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A Calendar Spread Trading Simulation of Seasonal Processing Spreads

Christine A. Cole, Terry L. Kastens, Fredrick A. Hampel, and Laura R. Gow*

This study examined the potential reliability of seasonality in intermarket incremental margin calendar crushes, expected margin calendar crushes, and deferred crushes for application in real-time futures trading. Seasonal rolling averages were used to select the expected high (sell) and buy (low) points for out-of-sample trading simulations of four processing spreads: the heating oil crush, the unleaded gasoline crush, the soybean complex crush, and the cattle crush. Results suggest that simple buy (sell) and hold trading strategies based on historical seasonality do not generally produce positive profits that are significantly different from zero. Results indicate that of the twelve crush combinations examined, only the incremental cattle and the May deferred cattle crushes exhibited statistically significant profits. Furthermore, results suggest that although seasonal recurring patterns allude to profit opportunities, these opportunities erode quickly due to rolling and trading transactions costs.

Introduction

The potential for futures market profits through the application of simple trading rules has been an interest of traders and researchers for some time. Much of the recent interest has been concentrated in the possible profit opportunities existing in spread trades (Abken; Barrett and Kolb; Girma and Paulson; Johnson et al.). Futures contract spreading involves simultaneously buying and selling various futures contracts. The return on the spread depends on the subsequent movement of the futures prices comprising the spread and thus, the ending spread value relative to the initial spread value.

The price behavior of spreads accounts for a large portion of the speculative trading behavior in the futures market (Barrett and Kolb). However, spreads have generally received less attention than price levels when examining trading. The majority of the literature discussing spreads has typically focused on intracommodity (intramarket) spreads. However, numerous other spreads exist and are of interest, especially to traders. One topic related to commodity prices that is commonly examined in research is that of seasonality. Obviously, if any spread exhibits a recurring seasonal pattern, then a clear profit potential exists. Seasonal patterns have been shown to exist in several commodities and markets including the stock market, interest rate futures, and gold futures (Gay and Kim). In conjunction with seasonality, speculative traders are continually looking for simple, easy-to-follow, easy-to-understand, and apply trading rules that have a high probability of being profitable. Trading rules which are complex and time

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consuming are of little interest to traders, who must respond quickly to changing markets.

This study examines the profit opportunities existing in several futures-based spreads with the application of a few relatively simple trading rules. In particular, the objective of this study is to determine whether futures-based heating oil crack, gasoline crack, soybean crush, and cattle feeding margin spreads exhibit seasonality that can be predicted out-of-sample and profitably exploited through a few simple trading rules.

Previous Research

Several previous studies have examined seasonality in futures markets and spread trades. Chiang and Tapley examined 15 commodity futures and 6 financial futures contracts traded on the Chicago Board of Trade (CBT) from 1972-1980 for day-of-the-week effects. They concluded that day-of-the-week effects did exist. Gay and Kim investigated seasonality in the Commodity Research Bureau (CRB) futures price index. They confirmed the existence of day-of-the week effects and concluded that seasonality in the futures market is similar to that documented for the stock market, despite the existence of institutional differences between the two markets. Hampel, Schroeder, and Kastens studied the expected returns in cattle feeding in association with risk. They indicated the existence of seasonality in both expected and actual cash cattle feeding margins.

A few studies have analyzed spreads in agricultural futures. Barrett and Kolb tested for regularities in the profitability of intramarket and intermarket spreads for corn, wheat, oats, and soybeans. They concluded that little evidence exists to support regularities in profit potential in these spreads on either a calendar or contract time basis. Johnson et al. used implied profit margin trading rules to test for market efficiency (speculative opportunities) in the soy complex crush margin. They found spread trading in the nearby contracts did not exhibit significant profit opportunities, however, such opportunities did exist in trading distant contracts.

Studies have also examined energy market futures and processing spreads. For example, Abken found that intramarket heating oil futures spreads exhibit seasonality and that positive profits were greater in winter spread trades than summer trades. Girma and Paulson examined petroleum crack spreads for trading month and trading week seasonality and exploitable profit opportunities. They demonstrated that historically simple buy (sell) and hold trading strategies can produce statistically significant trading profits in futures-based petroleum crack spreads.

These studies have documented seasonality, and they provide relevant information about profit opportunities. However, they have not examined the use of specific trading rules based on seasonal peaks and troughs, nor have they directly tested intramarket calendar spreads. The relationships concerning processing spreads can be complex and difficult to understand, and as Girma and Paulson have noted, a concrete theoretical foundation that explains the behavior of these spreads is generally lacking. Empirical trading simulations provide economists with evidence of market efficiency, however, the primary implication of this study is to document and analyze the seasonal behavior of processing spreads and their intramarket tendencies so that

market participants will have a better understanding of seasonal periodicity and its potential reliability for real-time trading. Traders, processors, and vertical integration-minded producers should be interested in these relationships.

Crush Spread Trading

Crush spreads are traded with the objective of making a trading profit, or more appropriately, to maximize profit. The existence of seasonality conceptually implies profit opportunity, provided that historically recurring seasonal patterns persist into the future. However, the level of profit is conditional on losses due to rolling and trading transactions costs, in addition to a persistent seasonal pattern.

It seems reasonable that the characteristics of supply and demand should lead to seasonal patterns in both the petroleum based crushes and the agricultural crushes. Supply and demand for heating oil and gasoline are affected by seasonal weather patterns, political situations, and the economic environment. Gasoline demand typically peaks during the summer months as travel increases, and the demand for heating oil generally peaks during the winter when temperatures drop. Changes in the demand for gasoline and heating oil will affect the demand for crude oil, an input into their production, which will thereby affect petroleum crush spreads. Supply and demand for soybean meal, soybean oil, and live cattle are also affected by seasonal crop and livestock production, the economic environment, and seasonal weather patterns. Interestingly, weather most heavily affects the demand side for petroleum products whereas it most heavily affects the supply side for the agricultural products. The supply of soybeans and corn generally peaks during the fall when harvest occurs and decreases throughout the rest of the year as inventory is consumed. Additionally, whereas many agricultural decisions, especially grain supply, are made only one time per year, petroleum supply decisions can be made daily, providing petroleum with a more elastic supply.

Data

The data consist of weekly heating oil and crude oil futures prices from April 1983 through December 1998, unleaded gasoline futures prices from January1985 through December 1998, and soybean, soybean meal, soybean oil, corn, feeder cattle, and live cattle futures prices from January 1973 through December 1998. Wednesday's closing price was used as the weekly futures price. Tuesday's price was used whenever Wednesday was not a trading day. Futures prices were obtained from the *Bridge/CRB Electronic Database* and from the *Wall Street Journal.*

All months were standardized to four weeks which assumes a 48 week calendar year. For months with five Wednesdays, prices for the fourth and fifth week were averaged and reported as the quote for the fourth week. Additionally, for simulation purposes, grain and cattle contracts were considered to end in the second week of the delivery month, and petroleum contracts were considered to end in the second week in the month preceding delivery. Contracts were considered to end at these times in order to ensure trading price existence and annual consistency

across calendar weeks and contracts.

Analytical Framework

In order to determine the profitability of using simple buy (sell) and hold trading strategies coupled with seasonality in intermarket crush spreads, two main types of processing crushes are used in this analysis: incremental crushes and expected margin crushes. An incremental crush can be described as a real-time crush or practical crush. An incremental crush theoretically assumes that there is immediate turnaround and conversion of inputs into product (or output). Thus, an incremental crush always consists of the nearby (spot) contract for both the product and input contracts. In other words, with an incremental crush, a trader trades whatever contract is nearest the cash.

Expected crushes, on the other hand, resemble the actual holding period or processing period of input into product. They assume a realistic processing period between the point in time when inputs are acquired and the time when the finished product can be sold. Expected crushes will typically consist of the nearby contract for the inputs and deferred contracts for the products in the spreads. Since the expected crush is developed more with physical limitations in mind than the almost-naive incremental crush, there may be greater opportunities to profit in an expected crush since theory would suggest arbitrage opportunities there. For this simulation, the heating oil, gasoline, and soybean crushes were developed assuming a one month (4 week) processing period. Following Kastens and Schroeder, the cattle crush was developed assuming a 19 week production period.

All crush values in this analysis are in terms of product value less input value, thus, profit margins of the production process. For simplicity and in order to conform with typical and realistic trading practices, only whole contracts were used. That is, all contracts were rounded to whole numbers. Thus, the crushes are the 1:1 heating oil crush, 1:1 gasoline crush, 1:1:1 soybean crush, and the 2:1:1 cattle crush. Since not all contracts used in a particular crush are quoted in the same units, it is necessary to convert all prices within a spread into the same unit of measure. Crude oil prices are quoted in dollars per 42 gallon barrel while unleaded gasoline and heating oil are quoted in dollars per gallon. All three contracts are for 1000 barrels. In this research, petroleum crushes are reported in terms of dollars per barrel of crude oil. Mathematically, these crushes are as follows:

$$1{:}1\ \textit{Heating Oil Crush}\ (HOC) = (42 \times HO) - CL$$

$$1{:}\ \textit{Gasoline Crush}\ (GC) = (42 \times HU) - CL$$

where *HO, CL,* and *HU* are heating oil, crude oil, and unleaded gasoline futures contract prices, respectively. Equations (1) and (2) depict the margin in dollars associated with converting one barrel of crude oil into either one barrel of heating oil (HOC) or one barrel of gasoline (GC).

Soybean meal prices are quoted in dollars per ton, soybean oil in cents per pound, and soybeans in cents per bushel. In this research, the soybean crush is reported in terms of dollars per ton of soybean meal. Soybeans, soybean oil, and soybean meal contracts are 5000 bushels, 30 tons, and 100 ton, respectively. The conversion is as follows:

$$(3) \qquad :1:1\ Soybean\ Crush\ (SC) = [(6 \times BO) + SM] - [(1/2) \times S]$$

where *SM, BO,* and *S* are soybean meal, soybean oil, and soybean futures contract prices, respectively. Equation (3) depicts the margin in dollars associated with converting 50 bushels (1.5 tons) of soybeans into 1 ton of soybean meal and 0.3 tons of soybean oil.

Live cattle and feeder cattle prices are quoted in cents per pound while corn prices are quoted in cents per bushel. Live cattle, feeder cattle, and corn contracts are 40,000 pounds, 50,000 pounds, and 5,000 bushels, respectively.[1] These prices are converted to report the crush in dollars per hundredweight of feeder cattle. The crush conversion is as follows:

$$(4) \qquad 2:1:1\ Cattle\ Crush\ (CC) = (1.6 \times LC) - FC - |(C \div 10)$$

where *LC, FC,* and *C* are live cattle, feeder cattle, and corn futures contract prices, respectively. Equation (4) depicts the margin in dollars associated with converting 100 pounds of feeder cattle and 10 bushels of corn into 160 pounds of live cattle.

The trading rule followed for this analysis was that of placing one trade on the out-of-sample expected seasonal high (low) and maintaining the position until it is unwound at the out-of-sample expected seasonal low (high). For the incremental margins crushes, this means rolling from one nearby crush to the next nearby crush. For the expected margin crushes this means rolling from one expected margin crush to another when the nearby input leg of the crush expires. All crush position profits (losses) were adjusted for gains (losses) experienced due to rolling the position as needed to keep the crush trade active.[2] The point in this simulation is to determine if historical seasonal extremes can be used to predict out-of-sample patterns for the purpose of generating profit. Expected seasonal peaks and troughs for each crush were taken to be the historical five-year rolling average of the crush. Seasonal rolling averages were created for both the incremental and the expected margin crushes. Commission costs of $50 per round-

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[1] We have ignored the fact that feeder cattle contracts changed from 44,000 pounds to 50,000 pounds during the study period (with the January 1993 contract), which is consistent with the idea that feeder cattle and live cattle weights per head have both increased during the study. Furthermore, the crush is a simplified crush in terms of numbers of contracts.

[2] Differences in weekly crush values across time cannot necessarily be captured in trading because rolling involves discrete changes in position when expiring contracts are closed out and "next out" contracts are simultaneously opened.

turn trade are accounted for at the end of the analysis. Justification for the simplicity in this trading simulation originates from the demand of professional traders for simple, quick, and easy trading rules. Traders typically desire rules which are easy to understand and simple to apply.

An additional portion of this trading simulation examined seasonality and profit opportunities in deferred crushes. For exposition, we consider such crushes labeled by month, with an X-month crush considered to expire in the second week of month X. Alternatively, deferred crushes can be thought of as expected crushes, only without rolling. Analyzing deferred crushes involves examining crushes from a point in time well in advance of when they are actually nearby crushes, up until they are nearby. This simulation examines deferred crushes up to 48 weeks in advance of their expiration, although contracts often may not trade that far in advance. We examine seasonality in the 48 weeks of crush prices by taking the average of the previous five years' crush prices, and then we trade the high and low points in the crush. For example, the January 1978 cattle crush consists of the January 1978 feeder cattle price, the March 1978 corn price, and the June 1978 live cattle price, all considered observed for the last time in the second week of January 1978. This crush was considered as far in advance as the second week in January 1977, provided all contracts were actually trading that far in advance. The high and low points for the January 1978 crush were determined using a five year average of the January 1973 to January 1977 crushes. In order for a five year historical series to be considered for seasonally timing trades, we assumed it had to have at least three out of the five years' points trading. In some cases, the high or low point of the 5-year historical average occurs earlier in the year in history than when the crush we want to trade begins trading. In these circumstances, the first week in which the crush actually trades is considered to be the entry point.

Seasonality and Trading Results

Figures 1, 2, 3, and 4 confirm the existence of seasonal patterns in the intermarket processing crushes. The most notable patterns occur in the heating oil and gasoline crushes with the heating oil crush reaching its high during the winter and its low during the summer and the gasoline crush peaking in the summer and bottoming out during the winter. Although not as apparent as in the petroleum crushes, and dwarfed by the associated year-to-year variability, Figure 3 shows some evidence of seasonality in the soybean crush. The cattle crush (Figure 4) displays a tendency for two peaks and troughs per year—although they are not large. It is important to note, with all four incremental crushes, that even recurring seasonality may not be practically tradeable. That is, small profits can quickly erode with numerous futures transaction changes. Furthermore, the figures belie potential losses in position experienced during rolls forward of the underlying contracts.

Table 1 presents the trading simulation results for the incremental margin crushes. The heating oil crush was traded for the 11 year period of 1988-1998, the gasoline crush for the nine years of 1990-1998, and the soybean and cattle crushes for the 21 years of 1978-1998. Transaction costs of $50 per round-turn trade are taken into account in all profit calculations. Results indicate the mean annual loss for the heating oil crush over the 11 year period was $0.62

per barrel of crude oil. Only 3 out of the 11 trading years exhibited positive profits. Mean annual profit for the gasoline crush was $0.34 per barrel of crude oil. Only 3 of the 9 years of this trade exhibited losses; however, these losses were all greater than the profits in 5 of the 6 positive years. The incremental soybean crush had a mean annual profit of $1.57 per ton and a 21 year total profit of $33.07 per ton of soybean meal. Nearly half of the years for this crush ended with losses, however, many of the annual profits were considerably larger than the losses in negative years.

In Table 1, the cattle crush exhibited the most profitability per crush trading unit of the incremental crushes. Its mean annual profit was $4.29 per cwt of feeder cattle. Only 6 of the 21 years traded for the cattle crush incurred losses. Moreover, annual losses were scattered throughout the study period, suggesting that perceived risk in trading such a scheme may not have been excessive. Interestingly, the crush would have been sold in week 14 during 8 of 21 years in the simulation and would have been bought at nearly the same time (weeks 23, 24, or 25) in 12 of 21 years. Overall, two-tail p-values for the crushes in Table 1 indicate only the cattle crush profits were statistically different from zero.

Table 2 presents simulation results for the expected margin crush profits. Results indicate a mean annual loss of $1.15 per barrel of crude oil and a total trading period loss of $12.65 per barrel for the heating oil crush. Profits were positive for only 3 of the 11 years traded for this crush. Although still negative, the gasoline crush results were somewhat better than those for heating oil, with a mean annual loss of $0.43 per barrel of crude oil and total losses of $3.90 per barrel. Five of 9 years incurred losses trading this crush. Results for the expected margin soybean crush were relatively worse than those for its incremental counterpart in Table 1, with the expected margin crush incurring a mean annual loss of $0.43 per ton of soybean meal and a total trading period loss of $9.06 per ton. Only 43% of the trading years showed positive profits for this crush. As with the incremental crushes in Table 1, the expected margin cattle crush was the most profitable of the expected margin crushes. Results indicate a mean annual profit of $0.07 per cwt of feeder cattle and a total trading period profit of $1.43 per cwt for the expected margin cattle crush. Eleven of the 21 trading years achieved positive profits. Despite its relative positive performance, a two-tail p-value indicates that profits of the cattle crush are not statistically different from zero. P-values for the losses of the other three expected margin crushes indicate those for the heating oil crush were statistically different from zero (albeit losses rather than profits) while those for the gasoline and soybean crushes were not statistically significant.

Table 3 presents the results for the deferred crush trading simulations. Here, results are averages (across years) by crush expiration month.[3] For example, the deferred January heating oil crush result in Table 3 is the average of the deferred crushes traded that expired in the month of January for the years 1988 through 1998. Results indicate that mean profits for the deferred

[3] For deferred crushes, historical seasonality is based on the 12 month period where a crush can be traded rather than on calendar years. Moreover, trading these crushes does not involve rolling through contracts over time.

heating oil crush were only positive for the deferred February, March, and September crushes. Typically, the heating oil deferred crushes were first sold and then bought back for at least 7 of the 12 deferred crushes. Average selling weeks ranged from 11 to 27 weeks prior to the contract expiration, and average buying weeks ranged from 4 to 33 weeks prior to expiration. P-values for the twelve deferred contracts all exceed 0.50, indicating wide variability in annual trading profits. Mean profits for the monthly deferred gasoline crush were positive for eight contracts, with average losses occurring in the crushes ending in August through November. The gasoline crush was typically bought first and then sold back. Average crush selling weeks ranged from 6 to 24 weeks prior to contract expiration, and average buying weeks ranged from 6 to 29 weeks prior to expiration. P-values were not indicative of significantly-different-from-zero profits.

Results for the soybean crush indicate that on average only the deferred crushes expiring in May and August realized a profit. Average crush selling weeks for all deferred positions ranged from 8 to 28 weeks prior to contract expiration, and buying weeks ranged from 15 to 34 weeks prior to contract expiration. Profits were not significantly different from zero for the soybean crush. Mean profits for the deferred cattle crush were only positive for the deferred positions expiring in May, October, and December. Typically (10 of 12 months), the deferred cattle crushes were bought first and were then subsequently sold back. Average crush selling weeks extended from 5 to 22 weeks prior to contract expiration, and buying weeks ranged from 14 to 26 weeks prior to expiration. Average profit was significantly different from zero for only the cattle crush expiring in May. Although not shown, this was mainly due to a relatively large ($11.25) profit in 1980. The largest absolute profit across all other years was $4.98. The December deferred crush was marginally significant.

Conclusions and Implications

This study examined the potential reliability of seasonality in intermarket processing spreads for application in real-time futures trading. The study used seasonal rolling averages to select the expected high (sell) and low (buy) points for out-of-sample trading simulations. Three crush types were examined: incremental margin calendar crushes, expected margin calendar crushes, and deferred crushes. These crush types were analyzed for the heating oil crush, the unleaded gasoline crush, the soybean complex crush, and the cattle crush.

Previous studies have shown significant profits to exist in trading various spreads (Abken; Girma and Paulson; Johnson et.al). Results of this study suggest that simple buy (sell) and hold trading strategies based on historical seasonality do not generally produce positive profits that are significantly different from zero after transactions costs of $50 per round-turn trade are taken into account. Results indicate that for the four processing crushes examined, only the incremental cattle crush and the May deferred cattle crushes exhibited positive profits which were significantly different from zero. The expected margin heating oil crush had losses which were significantly different from zero. All other trading profits were not statistically significant.

As with all economic analyses that rely on statistical significance, the relevant question is, Does uncovered statistical significance parallel an intuition or theoretical understanding of the

underlying forces? Would a trader actually "do the opposite" in the case of the expected margin heating oil crush by buying when history indicated a sell and selling when a buy was indicated? Would a trader have the courage to trade the largely profitable (and statistically significant) incremental margin cattle crush when the slightly differently defined expected margin cattle crush did not have significant profits?

Although seasonality does appear to exist in the intermarket processing spreads examined in this study, the results suggest that the opportunity for profit dissipates quickly due to rolling and commission costs. The lack of tradeable profit opportunity is consistent with the results of Barrett and Kolb who found little evidence supporting profit potential in intramarket and intermarket crop spreads and with Johnson et. al who found no significant profit opportunities in the nearby soybean complex. The results are also consistent with an efficient market.

References

Abken, P.A. "An Analysis of Intra-Market Spreads in Heating Oil Futures." *The Journal of Futures Markets*. 9(1989):77-86.

Barrett, W.B. and R.W. Kolb. "Analysis of Spreads in Agricultural Futures." *The Journal of Futures Markets*. 15(1995):69-86.

Bridge/CRB Electronic Database. Chicago, Illinois. Source of 1973-1998 futures prices.

Chiang, R. and T.C. Tapley. "The Day of the Week Effect in the Futures Market." *Review of Research in Futures Markets*. 2(1983):356-410.

Gay, G.D. and T.H. Kim. "An Investigation into Seasonality in the Futures Market." *The Journal of Futures Markets*. 7(1987):169-81.

Girma, P.B. and A.S. Paulson. "Seasonality in Petroleum Futures Spreads." *The Journal of Futures Markets*. 18(1998):581-98

Hampel, F.A., T.C. Schroeder, and T.L. Kastens. "Risk and Expected Returns in Cattle Feeding." *Proceedings of NCR-134 Applied Commodity Price Analysis, Forecasting, and Market Risk Management*, Chicago, IL. (April 1998):265-277.

Johnson, R.L., C.R. Zulauf, S.H. Irwin, and M.E. Gerlow. "The Soybean Complex Spread: An Examination of Market Efficiency from the Viewpoint of a Production Process." *The Journal of Futures Markets*. 11(1991):25-37.

Kastens, T.L. and T.C. Schroeder. "A Trading Simulation Test for Weak-Form Efficiency in Live Cattle Futures." *The Journal of Futures Markets*. 15(1995):649-75.

The Wall Street Journal. Various Issues, 1985-1998.

Table 1. Estimated Petroleum Based and Agricultural *Incremental* Margin Crush Profits by Year, 1978-1998 [a]

	Heating Oil Crush			[illegible]			Soybean Crush			Cattle Crush		
	Week Sold	Week Bought	Annual Profit	Week Sold	Week Bought	Annual Profit	Week Sold	Week Bought	Annual Profit	Week Sold	Week Bought	Annual Profit
1978	-----	-----	-----	-----	-----	-----	31	22	$4.53	17	6	$2.30
1979	-----	-----	-----	-----	-----	-----	8	15	($2.49)	17	6	$6.05
1980	-----	-----	-----	-----	-----	-----	41	17	($3.15)	17	5	$8.22
1981	-----	-----	-----	-----	-----	-----	41	16	($4.91)	17	45	($8.01)
1982	-----	-----	-----	-----	-----	-----	42	16	$0.93	17	5	$12.93
1983	-----	-----	-----	-----	-----	-----	41	17	$1.66	22	45	($0.83)
1984	-----	-----	-----	-----	-----	-----	41	20	$34.00	22	4	$4.33
1985	-----	-----	-----	-----	-----	-----	42	13	($17.13)	18	4	($2.05)
1986	-----	-----	-----	-----	-----	-----	42	12	($35.19)	18	4	$0.66
1987	-----	-----	-----	-----	-----	-----	42	29	$25.22	14	23	$4.51
1988	48	21	$0.66	-----	-----	-----	42	19	$12.28	14	23	$4.92
1989	2	22	$6.34	-----	-----	-----	42	19	$27.61	12	24	($1.46)
1990	48	22	($1.58)	16	46	($2.35)	40	24	($7.21)	14	25	($9.95)
1991	1	22	$0.64	18	46	$1.25	40	24	$13.16	14	25	$8.94
1992	45	22	($2.40)	18	46	$1.78	40	24	($13.98)	14	25	$8.45
1993	48	22	($0.29)	17	46	$0.76	40	25	$7.17	14	25	$9.29
1994	39	16	($4.10)	17	46	$1.39	40	22	$16.44	14	24	$9.02
1995	39	18	($1.01)	13	37	($2.41)	40	7	($6.94)	14	24	$4.59
1996	40	18	($1.37)	17	37	$5.03	39	23	($4.38)	9	23	$10.18
1997	43	22	($1.32)	17	36	($3.15)	39	23	($5.67)	11	25	$4.38
1998	43	22	($2.43)	17	37	$0.77	33	23	($8.84)	11	25	($6.30)
Sum			($6.86)			$3.07			$33.07			$90.09
Mean			($0.62)			$0.34			$1.57			$4.29
N			11			9			21			21
Std Error of Mean			$0.81			$0.86			$3.51			$1.22
t-Statistic			-0.77			0.40			0.45			3.51
2-tail p-value			0.4601			0.7020			0.6584			0.0022

[a]Heating oil and gasoline crushes are reported in $/barrel of crude oil. Soybean crushes are reported in $/ton of soybean meal. Cattle crushes are reported in $/cwt of feeder cattle. Weeks bought and sold are calendar weeks in a 48-week year.

Table 2. Estimated Petroleum Based and Agricultural *Expected* Margin Crush Profits by Year, 1978-1998 [a]

	Heating Oil Crush			Gasoline Crush			Soybean Crush			Cattle Crush		
	Week Sold	Week Bought	Annual Profit	Week Sold	Week Bought	Annual Profit	Week Sold	Week Bought	Annual Profit	Week Sold	Week Bought	Annual Profit
1978	-----	-----	-----	-----	-----	-----	48	23	$16.58	45	31	$15.67
1979	-----	-----	-----	-----	-----	-----	7	23	($0.21)	46	14	($13.30)
1980	-----	-----	-----	-----	-----	-----	41	23	($0.40)	1	12	($25.12)
1981	-----	-----	-----	-----	-----	-----	41	23	($16.69)	1	10	($10.90)
1982	-----	-----	-----	-----	-----	-----	47	20	($16.20)	46	12	$11.86
1983	-----	-----	-----	-----	-----	-----	42	20	$6.37	1	33	($10.77)
1984	-----	-----	-----	-----	-----	-----	42	20	$39.26	1	9	$1.32
1985	-----	-----	-----	-----	-----	-----	42	20	($20.73)	42	14	$7.44
1986	-----	-----	-----	-----	-----	-----	42	19	($30.52)	41	14	$17.60
1987	-----	-----	-----	-----	-----	-----	42	30	$36.03	41	13	$10.51
1988	36	18	($0.98)	-----	-----	-----	42	30	$7.77	41	12	$7.02
1989	45	11	($2.28)	-----	-----	-----	42	27	$28.28	41	5	$12.23
1990	45	22	$0.74	16	46	($0.88)	40	25	($3.19)	41	5	$10.78
1991	45	16	($0.86)	18	46	$0.81	40	25	$5.35	42	4	($7.90)
1992	45	16	($2.09)	14	38	$0.96	40	25	($11.99)	42	5	$14.88
1993	39	16	$0.30	17	38	($1.38)	40	25	($1.29)	43	5	($9.23)
1994	39	16	($4.43)	17	38	($0.15)	40	22	$4.51	43	5	$23.61
1995	39	18	($1.14)	13	36	($1.42)	39	19	$6.54	39	48	$4.67
1996	36	18	$0.23	9	34	$1.65	39	20	($20.19)	39	48	($2.17)
1997	37	14	($0.75)	7	34	($3.56)	39	26	($33.16)	37	1	($26.67)
1998	42	13	($1.40)	14	34	$0.06	39	30	$7.90	15	48	($16.08)
Sum			($12.65)			($3.90)			($9.06)			$1.43
Mean			($1.15)			($0.43)			($0.43)			$0.07
N			11			9			21			21
Std Error of Mean			$0.44			$0.53			$4.29			$3.14
t-Statistic			-2.64			-0.82			-0.10			0.02
2-tail p-value			0.0246			0.4348			0.9209			0.9830

[a]Heating oil and gasoline crushes are reported in $/barrel of crude oil. Soybean crushes are reported in $/ton of soybean meal. Cattle crushes are reported in $/cwt of feeder cattle. Weeks bought and sold are calendar weeks in a 48-week year.

Table 3. Estimated Petroleum Based and Agricultural Deferred Margin Crush Profits by Month, 1978-1998[a]

	Heating Oil Crush (1988-1998)			Gasoline Crush (1990-1998)			Soybean Crush (1978-1998)			Cattle Crush (1978-1998)		
	Mean Profit ($/barrel)	P-Value	Average Buy, Sell Weeks	Mean Profit ($/barrel)	P-Value	Average Buy, Sell Weeks	Mean Profit ($/ton)	P-Value	Average Buy, Sell Weeks	Mean Profit ($/cwt)	P-Value	Average Buy, Sell Weeks
January	($0.21)	0.89	4, 19	$0.31	0.65	8, 11	($5.81)	0.51	26, 24	($0.20)	0.50	16, 20
February	$0.55	0.50	6, 27	$0.68	0.53	18, 12	($9.83)	0.22	30, 28	($0.21)	0.50	20, 10
March	$0.25	0.66	13, 25	$1.77	0.14	15, 7	($9.71)	0.15	31, 19	($0.16)	0.52	24, 9
April	($0.01)	0.92	15, 20	$1.06	0.39	20, 9	($7.59)	0.28	32, 24	($1.02)	0.21	22, 9
May	($0.28)	0.83	18, 25	$1.16	0.25	22, 6	$0.07	0.77	34, 15	$1.41	0.01	26, 5
June	($0.55)	0.60	28, 26	$0.07	0.88	19, 24	($4.67)	0.51	33, 19	($0.61)	0.81	19, 10
July	($0.48)	0.56	23, 27	$0.18	0.76	26, 22	($3.05)	0.79	21, 14	($0.46)	0.99	17, 14
August	($0.43)	0.66	29, 13	($0.56)	0.50	29, 11	$2.30	0.58	22, 12	($0.66)	0.71	17, 11
September	$0.25	0.61	33, 12	($0.54)	0.59	25, 15	($5.14)	0.62	22, 8	($0.25)	0.71	21, 12
October	($0.06)	0.90	31, 11	($0.10)	0.99	27, 14	($2.66)	0.87	15, 13	$0.09	0.19	17, 15
November	($0.32)	0.67	20, 15	($0.65)	0.45	6, 17	($0.48)	0.88	18, 14	($0.12)	0.54	18, 14
December	($0.33)	0.76	17, 18	$1.66	0.14	6, 7	($6.57)	0.49	23, 19	$0.19	0.08	14, 22

[a]Heating oil and gasoline crushes are reported in $/barrel of crude oil. Soybean crushes are reported in $/ton of soybean meal. Cattle crushes are reported in $/cwt of feeder cattle. Weeks bought and sold are calendar weeks prior to the week when a deferred crush was considered expired.

Figure 1

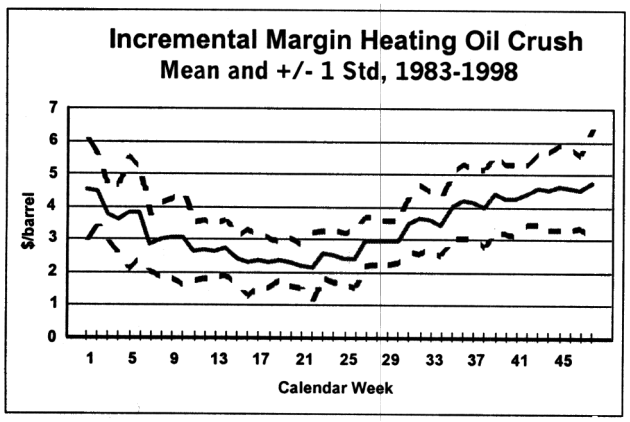

Figure 2

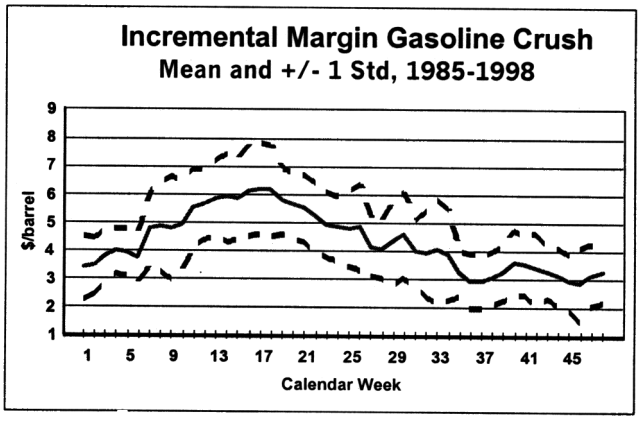

Figure 3

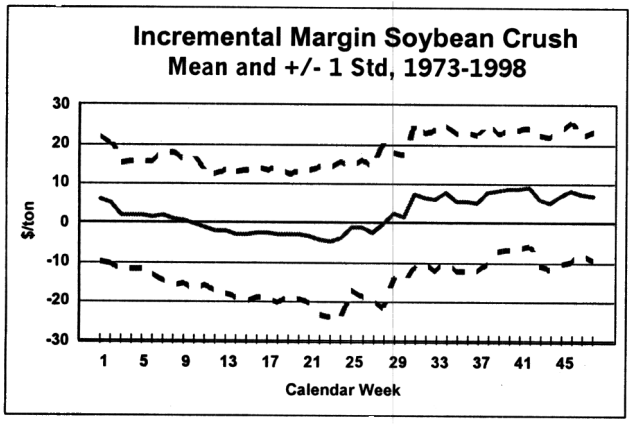

Figure 4