A Classroom Demonstration of Pairs Trading

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INTRODUCTION

In the capital markets courses that we teach, there are many opportunities to take stories from the financial press headlines and bring them into the classroom. One of these is Pairs Trading which was a trading strategy used extensively by the former hedge fund known *as Long-Term Capital Management*. Lowenstein (2011)

A HISTORICAL PERSPECTIVE

Pairs Trading or Pairwise Trading is part of a larger category of trades known as Statistical Arbitrage. Such trades have their genesis in the 1980s with the Morgan Stanley block-trading desk's need to hedge large positions as described by Bookstraber (2007). Morgan Stanley faced significant risk in executing block trades for clients. The problem in handling a block trade is one of price movement. Feeding a large sell order, for example, into the market will result in a price penalty as traders may perceive they are trading with a better informed counter-party and thus the seller of the block trade will suffer a price penalty. A better solution is to feed the order into the market piece meal. However, traders on the other side of the market may deduce that the consistent stream of sell orders are from a more informed trader thus eventually resulting in a price penalty. The solution to this problem is for the block-trading desk to give the institutional block trader a single price for the order serving as an intermediary. Morgan Stanley still faces the risk of trading with a better informed party. However, with their knowledge of the client, they are better able to discern that the block trade is a single event, rather than the beginning of a stream of additional block trades on the same side of the market. Morgan Stanley is then able to adjust their spread they demand for executing the block trade. Morgan Stanley can feed the trade

in with those of other clients or even find a client interested in taking the other side of the transaction. The problem for Morgan Stanley arises when they must sit on the block trade for a period of time which puts them in the unenviable position of the price moving against them. A strategy evolved to reduce the risk of taking such a large position. The key was to find another offsetting position. The solution was to take a short position in another stock whose price historically moved with the block of stock to be hedged. For example, use a short position in Ford to hedge a block position in General Motors. The assumption was that news which would affect the price of General Motors would also affect the price of Ford. Thus, Morgan Stanley developed a list of stock pairs. This hedge gave the block-trading desk additional time to work out the block trade and reduce the risk of a price penalty and eventually profit for the trading desk was increased.

DEVELOPMENT OF PAIRS TRADING

The quants at Morgan Stanley, who were responsible for identifying stock pairs, made an interesting discovery. They began to view the pairs-hedging as a possible trading strategy. They noticed that if one of the stocks in a pairs-hedge began to rise (fall) for no apparent reason, one of two things was possible. 1.) The rising (falling) price could be as a result of a block trade or other liquidity demands moving the price up (down). In this case, the rise (fall) in stock price would be temporary as once the block trade was filled, the stock would revert to its normal spread against its pair as the price change not a harbinger of a permanent change in the value of the stock. 2.) The rise (fall) in stock price may be due to the release of some company specific information which arrived in a random fashion. In case 1, one could arbitrage such a situation by

longing the undervalued stock and shorting the overvalued stock. When the price spread narrowed to its normal level, the position would profit. The problem lay case 2. What would happen to such a position if company specific news were to arrive and change the fundamental value of one of the stocks? This company specific risk could be eliminated by holding a large number of pairs. Morgan Stanley determined that an individual pairs trade was risky as a company specific announcement could widen the spread and potentially blow up the trade. The success of the strategy lay in the holding of many pairs. Although this was not arbitrage in the truest sense of the word, these spread trades proved to be quite profitable. In their first year alone, this strategy made Morgan Stanley $6 million.

IDENTIFYING PAIRS

A number of methods exist to identify two stock whose prices historically move together

The *distance method* (Gatev et al, 1999 and Nath 2003) measures the co-movement of stocks as the distance or sum of squared errors between the normalized price series of two stocks.

The *co-integration method* (Vidyamurthy, 2004) evaluates the cointigration of a time series of price data looking for stationarity in the price spread.

The stochastic spread method (Elliot et al, 2005) explicitly models the mean reversion behavior of the two stock prices in a continuous time setting.

HOW THE POSITION MAKES MONEY

As the two stock prices converge, a number of scenarios can occur as we go long the undervalued stock and go short the overvalued stock. 1. The overvalued stock declines in price, while the undervalued stock price remains constant. In this case, the short position generates a positive cash flow while the long position generates a cash flow of zero. 2. The overvalued stock price remains constant, while the undervalued stock increases in price. In this case, the short position generates a cash flow of zero while the longer position generates a positive cash flow. 3. The overvalued stock declines in value while the undervalued stock increases in value. In this case, both positions generate a positive cash flow. 4. Both stocks decline in price. In this case it is a matter of degree. For the overall position to generate a positive cash flow, the overvalued stock price must decline more than the price of the undervalued stock. 5. Both stocks increase in price. This case is also a matter of degree. For the overall position to generate a positive cash flow, the undervalued stock price must increase by more than the price of the overvalued stock.

METHODS FOR SETTING UP THE POSITION

Skyba (2011) lists two methods that can be used to set up a market-neutral portfolio.

The first is a dollar-neutral portfolio in which the dollar amount of the long position equal the dollar amount of the short position. This method is used almost exclusively by arbitragers and

proprietary trading desks and is virtually self-financing. For example, we short $100,000 which we use to purchase the long position. Thus, there is no dollar equity exposure. The second method is to use a beta-neutral portfolio. The beta of the long position weighted by its market value in percent of net equity exposure equals the weighted beta of the short position. In this way, the systematic risk of the short position cancels out systematic risk of the long position. The dollar neutral strategy can virtually self-financing assuming a small or zero haircut. That is, we use the funds generated from the short position to purchase the long position. The beta-neutral position may or not be self-financing based upon which stock is purchased and which stock is shorted.

DOLLAR NEUTRAL POSITION EXAMPLE:

Consider stock ABC and stock XYZ with current prices of $100 and $75 respectively. The dollar spread is then $100 - $75 = $25. We construct a position that will profit from a decrease in the spread by shorting $100,000 of stock ABC and buying $100,000 of stock XYZ. That is, we short $100,000/$100 = 1,000 shares of ABC and buy $100,000/$75 = 1,333 shares of XYZ.

We define the following profit/loss equation for the position:

$$(\#Shares\ Short)\left(P_{short,t=0} - P_{short,t=1}\right) + (\#Shares\ Long)(P_{long,t=1} - P_{,t=1}) \quad (1)$$

Where: #Shares Short = number of shares sold short.

$P_{short,t=0}$ = Price at which the stock is sold short at time t=0.

$P_{short,t=1}$ = Price at which the short position is closed out at time t=1.

#Shares Long = number of shares purchased for the long position.

$P_{long,t=1}$ = Price at which the long position is closed out at time t=1.

$P_{long,t=0}$ = Price at which the stock is purchased for the long position at time t=0.

We consider three scenarios:

1. Both prices increase, while the spread narrows:

Stock	$Price_{t=0}$	$Price_{t=1}$
ABC	$100	$110
XYZ	$75	$88
Spread	$25	$22

1,000($100 - $110) + 1,333($88-$75)

-$10,000 + $17,329 = $7,329

Note that the short position loses while the long position gains.

2. Both prices decrease while the spread narrows:

Stock	$Price_{t=0}$	$Price_{t=1}$
ABC	$100	$95
XYZ	$75	$73
Spread	$25	$22

1,000($100 - $95) + 1,333($73-$75)

$5,000 - $2,334 = $2,334

Note that the short position gains while the long position loses.

3. Price of ABC falls while price of XYZ rises.

Stock	$Price_{t=0}$	$Price_{t=1}$
ABC	$100	$98
XYZ	$75	$77
Spread	$25	$22

1,000($100 - $98) + 1,333($77-$75)

$2,000 + $2,666 = $4,666

Note that both positions gain.

BETA NEUTRAL POSITION EXAMPLE

We follow the work of Skyba (2011), in constructing beta-neutral pairs.

Consider two stocks and their corresponding betas relative to the S&P 500.

Stock	**Beta**
ABC	1.29
XYZ	1.98

We construct a beta neutral portfolio by solving for the percentage of the investment we would invest into XYZ (x) which delivers a total beta position of zero.

$$0 = 1.98X - 1.29(1 - X)$$

$$X = \frac{1.29}{1.98 + \ 1.29} = 0.3945$$

As we consider stock ABC to be overvalued relative to XZY, we would short ABC with a weight of 1 – 0.3945 = 0.6055 and long XYZ with a weight of 0.3945. Thus, we create a beta-neutral position ex-ante:

$$(0.394)(1.98) - (0.6055)(1.29) = 0$$

In our example we short (0.6055)($100,000) = $60,550 or $60,550/$100 shares of ABC and long (0.3945)($100,000) = $39,450 or $39,450/$75 =536 shares of XYZ.

1. We first provide a numerical proof that our position is beta neutral as follows:

Stock	$Price_{t=0}$	Percent change in S&P 500	Predicted percent change in stock price	$Price_{t=1}$
ABC	*$100*	*1%*	*1.29%*	*$101.29*
XYZ	$75	1%	1.98%	$76.485

We use equation (1) above to compute the profit/loss of the position.

605.5($100 - $101.29) + 526($76.485 - $75)

-$781.10 + $781.11 = $0.01 or approximately $0.

2. Now consider a situation where both prices rise while stock XYZ slightly more than would be predicted by its beta.*

Stock	$Price_{t=0}$	Percent change in S&P 500	Predicted percent change in stock price	$Price_{t=1}$
ABC	*$100*	*1%*	*1.29%*	*$101.29*
XYZ	$75	1%	1.98%	$77.00*

We use equation (1) above to compute the profit/loss of the position.

605.5($100 - $101.29) + 526($77.00 - $75) = $270.91

-$781.10 + $1,052.00 = $270.90

SUMMARY

The final paper provides a basis for a teaching example in an investment or capital markets course.

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