Not All It's Cracked Up To Be

"We have white wine so the children can have something to drink," or so said a recent colleague of the French persuasion. A similar, if often unspoken, attitude persists among commercial traders who have to account for the vicissitudes of spreads in their daily work. After all, any boy with a chart and a moving average can trade price trends outright, but it takes a man -- an alpha male, a real Al Gore -- to understand the economics behind an intermarket spread.

Before you dash off to the woods to pound a hapless bear into submission, please understand these spreads fall into three classes, joint product, substitute, and related. A joint product spread, such as the petroleum crack (see "No Margin For Error," *Futures*, February 1999), the soybean crush, the cattle crush, the spark, or the hog-belly is derived from a conversion relationship. These spreads are traded constantly, always reflect an underlying economic process, and tend to have well-defined bounds. We can convert crude oil into heating oil and gasoline, or soybeans into oil and meal, and the economics of these conversions have practical limits.

Substitution spreads include copper/aluminum, natural gas/heating oil, canola/soybean oil (see "Canadian Content," *Futures*, April 1999), or any other group of commodities that can replace one another in an economic process. These spreads tend to be traded only at their extremes and often constitute fundamental support or resistance for their constituent commodities. For example, grain traders always keep an eye on the Chicago-Kansas City wheat spread (see "Going To Kansas City," *Futures*, May 1997), but active trade only erupts when it becomes economic to substitute one for the other physically.

Related spreads reflect speculative trading opportunities more than any underlying economics. Examples include gold/silver, (see "Aren't You Precious", *Futures*, April 1998) yen/euro, S&P 500/DAX (see "Just The DAX, Ma'am," *Futures*, August 1997), most yield curve and credit quality trades, and of course the ever-popular yet nonexistent oats/notes (see any January *Futures* from 1997 onward). Since these spreads are subject to sudden and massive dislocations in their historical correlation structure, they are a good way to garner some unwanted publicity, as our friends at Long Term Capital Management found out in 1998.

The Magic Word

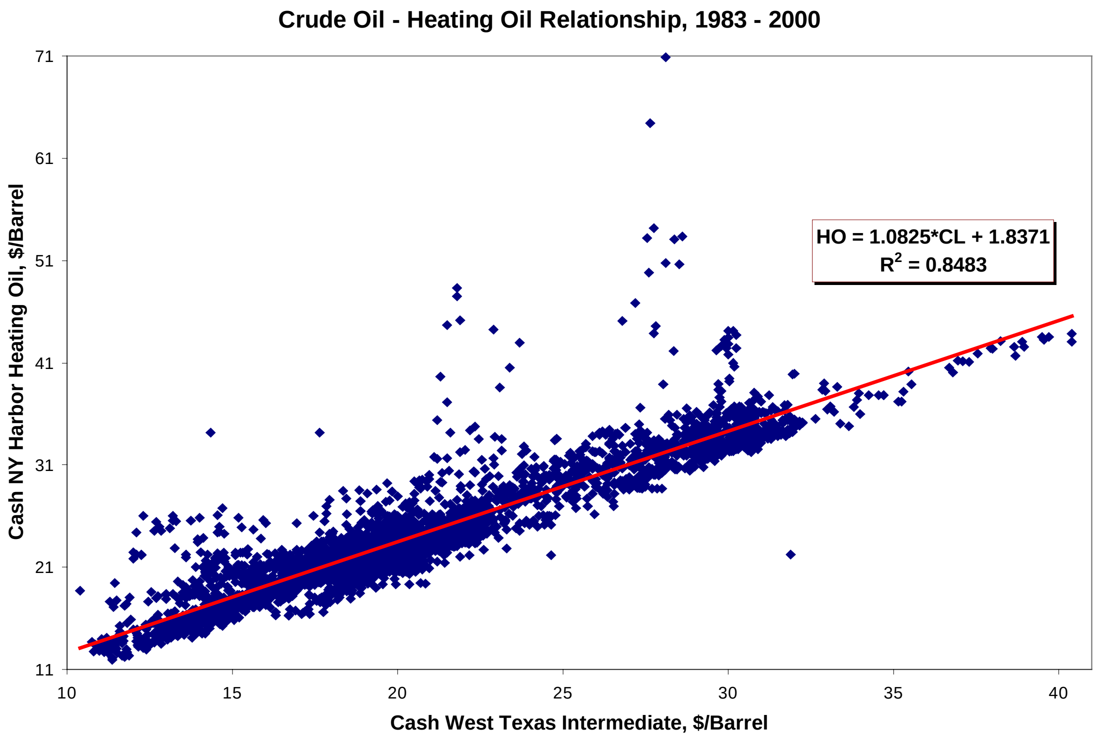
We will focus on a single joint product spread, the heating oil crack, but before we delve into spread options, we will need to discuss the key concept behind spread trading, correlation. Cash market spot prices will be used instead of NYMEX futures to avoid the effects of different expiration times, price limits, and the pronounced backwardation and contango periods present in petroleum markets. Purged of these distortions, the resulting data will overstate the correlation between crude oil (CL) and heating oil (HO).

The correlation between CL and HO is given as:

$$Correlation_{CL,HO} = \frac{E(CL-\mu_{CL})(HO-\mu_{HO})}{\sigma_{CL}\sigma_{HO}}$$

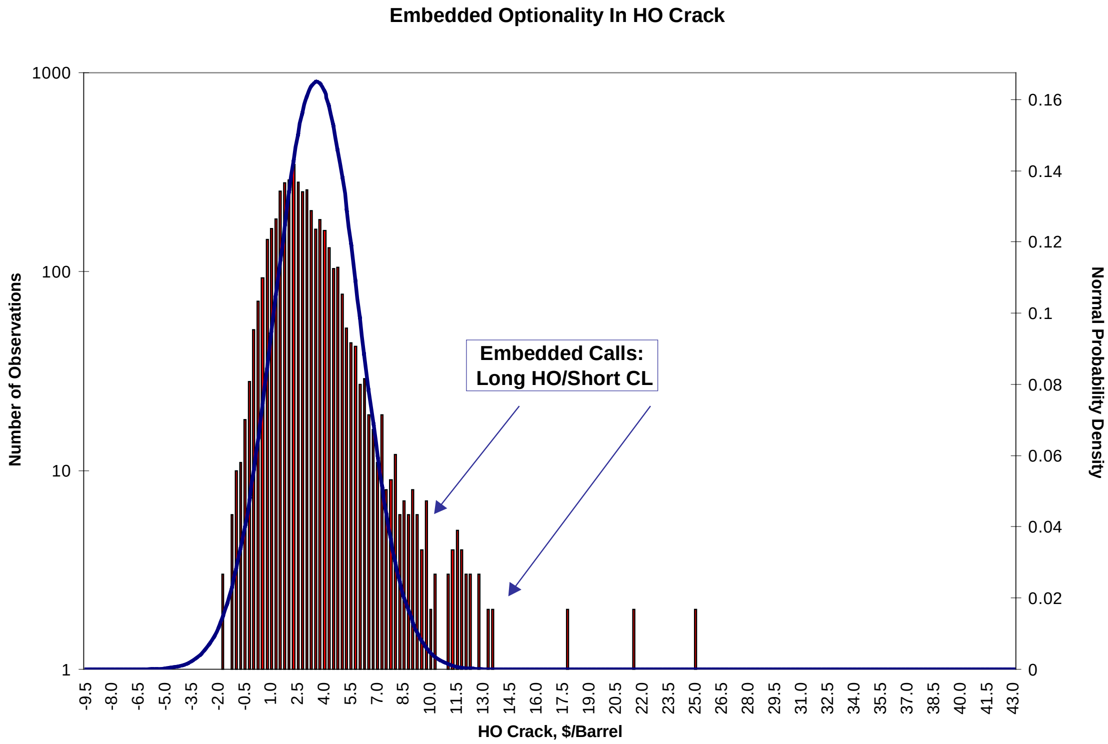
Where E is the expectation operator, μ is the mean, and σ is the standard deviation. Any increase in volatility for either CL or HO will act to reduce the overall correlation between the two, and will increase the standard error of estimate -- our confidence band -- around the resulting correlation coefficient.

We can look at the spread on a long-term statistical basis, as seen below, to get an idea whether the two products are in fact correlated. With over 4,200 observations since 1983, we observe an R^2 of .85, a regression coefficient of 1.08, and a constant of 1.84. The verbal interpretation of these data points is "we can explain 85% of the variance in HO prices with CL prices, heating oil is 1.08 times as volatile as crude, and the constant of 1.85 corresponds very closely to the marginal refining cost of HO." As the old Wall Street joke goes, we have two types of analysis, standard and poor. At best, the above litany was standard.



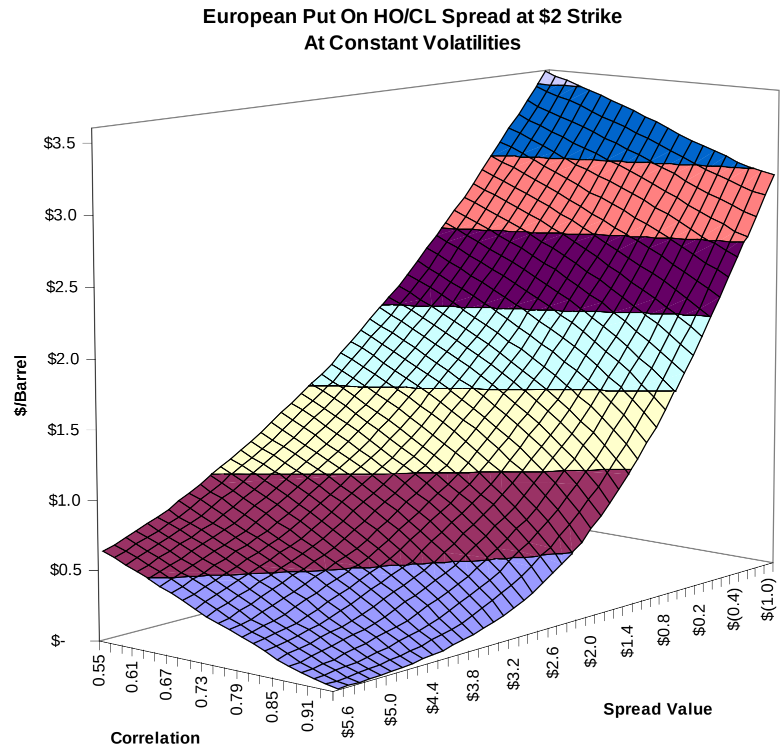
Another way to look at this spread is to notice the aberrant HO prices clustered over the regression trendline and deduce an embedded optionality in the HO crack spread, as seen below. The option implied in being long HO and short CL should not come as a surprise. Ask yourself how high heating oil prices would have to get for you to turn off the furnace and take your chances with the cold (see "If The Sky's Not The Limit, What Is," *Futures*, May 1998).

The moral of the story is simple: Correlation is not a linear phenomenon, and woe to those who assume stability of intermarket relationships, constant volatility, and an elastic supply of market liquidity. The HO crack is not even extreme as far as joint product spread blowouts go; the electricity/natural gas spark spread has intraday moves in both price and volatility orders of magnitude higher.



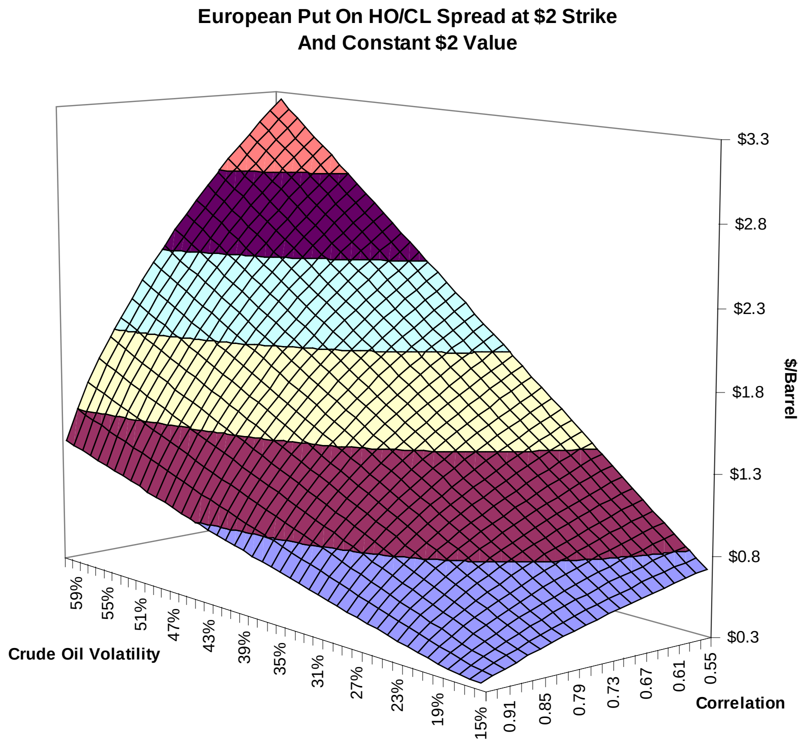
Options On The Spread
Options embedded *in* the spread will make options *on* the spread more difficult to evaluate, as they constitute evidence of non-constant correlation over time. While this will create opportunities for the nimble, it also requires an understanding of the sensitivity of spread option prices to changes in correlation. Since spread options require the volatility of the underlying legs as inputs, and since increases in volatility should lower the correlation between two markets over any time segment. In our particular example of the HO/CL spread, we have the additional problem of HO volatility rising with price, while CL volatility tends to fall with price unless the market moves into strong backwardation (see "Backwardation Has Its Price," *Futures*, June 1994). In a volatile market, we must be less confident of each price observation representing underlying economic value. Assumptions will abound. We will be forced into projecting price paths, spread bounds, correlation between the legs, and relative volatilities. The dangers of this course should be apparent to all by now.

However, we will have to make some simplifying assumptions for the purposes of illustration. Let's price a European put option on a 3-month HO/CL spread with a volatility of 35% on the CL and 30% on the HO, and a strike of $2 per barrel. A put option of this type might be of interest to a refiner in times of strong gasoline prices; as gasoline production increases, more and more heating oil will be produced whether or not it is needed. While the correlation between the HO and CL normally ranges near .92, short-term correlation can take on any value, and can be negative. A correlation range of .55 to .95 is shown.



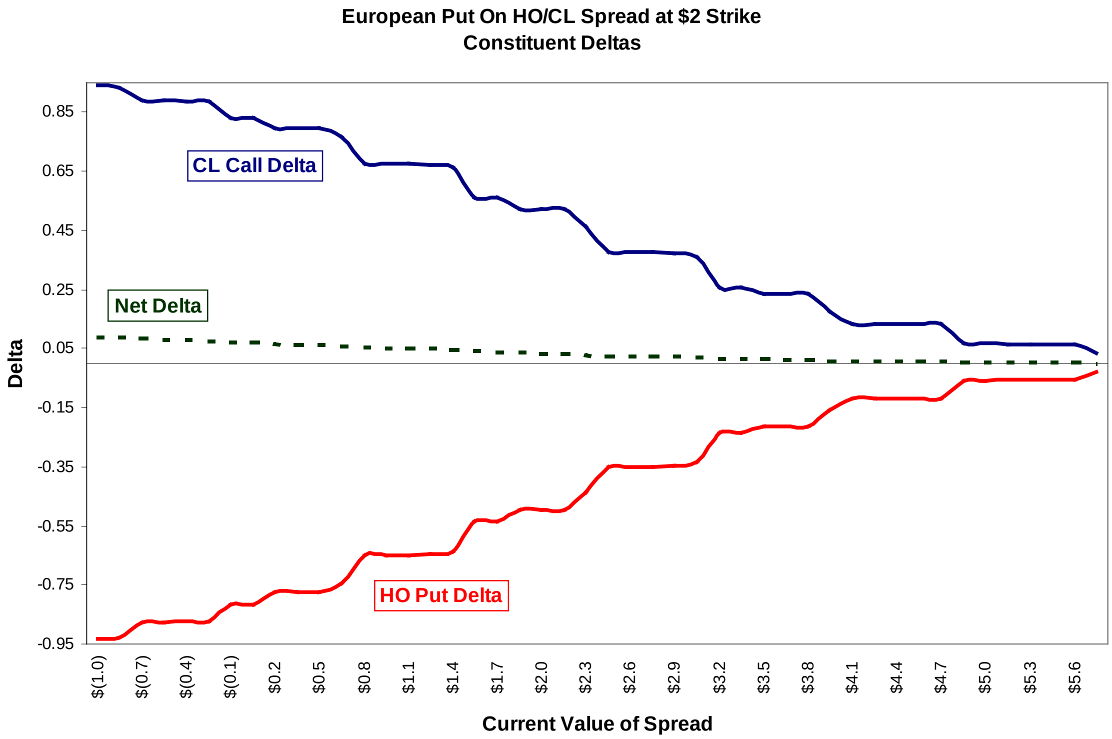
As the correlation between HO and CL decreases, which is likely to happen in volatile markets, the value of the European put option will increase. At lower correlation levels, the distribution of the spread will be wider, which is functionally equivalent to higher volatility in a plain vanilla option.

The same principle can be illustrated by pricing our European $2 put option over a range of crude oil volatility and HO/CL correlation; HO volatility will be held at a flat 5% under CL volatility. The point of maximum put option value occurs at a combination of high market volatility and low correlation, both of which will serve to increase the probability of the put settling in the money. Since the combinations of high volatility/low correlation and low volatility/high correlation are the most likely, the realizations of spread options are more likely than those of plain vanilla options to oscillate between the highest and lowest possible value ranges.



Derivative Distortions

The interactions between the spread, the correlation between the legs, and the volatilities of the legs produce a number of distortions in our familiar option Greeks. In the simple example below, we can see how the delta of our European $2 put option and its two legs, measured at the 35%/30% volatility combination and .92 correlation, varies across the value of the spread. We are presented with the paradox of the total put delta holding positive values across the entire range of the underlying. The vega, or sensitivity of the option's price to volatility, of the spread option will be negative as well. As volatility falls, correlation tends to rise, and this acts to lower the spread option's price.



The added complexities of spread options may go a long way toward explaining their quick disappearances from exchange-traded menus. No commercial hedger could forecast all of the different combinations affecting these spreads, which degrades their commercial utility. Other, more efficient solutions to the margin hedging problem are available, including the course recommended here of hedging both legs separately with plain vanilla options. The true commercial value of multiple-asset options is in markets with currency exposure. This is where we will turn our attention next.