

# **EXECUTION OF PAIRS TRADING STRATEGY: SOME PROPOSITIONS<sup>#</sup>**

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# The views expressed in the paper are those of the authors and do not reflect those of Calcutta Business School or HDFC Ltd.

## **ABSTRACT**

Stock prices are subject to both systematic risk and unsystematic risk. While unsystematic risk can be reduced to some extent by portfolio diversification, systematic risk is external to a firm and in a sense reflects market sentiment and the existing macroeconomic condition. In this paper we ask the question, is there some way in which savers/traders could control this latter risk and still expect reasonable returns from the market? The answer lies in Pairs Trading which involves trading the ratio of prices of two stocks which belong to the same sector and whose prices are highly correlated. Ideally, the ratio of the price of the two such stocks should be steady. However, given the inherent randomness of stock price movements, this ratio tends to fluctuate. The fundamental basis of Pairs Trading is that although there would be fluctuations in the ratio of the prices, this ratio would be mean reverting. Thus if the ratio rises the trading strategy would be to short the faster moving stock and long the slower moving stock. This paper is written from the trading point of view. It differs from the existing literature as it provides a framework for a trader to profit in the short run by using technical analysis. The three technical indicators that we use in our study are Momentum, Bollinger Band and Moving Average Convergence Divergence (MACD).

## 1. INTRODUCTION

Stock prices are subject to both systematic risk and unsystematic risk. While unsystematic risk can be reduced to some extent by portfolio diversification, systematic risk is external to a firm and in a sense reflects market sentiment and the existing macroeconomic condition. In this paper we ask the question, is there some way in which savers/traders could control this latter risk and still expect reasonable return from the market? The answer lies in Pairs Trading which involves taking the ratio of prices of two stocks which belong to the same sector and whose prices are highly correlated. Ideally, the ratio of the price of the two such stocks should be steady. However, given the inherent randomness of stock price movements, this ratio tends to fluctuate. The fundamental basis of Pair Trading is that although there would be fluctuations in the ratio of the prices, this ratio would be mean reverting. Thus if the ratio rises, it is expected that it would fall and if the ratio falls, then it is expected to rise. If the ratio rises, it implies that price of one stock is rising at a faster rate than the other one, in spite of the fact that they are from the same sector and are having highly correlated prices. The trading strategy in this case is to short the faster moving stock and long the slower moving stock. The expectation is that the stock, whose price is rising faster, will fall, and the stock whose price is not rising that fast, will continue to rise. Thus it is expected that there will be profit on both legs of the transaction. Similarly, if the ratio falls, then we long the faster falling one and short the slower falling one. Given that the strategy involves stocks that belong to the same sector, the ratio controls for systematic risk and consequently opens up opportunities for arbitrage.

This paper is written from the trading point of view. It differs from the existing literature as it provides a framework for a trader to profit in the short run by using technical analysis. Since the trade has two legs, a long position and a short position, the short run time span also helps in minimizing transaction costs. As we are using technical analysis, we are not going for long run forecasting.

The ratio of two share prices can rise or fall depending on the relative movement of the numerator and the denominator. Table 1 shows the various possibilities.

**Table 1**

The ratio of prices rises	This can happen when
	Numerator rises, Denominator falls
	Numerator rises at a faster rate than the Denominator
	Denominator falls at a faster rate than the Numerator

The ratio of prices falls	This can happen when
	Denominator rises, Numerator falls
	Denominator falls at a slower rate than the Numerator
	Denominator rises at a faster rate than the Numerator

Note that the movement in the price ratio not only depends on the absolute rises and falls in the two prices, but also on their rate of change. This is why we introduce technical analysis in pair trading.

## 2. OBJECTIVE OF THE STUDY

The paper proposes a framework for pairs trading using technical analysis of share prices. Our focus is on pair trading between stocks from the same sector. The premise is that sectoral perception would be identical for both the stocks and they would be influenced in an identical fashion by the external environment. For example, given their business models, both TCS and Infosys would be open to exchange rate fluctuations and the market would factor that in. The absolute level of prices would be different for the two companies, depending on their fundamentals, but the relative valuation should be stable. If the value of the ratio of the two prices increases or decreases, it would give rise to an opportunity for arbitrage where opposite trading positions of buy and sell would be taken for the two shares. Due to arbitrage by traders, market prices would change and the value of the pair would revert back to its previous stable position. Profits would be booked in the process. This has been denoted as the mean reverting property of a pair of prices.

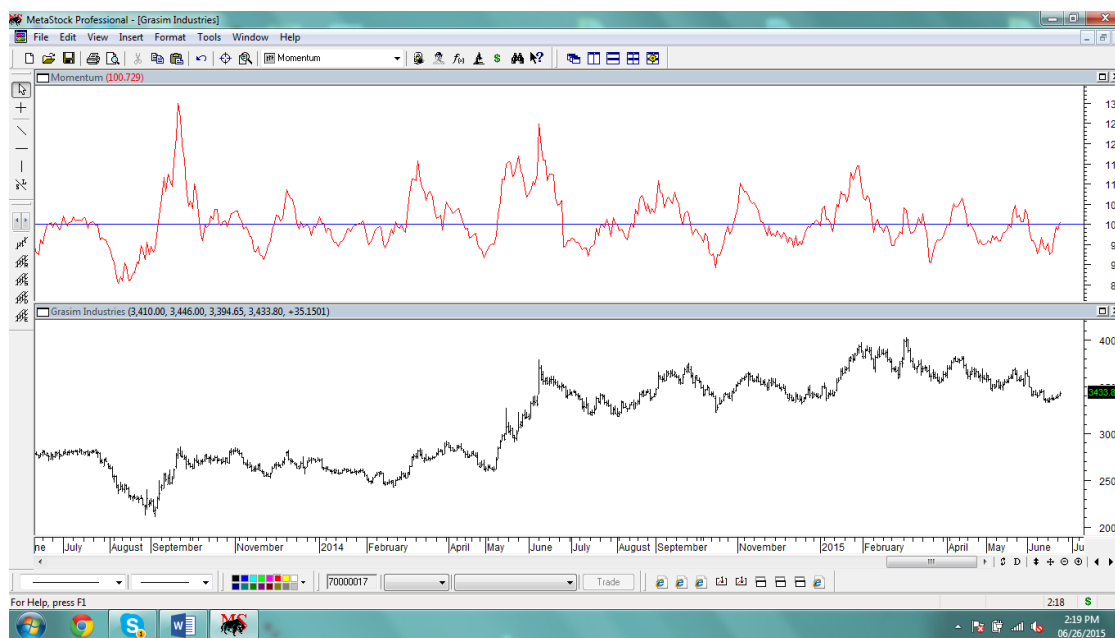
The plan of the paper is as follows. Technical indicators that we will use in the study are described in Section 3. A literature review is presented in Section 4. The methodology and some propositions on execution of pair trading are examined in Section 5 and Section 6 concludes the paper.

## 3. METHODOLOGY

This section focuses on three technical indicators that we will use in our study. They are Momentum, Bollinger Band and Moving Average Convergence Divergence (MACD). Our belief is that pair trading is a short term arbitrage strategy based on a mean reversal property and these technical indicators will be helpful in identifying arbitrage opportunities.

A brief description of the three indicators is in order. The Momentum indicator measures the amount that a security's price has changed over a given time span. It may be defined as the ratio of today's price compared to the price x-periods ago, i.e.  $(\text{Close}/\text{close } x\text{-time periods ago}) * 100$ . It can also be defined as a percentage change in prices. Figure 1 shows a typical Momentum diagram.

**Figure 1: Momentum**



**Source: Metastock**

The lower window gives the actual movement in prices of a stock over a period of time and the upper window gives the Momentum. It shows the rate of increase in prices. Observe that the value of Momentum fluctuates and this property we will use later in our analysis. Empirically, prices cannot keep increasing at an increasing rate, and after a short run, it loses steam. As a matter of fact, absolute level of prices also does not keep increasing continuously. There are short term and long term cycles. Looking at numerous charts on momentum for various stocks, an additional insight is that if the momentum of a stock is on the rise, the actual stock price rises for a few days and then falls. Or in other words, if a stock price is rising and the momentum is also on the rise, then price reversal takes a few days' time, other things remaining the same. Same is the case when the stock price is falling and momentum is rising. If on the other hand, stock prices are rising, but momentum is falling, then price reversal will happen shortly.

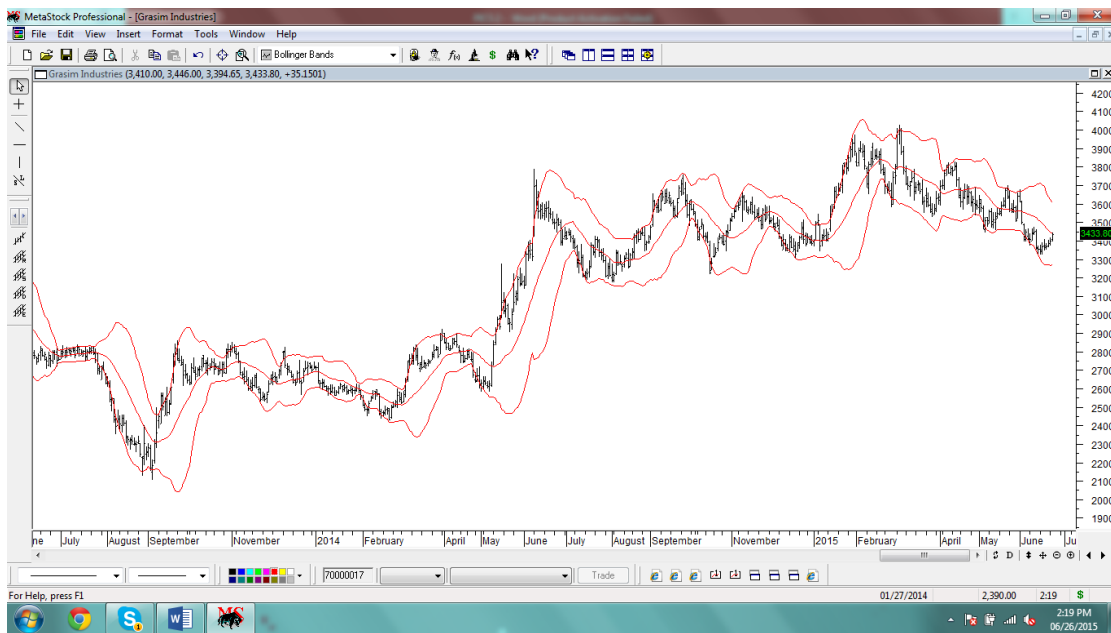
Bollinger Band is constructed as an envelope around a 20 day moving average of the actual price; the upper band being  $+2 * \text{standard deviations}$  away from the moving average and the lower band being  $-2 * \text{standard deviations}$  away. Since the spacing between the bands is based on the standard deviation, the bands widen when the security becomes more volatile. They band

contracts when the security becomes less volatile. A study of charts on Bollinger Bands has led us to make the following observations.

- a. When the actual price hugs the upper band, prices fall after that, and when it hugs the lower bound, it is time for prices to rise;
- b. When the band narrows along a trend, it is time for a reversal; a narrowing of the band implies consolidation and reversal;
- c. When the actual prices move outside the band, it implies that the trend will continue.
- d. The trend of the band is also important to take into consideration for price reversal.

Figure 2 gives an example of a Bollinger Band of a stock and the above four observations.

**Figure 2: Bollinger Band**

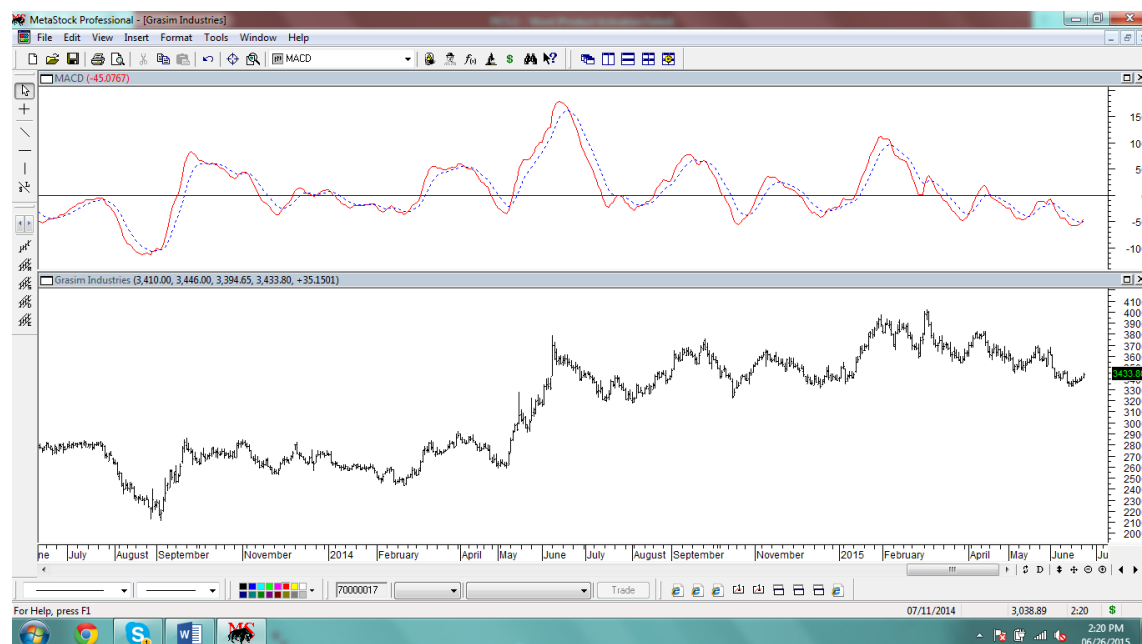


**Source: Metastock**

MACD is an oscillator and is calculated by subtracting the value of a 26 day exponential moving average from a 12 day exponential moving average. A 9 day exponential moving average of the above difference (trigger line) is imposed on top of the MACD line. If the MACD line intersects the trigger line from above then it is a sell signal and if it intersects from below then it is a buy signal. We also have to note whether the intersection is taking place below or above the zero line. If MACD falls below zero then the stock is oversold. If MACD rises above zero, then the

stock is overbought. We then have to work out our buy sell decisions. One should be careful in buying in an overbought situation and selling in an oversold situation.

**Figure 3: MACD**



**Source: Metastock**

In this paper, our demonstration of pair trading will rely fully on the above three technical indicators along with actual price movement. For our analysis we will consider the following pair of India companies listed in both the Bombay Stock Exchange and the National Stock Exchange:

- i. Punjab National Bank and Bank of Baroda
- ii. Cipla Limited and Dr. Reddy's Laboratories
- iii. Hero Motocorp and Bajaj Auto
- iv. Infosys Ltd. and TCS

#### **4. LITERATURE REVIEW**

Insights on pairs trading can be found in Gatev et al. (2006) and in books by Vidyamurthy (2004) and Whistler (2004). Classical study of pair trading strategy involving stocks of Royal Dutch and Shell was discussed by Reverre (2001). Mean reverting Gaussian Markov chain model for the spread which is observed in Gaussian noise was proposed as an analytical model for pair trading

strategy by Elliott et al. (2005). Unlike the traditional pair trading strategy, Bock and Mestel (2008) implemented Markov regime switching approach in statistical arbitrage trading rule and found positive returns with DJ STXX 600 universe.

In the literature mentioned above, the three main methods for choice of pairs discussed are the distance method, the cointegration method and the stochastic spread method. The distance method is used in Gatev et al (2006) and Nath (2003) for empirical testing whereas the cointegration method is detailed in Vidyamurthy (2004). The stochastic spread approach has been proposed by Elliott et al (2005). Under the distance method, the co-movement in a pair is measured by what is known as the distance, or the sum of squared differences between two normalized price series. Trading is triggered when the distance reaches a certain threshold, as determined during a formation period. In Gatev et al (2006), the pairs are selected by choosing, for each stock, a matching partner that minimizes the distance. The trading trigger is two historical standard deviations as estimated during the formation period. Nath (2003) keeps a record of distances for each pair in the universe, in an empirical distribution format, so that each time an observed distance crosses a trigger of fifth percentile, a trade is entered for that pair. Risk control is instigated by limiting a trading period at the end of which positions have to be closed out regardless of outcomes. In overall, the distance approach purely exploits the statistical relationship of a pair, at a price level.

The cointegration approach outlined in Vidyamurthy (2004) is an attempt to parameterize pairs trading, by exploring the possibility of cointegration (Engle and Granger, 1987). Cointegration is the phenomenon that two time series that are both integrated of order 1 can be linearly combined to produce a single time series that is integrated of order 0. As the combined time series is stationary, this is desirable from the forecasting perspective. The paper observes that as the logarithm of two stock prices are often assumed to follow a random walk, or be non-stationary, there is a good chance that they will be co-integrated. If that is the case, cointegration results can be used to determine how far the spread is away from its equilibrium so that long/short positions can be entered to profit from the mispricing.



## 5. METHODOLOGY, ANALYSIS and STRATEGY

The definitions given in Table 2 will be used in the analysis to follow.

**Table 2**

Momentum of Numerator (N)	Momentum Rising (R) NR	Momentum Falling (F) NF	Momentum Constant (C) NC
Momentum of Denominator (D)	Momentum Rising (R) DR	Momentum Falling (F) DF	Momentum Constant (C) DC

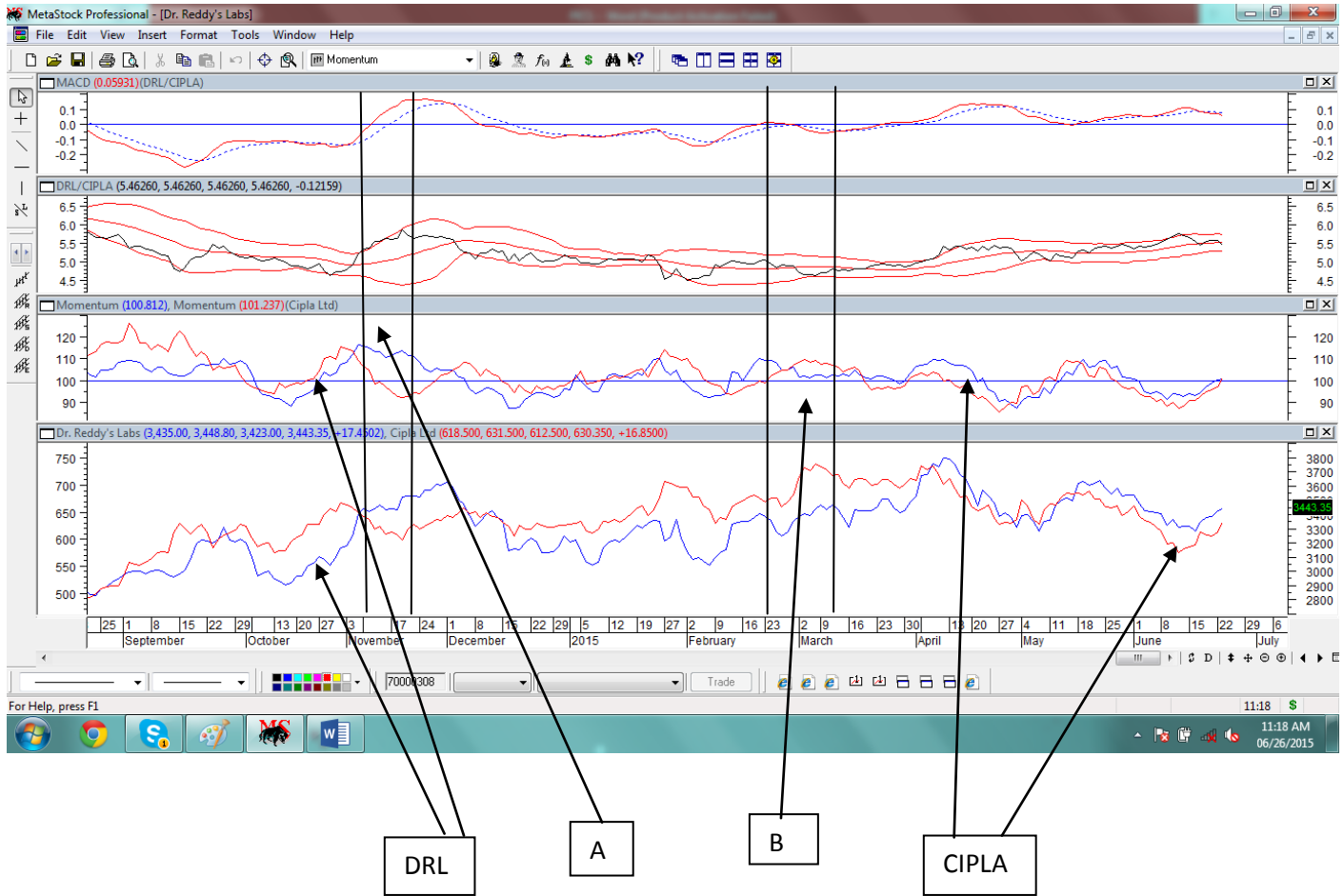
The momentum positions defined in Table 2, combined with the alternatives given in Table 1, will determine profitability of trading position. The entry exit points will be given by the other technical indicators. As an example, let us consider pair trading in Cipla Limited and Dr. Reddy's Laboratories (DRL). The analysis will be done in terms of Figure 4 where the pair price has price of shares of DRL in the numerator and the price of shares of Cipla in the denominator.

In the figure, the bottom most panel gives the movement in prices of the two shares. The second panel gives the movement in momentum of the individual stocks. The third panel plots the pair value of the two prices along with its Bollinger Band. The top most panel gives the MACD of the pair of prices.

A few observations are in order.

1. The third panel from the bottom shows the mean reversal pattern of the pair of prices;
2. When the pair touches the upper (lower) band of the Bollinger Band, the pair value falls (rises);
3. The band narrows or widens depending on the volatility of the pairs;
4. A sudden upward movement in the pair, causes the band to widen;
5. As a consequence, MACD jumps to the overbought zone;

**Figure 4: Dr. Reddy's Laboratories and Cipla Ltd. Stock Prices, Pair of Prices, Momentum, MACD and Bollinger Band**



**Source: Metastock and Authors' own construction**

In the time zone A, the price of DRL is rising and that of Cipla is falling. This has caused the pair value to jump thus leading to sudden widening of the Bollinger Band and MACD rising to the overbought zone. This movement in prices has led the momentum of Cipla to fall drastically and that of DRL to be stable. This is an ideal situation to profit from the pair. The Bollinger Band says that the pair value will fall and MACD is also giving sell signal. So we short DRL and long Cipla. Observe that we make a profit as subsequently prices of shares of DRL has fallen and that of Cipla has gone up. So we observe the movements in the band and profit outside the band. Here we make profit on both legs. The basic entry or exit is suggested by Bollinger Band and MACD. We feel that the success of the strategy lies in tracking the momentum.

If we turn to time zone B, we observe the opposite movements to time zone A. Here the pair value is falling and moving towards the lower band of the Bollinger Band. Although the actual prices of the two shares are rising, Cipla is rising at a faster rate than DRL. This is shown by momentum of Cipla rising and that of DRL falling. So short Cipla and long DRL. The moment we move to the right of time zone B where the ratio has bounced back from the lower band of the Bollinger Band, reverse the strategy.

The momentum position to generate profit is summarized in Table 3.

**Table 3**

Strategy when ratio of prices rises	This can happen when	Momentum position to generate profit
Short N Long D	Numerator rises, Denominator falls	NR DF - profit from momentum reversal – may take a few days
Short N Long D	Numerator rises at a faster rate than the Denominator rise	NF DR - profit as momentum reversal has taken place – profit booking immediate
Short N Long D	Denominator falls at a faster rate than the numerator fall	NR DF - profit from momentum reversal – may take a few days
The ratio of prices falls	This can happen when	
Long N Short D	Denominator rises, Numerator falls	NF DR - profit from momentum reversal – may take a few days
Long N Short D	Denominator falls at a slower rate than the Numerator fall	NR DF - profit as momentum reversal has taken place – profit booking immediate
Long N Short D	Denominator rises at a faster rate than the Numerator rise	NR DF - profit from momentum reversal – may take a few days

**Source: Authors’ own construction**

We thus have the following propositions.

**Proposition 1**

- i. When the ratio of stock prices of two companies from the same sector are rising, and
- ii. If stock prices of both the companies are rising, and
- iii. If numerator stock price is rising faster than the denominator stock price given by the difference in momentum, and

- iv. If the momentum of the faster one is rising, and the slower one is falling;

Then a pair trade of Short N and long D can be executed.

### **Proposition 2**

- i. When the ratio of stock prices of two companies from the same sector are falling, and
- ii. If stock prices of both the companies are falling, and
- iii. If the numerator stock price is falling faster than the denominator stock price given by the difference in momentum, and
- iv. If the momentum of faster one is falling, and the other is rising;

then a pair trade of Long N and Short D can be executed.

### **Proposition 3**

- i. When the ratio of stock prices of two companies from the same sector are falling, and
- ii. If numerator stock price is falling and denominator stock price is rising, and
- iii. If the momentum of numerator stock price is falling, and the momentum of the denominator stock price is rising, and

then a pair trade of Long N and Short D can be executed.

### **Proposition 4**

- i. When the ratio of stock prices of two companies from the same sector are rising, and
- ii. If numerator stock price is rising and denominator stock price is falling, and
- iii. If the momentum of numerator stock price is rising, and the momentum of the denominator stock price is falling;

then a pair trade of Short N and Long D can be executed.

### **Proposition 5**

- i. When the ratio of stock prices of two companies from the same sector are rising, and
- ii. If both the individual stock prices are both falling, and
- iii. If the denominator stock price is falling faster than the numerator stock price, and
- iv. If the momentum of numerator stock price is rising, and the momentum of the denominator stock price is falling;

then a pair trade of Short N and Long D can be executed.

### **Proposition 6**

- i. When the ratio of stock prices of two companies from the same sector are falling, and
- ii. If both the individual stock prices are both rising, and
- iii. If the denominator stock price is rising faster than the numerator stock price, and
- iv. If the momentum of numerator stock price is falling, and the momentum of the denominator stock price is rising;

then a pair trade of long N and Short D can be executed.

Based on the analysis provided above, an interested reader can work out profit making opportunities from Figures 5, 6 and 7 where all the technical indicators are shown for three different sets of companies.

## **6. CONCLUDING REMARKS**

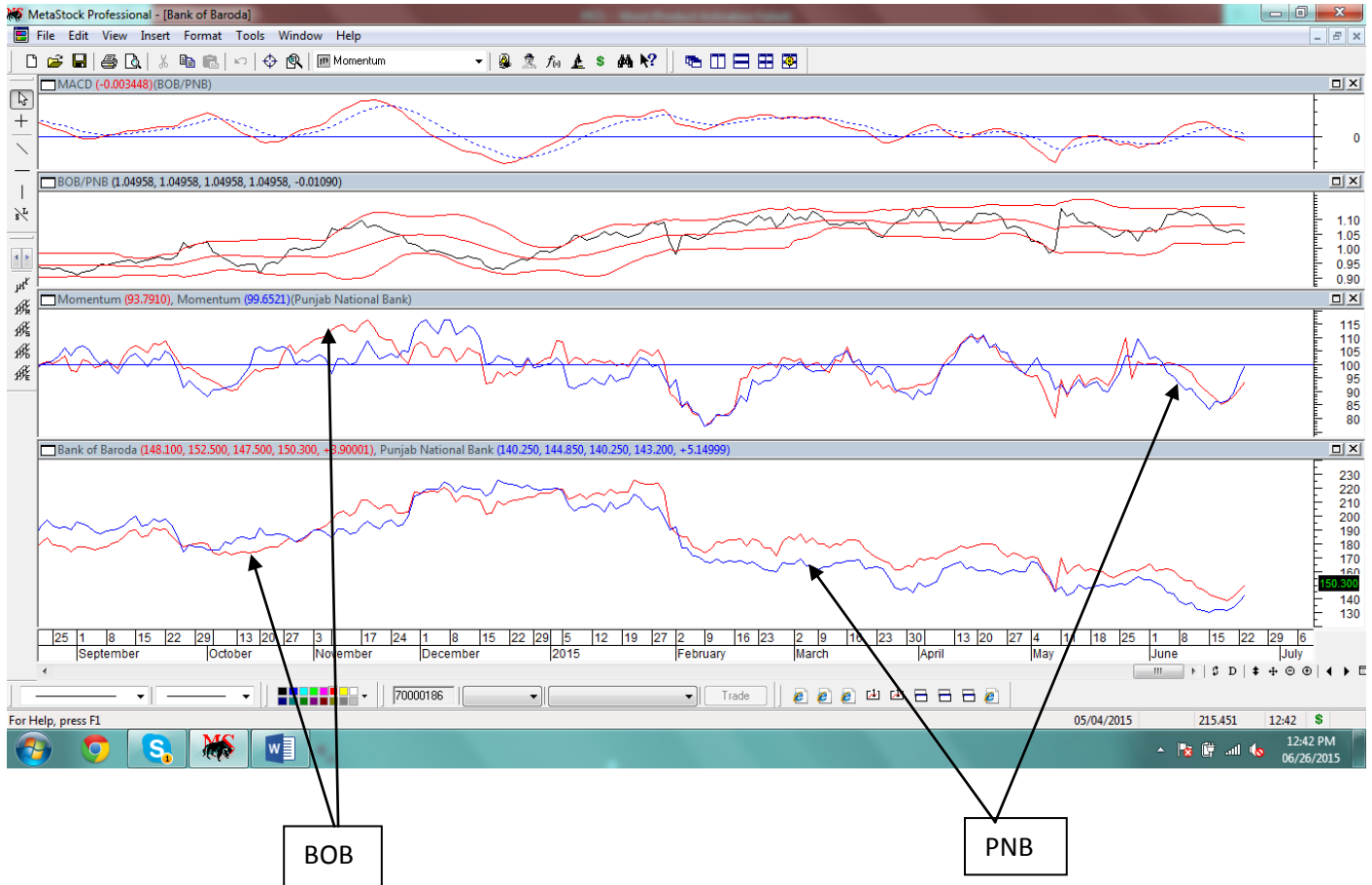
Pairs trading is an arbitrage strategy for profit making by taking opposite positions (buy/sell) in two financial assets. In the case of shares of companies, it works when the shares chosen are of companies from the same sector. Given that the systematic risk faced by both companies from the same sector would be identical, the strategy hinges on deviation of the ratio of prices from a mean and reversal to the mean. The purpose of this paper was to integrate technical analysis with pair trading and show that technical indicators do help in profit making from pair trade. It showed that in some cases the trade could give immediate results and in some cases time would be required. We have to keep in mind that as this is an arbitrage strategy, keeping the position open for a long time would not yield results and would be expensive.

Pairs trades can be performed between two companies under the same ownership and also between spot and futures. Our future research will explore the possibilities along these lines.

## References:

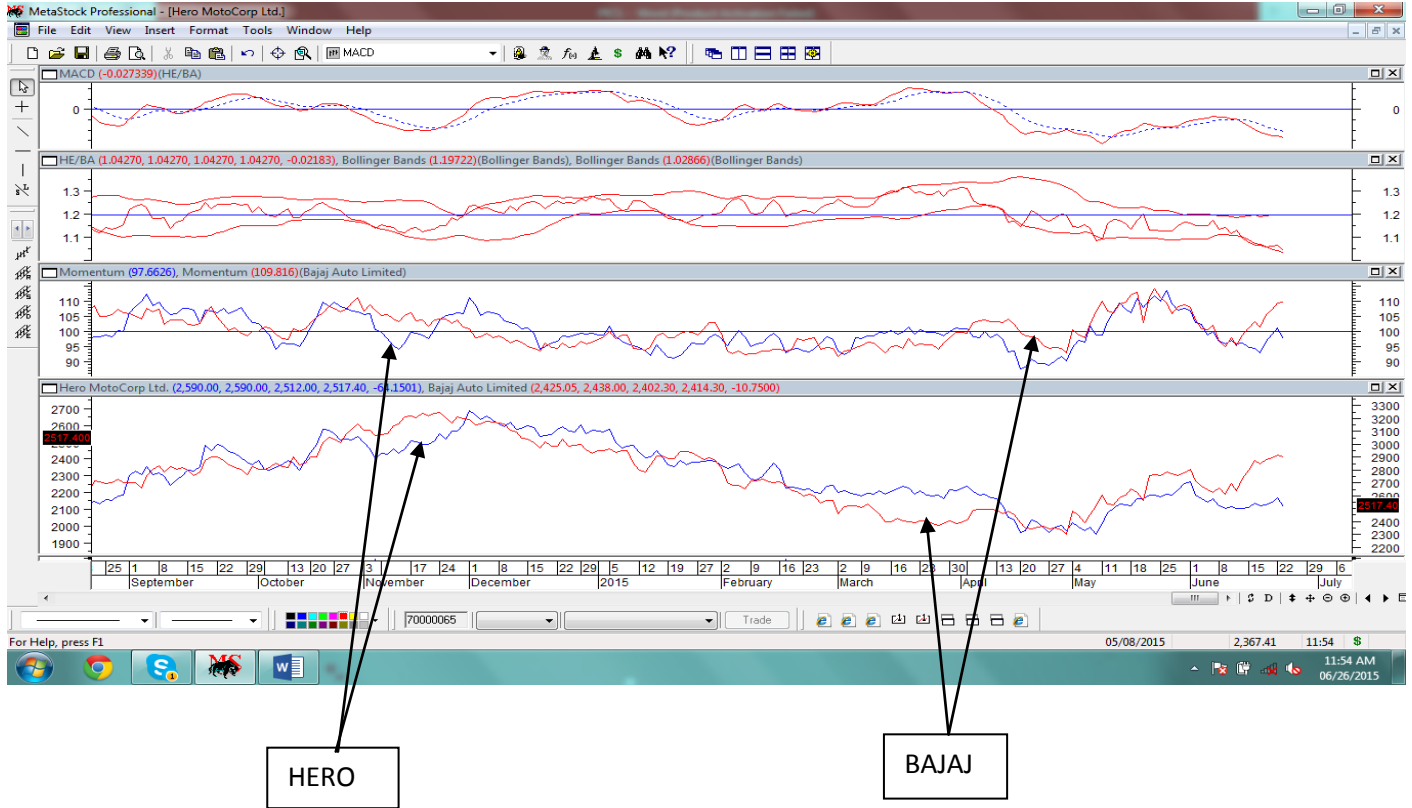
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**Figure 5: Bank of Baroda and Punjab National Bank Stock Prices, Pair of Prices, Momentum, MACD and Bollinger Band**



**Source: Metastock and Authors' own construction**

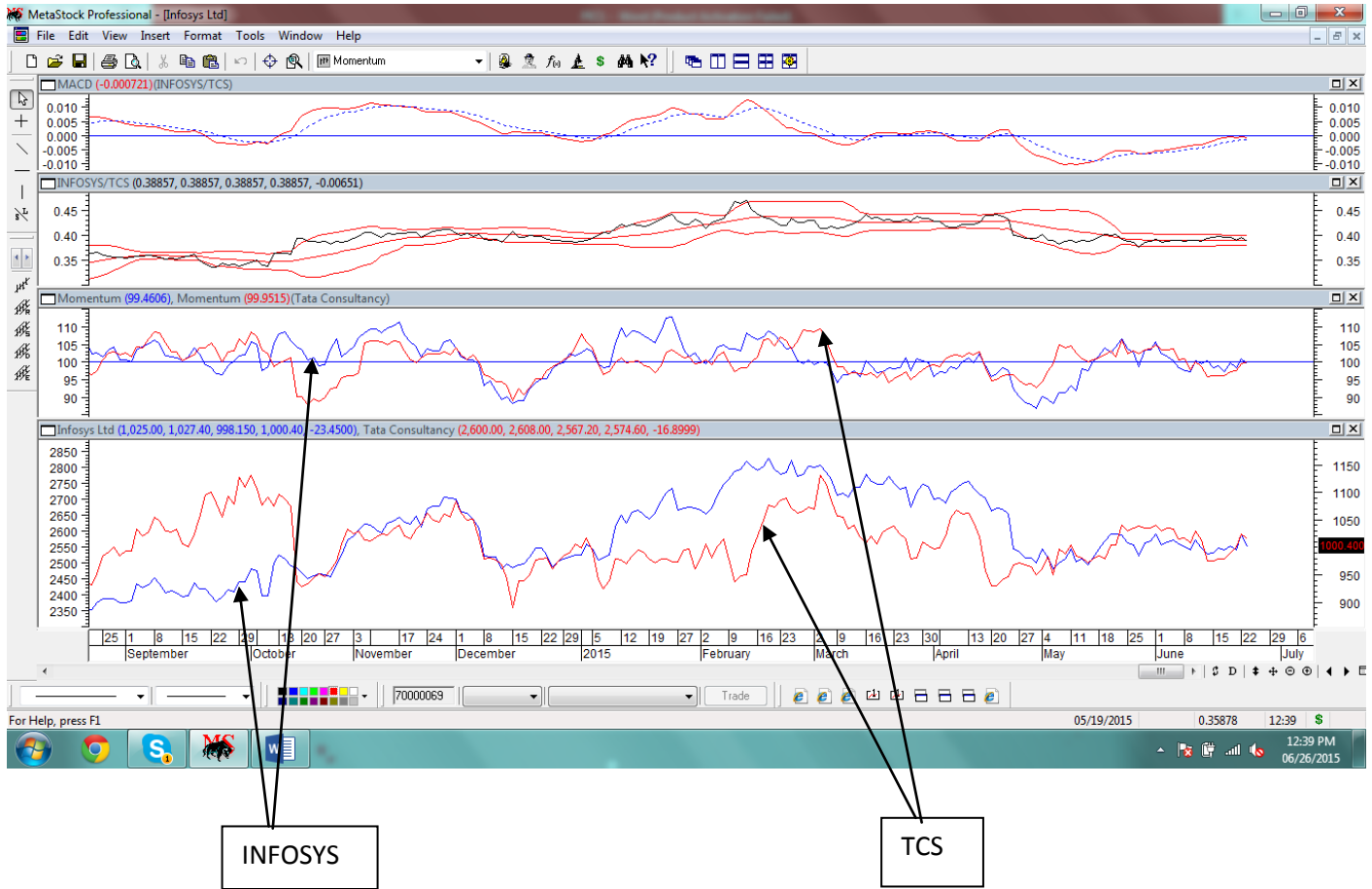
**Figure 6: Hero Motocorp and Bajaj Auto Stock Prices, Pair of Prices, Momentum, MACD and Bollinger Band**



Source: Metastock and Authors' own construction



**Figure 7: Infosys Ltd. and TCS Stock Prices, Pair of Prices, Momentum, MACD and Bollinger Band**



Source: Metastock and Authors' own construction