

Refining crude-oil breakouts

Various tools are used to understand a crude oil system's behavior and boost its output.

BY KEVIN J. DAVEY

Crude oil is a volatile market — prone to violent price swings and large overnight moves — making it especially challenging for system traders. Starting with a combined trend/counter-trend trade setup, we'll use different tools to analyze the system's results and improve performance.

First, let's attempt to create a crude oil (CL) trading strategy that performs well on out-of-sample data. The setup occurs when crude oil's closing price hits its highest high or lowest low over a certain number of bars. When this happens, the system trades in the direction of a trend or against it depending on degree of trend strength or price momentum, as measured by the average directional movement index (ADX). If the indicator is high and/or rising, the market may be trending, which would validate a breakout trade. But if the ADX is low and/or dropping, the market's trend is likely weak, a sign of a possible false breakout.

The system is stop-and-reverse, meaning buy signals close existing short trades and simultaneously establish new long positions, and vice versa. The strategy is designed to exploit large trends and tends to stall in range-bound markets.

Trend-following rules:

1. Go long (and exit shorts)

at next bar's open if:

- a. Current bar's close = x-bar highest closing price
- b. 11-bar ADX \geq 11-bar ADX[Y]

2. Sell short (and exit longs)

at next bar's open if:

- a. Current bar's close = x-bar lowest closing price
- b. 11-bar ADX \geq 11-bar ADX[Y]

Counter-trend rules:

3. Go long (and exit shorts)

at next bar's open if:

- a. Current bar's close = x-bar lowest closing price
- b. 11-bar ADX $<$ 11-bar ADX[Y]

4. Sell short (and exit longs)

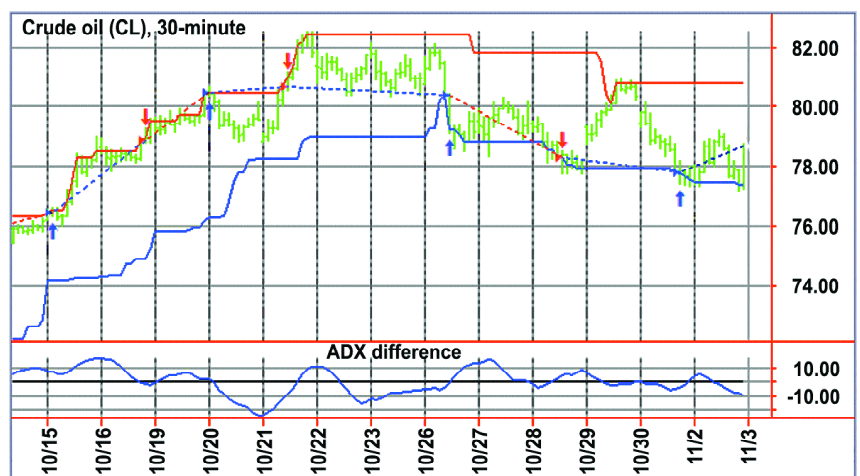
at next bar's open if:

- a. Current bar's close = x-bar highest closing price
- b. 11-bar ADX $<$ 11-bar ADX[Y]

where:

- x = breakout channel length
- y = look-back periods

FIGURE 1: TRADE EXAMPLES



The system is designed to profit in different market conditions, but it seems to exploit trends better than flat periods.

Source for all figures and tables: TradeStation

TradeStation code for the system can be copied from www.activetradermag.com > Web Only > Strategy Code. The system doesn't distinguish between the two sets of trade rules. If it takes a long trend-following signal (rule 1), it may exit based on either a short trend-following signal (rule 2) or a long counter-trend signal (rule 4).

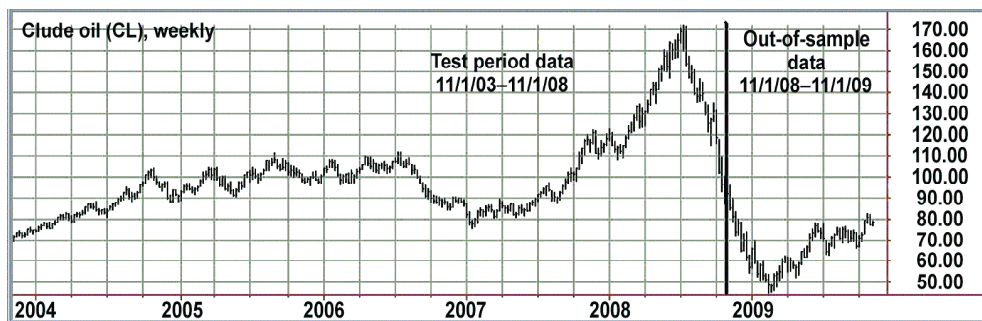
Figure 1 shows a 30-minute chart of crude oil futures with several trade examples in October 2009. The system exploited trends better than flat periods. Five of seven trades made money, but the strategy had trouble pinpointing relative highs and lows when crude oil meandered in the second half of October.

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KC For more information about the following concepts, go to "Key concepts" on p. xx.

- Average directional movement index
- Coefficient of determination (R^2 , "r-squared")
- In-sample
- Optimization
- Out-of-sample
- True range
- Walk-forward testing

FIGURE 2: WEEKLY CRUDE OIL



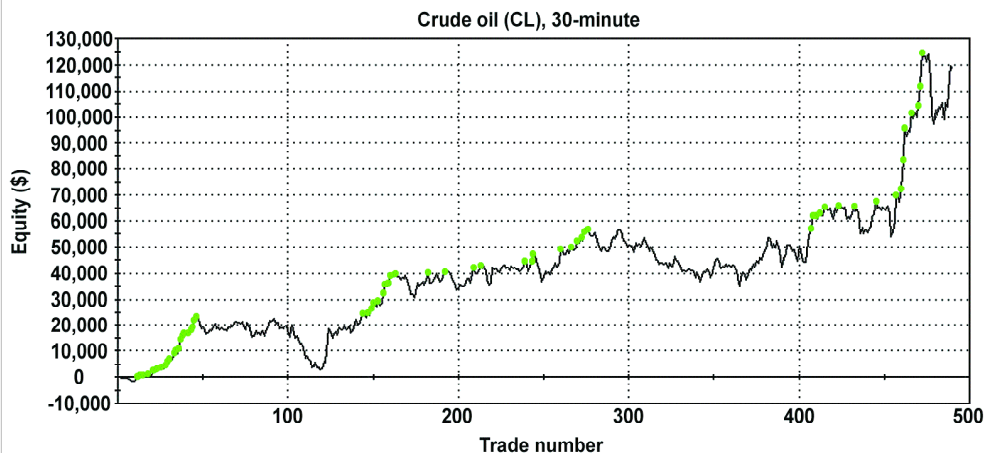
The in-sample period from 2003 to 2008 included trending and range-bound markets, ideal for testing different types of strategies.

FIGURE 3: OPTIMIZING THE VARIABLES



The breakout strategy made money across a wide range of variables, which suggests it has promise. The best-performing parameters — 34-bar breakout channel and 10-bar ADX look-back period — were selected.

FIGURE 4: OPTIMIZED STRATEGY EQUITY CURVE



Although the optimized strategy was profitable, it suffered large drawdowns and was either flat or underwater from late 2006 to early 2008.

Nov. 1, 2003 to Nov. 1, 2008 will be the in-sample period used to optimize the strategy's variables, and the following year (Nov. 1, 2008 to Nov. 1, 2009) will be used for out-of-sample testing. Figure 2 shows a weekly chart of the in- and out-of-sample test periods.

The optimization period provides extended trending and non-trending periods, so it should be a good gauge of the strategy's viability. The system trades only the 30-minute bars during the highest-volume hours of 9 a.m. to 2:30 p.m. ET, even though this leaves the strategy vulnerable to significant overnight gaps. Commission and slippage of \$45 for each round-trip trade is included.

Optimizing the variables

Instead of arbitrarily picking the number of bars in the breakout channel or ADX

look-back period, let's test a range of 10 to 50 bars for the breakout channel, and

performed well over a wide range of channel length values using both ADX

values; the 10-bar ADX length produced the best results. The average profit line (yellow line) peaks at \$55,000 net profit with a 34-bar breakout channel length. Creating a less-optimized system that works in the future is preferable to a fully optimized system that performs better on historical price data.

Figure 3 (p. xx) shows the net profit using different breakout channel length vs. two- and 10-bar ADX look-back periods. The strategy

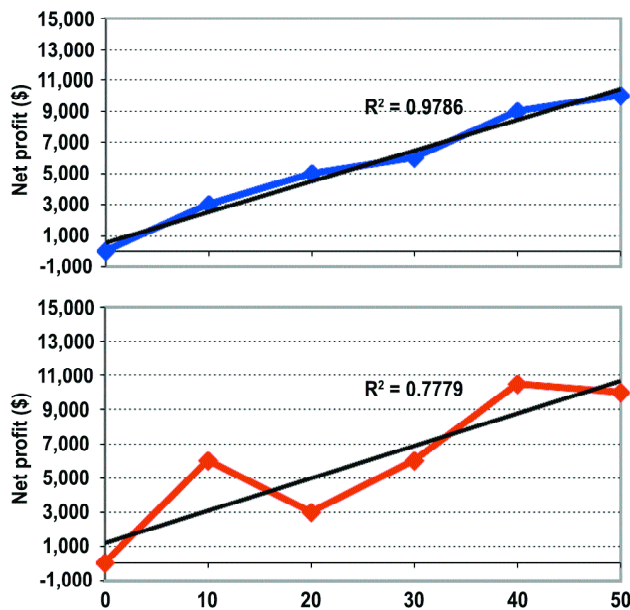
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The next step is to test the strategy with the optimized variables (34-bar breakout, 10-bar ADX look-back). Because the strategy makes money with a wide range of variables, you might decide to start trading it. On the surface, this decision is understandable, but a closer look reveals some significant drawdowns in the strategy.

Figure 4 shows the optimized strategy's equity curve. Its overall profit is acceptable, but two red flags appear: several large drawdowns and a flat-to-losing period from late 2006 to early 2008.

When system developers

FIGURE 5: LINEAR REGRESSION LINES



The top equity curve is preferable as it shows consistent gains. By contrast, the lower curve deviates further from the regression's "best-fit" line.

FIGURE 6: ROLLING OPTIMIZATION

Perform steps in sequence							
Period 1	Period 2	Period 3	Period 4	Period 5	Period 6	Period 7	Period 8
Optimization dataset (optimize parameters with this data), use best params in period "Roll 1"							
					Roll 1		
Optimization dataset (optimize parameters with this data), use best params in period "Roll 2"							
						Roll 2	
Optimization dataset (optimize parameters with this data), use best params in period "Roll 3"							
							Roll 3

In a walk-forward analysis, strategies are optimized on in-sample data before testing them on out-of-sample data. At that point, both data sets shift forward — out-of-sample data is added to in-sample, and a more recent period is used for out-of-sample testing.

run into trouble, they tend to add rules to compensate for the problems they've identified with hindsight. Let's examine three alternative methods for improving a system: linear regression analysis, walk-forward testing, and adapting to market volatility.

Linear regression optimization

When optimizing a strategy, most traders focus on the largest net profit. But this ignores drawdown, which really makes or breaks a strategy. Ideally, the best system parameters will create an equity curve with no drawdown. In short, researchers want an equity curve that has a regression R² value near 1.0, which means it's as close to a straight line as possible.

Figure 5 illustrates this concept. The top equity curve is more desirable because it produces the same profit as the bottom curve with less volatility. Strategies with this type of equity curve benefit the most from position sizing and leverage, because their drawdowns are

TABLE 1: PERFORMANCE STATISTICS

Method	Net profit	Max intraday drawdown	Flat period (days)
Baseline	\$63,005	-\$35,035	490
Linear regression	\$70,545	-\$34,965	490
Rolling optimization/ Walk-forward	\$46,715	-\$42,155	487
Adapt to volatility	\$67,855	-\$33,125	733

The three techniques to improve the basic system's performance failed to reduce drawdowns or shorten flat periods.

small — i.e., you can increase your leverage without inflating risk disproportionately because the limited volatility will help limit drawdowns. By contrast, the lower equity curve deviates more from the regression line and represents a higher-risk strategy.

We performed linear regressions on each iteration (breakout channel, ADX look-back period) of the strategy and

chose the equity curve with the highest R² value that also made money. The selected strategy had a 33-bar breakout channel length and an ADX look-back period of 10 bars, very close to the optimized strategy's variables.

Rolling optimization

Another method to improve strategy per-
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formance without changing trade rules is to use a rolling optimization, or walk-forward testing process. This method optimizes strategy parameters on a short period of price data and then tests those parameters on an out-of-sample period.

Figure 6 (p. xx) shows an example of rolling optimization. The in-sample data is always the same length — for example, one year and nine months. The out-of-sample period also remains the same, say, six months. After the strategy is tested on the first set of in- and out-of-sample periods, the “forward” test period becomes in-sample. At this point, both in- and out-of-sample data sets are shifted forward and the process is repeated. The best parameters for each period are then tested on out-of-sample data.

By dividing the test period into smaller parts, you’re more likely to identify drawdowns and flat periods.

Adapting to market volatility

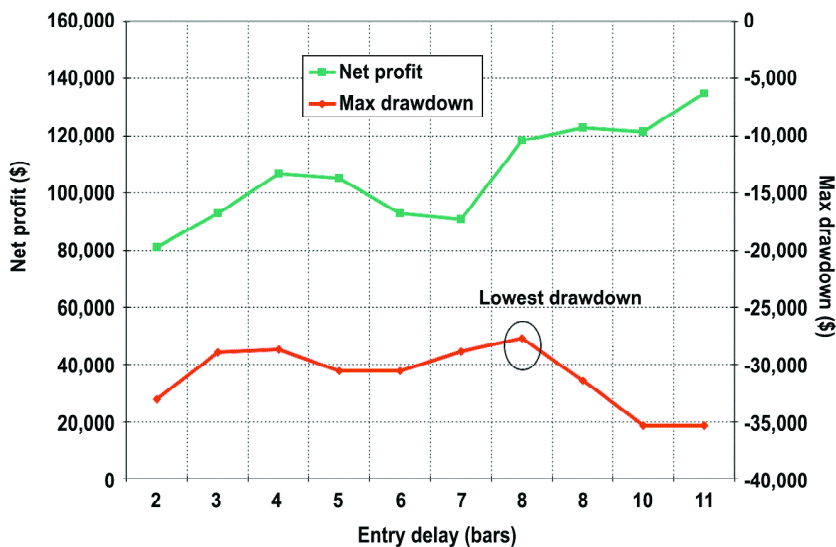
A third way to improve the strategy is to adapt the breakout channel to market volatility instead of simply optimizing its length.

When volatility, as measured by average true range (ATR), is low, the breakout channel’s length is short. As volatility climbs, the length will increase, a tactic proposed in George Pruitt and John Hill’s book *Building Winning Trading Systems* (John Wiley & Sons, 2002). On the other hand, Tushar Chande’s *Beyond Technical Analysis* (Wiley, 2001) proposed the opposite approach for adaptive breakouts (i.e., low volatility leads to a long channel length). This system changes the breakout channel as follows:

$$\text{Channel length} = 20 * 22\text{-bar ATR} + 10$$

The channel length fluctuates between 10 and 50 bars but cannot

FIGURE 7: AVOIDING FALSE BREAKOUTS



Delaying the system’s entry signals up to 10 bars can help it bypass choppy markets that erode profits. Waiting eight bars to re-enter the market lowered the strategy’s drawdown the most.

TABLE 2: DELAY BOOSTS PROFITS

Net profit	Max. intraday drawdown	Flat period (days)
\$118,230	(\$29,520)	447

Waiting eight bars to re-enter the market boosted the strategy’s profit by 87 percent, lowered its maximum drawdown by 16 percent, and shortened its flat periods by 9 percent.

TABLE 3: REVISED STRATEGY PERFORMANCE

	In-sample	Out-of-sample	Combined
Dates	11/1/03 - 11/1/08	11/1/08 - 11/1/09	11/1/03 - 11/1/09
Net profit	\$118,230.00	\$16,325.00	\$134,555.00
Number of trades	490	115	605
% winning trades	52.9%	52.2%	52.7%
Profit factor	1.32	1.15	1.28
Avg. trade	\$241.29	\$141.96	\$222.40
Avg. winning trade	\$1,861.45	\$2,115.00	\$1,902.71
Avg. losing trade	-\$1,575.26	-\$2,010.45	-\$1,651.78
Max. drawdown	-\$29,520.00	-\$19,320.00	-\$30,470.00
Profit/drawdown	4.01	0.84	4.42

Although the strategy was less profitable during the out-of-sample period, it still made enough profit to justify its use. Overall, it earned \$134,555 in six years with 53 percent winners and a profit factor of 1.3.

exceed those limits.

Table 1 (p. xx) compares the performance of the standard optimized strategy (Figure 3) to the three revised techniques. The linear-regression and volatility-adjusted systems were slightly more profitable than the original, but they didn't reduce the maximum drawdown or shorten the flat period.

Avoiding false breakouts

The first three attempts to boost performance failed, so let's see if adding additional trade rules might work in this case. Tweaking the rules may help, at the risk of reducing the strategy's "degrees of freedom" (i.e., increasing the chances of fitting the system to past data). Ideally, this step is a last resort, and to justify it, performance must significantly improve with each additional rule.

False breakouts often occur in clusters, which can lead to the system getting "whipsawed" by series of losing trades. To help minimize false breakouts, you can delay the system from one signal to the next — for example, a new entry signal cannot be generated until x bars have elapsed since the previous exit.

To prevent over-optimization, a subsequent test left the original optimized parameters intact (channel = 34, look-back = 10) and optimized a "delay" variable from two to 11 bars. Figure 7 shows the strategy's net profit and maximum drawdown, according to delay length. An eight-bar delay produced Figure 7's smallest drawdown.

Table 2 lists performance statistics for the strategy with the delayed entry rule. Again, the three previous revisions didn't boost performance, but the delayed entry rule significantly improved net profit, reduced the maximum drawdown by more than 15 percent, and shortened the flat period by almost 10 percent. Such progress justifies the additional rule.

Related reading

Kevin J. Davey articles:

"After testing, before trading"

Active Trader, January 2010.

Even after successful walk-forward testing, there's a great deal you can — and should — learn about your system before risking money on it.

"From cliché to strategy"

Active Trader, December 2009.

A gold-based system shows how effective trading requires moving beyond vague concepts to tested concepts.

Other articles:

"System design series, part 4: Developing a testing framework"

Active Trader, April 2009.

The fourth installment of our system-design series addresses the testing process and the thorny issue of optimization.

"Trading System Lab: Multi-system trading"

Active Trader, December 2008.

There's more to trading multiple systems than first meets the eye. The less correlated the systems are, the smoother the resulting equity curve will be. This can be achieved by mixing styles: countertrend vs. trend-following, oscillator-based vs. volatility breakouts, short-term vs. long-term.

"Crude oil: The outside scoop"

Active Trader, October 2008.

Short-term setups sometimes accompany outside days in crude.

"Filtering Bollinger Band breakouts"


Active Trader, December 2007.

Does volatility make or break your strategy? Avoiding choppy market conditions strengthens this system.

"Short-term crude oil tendencies"

Active Trader, June 2007.

Crude can be a wild market, but understanding the typical price behavior of both the pit and electronically traded sessions will sharpen your trading strategies and skills.

Table 3 shows the strategy's performance with the delay rule during the in- and out-of-sample periods, and overall. In the past year, it has been very profitable, especially given the volatile market conditions in late 2008 and early 2009. As expected, profits slipped in the out-of-sample period, but not drastically. 

For information on the author see p. 6.

System code

TradeStation code can be copied from the Strategy Code page at www.activetradermag.com > Web Only > Strategy Code.