production process and estimated production costs.

One approach used to estimate production costs employs cash prices, historical prices, and/or imputed opportunity costs for variable and/or fixed inputs. Hedging studies employing this approach usually hedge only the output price (for examples of crop studies see Frank *et al.* (1989); soybeans; and Wood, *et al.,* (1989); cotton; for examples of livestock studies see Holland, *et al.* (1972); fed cattle; Leuthold and Pe-

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terson (1980); hogs; and Hayenga *et al.* (1984); fed cattle and hogs). A second approach to estimating production costs is to use current futures prices for inputs traded on futures exchanges. This approach is employed when both input and output prices are hedged (for examples, see Kenyon and Shapiro (1976); broilers, corn, and soybean meal; Shafer, *et al.* (1978); fed cattle, corn and feeder cattle; Leuthold and Mokler (1979); fed cattle, corn, and feeder cattle; Spahr and Sawaya (1981); fed cattle, corn, and feeder cattle; Kenyon and Clay (1987); hogs, corn, and soybean meal; Schroeder and Hayenga (1988); fed cattle, corn, and feeder cattle). In general, profit margin hedging studies, especially those using input-output hedges, find that selective implementation of a profit margin trading rule increases mean return and/or reduces the standard deviation of returns compared to a cash only or routine hedging strategy.

In related research, Helmuth (1981) (fed cattle) and Pluhar, *et al.* (1985) (fed cattle) find that, once the daily high price for live cattle futures equals or exceeds the cost of feeding cattle in the corn belt plus a basis adjustment, trading profits are generated by establishing a short position in fed cattle futures. As the authors note, these results suggest the potential existence of market inefficiency.

To further investigate the issue of market inefficiency relative to profit margin hedging, a variation of the profit margin trading rule is investigated in this study. Except for Kenyon and Shapiro and Leuthold and Mokler, the hedging studies do not investigate returns to futures positions when negative implied profits exist. Kenyon and Shapiro find evidence that profits may exist and Leuthold and Mokler find they do exist if the "reverse" hedge position is taken when negative implied profits exist.

This study investigates the existence of trading returns for positive and negative implied profits in the soybean processing (crushing) spread. Specifically, if positive soybean processing profits are implied by futures prices, the normal crush position is taken (long soybeans, short meal, short oil). On the other hand, if processing losses are implied by futures prices, the reverse crush position is taken (short soybeans, long meal, long oil). Despite wide-spread use of futures markets by soybean processors, a review of the academic literature finds only two studies of the price behavior of the soybean crush spread, Hieronymus (1949) and Dueringer (1972).

REVIEW OF RELEVANT LITERATURE

Efficient Market Hypothesis

The efficient market hypothesis (EMH) describes an efficient market as one that accurately incorporates all known information in determining prices (Fama (1970)). EMH assumes that there are no transaction costs, information is costlessly available to all market participants, and implications of current information for both the current price and distributions of future prices are generally accepted by all market participants.

At least two of the three assumptions of the EMH are unrealistic in an actual market place. First, transaction costs (brokerage fees, opportunity cost of margin, etc.) exist. Therefore, Jensen (1968) argues that a market is efficient as long as a trading system cannot produce risk-adjusted profits greater than transaction costs.

Second, information is not costless. Its acquisition involves costs which demand returns. Returns are earned as traders bid up undervalued securities and sell off overvalued ones. Grossman and Stiglitz (1980) argue that the cost of acquiring and interpreting information slows price adjustment.

While Fama (1970) argues that most of the time information arrives in small random doses, empirical evidence suggests that it arrives in large nonrandom doses and can best be described as a sporadic jump process (Oldfield *et al.* (1977)). Cohen *et al.* (1980) supports the existence of a noncontinuous information process. Black (1976) shows that an uneven flow of information impedes market reaction, thus creating the potential for profitable trading. Nawrocki (1984) argues that the existence of noncontinuous information flows in combination with institutional impediments, such as transaction costs and information acquisition costs, cause disequilibrium in prices and, thus, opportunities for profitable trading.

Tests of Market Efficiency

Studies of market efficiency can be categorized broadly into random walk studies, forecasting studies, and profit generating studies. Working (1934) was the first to propose that changes in futures prices are random if new information arrives randomly in the market place. Irwin (1986) in reviewing 18 studies that tested if changes in futures prices followed a random walk, concludes that futures prices do not behave randomly.

Forecasting studies of market efficiency test the unbiased nature of futures prices as predictors of subsequent cash and/or futures prices (for example, Tomek and Gray (1970); corn, soybeans, and potatoes; Martin and Garcia (1981); cattle and hogs; Rausser and Carter (1983); soybeans, soyoil, and soymeal; Kodres (1988); foreign exchange)[1]. Results vary, not surprisingly, because different markets are studied over different time periods at varying trade lengths and using a variety of alternative forecasting techniques.

Elam and Dixon (1988) show that biased results are produced by tests of futures market efficiency which are based on ordinary least squares regression of the spot price at time $t + i$ on a futures price for time $t + i$ quoted at some previous time t. The reason is that the independent variable, futures price, is a lagged value of the dependent variable, eventual spot price. This relationship produces correlation between the independent variable and error term. The resulting bias becomes more pronounced the smaller the data set, and small data sets are a characteristic of many studies employing this methodology (e.g., Martin and Garcia (1981) and Tomek and Gray (1970)). Therefore, forecasting studies that use this statistical framework may inappropriately reject market efficiency.

Profit generating studies test for market efficiency by directly testing for the existence or absence of trading profits. Taylor and Tari (forthcoming) find significant profits from trading in financial and commodity futures. Lukac, Brorsen, and Irwin (1988) and Lukac and Brorsen (1988) find that several technical trading systems earned significant risk-adjusted profits above transaction costs in agricultural and other futures markets. Sweeney (1988) produces significant profits for floor traders that exceed transaction costs by using a filter rule to trade stocks. These results of profit generating studies suggest that futures prices are not efficient at all times.

[1]See Garcia *et al.* (1988) for a review of price forecasting efficiency studies of agricultural futures markets. Their review indicates a wide variety of results.

METHODOLOGY

The Empirical Model

The normal soybean crush position (long soybeans, short meal, short oil) is taken when soy complex futures prices imply that gross returns from processing soybeans exceeds processing costs. When soy complex futures prices imply negative processing profits, the reverse crush position is taken (short soybeans, long meal, long oil).

This trading rule is consistent with market reaction to supply and demand. A positive (negative) profit margin signals that soy complex futures are offering an incentive for producers to crush (not crush) soybeans. If producers react to the incentives, supplies of oil and meal will increase (decrease) relative to supplies of soybeans. In turn, prices for oil and meal will decline (increase) relative to the price for soybeans, resulting in a corresponding change in the soy complex spread. Therefore, over time, gross crushing margins should adjust to a level that approximates crushing costs as producers and consumers react to profit incentives or disincentives. If gross crushing margins do not move towards crushing costs, arbitrage opportunities will persist in the long run, clearly an unsustainable phenomenon.

Normal crush positions should result in profitable trades when gross crushing margins exceed processing costs. On the other hand, reverse crush positions should result in profitable trades when processing costs exceed gross crushing margins. The larger the difference between gross crushing margins and processing costs, the higher trading profits should be because the market must move further to adjust processing margins to crushing costs.

The gross processing margin impled by soy complex futures prices at time t for time $t + n$ is computed as:

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

where

$GCM_{t,t+n}$ = Gross crushing margin in dollars per bushel of soybeans as of time t for time $t + n$,
$FM_{t,t+n}$ = Futures price of meal in dollars per ton as of time t for time $t + n$,
$FO_{t,t+n}$ = Futures price of oil in dollars per 100 pounds as of time t for time $t + n$, and
$FS_{t,t+n}$ = Futures price of soybeans in dollars per bushel as of time t for time $t + n$,

This calculation utilizes the long-term crushing average of 48 pounds of meal and 11 pounds of oil processed from 60 pounds or one bushel of soybeans (U.S. Department of Agriculture, (1988)).

Subtracting crushing costs from the gross processing margin yields the profit from crushing implied by the futures market as of time t for time $t + n$. This net crushing margin as of time t for time $t + n$, hereafter referred to as the implied margin, is calculated as:

$$NCM_{t,t+n} = GCM_{t,t+n} - CC_{t+n} \quad (2)$$

where

$NCM_{t,t+n}$ = Net crushing margin (implied margin) in dollars per bushel of soybeans as of time t for $t + n$, and

CC_{t+n} = Cost of crushing in dollars per bushel of soybeans at time $t + n$

An implied margin of zero is consistent with no abnormal processing losses or gains. An implied margin greater than zero signals that a normal crush position (long beans, short meal, short oil) should be taken because profits are expected from processing soybeans. In contrast, an implied margin less than zero signals that a reverse crush position (short soybeans, long meal, long oil) should be taken because, as of time t, processing losses are expected.

The response of producers and consumers to soybean crushing margins depends on cash prices as well as expected futures prices. Therefore, it is important for the price response argument that the cash and futures market send the same price signals. Consequently, a cash soy complex basis is calculated for Decatur, Illinois, a major soybean processing center, for the first trading day of each month over the period 1960 to 1988. On average, the basis is nearly zero. Thus, the resource adjustment signals sent by the soy complex futures markets are, on average, equivalent to the resource adjustment signals in a major soybean crushing center.

Implementing the Trading Rule

The specific trading strategy used in this study places five trades at the closing prices on the 15th of every month. One trade is lifted at each of the following times from placement: 9.5, 7.5, 5.5, 3.5, and 1.5 months. Positions are taken in the soybean, meal, and oil futures contracts maturing nearest to but later than the calendar day when the trade is to be lifted. After a trade is initiated, based on the implied margin, it is held for the pre-determined trade length. To avoid erratic trading which can occur during the delivery month of a futures contract, trades are lifted at the closing prices on the first trading day of each month. All prices are from the Dunn and Hargitt, Inc. data base.

Based on the historical crushing yield of 48 pounds of meal and 11 pounds of oil per bushel of soybeans (U.S. Department of Agriculture (1988)) and the traded contract sizes of 5,000 bushels of soybeans, 100 tons of soybean meal, and 60,000 pounds of soybean oil, the exact trading relationship is 1.2 and 0.915 futures contracts of meal and oil, respectively, for each futures contract of soybeans. However, only one contract of each is traded. This keeps the number of contracts small and in round numbers while maintaining the essential underlying processing relationship.

Because the cost of crushing soybeans is proprietary information, this cost has to be estimated. From economic theory, it is assumed that an economic activity must cover its long-run average total cost of production if the activity is to continue. Thus, as of the time the trend is placed, the cost of crushing is estimated using a moving average of past gross crushing margins (Eq. (1)), which are calculated for the first trading day of each month using the nearby futures contracts. Again, the first trading day of the month is used to avoid potential erratic trading that can occur as a contract nears expiration. Moving averages of 36, 60, and 120 months are used to test the sensitivity of the trading profits to the method used to estimate the cost of crushing.

Trading in the soy complex futures contracts does not consistently occur 9.5 months from expiration prior to 1973. Trading at 7.5 months from maturity for meal and oil averages less than 100 contracts per day prior to 1966. Therefore, all trades held 7.5 months or less begin in 1966[2]. Trades at the 9.5 month length begin in 1973.

[2]Trades could have been placed for 5.5 month and shorter trade lengths prior to 1966. However, 1966 is chosen as the starting date to keep results for the 7.5 month and shorter trade lengths comparable.

All trading results are *ex ante*. Positions are based only on information available at the time the positions are taken: futures prices of soybeans, soyoil, and soymeal for some future delivery month and the cost of crushing estimated as a moving average of past gross processing margins.

An advantage of the profit margin trading rule employed in this study is its simplicity in construction and use. It requires access only to the closing futures prices for the soy complex, which are reported in many outlets including the *Wall Street Journal* and *New York Times.* Thus, the costs associated with constructing the trading model and obtaining information needed to implement it are minimal. Positive returns to a simple trading strategy which is based on minimal information needs are a better indicator of market inefficiency than returns to a trading strategy which requires greater amounts of specialized information.

Transaction Costs

Transaction costs equal to the sum of execution costs and brokerage fees are estimated for the soy complex trades. Execution costs are associated with having a market order filled. They reflect the size of the bid-ask spread and increase as time from contract maturity increases and trading becomes less liquid (see Brorsen and Nielsen (1986) and Thompson and Waller, (1987)). Following Brorsen and Nielsen, cost of executing a trade is estimated at one price tick to get into each contract at trade lengths of 5.5 months or less. At trade lengths of 7.5 and 9.5 months, two ticks are used to get into each contract. The cost to close the trade is estimated at one tick per contract for all trade lengths.

Price ticks for soybeans, meal, and oil are 1/4 cent per bushel, 10 cents per ton, and one hundredth of a cent per pound, respectively. Therefore, execution costs are estimated to be $57 per spread trade for trades held 5.5 months or less and $86 for trades held 7.5 and 9.5 months.

Brokerage costs vary among brokerage firms and differ by type of trader. A large brokerage firm recently quoted fees for the crush spread at $150 per round trip for public traders and $75 for commercial hedgers (Markey (1989)). The credit worthiness of the trader is another factor for brokerage firms to consider when establishing fees. The conservative amount of $150 per round trip is used in this study. Therefore, for trade lengths of 5.5 months or less, transaction costs are estimated to be $207. For trade lengths of 7.5 months and 9.5 months, transaction costs are estimated to be $236.

Profits are measured in dollars per trade and are a return to the spread between the three soybean commodities. Because soy complex prices are highly correlated, the value at risk is less than the total value of the traded contracts. Therefore, a return calculated to the total value of the position, as is common in technical trading studies, would be inappropriate because it would understate the return relative to the value exposed to risk. Since risk exposure associated with the soy complex trade is unclear, profits are not adjusted for risk. Consequently, a risk adjusted test of market efficiency is not conducted.

RESULTS OF THE TRADING STRATEGY

Aggregate Results

The specific trading strategy analyzed here calls for placing the normal crush position (long soybeans, short meal, and short oil) whenever the implied profit margin is greater than zero (whether 0.25 cents or 25 cents). In contrast, the reverse crush position (short soybeans, long meal, long oil) is taken whenever the implied profit margin is less than zero. The last trades are lifted on the first trading day of December 1988. Because results are similar for all three moving averages used to estimate the cost of crush, only the results for the 60 month average are presented.

Average implied profit margins (Table I) are positive at the time trades are placed for the 1.5 and 3.5 month trades, but become increasingly negative as trade length increases. The increasingly negative implied margins are associated with higher trading losses for the routine normal crush position. In contrast, the combination of reverse crush positions (short soybeans, long meal, long oil) at implied margins below zero and normal crush positions (long soybeans, short meal, short oil) at implied margins above zero produces profits that exceed transactions costs by at least $235 per trade for trade lengths of 5.5 months or longer.

The normal crush position generates (Table II) larger profits and a higher percentage of profitable trades as implied margins become more positive. The same pattern occurres for the reverse crush as implied margins become more negative. At trade lengths of 3.5 months or longer, nearly all trades initiated by this trading strategy produce positive returns when implied margins at the time the trade is placed exceeds 20 cents or are less than negative 20 cents.

Table I
AVERAGE PROFITS NET OF TRANSACTION COSTS AND IMPLIED PROFIT MARGINS PER SOY COMPLEX SPREAD TRADE, CHICAGO BOARD OF TRADE, 1966 TO 1988

			Trading Strategies	
Length of Trade	Trades	Implied Profit Margin[a]	Normal Crush Position[b] Only	Normal Crush if Implied Profit Above 0; Reverse Crush[c] if Implied Profit Below 0
months	number	cents/bu.[d]	$ per trade[d]	
1.5	274	3.3	−373	−156
		(17.0)[d]	(905)[d]	(918)[d]
3.5	272	0.1	−477	3
		(15.6)	(1236)	(1248)
5.5	270	−1.2	−563	241
		(15.0)	(1312)	(1283)
7.5	268	−4.1	−722	235
		(11.1)	(1309)	(1315)
9.5[e]	182	−5.5	−837	418
		(13.5)	(1468)	(1445)

[a]Implied profit margin is calculated by subtracting estimated cost of crushing from the gross spread at the time of trade placement. Reported in cents per bushel of soybeans.

[b]The normal crush position is long soybeans, short meal, short oil.

[c]This strategy takes the reverse position (short soybeans, long meal, long oil) at all implied margins less than zero and the normal crush position at all implied margins greater than zero.

[d]Standard deviations are in parenthesis.

[e]Trades at 9.5 months were made over the 1973–1988 period because of thin trading that occurred prior to 1973.

Table II
PROFITS PER TRADE NET OF TRANSACTION COSTS BY LEVEL OF IMPLIED MARGIN; NORMAL CRUSH POSITION IF IMPLIED MARGINS GREATER THAN ZERO AND REVERSE CRUSH POSITION IF IMPLIED MARGINS LESS THAN ZERO; CHICAGO BOARD OF TRADE, 1966 TO 1988[a]

Implied Margins		Trade Length in Months				
		1.5	3.5	5.5	7.5	9.5[b]
cents[c]						
<−20	Mean Profit ($)	−70	1962	2703	2458	2296
	Stan. Dev.[d] ($)	377	2128	2236	2131	1932
	Nos. of Trades	2	5	11	15	22
	% Profitable[e]	50%	100%	100%	100%	95%
−20- −10	Mean Profit ($)	5	548	323	222	500
	Stan. Dev. ($)	655	1437	1165	1194	1477
	Nos. of Trades	35	33	37	39	37
	% Profitable	57%	64%	62%	62%	65%
−10-0	Mean Profit ($)	53	74	300	297	217
	Stan. Dev. ($)	740	969	1047	1194	1047
	Nos. of Trades	85	105	112	131	69
	% Profitable	36%	43%	56%	60%	58%
0-10	Mean Profit ($)	−366	−537	−364	−377	−276
	Stan. Dev. ($)	677	911	777	759	914
	Nos. of Trades	94	89	80	69	34
	% Profitable	23%	20%	25%	20%	47%
10-20	Mean Profit ($)	−402	−258	200	−2	−118
	Stan. Dev. ($)	1393	1281	1515	1581	1135
	Nos. of Trades	34	27	19	10	15
	% Profitable	38%	44%	47%	50%	60%
>20	Mean Profit ($)	38	1526	1357	1092	648
	Stan. Dev. ($)	1550	2001	1848	697	1359
	Nos. of Trades	24	13	11	4	5
	% Profitable	50%	77%	82%	100%	80%

[a]Normal crush is long soybeans, short meal, and short oil. Reverse crush is short soybeans, long meal, and long oil.
[b]Trades at 9.5 months were made over the 1973–1988 period because of thin trading that occurred prior to 1973.
[c]Cents per bushel of soybean futures.
[d]Standard deviation of profits per trade.
[e]Percent of trades that produced positive profits.

Positive trading returns are more consistently generated for the reverse crush (negative implied margins) as opposed to the normal crush (positive implied margins). In addition, the average returns are greater for the reverse crush trades than for the normal crush trades. These asymmetries are interesting, but current research does not provide a reason for these asymmetries. Additional research is needed, not only on the soybean crush spread, but on other processing spreads, such as the hog and cattle feeding margin spreads and the petroleum cracking spread.

Disaggregated Results

Statistical tests can not be performed on the aggregate results because positive autocorrelation exists due to the overlapping of trading periods. For example, the holding period for trades held for 7.5 months and placed on January 15, 1966 and February 15, 1966 overlap for 6.5 months.

To statistically test the trading results, profits are disaggregated by the month the trade is placed. For example, trades placed in January from 1966 to 1988 and held for 7.5 months are examined as a separate series. The autocorrelation function for these monthly series is not significantly different than zero.

No month at either the 1.5 or 3.5 trade length (Table III) has average monthly profits which are statistically significant at the five percent level. For each trade length of 5.5 months and longer, two or three months have significant average profits at the 5 percent level. At the 10 percent level of significance for these longer trade lengths, five months have average profits that are statistically significant. Note, also, that no discernable seasonal pattern of profits is observed.

Under a null hypothesis of market efficiency and assuming a t-distribution on trading returns, the number of monthly return series expected to have significant profits at the five and ten percent level are 0.6 and 1.2 months, respectively. These critical values are exceeded at trade lengths of 5.5 months and beyond.

Results obtained for the monthly disaggregated analysis are tested for sensitivity to different trading periods. Periods analyzed for trade lengths of 7.5 months or less are (1) 1966 through 1988 excluding 1973 and 1974, (2) 1966 through 1976, and (3) 1977 through 1988. For the 9.5 month trade length, periods tested are (1) 1975 through 1988 and (2) 1977 through 1988. The same general results are obtained for each of these subperiods as for the entire study period although the exclusion of 1973 and 1974 does reduce the level of profits. Furthermore, trading profits are more prevalent for the 1977–1988 period than for the 1966–1976 period. Last, the trading strategy is profitable in both 1987 and 1988. Taken together, these results suggest that the trading strategy remains profitable over the 23 year period studied. (For a more complete discussion of the subperiod analysis, see Johnson (1989)).

CONCLUSIONS AND IMPLICATIONS

This research uses a combination of profit margin trading rules to test the market efficiency of the soy complex (soybeans, soyoil, and soymeal). Normal crush positions (long soybeans, short soyoil, short soymeal) are taken when positive processing margins are implied by soy complex futures prices. Reverse crush positions (short soybeans, long soyoil, long soymeal) are taken when negative processing margins are implied. Significant profits above transaction costs are not found at trade lengths of 1.5 and 3.5 months, but are found at trade lengths of 5.5 months or longer. These findings suggest that, while nearby soy complex futures price spreads are efficient according to Fama's criterion; distant soy complex futures price spreads are not Fama efficient.

Stein (1981) provides theoretical evidence that the optimality of resource allocation depends on the accuracy of futures price forecasts of subsequent realized prices. Because this study utilizes a buy (sell) and hold strategy, the trading results provide a test of the unbiased nature of the soybean crush spread from the perspective of economic profits associated with crushing soybeans. Results of this study suggest that soy complex futures price spreads are not unbiased forecasts over longer time periods. Biased spread forecasts are found also by Shapiro and Kenyon

Table III

PROFITS PER TRADE NET OF TRANSACTION COSTS BY MONTH TRADE IS PLACED; NORMAL CRUSH POSITION IF IMPLIED MARGINS GREATER THAN ZERO AND REVERSE CRUSH POSITION IF IMPLIED MARGINS LESS THAN ZERO; CHICAGO BOARD OF TRADE, 1966 TO 1988[a]

Month	Trade Length in Months[b]				
Trade Placed	1.5	3.5	5.5	7.5	9.5
			$ per trade[c,d]		
Jan	−251	−179	496¶¶	−206	−344
	(1315)	(1016)	(1247)	(712)	(1247)
Feb	−171	137	478	−22	396
	(594)	(1550)	(1378)	(974)	(1728)
Mar	−85	146	−29	−292	693¶¶
	(692)	(1084)	(827)	(1062)	(1341)
Apr	139	349¶	81	368	655¶¶
	(880)	(1095)	(931)	(1412)	(1088)
May	0	151	−701	672¶¶	525
	(600)	(926)	(907)	(1147)	(1830)
Jun	−66	124	336	566¶¶	558¶¶
	(1003)	(1208)	(1250)	(1013)	(1026)
Jul	−40	−392	437¶	516	435
	(1159)	(1049)	(1475)	(1871)	(1598)
Aug	−212	−199	536¶¶	337¶	622¶
	(788)	(1538)	(1362)	(1155)	(1701)
Sep	−515	57	340	137	364
	(719)	(1438)	(1793)	(1382)	(1663)
Oct	−44	6	68	−84	785¶
	(1201)	(1328)	(1101)	(1717)	(1779)
Nov	−445	−84	306	405¶	232
	(984)	(1684)	(1202)	(1425)	(821)
Dec	−195	−89	577¶¶	466¶	175
	(713)	(868)	(1358)	(1348)	(1192)
Significance	Number of Months with Significant Profits				
5% level:	0	0	3	2	3
10% level:	0	1	5	5	5

[a]Normal crush is long soybeans, short meal, and short oil. Reverse crush is short soybeans, long meal, and long oil. Trades were placed from 1966 to 1988 for trade lengths of 7.5 months or less and from 1973 to 1988 for the 9.5 month trade length.

[b]Number of trades (observations) per month by trade length were: 1.5 months-22 for Nov. and Dec. and 23 otherwise; 3.5 months-22 for Sep. through Dec. and 23 otherwise; 5.5 months-22 for Jul. through Dec. and 23 otherwise; 7.5 months-22 for May through Dec. and 23 otherwise; and 9.5 months-15 for Mar. through Dec. and 6 otherwise.

[c]Standard deviations are in parenthesis.

[d]¶ and ¶¶-profits significantly above zero at 10% and 5%, respectively, using a one-tailed *t*-test.

(1976) for the broiler-corn-soybean meal feeding margin spread and by Kenyon and Clay (1987) for the hog-corn-soybean meal feeding margin spread.

According to Stein's theoretical model, the soybean processing spread does not produce an optimal allocation of soybean processing resources. However, the results of this study are consistent with the economic response of producers and consumers to incentives or disincentives for soybean processing. These responses cause soybean processing profits to move toward the cost of production by bringing an allocation of resources which is more optimal. In other words, the trading profits are consistent with a mean reversion process (see Fama and French (1988) and DeBondt and Thaler (1989)) with the cost of production being the mean. The trading results are also consistent with Cootner's (1964) and Samuelson's (1976) observation that prices are not truly a random walk but are constrained by economically determined barriers.

This research has implications for the conventional view of hedging. Traditionally, a futures position is considered a hedge if it "is intended as a temporary substitute for the sale or purchase of the actual commodity" (Chicago Board of Trade, p. 351). However, this research suggests that routinely hedging the soybean crush in accordance with the traditional view of hedging (i.e., normal crush hedge) would be highly unprofitable. In contrast, this study suggests that successful hedging in the soybean complex might be described more accurately as arbitraging the relationship between the cost of an economic activity and the profit futures prices offer firms to enter into or exist from soybean crushing.

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