Another Way To Pair Trade

Neural Network Pair Trading

Pair trading is a market-neutral trading strategy. But how do you find the right pair? Using neural networks, of course.

by Marge Sherald

Are you taking a second look at market-neutral trading systems in today’s difficult markets? Pair trading is popular, but finding the right pair is more challenging. Neural networks offer an alternative to traditional pair-matching methods.

The usual pair-trading strategies speculate on future convergence of a price spread between similar securities. Once a pair is identified, the customary rule is to buy one security and sell the other short in an attempt to create a market-neutral trading system. The trades are initiated when the two normalized securities prices diverge a specified amount, often by two standard deviations. The trades are exited when the prices once again converge.

Instead of crossing normalized prices, neural nets use one stock to predict another. Trading signals are generated based on the spread between the actual and predicted values. The optimized neural net can even select the security used to make the prediction from a basket of securities; the neural net can be a matchmaker of sorts.

Once the neural net has found the pair, another artificial intelligence technique — a genetic algorithm optimizer — can customize buy/sell decisions for a particular pair rather than using static rules such as buy when the pair diverges by two standard deviations. In Figure 1, you see three energy stocks that could be candidates for a pair-trading system.

Building Alternative Pair Models

We’re going to build our pair-trading system in two steps:

1. Build a neural network prediction for the price of one stock based on another stock in the same sector.

2. Use the spread between the actual and predicted values of the stock to generate simultaneous buy/sell hedging signals for the stock used as the basis for the prediction and the predicted stock.

Neural Network Prediction

We decided to model several stocks in the utility sector, which are described in a paper by trader/analyst Binh Do as homogenous due to their stable demand and product similarity.

We constructed a chart with prices for Consolidated Edison (ED), Pepco Holdings (POM), and Southern Company (SO). Using NeuroShell Trader Professional, we created a neural network prediction for the Consolidated Edison close using the Pepco
close and the Southern Co. close as possible inputs (or independent variables) to the model. We set up the optimizer to find a neural network with a maximum of one input, forcing the optimizer to decide whether the closing price of Pepco or Southern Co. produces a more accurate model for the closing price of Consolidated Edison.

For proper hedging, we need to force the creation of a “trivial” neural network that makes a linear prediction rather than a nonlinear one. We want to limit the accuracy of the network because we want a “loose fit” rather than a highly accurate prediction. In our system, we accomplish this by setting the number of hidden neurons to zero.

After training the neural net, the prediction analysis window in the NeuroShell Trader Professional displays a percentage contribution of each of the inputs to the model. Since we directed that the net only uses one input, the net chose Pepco with a 100% contribution factor as the best stock to use for predicting the price of Consolidated Edison. The contribution factors are displayed in Figure 2.

The actual and predicted values are graphed on the chart in Figure 3. Note that the actual and predicted values cross one another often and then spread apart. The relationship of whether the actual close is above or below the predicted value will determine which stock is bought and which stock is sold short in the trading rules. The magnitude of the spread will determine the timing.

We also verified that the predicted value of Consolidated Edison moves in the same direction as Pepco. This directional correlation is essential for a normal hedging situation.

**TRADING RULES**

Traders using traditional pair models often use complicated spread metrics between two securities to gauge entry and exit points — that is, the sum of the squared differences between normalized prices. The neural network method, however, compares simple differences between the actual and predicted prices. The prices are in the same range so they don’t need to be normalized. For simplicity, we use the absolute value of the difference between the actual and predicted values as the spread in the trading rules.
IMPLEMENTING THE TRADING RULES

We begin by adding a chart page for Pepco to the chart we previously made for the neural net prediction of Consolidated Edison. Next, we construct trading rules based on the following considerations:

1. For entry positions, is the actual close of Consolidated Edison greater or less than the predicted value, and did the spread between the actual and predicted values widen to meet or exceed an entry threshold?

2. For exit positions, did the spread narrow enough in order to equal or fall below an exit threshold?

3. For a protective stop, did the spread widen enough in order to equal or exceed a stop threshold?

The genetic algorithm optimizer in the NeuroShell Trader Professional found the optimal spread values used in the rules. Other optimization techniques may be used, including manual trial and error backtesting. However, the genetic algorithm optimizer speeds up the process significantly because it uses the evolutionary techniques to search for values that are more effective in solving the problem rather than trying every possible solution.

Note that in the rules the spread values for entries, exits, and protective stops are the same for both stocks in order for the trades to occur simultaneously and keep the trading system market neutral.

Entry rules for Consolidated Edison (ED)

**Long entry rules:**
- Actual value of ED < predicted value of ED
- And the absolute value of the spread between actual and predicted values of ED crosses from below the threshold of 2.69 to equal or above the threshold.

**Short entry rules:**
- Predicted value of ED < actual value of ED
- And the absolute value of the spread between actual and predicted values of ED crosses from below the threshold of 2.69 to equal or above the threshold.

Entry rules for Pepco (POM)

**Long entry rules:**
- Predicted value of ED < actual value of ED
- And the absolute value of the spread between actual and predicted values of ED crosses from below the threshold of 2.69 to equal or above the threshold.

**Short entry rules:**
- Actual value of ED < predicted value of ED
- And the absolute value of the spread between actual and predicted values of ED crosses from below the threshold of 2.69 to equal or above the threshold.

Exit rules for both ED and POM

**Long and short exit rules:**
- The absolute value of the spread between the actual and predicted values of ED <= 0.23
- All entries use the same ProxyExit parameters in order for the trades to occur simultaneously.

ProxyExit parameters:

- Close = Close of the current chart page
- proxy1 = Actual value of the Consolidated Edison close
- proxy2 = Predicted value of the Consolidated Edison close
- spread = 3 (set according to the spread between actual and predicted values)

The entry spread value for the long entry and short entry is linked (optimized to the same value) so that the trades occur simultaneously and the system maintains market neutrality. The exit spread and stop spread values are linked and optimized in a similar manner.

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Or hit a protective stop when the absolute value of the spread between the actual and predicted values of ED >= 4.6.

All exit rules are the same in order for the trades to occur simultaneously. See sidebar, “Implementing The Proxy Pair Trading System In NeuroShell Trader Professional.”

**Optimizing the Trading Rules**

Some judgment should be exercised in setting up the optimization to find the optimal spreads. Reasonable ranges in which the optimizer will search should be used. The values for the spread ranges should be based on the specific pair being traded. In any case, make sure that the optimizer obeys the following relationship: exit spread < entry spread < stop spread.

We set the spread ranges for Pepco/Ed pair as follows:

- **Entry spread:** 2 to 4
- **Exit spread:** 0.01 to 1.9 (when the actual and predicted values are coming together)
- **Stop exit:** 4.1 to 6 (values that occur rarely)

**Summary**

The results displayed in Figure 4 show that the pair trading strategy is profitable in the out-of-sample (trading) period for both the predicted stock, Consolidated Edison, and the stock used to make the prediction, Pepco. The model was back-tested over the 2002–08 period and remained profitable in the out-of-sample period from January 2 to September 16, 2009, a particularly challenging time in the markets. Profits are based on investing $10,000 in each stock on all trade entries. Commissions are $2 for each trade.

These results demonstrate that you can use a neural network to create a successful pair trading system with stocks in different price ranges. The close of one stock is used to predict another. The spread for the pair trade is calculated as the difference between the net’s actual and predicted values. These spread levels may be optimized to determine profitable entry and exit points.

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**Suggested reading**