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ADDRESSING THE INVESTORS DILEMMA USING PAIRS TRADING - CO-INTEGRATIONAL STUDY OF INDIAN STOCKS

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Abstract

The increasing volatility in stock, commodities and foreign exchange markets compel investors and scholars to look for strategies which would immunize the investors against the unprecedented movement of the markets. Investors are often at dilemma to take correct positions to offset the risks in the market. This effort to offset market risk led to discovery of several market-neutral investment strategies of which a very popular one is Pairs Trading. It essentially involves taking opposite positions in two highly correlated assets. This study is on identifying pairs of stocks in the National Stock Exchange (NSE) which are suitable for pairs trading. The method of cointegration, both in long and short run, have been utilized in this study. Related statistical concepts of autocorrelation and stationarity have also been used in the study.

Keywords:

Pairs Trading, NSE, Cointegration, Autocorrelation, Stationarity

1. INTRODUCTION

To invest of not to invest is a dilemma faced by investors around the world. It would not be wrong to propound that investment decisions hold the key to investor's behaviour in the stock markets. Investors across the world employ a wide array of strategies with common objective of maximizing profits and minimizing risks [5]. In recent time, large institutional investors, hedge funds etc. have focused largely on quantitative and algorithmic trading and they have come up with increasingly complex strategies with varied levels of success. In early 1980s a quantitative research group called Nunzio Tartaglias quantitative technique using group within Morgan Stanley came up with a market neutral strategy called pairs trading strategy [6]. Pairs trading as a strategy is popular among individual as well as institutional investors. Nobel laureates Myron Scholes and Robert C. Merton were some of its well-known practitioners [7].

Pairs trading exploits market inefficiencies. An investor identifies two assets such as both of them carry same amount of inherent risk due to having same characteristics or due to being in same industry etc. By employing statistical tools like correlation, cointegration etc., it is verified whether they have a history of moving together i.e. generating similar returns in long run [11]. Thus any deviation in their returns is a short term anomaly and will be rectified in the long run. Thus trading position is opened when prices of two assets diverge beyond a threshold point, to take advantage of relative mispricing by going long on underperforming asset and short selling the relative outperformer [13]. Trading position is closed when the prices of the two assets start to converge again by reversing the previous transaction and generating arbitrage profit. Market frictions such transaction costs, financing costs, taxes etc. can erode the profit generated. Pairs trading is thus a kind of arbitrage strategy but not a pure arbitrage as it has some inherent risks like for example due to inefficiencies of the market, divergence of price of two assets generating similar returns in the past may widen instead of converging in the long run, or counterparty for trade is unavailable etc. Thus, it can be inferred that pairs trading is a kind of statistical arbitrage as it uses different statistical tools to form an asset pair and generating signals for opening and closing trade. Pairs trading can also be classified as market neutral as it has exposure to market risk on both long and short positions. By having simultaneous exposure on both long and short positions the upside and downside risk of movement of market in any one direction is eliminated. Thus, the returns have no correlation with benchmark index and it behaves like a beta-zero portfolio or in other words systematic risks are eliminated substantially. There are three main methods used in pairs trading:

1. *Distance Method*: Under distance method, the co-movement of a pair is measured by distance or the sum of square of distance between two normalised price series;
2. *Cointegration Method*: Under cointegration method, two integrated non-stationary stock price series are combined to form a stationary portfolio time series;
3. *Stochastic Spread Method*: The stochastic spread method is based on mean reversion of spread in a continuous time setting. Here spread means difference between prices of two stocks

Pairs trading is an almost four decades old strategy which has remain popular till now due to its being relatively easier to understand and execute It does not require frequent intra-day trading thus allowing automation. It can be used by individuals and institutional investors having widely different investment styles.

1.1 OBJECTIVES AND SCOPE OF THE STUDY

The study aims to find out the feasibility of pairs trading strategy by constructing a pairs trading portfolio through cointegration from stocks of companies belonging to same sector. The study has been done on the basis of the audited financial reports of the companies for the year ended 31st March 2019.

2. REVIEW OF LITERATURE

Modern Portfolio Theory pioneered by Harry Markowitz [1] provides the framework for portfolio selection by an investor based on his expected returns and risk appetite through mean-variance analysis. But this model encountered some problems afterwards. Portfolio diversification became a problem because most assets in a market or most markets for that matter became

highly correlated in the long run and calculations for portfolio constructed with more than three assets became highly complex and tedious. Thus hedge funds and other large financial institutions with high risk appetite were looking for different strategies for arbitrage and a quantitative technique using group of Morgan Stanley came up with the concept of pairs trading in early 1980s where they formed portfolios with highly correlated assets as opposed to Markowitz model which suggested that portfolio should be diversified i.e. constructed with assets that had negative correlation.

Survey of literature revealed that cointegration method for pairs trading became increasingly popular method of pairs trading in the last decade. Cointegration method was applied to a wide variety of assets like commodity, currency, equity, exchange traded funds etc.

Balarezo and Moura [9] used cointegration method in combination with modern portfolio theory to build a portfolio with Exchange Traded Funds (ETF) of USA and fifteen other countries to form an internationally diversified portfolio from the point of view of an individual investor situated in USA. The performance of this portfolio was compared against the benchmark which was a portfolio constructed based on modern portfolio theory. Thirty nine pairs of portfolios were created and tested. For thirty six pairs, the portfolio created with cointegration method outperformed the portfolios created by only modern portfolio method.

Dunis et al. [3] examined the possibility of optimisation of currency portfolio using cointegration method. Their benchmark was EUR/USD for portfolios constructed using USD and EUR and GBP/USD for sterling portfolios. They formed major currency pair tracking portfolio mimicking index tracking equity portfolios. They then compared out-of-sample performances of these portfolios to simple benchmark techniques of optimisation. The results showed that cointegrated portfolios showed lower volatility than the benchmark and thus offered better risk adjusted return in the long run. Bansal and Kiku [12] in their paper compared optimal asset allocation based on the error- correction vector autoregression (EC-VAR) specification with that of traditional VAR. The EC-VAR model which incorporated cointegration for constructing portfolio was able to outperform traditional VAR based portfolio in midterm to long term range.

Caldeira and Moura [8] used data of closing prices of fifty stocks with largest weights in the Ibovespa index from Sao Paulo Stock Exchange in the beginning of each trading period of four months duration. These were selected as they were highly liquid and so transaction cost was low. As constituents of the index changed every four months the stocks in the sample was also changed and the data was adjusted for dividends and stock splits. Stocks from both same and different sectors were used to form pairs using cointegration method. From all possible pairs, twenty with highest Sharpe ratio was selected and traded for four months. The results show that pairs selected through cointegration had a higher Sharpe ratio than the benchmark and hence a higher risk adjusted performance and also relatively low levels of volatility and no significant correlation to Ibovespa, confirming its market neutrality.

Do and Faff [2] used a relative arbitrage strategy involving cointegration on empirical data of US equity market. Over the sample period, the performance of relative value arbitrage was profitable among pairs of close economic substitutes and for pairs which were not close economic substitute, it converged towards contrarian trading of individual stocks.

Harlacher [10] analysed an algorithmic strategies based on cointegrated pairs of assets which were stocks of SandP 500 and found they had only a marginal correlation with the market in terms of returns. In addition they yielded higher average returns than the benchmark and lower volatility. Lin selected pairs based on cointegration on securities listed with NYSE and were ranked based on their performance during formative period. From them top five pairs were selected to form a portfolio with weightage changing over time i.e. dynamic allocation. The performance of the portfolio was measured against a benchmark which was a portfolio with even weightage and baseline t-bill. They were able to beat portfolio with even weightage and stay competitive with three month month t-bill baseline.

On the other hand Bolgun et al. [4] used a dynamic pairs trading model based on distance method to construct a portfolio from stocks of companies included in ISE-30. It was not sector specific study and the constituents of was subject to change every quarter. The stocks which were part of the index at the beginning of the study were tracked and adjusted for corporate action and VAR analysis was carried out to determine risk. The results showed the benchmark underperformed against pair's portfolio both in terms of return and volatility. The pairs trading strategy was most potent when the market was volatile and did not show any clear trend. More favourable results were obtained with tighter constrains but profits were eroded due to trade restrictions and commissions but performance analysis clearly showed that pairs trading strategy yielded excess returns and less volatility than the market portfolio.

Habibi and Pakizeh [14] carried out an empirical analysis of pairs trading strategy across different asset classes which included stocks of Tehran Stock Exchange, *S&P*500 and also commodities. They used both distance method and cointegration methods of pairs trading and compared the results. The results showed distance method yielded highest average returns and portfolio constructed using distance method had the highest Sharpe Ratio i.e. best risk adjusted returns. Thus they concluded distance method was more effective for pairs trading involving different asset classes.

In most of the research literature surveyed, it was found that majority of them had access to huge amount of data related to prices of both equity and non-equity assets. They used dynamic asset allocation for the portfolio that involved complex calculations and had long investment horizons. Thus this method is suitable for investors with long investment horizon having access to huge amount of data and specialised software with inclination towards low-risk moderate gains.

3. OBJECTIVE OF THE STUDY

The objective of this study was three-fold:

- Firstly, the sectors in the Indian economy had to be identified with the highest returns with more weight on recent returns

- Secondly the companies in each such identified sector had to be identified with positive returns on year-to-date, half-year-to- date, quarter-to-date and month-to-date basis.
- Thirdly, pairs suitable for pairs trading had to be identified.
- The third objective was the main objective for the study and the first two were the ancillary objectives.

4. METHODOLOGY FOR THE STUDY

4.1 DATA COLLECTION

The data used in the study was entirely secondary in nature. The data was collected from Ace Equity© data product. Data pertaining to the financial year ended 2018-19 were taken for a cross sectional study.

4.2 RESEARCH METHODS

The weighted average of month-to-date, quarter-to-date, half year-to-date and year-to-date returns for the financial year 2018-19 of different sectors of Indian economy have been computed with shorter time periods being accorded higher weights and on the basis of that, the sectors have been ranked. Stocks listed with NSE have been considered for the study.

4.3 DATA PRESENTATION AND ANALYSIS

The top five sectors were selected. In each sectors only those companies were selected which posted positive returns for month-to-date, quarter-to-date, half year-to-date and year-to-date periods. The daily adjusted closing prices of the selected stocks were checked for stationarity using the Augmented Dickey Fuller Test at five percent level of significance to filter out those stocks whose prices were non-stationary. The hypotheses framed were:

H_0: There price data is non-stationary

H_1: The price data is stationary

In each sector all possible pairs were tested for long-term cointegration by subjecting them to Johansen Test at one percent level of significance. The hypotheses framed were:

H_0: There no co-integration between the pair of price data

H_1: There co-integration between the pair of price data

If long term cointegration was not found in any pair, the pairs were subjected to Vector Auto Regression (VAR) for short-term cointegration.

The appropriate lags were selected by applying four criteria i.e. Akaike Information Criteria, Hannan-Quinn Criteria, Schwarz Crietra and Final Prediction Error to identify the minimum lag. In case of there were different minimum lags suggested by the four criteria, all the different lags were used to frame the equations for VAR.

For the two regression equations for each pair, the equation with higher adjusted R^2 was selected and the residuals were subjected to Box-Ljung portmanteau test for autocorrelation at five percent level of significance. If the residuals were found to be autocorrelated, the test failed and the pair was found suitable for short-term cointegration. The hypotheses framed were:

H_0: There no autocorrelation in the residuals

H_1: There is autocorrelation in the residuals

Table.1. Month-to-Date, Quarter-to-Date, Half Year-to-Date and Year-to-Date for the YE 31/03/2019 (All figures except weights and weighted returns, are in percentages)

Weights	**0.40**	**0.30**	**0.20**	**0.10**	**WTRET**
Sectors	**RETMTD**	**RETQTD**	**RETHTD**	**RETYTD**	
Miscellaneous	-66.58	-64.04	-64.04	-64.04	-0.65056
Agriculture	-26.15	-31.99	-31.99	-31.99	-0.29654
Alcohol	-4.54	-7.95	-7.95	-7.95	-0.06586
Automobile and ancillaries	-29.40	-32.17	-32.17	-32.17	-0.31062
Aviation	-5.93	-8.51	-8.51	-8.51	-0.07478
Banks	-1.27	2.24	2.24	2.24	0.00836
Capital Goods	-23.82	-23.38	-23.38	-23.38	-0.23556
Chemicals	7.51	5.31	5.31	5.31	0.0619
Construction Materials	-14.67	-17.31	-17.31	-17.31	-0.16254
Consumer Durables	3.90	-2.68	-2.68	-2.68	-0.00048
Containers and Packaging	-42.70	-47.92	-47.92	-47.92	-0.45832
Diamond and Jewellery	1.14	3.21	3.21	3.21	0.02382
Diversified	-27.76	-30.03	-30.03	-30.03	-0.29122
Electricals	-48.02	-42.80	-42.80	-42.80	-0.44888
ETF	-9.77	-7.56	-7.56	-7.56	-0.08444
Finance	7.87	8.58	8.58	8.58	0.08296
FMCG	16.18	16.37	16.37	16.37	0.16294
Footwear	95.72	82.07	82.07	82.07	0.8753

Healthcare	-5.81	-6.60	-6.60	-6.60	-0.06284
Hospitality	-37.47	-33.41	-33.41	-33.41	-0.35034
Industrial Gases and fuels	-8.75	-12.96	-12.96	-12.96	-0.11276
Infrastructure	-18.68	-13.69	-13.69	-13.69	-0.15686
Insurance	16.08	19.97	19.97	19.97	0.18414
Logistics	-27.75	-29.40	-29.40	-29.40	-0.2874
Manufacturing	-17.63	-21.02	-21.02	-21.02	-0.19664
Media and Entertainment	-51.49	-51.24	-51.24	-51.24	-0.5134
Metals and Mining	-33.25	-31.38	-31.38	-31.38	-0.32128
Miscellaneous	-19.31	-21.53	-21.53	-21.53	-0.20642
Oil and Gas	10.78	14.22	14.22	14.22	0.12844
Paper	-56.05	-55.82	-55.82	-55.82	-0.55912
Photographic Products	-38.30	-43.79	-43.79	-43.79	-0.41594
Plastic Products	-17.87	-19.49	-19.49	-19.49	-0.18842
Power	-14.26	-18.29	-18.29	-18.29	-0.16678
Real Estate	-22.92	-24.61	-24.61	-24.61	-0.23934
Retailing	21.52	21.59	21.59	21.59	0.21562
Ship Building	-24.38	-26.18	-26.18	-26.18	-0.2546
Software and IT Services	22.34	34.88	34.88	34.88	0.29864
Telecom	-36.29	-44.84	-44.84	-44.84	-0.4142
Textiles	-35.59	-40.13	-40.13	-40.13	-0.38314
Trading	-19.27	-15.18	-15.18	-15.18	-0.16816

Table.2. Ranking of the sectors on the basis of weighted returns

Sectors	WTRET	Rank	Sectors	WTRET	Rank
Footwear	0.87530	1	Plastic Products	-0.18842	21
Software and IT Services	0.29864	2	Manufacturing	-0.19664	22
Retailing	0.21562	3	Miscellaneous	-0.20642	23
Insurance	0.18414	4	Capital Goods	-0.23556	24
FMCG	0.16294	5	Real Estate	-0.23934	25
Oil and Gas	0.12844	6	Ship Building	-0.25460	26
Finance	0.08296	7	Logistics	-0.28740	27
Chemicals	0.06190	8	Diversified	-0.29122	28
Diamond and Jewellery	0.02382	9	Agriculture	-0.29654	29
Banks	0.00836	10	Automobile and Ancillaries	-0.31062	30
Consumer Durables	-0.00048	11	Metals and Mining	-0.32128	31
Healthcare	-0.06284	12	Hospitality	-0.35034	32
Alcohol	-0.06586	13	Textiles	-0.38314	33
Aviation	-0.07478	14	Telecom	-0.41420	34
ETF	-0.08444	15	Photographic Products	-0.41594	35
Industrial Gases and Fuels	-0.11276	16	Electricals	-0.44888	36
Infrastructure	-0.15686	17	Containers and Packaging	-0.45832	37
Construction Materials	-0.16254	18	Media and Entertainment	-0.51340	38
Power	-0.16678	19	Paper	-0.55912	39
Trading	-0.16816	20	Miscellaneous	-0.65056	40

Table.3. Consistency of positive returns of the stocks considered for pair trading

Sector	Company	MTD	QTD	HTD	YTD
Footwear	Bata	Positive	Positive	Positive	Positive
	Relaxo Footwear	Positive	Positive	Positive	Positive
Software and IT Industries	AJEL	Positive	Positive	Positive	Positive
Retailing	Aditya Birls F	Positive	Positive	Positive	Positive
	AFL	Positive	Positive	Positive	Positive
	Avenue Supermart	Positive	Positive	Positive	Positive
Insurance	ICICI Lombard	Positive	Positive	Positive	Positive
	HDFC Life	Positive	Positive	Positive	Positive
	ICICI Prudential	Positive	Positive	Positive	Positive
	SBI Life Insurance	Positive	Positive	Positive	Positive
FMCG	Varun Beverages	Positive	Positive	Positive	Positive
	Britannia	Positive	Positive	Positive	Positive

Table.4. Results of ADF tests for testing stationarity or otherwise of the prices of the selected seven stocks

Stocks	Dickey-Fuller Statistic	p-Value	Null Hypotheses	Nature of time series of daily closing prices
ABFRL	-0.1535	0.5674	Accepted	Non-Stationary
AFL	0.9858	0.9123	Accepted	Non-Stationary
DMART	0.4363	0.7554	Accepted	Non-Stationary
ICICG	1.8146	0.9827	Accepted	Non-Stationary
HDFC	1.2047	0.9403	Accepted	Non-Stationary
ICIP	-0.3366	05091	Accepted	Non-Stationary
SBIL	0.6900	0.8363	Accepted	Non-Stationary

Source: Author's own calculations

Table.5. Results of Johansen tests for long term cointegration between possible pair of stocks

Pairs	Range	Test Statistic	Tabular Value at 5%	Null	Inference
ABFRL and AFL	$r \leq 1$	1.18	9.24	Accepted	No Long Term Cointegration is present. Hence Long- Term pairing cannot be done with any of these pair of stocks.
	$r = 0$	8.11	15.67	Accepted	
ABFRL and DMART	$r \leq 1$	3.74	9.24	Accepted	
	$r = 0$	7.28	15.67	Accepted	
AFL and DMART	$r \leq 1$	4.66	9.24	Accepted	
	$r = 0$	6.37	15.67	Accepted	
ICIG and HDFC	$r \leq 1$	2.06	9.24	Accepted	
	$r = 0$	9.88	15.67	Accepted	
ICIG and ICIP	$r \leq 1$	3.45	9.24	Accepted	
	$r = 0$	12.46	15.67	Accepted	
ICIG and SBIL	$r \leq 1$	4.70	9.24	Accepted	
	$r = 0$	6.09	15.67	Accepted	
HDFC and ICIP	$r \leq 1$	1.26	9.24	Accepted	
	$r = 0$	10. 53	15.67	Accepted	
HDFC and SBIL	$r \leq 1$	2.65	9.24	Accepted	
	$r = 0$	19.12	15.67	Accepted	
ICIP and SBIL	$r \leq 1$	0.73	9.24	Accepted	
	$r = 0$	11.33	15.67	Accepted	

Table.6. Results of ADF tests for stationarity and otherwise, for the residuals of regressions between possible pair of stocks

Pair	Dickey-Fuller Statistic	p-Value	Null Hypotheses	VAR	Feasibility of pair Trading
ABFRL and AFL	-2.3507	0.0198	Rejected	Not Applicable	Feasible
ABFRL and DMART	-1.8686	0.0623	Accepted	Applicable	Not Feasible
AFL and DMART	-1.5275	0.1295	Accepted	Applicable	Not Feasible
ICIG and HDFC	-1.5448	0.1240	.Accepted	Applicable	Not Feasible
ICIG and ICIP	-2.3322	0.0256	Rejected	Not Applicable	Feasible
ICIG and SBIL	-1.9722	0.0482	Rejected	Not Applicable	Feasible
HDFC and ICIP	-2.0829	0.0381	Rejected	Not Applicable	Feasible
HDFC and SBIL	-4.2243	0.0100	Rejected	Not Applicable	Feasible
ICIP and SBIL	-3.0026	0.0234	Rejected	Not Applicable	Feasible

Source: Author's own calculations

As all the price series are non-stationary (Table.4), it may be proceeded with to explore possibility of pair trading with each of these stocks. For long-term cointegration, Johansen Test is performed. The synopsis of the tests is appended in Table.5. Now it was imperative to be studied (Table.5) whether short-term cointegration exists so that short term pairing can be done. Accordingly VAR testing is proceeded to. The Johansen Tests (Table.6) confirmed that no long-term cointegration could be observed between the selected pairs.

However, short-term cointegration was observed in the pairs ABFRL-AFL, ICIG-ICIP, ICIG and SBIL, HDFC and ICIP, HDFC and SBIL, ICIP and SBIL.

5. CONCLUSION AND FUTURE SCOPE

Considering the selected sectors and the selected stocks, pair can be done for short term using cointegration methods in the Retail sector with stocks of ABFRL.

Pair can be done for short term using cointegration methods in the retail sector with stocks of ABFRL and AFL. The same can also be done in the insurance sector with stocks of ICIG-ICIP, ICIG and SBIL, HDFC and ICIP, HDFC and SBIL, ICIP and SBIL.

This paper has studied only equity stocks of five sectors and performed cointegration tests taking two stocks at a time. Further studies can be done on other sectors of investors' choice. Studies may also be carried out to examine if more than two assets are cointegrated. For example, studies could be carried out to see if more than two different ETFs tracking a common underlying e.g. gold are cointegrated.

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