

# Pairs Trading



■ Pairs trading refers to opposite positions in two different stocks or indices, that is, a long (bullish) position in one stock and another short (bearish) position in another stock. The objective is to make money on the relative price movements between them. The two stocks might both go up, but the stock you are long will go up more and faster than the stock you are short. Or, the two stocks might both go down, but the stock you are short will drop more and faster than the stock you are long. One half of the pairs trade may be profitable, and the other half of the pairs trade may lose money, but the goal is for the profits to exceed the losses.

Pairs trading can be simple in concept, but can be one of the most complex types of trading in practice. This article will outline the basic approach of pairs trading, and some ideas of how to apply the strategy.

What you do in a pairs trade is try to profit from a situation where one stock looks cheap or expensive relative to another. You buy the stock that is relatively cheap and sell the stock that is relatively expensive, speculating that the long position will rise relative to the short position. To make the trade more intuitive, I look at the price of one stock minus the price of another. I then try to see whether that difference is historically high or low, or if I expect it to move in one direction or another given stronger performance in one stock over another. Generally, I look at the historical spread between the two stocks to see if there is any consistent relationship. That is, does the

spread fluctuate back and forth around an average number (revert to a mean), or does it seem to trend up or down? If there is an average or mean spread price over a particular period of time, I can judge whether I should sell one stock and buy the other based on whether the current spread price is higher or lower than the average. For example, if the average difference between daily closing prices of stock A and stock B (stock A minus stock B) is \$1.00, and if the current price of stock A is \$53 and stock B is \$49, then the current difference is \$4.00. That \$4.00 is 3.00 points higher than the average difference. So, expecting that the difference will revert back to the mean of \$1.00, a trader could infer that either stock A is overpriced at \$53 or stock B is under-priced at \$49. Either way, the idea would be to sell stock A and buy stock B. If the spread comes back to its average of \$1.00, there is the possibility of making \$3.00 on that pairs trade. Alternatively, if I expected that stock A would continue to outperform stock B, I would buy stock A and sell stock B.

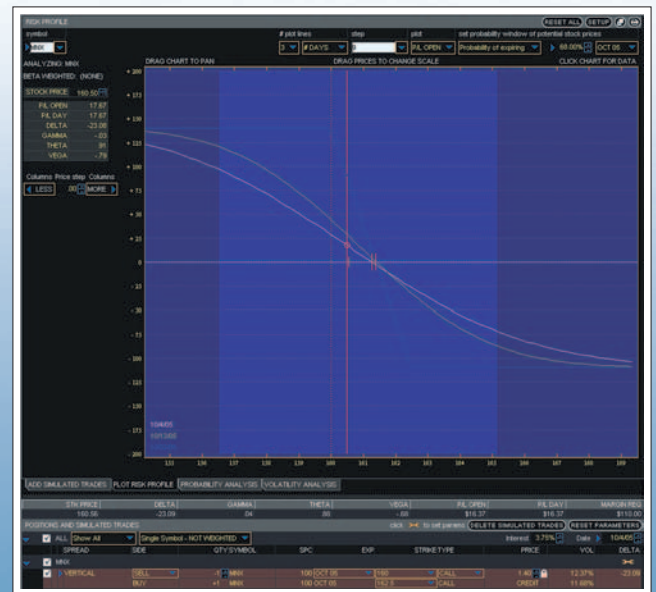
The stocks or indices that make good candidates for the pairs trade should have some measurable relationship. Ideally, the stocks or indices in the pairs trade should have a positive correlation and betas that are stable over time.

Correlation is a statistical coefficient that measures the strength, within a range of +1 to -1, of the relationship between two variables. In this case, the variables are stocks or indices. The idea of correlation

as it relates to trading is best described by an example. If stock A and stock B both move up and down at the same time, then stock A and B have a high positive correlation (close to +1). If stock A moves up and stock B moves down at the same time, then stock A and B have a high negative correlation (close to -1). If stock A and B move up and down completely randomly, then stock A and B have zero correlation. Correlation is calculated by dividing the covariance of the percentage changes of each stock or index divided by the product of the standard deviations for the two stocks. Covariance is a measure of the tendency of the two stocks or indices to move together, and dividing the covariance by the standard deviations sets the correlation between +1 and -1. Many trading software packages include correlations between stocks, but you can use a spreadsheet function to perform the calculation using historical stock and index data. The correlation will indicate the strength of the relationship between the changes of the two stocks for the time covered by the data.

When I look for candidate stocks for pairs trades, I look for correlations .80 or above. The reason for this is that I want stocks that have a very consistent relationship so that I can take advantage of that relationship if it appears out of line. The question when measuring the correlation coefficient between two stocks is about how much data to use. The correlation calculated using six months of daily data will almost certainly be different from the correlation and beta calculated using three years of monthly data. For example, the correlation between MSFT and IBM for six months of daily data is .41, but for three years of monthly data, the correlation is .55. Which one do you use? That is a question that each trader must decide for her-

## F1) MNX Short Vertical Call



The profit/loss graph of the short MNX 160/162.5 call vertical indicates profit below the break even point of 161.40, with the maximum loss reached at 162.50 or higher. The idea of the pairs trade is that the loss in one spread will be offset by the gains in another.

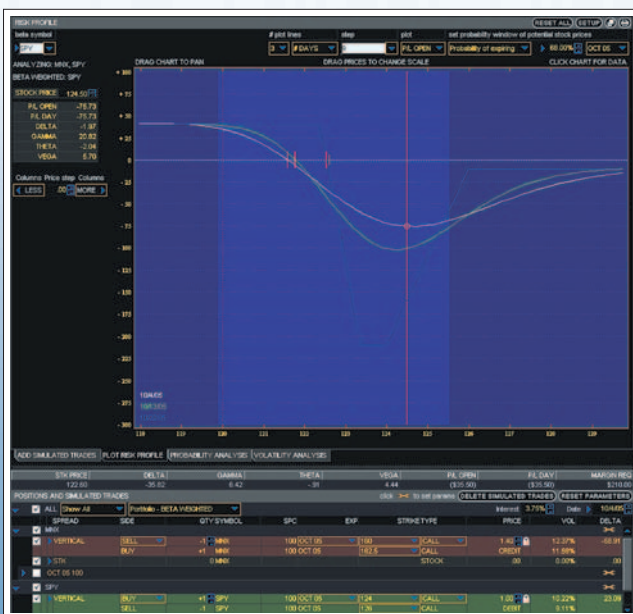
elf. But a good starting point is to use the correlation for approximately the same number of days that you predict you will hold the pairs trade. A technique I like that doesn't rely on more sophisticated statistical tests is to look at a range of dates for the calculations, say 30 days, 60 days, 90 days, and 120 days and see how similar the correlations are between them. The more similar they are, the more confident I am that the two stocks or indices will continue to have that relationship.

Beta is another tool used in pairs trading that predicts the behavior of one stock based on information about another stock. It is a coefficient that measures the magnitude of the relationship between two stocks or indices and is calculated with a linear regression model. In the regression, the set of one stock's percentage returns is set as the independent variable, and the other stock's percentage returns is set as the dependent variable. The beta indicates the magnitude of the relationship of the independent variable relative to the dependent variable. In trading terms, beta indicates how much a stock will move when another stock or index moves 1%. Beta is usually displayed as the percentage that a stock moves against a particular index, such as the S&P 500 in the U.S. For example, if you see that IBM has a beta of 1.6, that suggests that when the S&P 500 moves up 1%, IBM would move up 1.6%.

The questions about the amount of data to use for correlations are applicable to beta. For six months of daily data, the beta for IBM relative to MSFT is .54, meaning IBM moves .54% when MSFT moves 1%. For three years of monthly data, the beta for IBM relative to MSFT is .73, meaning IBM moves .73% when MSFT moves 1%. I would use the same data for the beta calculation that I use for the correlation, and would also look for the beta not to change very much between the different timeframes.

Beta is used to determine how many share of each stock to execute

## F2) MNX vs SPY Pairs Trade



Trading software can be used to evaluate the risk of positions across two or more underlying stocks or indices. In the case of a pairs trade, it is useful to see what the maximum risk is for a worst-case scenario. For the MNX/SPY pairs trade, the max risk is \$210 per pair if the correlation between the two indices breaks down.

## Verticals and Other Spreads

A vertical spread is typically an options strategy involving the purchase and sale of two options of the same type and expiration dates, but different strike prices. An example would be a bull call spread consisting for example of a long December call at a certain strike price and a short December call at a higher strike price. The spread reaches its maximum profit at expiration if the underlying instrument is at the same level of the higher strike price or higher.

The idea is very similar to a pairs trade which is also referred to as a vertical spread. Two correlated stocks are selected. One is purchased and the other is sold short, in the expectation for example that both rise but that the purchased stock increases more in relation to the stock that was sold short. In both cases the object of a vertical spread is to reduce risk by limiting potential loss and to reduce the effects of volatility.

One way to help remember what a vertical spread is, as well as its cousins the horizontal and the diagonal spread, is to think of the way newspapers list the closing prices of options. A vertical spread would involve two options from the same column in a newspaper listing, because they are of the same expiry month. Newspapers columns run vertically. A horizontal spread would involve two calls of the same strike price listed in the same row (horizontal) of a newspaper listing (i.e. same strike price, different months). A diagonal spread would involve an option from one row and column and another from a different row and column i.e., long a September call at one strike price, short a December call at a higher strike price.

for the pairs trade. Because beta measures the magnitude of the relationship between two stocks or indices, you can apply beta to the delta of the positions to determine the quantity for each stock in the pair. Remember that delta is an estimate of how much an option will change in value for a 1.00 change in the stock price. For example, if stock A has a beta of 2.00 relative to stock B, then if stock B moves up 1%, then stock A is expected to move up 2%. That means you need 200 shares of stock B to have the same potential risk/reward profile as 100 shares of stock A. There are finer points to this calculation that are beyond the scope of this article, but that is the basic approach. You can get more accurate "beta-weighted" deltas on some trading platforms. For convenience, I typically use stocks or indices that have a beta very close to 1.00 with each other. That way, one is not significantly riskier than the other, and the deltas can be roughly equivalent in the pairs positions.

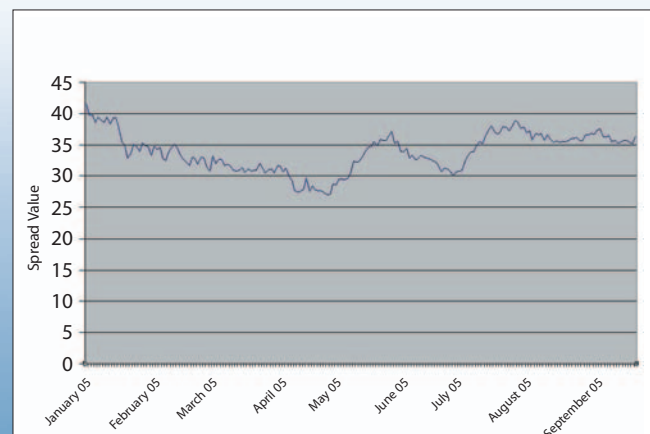
Once you determine how many deltas you want for each stock or index of the pairs trade, you have to find trades that will give you the correct relative exposure. You can choose between stocks, options, or stocks plus options. Each has advantages and disadvantages. Stocks are relatively easy to execute in actively traded stocks, but have virtually unlimited risk if you're wrong. That is, if you expect that a spread between two stocks will revert to a mean, but if it does not, you can lose a lot of money on both the long and short stock positions of the pairs trade. I use stocks only when I am highly confident in the trade.

Options are a good vehicle for pairs trading, and can simply be used as stock substitutes: long calls for long stock, long puts for short stock. Options have limited risk, but can be tougher to execute quickly. Options also usually have higher "slippage" in execution than stocks do. Also, buying options has its own risks, such as time decay and exposure to drops in implied volatility (vega). Option spreads have many advantages, such as limited risk and reduced exposure to gamma, theta, and vega. They can also be used to create situations where you can still profit if the spread between the pairs trade does not move the way you expect it will.

When looking for strategies comprising the pair, I want to have roughly the same dollar amount of risk between the positions. That is, I would make or lose roughly the same amount between the two verticals. The reason for doing this is to have the ability for one half of the pairs trade to make or lose as much as the other in the event that the pair does not move in the way you expect. You can also adjust the trade quantities to make the risk/reward of the long and short verticals equal. That is, you would buy two 2.50-point verticals and sell one 5.00-point vertical. Such a position could be considered to have equal risk and reward between the two verticals. The limited risk characteristics of vertical spreads provides a natural "stop" for the pairs trade.

Let's take a specific example. The MNX Mini-Nasdaq 100 Index and SPY S&P 500 Spiders have a very high, stable correlation between each other. MNX has a beta of 1.20 and SPX has a beta of 1.00, so we can expect that when SPY moves up 1%, MNX will likely move up 1.2%. Looking at the spread between the prices of MNX and the SPY for 2005, the average spread price is roughly 32, with the MNX trading 32 points higher than the SPY on average. But that spread seems to fluctuate around a mean, with high values of 38 and low value of 26. With the value currently at 36, it seems to be trading at the high end of its range. To take advantage of that, you might want to get short MNX at 160.50 and long SPY at 124.50. A possible trade would be selling the MNX Oct 160/162.50 call vertical for 1.40 credit and buying

### F3) MNX vs SPY 2005



A graph of the difference between one index and another, in this case the MNX Mini NASDAQ 100 Index and the SPY S&P 500 SPDR, can indicate not only whether the spread is mean-reverting, but also the typical magnitude of its range as well as overbought/oversold situations.



the SPY Oct 124/126 call vertical executed for 1.00 debit, which generates a .40 credit for the pair.

The delta of the short MNX vertical is -.15 and the delta of the SPY vertical is .19. The delta exposure between the two positions matches well, because the beta of MNX is higher than SPY, which means you need more deltas in the SPY vertical to hedge the MNX vertical.

Let's analyze the position a bit. With the MNX at 160.50 and SPY at 124.50, we are buying a call vertical in the SPY that is slightly in the money and selling a call vertical in the MNX that is slightly in of the money. The obvious directional bias is that we want the SPY to rally beyond 126 and the MNX to stay below 160. Conversely, we don't want to see the MNX rally and the SPY drop. If the MNX rises past 162.50 and the SPY drops below 124, the loss would be -2.10. The short MNX vertical would lose -1.10 and the long SPY vertical would lose -1.00. But that is unlikely, given the consistent correlation between the two indices that strongly suggests that there wouldn't be such a divergence. What is more likely is that they will both rally, both drop, or move up or down slightly relative to one another. In a large rally, the risk of the trade is really .10. That would occur if both verticals reach their maximum values, when the indices are trading beyond their higher strikes. The short MNX vertical will be 2.50, the long SPY vertical will be 2.00, and the .50 difference is offset by the initial .40 credit. That is, the short MNX vertical would lose -1.10, but the long SPY vertical would make +1.00. The loss would be limited to -.10.

If both indices drop with the MNX below 160 and the SPY below

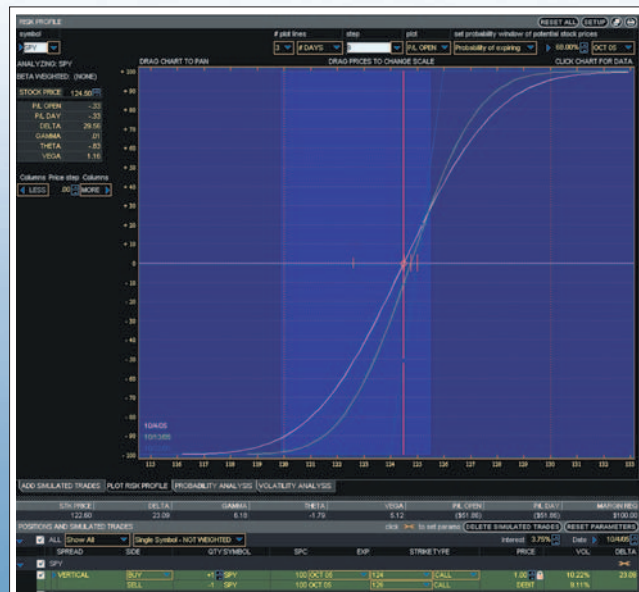
124, both the short MNX vertical and long SPY vertical will be worth 0.00. At that point, the profit would consist of the initial credit of .40 credit. The short MNX vertical would make +1.40 and the long SPY vertical would lose -1.00. The profit would be +.40.

If both indices stay right where they are, the MNX vertical would be worth .50, and the SPY vertical would be worth .50. The MNX would have a profit of +.90 and the SPY would have a loss of -.50, resulting in a net profit of +.40. The profit/loss of the position obviously varies at different points in the spread width, but if you expect the spread to go from 36 to 32, that would entail the SPY outperforming the MNX by 4.00 points by the expiration of the options. That could occur with a divergence of the two indices, which is possible, but unlikely. It could also occur if both rally, but the SPY rallies more. In that case, you don't want the the indices to rally past the higher strikes of the vertical, which would result in a small -.10 loss. If the SPY drops but the MNX drops more, which would also make the spread drop, then you keep that .40 credit.

There is a nearly unlimited number of possible MNX and SPY prices that would result in the spread between them moving lower yielding different profits and losses. Assessing the relative price movements between two stocks or indices and their magnitudes can be difficult. But if the spread between them does move lower, the pairs trade using the verticals should be profitable. If the spread moves higher, the loss is limited.

As you can see, the credit generated in the initial trade is important in providing profits and reducing losses, depending on where the pairs

## F4) SPY Long Vertical Call



The long SPY vertical makes money with the index above 125. The max profit is 1.00, which would offset the loss on the short MNX call vertical if the market rallies. The speculation is that the SPY will outperform the MNX in a rally, and the loss on the MNX is smaller than the profit on the SPY.

trade moves. When the sides of the pairs trade are of equal risk and reward, for example selling a 5.00-point vertical and buying a 5.00-point vertical, a credit is preferable. The initial credit allows for extreme moves in the spread and still provide the potential for profit. In the case of the MNX vertical vs SPY vertical, the difference in the width of the verticals (2.50 vs 2.00) was offset by the large initial credit of .40. That kept the loss limited to .10 on the upside.

When paying for a pairs trade, that is, incurring a debit upon execution, it is better to have one side to be able to make more money than the other. For example, selling a 2.00-point wide vertical and buying a 2.50-point wide vertical. In a very large move in both underlying stocks or indices, the profits on the long vertical are potentially greater than the loss on the short. So, a small debit is acceptable, as long as the long vertical's profits exceed both the loss on the short vertical and that initial debit. If both the long 2.50-point and short 2.00-point verticals reach their maximum value, the profit of the long should offset the loss on the short 2.00-point vertical and the initial debit. If both the long and short verticals reach their minimum values, the loss on the pairs trade is restricted to that minimum debit. Thus, in both cases where the pairs of stocks or indices make extreme price moves, there is a potential profit to balance the potential loss.

The concept of using verticals for pairs trading can be extended to other option spreads such as butterflies and condors, where the purchase of one option spread in one stock or index is offset by the sale of another option spread in a different stock or index. Indeed, the only conceptual limitation to pairs trading is the creativity of the trader.

There are, though, more practical issues regarding pairs trading that must be managed. First, it is not possible to submit pairs trades as a package electronically with most brokers. The exchanges have

no means of routing such orders to be executed. As such, you may have to call your broker to execute the pairs trade as one trade. The risk is in revealing a trade that you do not wish anyone else to take advantage of. Pairs trades are difficult to find, and you don't want anyone else profiting from your hard work.

The second is that if you can not enter the pairs trade in one execution electronically, you are forced to enter it by "legging", that is, executing the two different sides of the pairs trades independently. Trading stocks in the pairs trade is least risky in this regard, as long as the two stocks are liquid. Trading options, though, can be a problem because options are typically much less liquid than stocks, and getting good fills on options spreads quickly can be difficult. And time is often critical when trying to establish a pairs trade when the relationship between them presents a fleeting opportunity. The longer it takes to execute the pairs trade, the higher the risk of missing the opportunity.

Determining when to close out a pairs trade can be relatively straightforward. When the spread between the pair reverts back to its mean, the speculation behind the pairs trade has been met, and it is wise to close it out with a profit or loss. Losses should be rare when this happens if the trade was constructed carefully, such as with an initial credit for two verticals with equal profit/loss exposure. But if the spread does not revert, and even moves against you, when trading pairs with stocks you should have a stop loss point where you exit the pairs trade altogether to prevent further losses. But with options, even when the spread has moved dramatically against you, the potential loss may be manageable such that you don't need to exit the position, but might want to wait until the options' expiration. This case can happen when both stocks or indices of the pair move strongly in one direction, and your verticals are nearing maximum value. In that case, if the pair was established for a credit, that credit may still amount to a profit if both verticals are in the money or completely worthless. This illustrates how critical it is to get pairs trades on at good prices.

Pairs trading can require patience in acquiring the knowledge, finding and analyzing suitable opportunities, and executing the trade. But the strategy can open up an array of possibilities in market conditions that don't present attractive trades in single stocks or indices. Although pairs trading can have a wide range of risk/reward possibilities, using options the risks can be reduced significantly. And even though the returns may not be stunning, they can be consistent enough to constitute a long-term, profitable trading strategy.

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