A Tad Bit Of Logic

Using Correlation To Trade The S&P 500

Do you want to trade assets that are positively correlated or are you better off trading assets that move in different ways? Here's a look at how a correlation strategy compares with a moving average crossover strategy and a buy & hold strategy.

by Cassandra Wang

When you think of the term *correlation*, you think of it as a relationship between two distinct variables. A strong positive correlation means two variables move together; a strong negative correlation means the two variables move in opposite directions. So if you know how well two assets are correlated, you could infer the patterns of a variable. In the financial markets, when the movement of one asset corresponds to the movements of other assets, this results in inter-asset correlation.

HOW CORRELATED ARE YOU?

Inter-asset correlation is not a new idea. John Murphy, for example, studied this correlation in his book *Intermarket Technical Analysis*. He described the relationships between asset classes and proposed that traders and investors be mindful of potential changes in these correlations due to different market states. Various other studies have been done on the subject.

So what is the implication of inter-asset correlation on the movement of the S&P 500's future price? Can this correlation guide investors and traders? Can quantitative strategies based on correlation be developed and help people effectively trade the S&P 500? Let's take a look.

ETF SELECTION AND CORRELATION CALCULATION

The table in Figure 1 lists 29 exchange trade funds (ETFs) that were used to calculate inter-asset correlation. These ETFs

TRADE ANALYTICS

include equities, bonds, REITs, and currencies. They were selected based on availability of historical data and trading volumes. Note that these correlation results could change if you select a different set of ETFs.

Inter-asset correlation is defined as the average of all unique pairwise correlations among the ETFs for a given week. The calculations include 13-week, 26-week and 52-week interval periods that correspond to quarterly, semi-annual, and annual timeframes. Adjusted weekly close price data was obtained from Yahoo Finance.

INTER-ASSET CORRELATION WITH S&P 500

Figure 2 shows various inter-asset correlation interval periods plotted against the weekly close price of the SPY (S&P 500 total return ETF) from January 2002 to August 2016. With the 26-week interval period, correlation changes with time, ranging from 0.88 in the week of November 11, 2002 to 0.11 in the week of March 6, 2015. During the bull market between October 2002 and October 2007, inter-asset correlation experienced seven up/down cycles with its lowest value at 0.25 and highest value at 0.88. With reference to the correlation, the financial crisis of 2007–2009 began with a local minimum in the week of September 14, 2007 and ended near a local minimum in the week of April 3, 2009. You can see from Figure 2 that the correlation patterns of the financial crisis differ from those observed between 2002 and 2007. On the other hand, the correlation pattern corresponding to the bull market from March 2009 until August 2016 parallels those during the bull market between 2002 and 2007.

Although the major peaks and troughs of inter-asset correlation measured over 13-week and 26-week interval periods are in similar locations, the short 13-week period has more total peaks and troughs than the 26-week interval period. Similar trends are observed between the correlation plots of the 26-week and 52-week interval periods. It seems that larger interval periods yield fewer peaks and troughs than a smaller interval period over the same amount of time.

LET'S APPLY INTER-ASSET CORRELATION

I explored quantitative trading models to investigate the usefulness of inter-asset correlation in trading. One that I tested is a relatively simple trading strategy with the following rules:

- When inter-asset correlation, AVG_{corr}, is moving upward (that is, AVG_{corr} in the close of the week is higher than the previous week) a long SPY position is initiated.
- The long position is held until AVG_{corr} is lower than the previous week's AVG_{corr}.

SYMBOL	Description
AGG	iShares Core US Aggregate Bond
LQD	iShares iBoxx $ Invst Grade Crp Bond
TLT	iShares 20+ Year Treasury Bond
FXA	CurrencyShares Australian Dollar ETF
FXB	CurrencyShares British Pound Ster ETF
FXC	CurrencyShares Canadian Dollar ETF
FXE	CurrencyShares Euro ETF
FXF	CurrencyShares Swiss Franc ETF
FXY	CurrencyShares Japanese Yen ETF
EFA	iShares MSCI EAFE
EPP	iShares MSCI Pacific ex Japan
EWC	iShares MSCI Canada
EWJ	iShares MSCI Japan
EWL	iShares MSCI Switzerland Capped
EWU	iShares MSCI United Kingdom
EWZ	iShares MSCI Brazil Capped
IWN	iShares Russell 2000 Value
OIH	VanEck Vectors Oil Services ETF
QQQ	PowerShares QQQ ETF
SMH	VanEck Vectors Semiconductor ETF
SPY	SPDR S&P 500 ETF
XLE	Energy Select Sector SPDR ETF
XLF	Financial Select Sector SPDR ETF
XLI	Industrial Select Sector SPDR ETF
XLP	Consumer Staples Select Sector SPDR ETF
XLU	Utilities Select Sector SPDR ETF
XLV	Health Care Select Sector SPDR ETF
XLY	Consumer Discret Sel Sect SPDR ETF
VNQ	Vanguard REIT ETF

FIGURE 1: EXCHANGE TRADED FUNDS USED IN THE INTER-ASSET CORRELATION STUDY. This list includes ETFs, equities, bonds, REITs, and currencies.
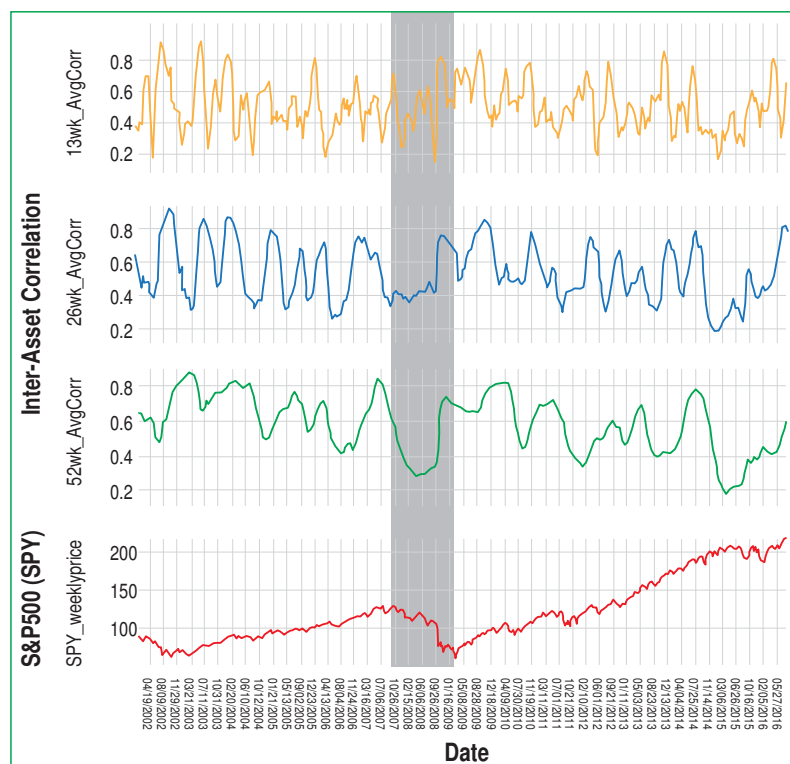
FIGURE 2: INTER-ASSET CORRELATION RELATIVE TO S&P 500. Although the major peaks and troughs of inter-asset correlation measured over 13-week and 26-week interval periods are in similar locations, the short 13-week period has more total peaks and troughs than the 26-week interval period.
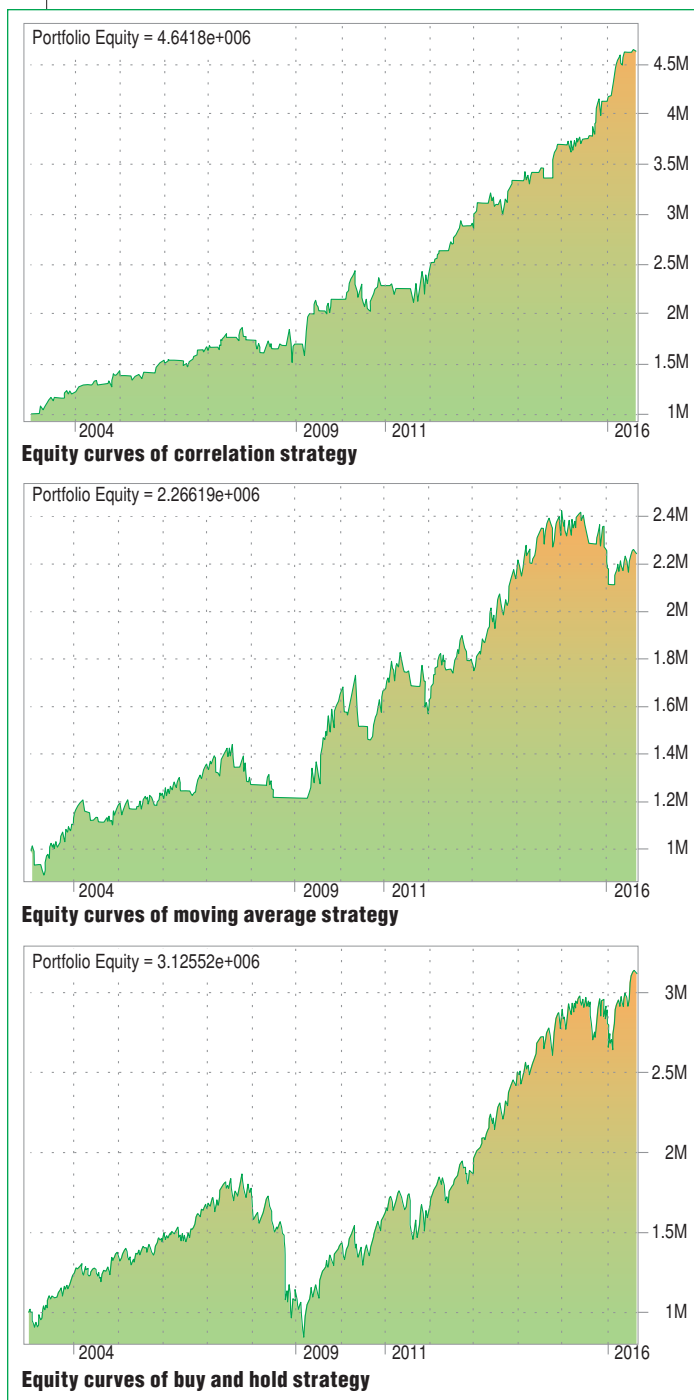
FIGURE 3: EQUITY CURVES OF THE THREE STRATEGIES BASED ON WEEKLY SPY DATA

	Correlation strategy	Moving average cross strategy	Buy and hold strategy
Initial capital	1,000,000.0	1,000,000.0	1,000,000.0
Ending capital	4,641,797.1	2,266,191.3	3,125,520.8
Net Profit %	364.2%	126.6%	212.6%
Exposure %	55.1%	72.6%	99.7%
Annual Return %	11.9%	6.2%	8.7%
All trades	42	37	1
Avg. Profit/Loss %	3.83%	2.54%	212.56%
Avg. Bars Held	10.38	15.03	714
Winners	34 (80.95 %)	18 (48.65 %)	1 (100.00 %)
Avg. Profit %	5.21%	8.19%	212.56%
Avg. Bars Held	11.18	26.06	714
Max. Consecutive	7	5	1
Largest win	421987.7	360568.3	2125520.8
# bars in largest win	15	44	714
Losers	8 (19.05 %)	19 (51.35 %)	0 (0.00 %)
Avg. Loss %	-0.0204	-0.0281	N/A
Avg. Bars Held	7	4.58	N/A
Max. Consecutive	2	4	0
Largest loss	-124358.4	-152486.6	0
# bars in largest loss	7	3	0
Max. system % drawdown	-18.9%	-15.7%	-54.6%
Recovery Factor	9.32	4.09	2.09
CAR/MaxDD	0.63	0.39	0.16
RAR/MaxDD	1.14	0.54	0.16
Profit Factor	11.96	2.52	N/A
Payoff Ratio	2.81	2.66	N/A
Standard Error	274842.8	134769.4	312054.3
Risk-Reward Ratio	0.84	0.78	0.41
Ulcer Index	4.53	6.73	14.27
Ulcer Performance Index	1.43	0.11	0.23
Sharpe Ratio of trades	1.4	0.25	N/A
K-Ratio	0.1245	0.115	0.0608

FIGURE 4: BACKTEST RESULTS OF THE THREE STRATEGIES BASED ON WEEKLY SPY DATA. The correlation strategy had the highest net profit and the least exposure to the market. The market exposures are 55.10% for the correlation strategy, 72.58% for the moving average crossover, and 100% for the buy & hold strategy.

Then cash is held in the account.
- The SPY long position is initiated again when the AVG_{corr} increases again.

I'll refer to this strategy as the *correlation strategy*. The backtesting process showed that using an eight-unit simple moving average (SMA) of the correlation calculated with a 13-week interval period produced good results, so the discussion that follows is based on that set of parameters.

I compared the correlation strategy to two other reference strategies. The first reference is the buy & hold SPY strategy for the period between January 2, 2003 and August 26, 2016. The second strategy I compared it to is a moving average crossover system using an 18-week lookback period. The 18-week lookback period was selected based on optimization results over the period using AmiBroker software. Using this strategy, a long SPY position is initiated when the weekly close price of the SPY crosses above its SMA. The long position is held until price crosses below the SMA. Taxes, trading spreads, trading commissions, and fees were not included in the backtest calculations.

Figure 3 illustrates equity curves generated by the three strategies between January 2, 2003 and August 26, 2016. The

Can quantitative strategies based on correlation be developed to effectively trade the S&P 500?

Year	Correlation strategy	Moving average cross strategy	Buy and hold strategy
2003	22.9%	16.7%	28.4%
2004	13.1%	0.6%	10.7%
2005	11.1%	7.6%	4.8%
2006	6.6%	7.1%	15.6%
2007	5.7%	-5.2%	5.5%
2008	-2.7%	-4.5%	-36.6%
2009	26.8%	38.1%	25.9%
2010	6.2%	0.8%	14.8%
2011	6.5%	-2.8%	2.1%
2012	23.3%	6.7%	15.9%
2013	11.4%	25.6%	32.2%
2014	10.9%	8.2%	13.5%
2015	11.8%	11.4%	1.4%
Aug-2016	12.3%	6.6%	7.8%

FIGURE 5: ANNUALIZED RETURN OF THE THREE STRATEGIES BASED ON WEEKLY SPY DATA. The correlation strategy reigns supreme. It produced more profitable results than the optimized moving average crossover and buy & hold strategies.

table in Figure 4 details the trading results for each strategy over a period of 13 years. If $1 million were invested into the SPY at the beginning of 2003, 13 years later, the correlation strategy would have yielded $4.6 million, a 364% net return. The buy & hold and moving average strategies produced net profits of 212.55% and 126.62%, respectively. Compounded annualized returns (CAR) were 11.9%, 6.2%, and 8.7% for the correlation, moving average cross, and buy & hold strategies respectively. Not only did the correlation strategy have the highest net profit, it also had the least exposure to the market. The market exposures are 55.10% for the correlation strategy, 72.58% for the moving average crossover, and 100% for the buy & hold strategy. The low exposure with the correlation strategy indicates its relatively low risk potential.

Looking at the trading details over the 13-year period, the correlation strategy completed 42 trades, the moving average crossover had 37 trades, and the buy & hold unsurprisingly only had one trade. The trader who bought and held the SPY had the highest average profit/loss percentage because he only completed one trade. The correlation strategy had an average profit/loss of 3.83%, higher than the 2.54% of the moving average strategy. The 11-week average holding period of the correlation strategy is shorter than the 26-week average holding period of the moving average cross strategy.

As shown in the table in Figure 5, the correlation strategy had 34 wins out of the total 42 trades, an 80.95% winning ratio; on the other hand, the moving average crossover strategy only had 18 wins out of 37 trades, a 48.65% winning odds, lower than those in the correlation strategy. The maximum consecutive wins for the correlation strategy was seven trades as opposed to five consecutive wins in the moving average strategy. Also, the correlation strategy's largest win was $421,987.70 after holding the SPY for 15 weeks, which is sizably greater than the moving average cross' $360,568.26 even though it was held for 44 weeks.

As for the losses, the correlation strategy had eight losses, which comprised 19.05% of its transactions over the 13-year period. This is less than half of the moving average cross strategy's 19 losers, which comprised 51.35% of its transactions. The total loss was smaller with the correlation strategy than with the moving average cross strategy. The average bars held for the losses was seven for the correlation strategy and 4.6 bars for the moving average cross. There were only two consecutive losses with the correlation strategy as compared to four consecutive losses with the moving average cross strategy. The correlation strategy's largest loss was held for seven bars while the moving average cross' largest loss was held for three bars.

The maximum percentage system drawdown, which is the largest percentage drop from a peak to a trough in portfolio equity, is -15.68% with the moving average strategy, -18.93% for the correlation strategy, and -54.61% for the buy & hold strategy. The recovery factor for each system, which is net profit divided by maximum system drawdown, was 2.09, 4.09, and 9.32 for the buy & hold, moving average crossover, and correlation strategies, respectively.

The CAR/MaxDD row in the table is the compounded annualized return (CAR) divided by the maximum system percentage drawdown (MaxDD). The correlation strategy has the highest value of 0.63, whereas the moving average crossover and buy & hold strategies have 0.54 and 0.16, respectively. The profit factor—profits divided by losses—was higher with the correlation model (11.96) than with the moving average cross (2.52). The same for the payoff ratio, which is the ratio between the average win and average loss.

The risk–reward ratio is best with the correlation method (0.84) and is trailed by the moving average crossover (0.78) and buy & hold methods (0.41). The *ulcer index* measures volatility in the downward direction and is lowest with the correlation model (4.53), meaning this model is the least volatile. The moving average crossover strategy has a higher ulcer index (6.73) than the correlation method, and the buy & hold method has the highest ulcer index of 14.27, implying that this method is very volatile. The correlation model has a good Sharpe ratio of 1.4, whereas the moving average crossover model has a subpar Sharpe ratio of 0.25.

WHICH STRATEGY REIGNS SUPREME?

The correlation strategy does. It produced more profitable results than the optimized moving average crossover or buy & hold strategy. If you follow the inter-asset correlation trends, you can buy and sell shares of the S&P 500 accordingly. When inter-asset correlation moves up, buy the S&P 500; when the correlation moves down, sell the S&P 500. The correlation

strategy produced an 11.9% compounded annualized return with relatively low market exposure and a small maximum percentage system drawdown based on backtests completed over the past 13 years. The system is relatively stable with a Sharpe ratio greater than 1. What's not to like about it?

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FURTHER READING

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