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MOMENTUM INVESTMENT STRATEGY

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ABSTRACT

Momentum investment strategy aims at buying well-performing stocks and shorting the poorly performing stocks to generate a decent return percentage. The aim is to capitalize on the continuance of existing trends. We have performed simulations in favour of momentum strategy for the stocks listed on NSE for the period between 2007 and 2012. Our results are in sync with the findings of Jegadeesh and Titman(1993).

Keywords: Market Efficiency Theory, Momentum, Technical Analysis, Fundamental Analysis

1. Introduction

Investment strategies have been a popular topic in the academic world over the past two decades and will continue to be — the reason being the uncertainty in market and the rise of world economy where people continue to pool their money into the stock market for a high return. Today's researchers are equipped with vast databases and insurmountable computing power, making the analysis easier and more efficient. Different strategies for different asset classes have been developed but equities in particular has received plenty of attention.

Momentum investment strategy involves buying stocks that have performed well in the past and shorting the stocks that have performed poorly in the past.[1] This strategy aims to generate significant returns over the persistence period or holding period. Momentum investment strategy is not just limited to a researcher's laptop but they have

[1] Selling of stocks can achieved through short sale or selling of futures.

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found real world applications, especially in asset management. Multi-billion dollar corporations in United States have succeeded in exploiting the momentum investment strategy to their gain by launching momentum-based fund schemes. Many of these strategies have been running for more than a decade with assets worth billions of dollars under management. However, momentum based investing is hardly used by anybody for the Indian stock market.

The weak form of market efficiency hypothesis. as discussed, states that abnormal profits cannot be produced through investment strategies based on historical data and if any such returns are earned it is a mere compensation for the higher risk taken. However, near zero-beta portfolios have been successfully created in the past. They have also been found to generate superior absolute returns — much higher than risk free rate of return.[2] Momentum profits have thus remained an anomaly in the markets and provide fund managers, an excellent tool to create beta-neutral, superior-return portfolios.

Till now, the explanation of short-term momentum returns has not been provided by any asset-pricing model. The three-factor version of asset pricing model by Fama and French successfully explained most of the anomalies in momentum investing, including long-term contrarian profits, however it could not explain the short-term returns. Grundy and Martin studied the risk sources of momentum strategies and concluded that while factor models can explain most of the variability of momentum returns, they fail to explain their mean returns. Momentum profits have been proved to exist across the major financial markets. This unexplained persistence of momentum returns is an anomaly and is seen by some as one of the major challenges in asset-pricing literature. However, one needs to analyse whether the momentum investment strategy is viable after taking into account the transaction cost. Korajczyk and Sadka (2002) estimated that as much as 5 billion dollars can be invested in momentum strategies before the apparent profit opportunities vanish due to price impact induced by trades

Since momentum investment strategy is not prevalent in India, very few studies have been done in this sector for Indian markets. The Indian market has undergone many changes in the last two decades (since Globalization) with the volumes and liquidity improving

[2] A portfolio of assets so constructed as to have no systemic risk is referred to as a zero-beta portfolio. Systematic risk, also known as “undiversifiable risk,” “volatility” or “market risk,” affects the overall market. This type of risk is both unpredictable and impossible to completely avoid. It cannot be mitigated through diversification. A zero-beta portfolio is similar to a risk-free asset

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considerably over last two decades. Strict guidelines, increasing role of institutional investors and the introduction of online and fully automated screen-based trading systems have increased the efficiency and effectiveness of the market. Turnover ratio has vastly improved from 32.7 percent in 1990-91 to 81.8 percent in 2006-07.[3] Trading in derivatives such as stock index futures, stock index options and futures and options in individual stocks have been introduced to provide hedging options to the investors and to improve the 'price-discovery' mechanism in the market. In India, certain factors might help in the successful implementation of momentum trading strategies like:

- regulations allowing short sales in the cash market
- reduction in transactions costs
- and the improved liquidity

This paper analyses momentum investment strategy to generate significant returns over a one to four month holding period. For the purpose of this study, we have employed a methodology used commonly by researchers studying momentum investment strategies but with some important modifications which not only establish that momentum investing can be profitable in India but also helps in devising portfolio strategies. The database for the study comprises of stocks listed on Nifty for the period 2007 to 2012. This is done to exclude any small cap or illiquid stock and negate the weak market-efficiency hypothesis. Our study aims at testing for existence of momentum profits and thus testing weak form of market efficiency. We back-test the momentum investment strategy in this paper under the assumption of zero transaction costs, however, fund managers can actually test this strategy to examine its robustness in the real world.

2.Momentum phenomenon

Debondt & Thaler in their paper of 1985, tested the momentum hypothesis and found significant momentum profits in the US market. Jagdeesh & Titman (1993) studied the stock data in the US market from 1965 to 1989 and found that the strategy, which selects stocks, based on a lookback period of six months and persistence period of six months, results in a compounded momentum return of 12.01% per year. Rouwenhorst (1998) reported that the momentum profits could also be obtained in the European markets. Chui, Titman, and Wei (2000) documented that momentum profits were obtained in Asian markets. A number of behavioural scientists have also attempted to explain the momentum

[3] Reserve Bank of India – Equity and Corporate Debt Market Report

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phenomenon. Daniel, Hirshleifer and Subrahmanyam (1998) attributed the momentum phenomenon to overconfidence and biased self-attribution.[4] Different explanation was given by Hong and Stein (1999) who divided the investors into two types — "news-watchers" and "momentum traders". Formers are the one who rely solely on their private information, while the latter rely exclusively on the historical data. Therefore, price is driven initially by the news-watchers as they receive and consequently react to their private information. The news gradually is transmitted to the market, where chartists may get breakouts on their charts and react to the news. The meaning of all this is that there initially is a period of under-reaction, which is, till the time momentum traders begin to react to the news and subsequently, it results in an overreaction when momentum traders react to the news. Schools of the literature discuss the possible reasons for momentum profits, some attribute it to investor behaviour, while others attribute it to risk factors not captured by CAPM or the Fama-French three-factor model.

3.Data and Methodology

3.1. Sampling

The sample for the study consists of the stocks which are listed on the NSE and are traded in the derivatives market. The list includes 104 stocks accounting for more than 30 sectors of the Indian economy. The reason behind selecting the stocks that are traded in the derivatives market is that it helps in avoiding issues associated with small and illiquid stocks influencing the results. Also since our strategy for momentum investing will involve taking short positions in stocks, only stocks traded in the futures market have been considered.

3.2. Data Collection

Adjusted daily closing prices on NSE of the stocks considered were obtained from the CMIE prowess[5] database for the period starting from January 2007 and ending July 2013. This

[4] Both are well known behavioral bias. Self-attribution bias occurs when people attribute successful outcomes to their own skill but blame unsuccessful outcomes on bad luck

5 The adjusted closing price on a specific date reflects all of the dividends and splits since that day. Each time a dividend is paid or a stock split declared, the adjusted closing price changes for every day in the history of the stock. For example: On Wednesday, Stock X closed at INR40 per share. On Thursday, a two-for-one stock split went into effect; Stock X opened at INR20 and closed at INR21, up INR1. The actual closing price would deceivingly indicate a INR19 decline (INR40-INR21). However, the adjusted close for Wednesday would change to INR20, and the adjusted close for Thursday of INR21 shows the actual INR1 gain in the share price. The adjusted closing price from a date in history can be used to calculate a close estimate of the total return, including dividends, that an investor earned if shares were purchased on that date. For example, $197.07 was both IBM's actual and adjusted closing price for July 12, 2013. Go back 20 years in history, and the actual closing price on July 12, 1993, was 48.13. However, the adjusted closing price was $9.52. This adjusted closing price shows that an investment in IBM on that date produced an almost 2,000 percent

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study which is for the period between January 2007 and July 2013, includes the stock market rally from 2007 to 2008, the global financial meltdown of 2008-2009, and the subsequent recovery and the consolidation period beginning soon after. Thus, the time period considered signifies all the major ups and downs in the Indian equity markets over the last decade.

3.3.Selection of scrips

Only those stocks have been considered, which were listed on the NSE throughout the time period between January 2007 and July 2013. Any stock whose data is not available due to the stock not being listed during the entire testing period for some reason or the other, has not been considered for portfolio formation. The stocks that fulfil the above mentioned criteria for the selected period are shown in Annexure 1.

3.4 Measurements of returns

Stock returns are measured using the adjusted daily closing price of the companies through the arithmetic return formula. Since, we won't be using any of the properties which normal distributions offer, lognormal returns have not been used for calculation. The main advantage of using logarithmic returns is that it is not affected by the base effect problem which we won't face in this paper. For example, an investment of Rs.100 that yields an arithmetic return of 10% followed by an arithmetic return of -10% percent results in a final value of INR 99; while an investment of INR 100 that yields a logarithmic return of 10% followed by a logarithmic return of -10% results in a final value of INR 100.

3.5 X-Y strategy

Here, we specifically use a strategy that selects stocks on the basis of returns over the past X days (i.e. Lookback period) and holds them for Y days (Persistence period). This is called as the X-Y strategy. At the beginning of each day, the candidate stocks are ranked in descending order on the basis of their returns in the past X days. The winner portfolio is defined as the set of stocks in which a long position is taken and loser portfolio is defined as the set of stocks in which a short position is taken. For example: some of the strategies, discussed in the paper will involve buying the top decile of the above stocks and selling of the bottom decile so the winner portfolio will be the top decile of stocks and the loser portfolio will be the bottom decile of stocks. Thus, the strategy involves simultaneously buying the winner portfolio and selling the loser portfolio and then holding this position for Y days. Furthermore, for a lookback period of 20 days, the persistence

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return for investors -- not the 310 percent that the actual closing price would indicate.

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period will vary from 1 to 20, thus generating strategies such as 20-1, 20-2, 20-3 and so on. Similarly, for a lookback period of 30 days, the persistence period will vary from 1 to 30, thus generating strategies such as 30-1, 30-2, 30-3, and so on.

3.6 Methodology

To test the momentum trading strategy for Indian market, the methodology used by Debondt and Thaler (1985, 1987) and Jegadeesh and Titman (1993) has been used with a slight modification. Instead of using abnormal returns, actual returns have been used for the analysis. This has two major advantages, first, it does not have any adverse impact on the robustness of analysis and second, it simplifies understanding and makes implementation easier. Another important aspect to be noted about X-Y strategy is that it uses overlapping portfolios. Jegadeesh and Titman (1993, 2001) suggest that using overlapping portfolios[6] helps reduce the effects of bid-ask bounce[7] and provides more robust results. Hence, overlapping portfolios have been used in this paper.

We will explain the methodology for 20-10 strategy for illustration purpose, although similar methodology has been used in other strategies as well. The analysis is performed using first 20 days' data for portfolio formation and next 10 days for portfolio testing period. As the study uses 1635 days' data (from January 2007 to 30 July 2013), there are 1605 winner and loser portfolios for the 20-10 strategy[8].

(Refer Table 1)

Similarly, the notation of adjusted closing price of the selected stocks is shown in the table below:

(Refer table 2)

3.7 Lookback Period

Let's take a scenario in which the 20-10 strategy is used. In such a case, if the portfolio is formed (Formation Date) for 21st January 2007 i.e. D_{21}, then the cumulative returns of the

[6] Consider the 2-1strategy. The portfolio formed at the end of Day3 based on last 2 days' returns would be held till Day 4. Similarly, portfolios formed at the end of Day 4,5,6,7 would be held till the end of Day 5,6,7,8 respectively. Thus, on any given day n, the strategies hold a series of portfolios that are selected on the current day as well as on the previous p – 1 days where p is the persistence period.

[7] Suppose a stock trades at bid 950 and ask 1000. Suppose no news appears for ten minutes. But, over this period, suppose that a buy order first comes in (at INR 1000) followed by a sell order (at INR 950). This sequence of events makes it seem that the stock price has dropped by INR 50. Even when no news is breaking, when a stock price is not changing, the `bid-ask bounce' is about prices bouncing up and down between bid and ask. These changes are spurious. This problem is the greatest with illiquid stocks where the bid-ask spread is wide.

[8] Number of winner or loser portfolios for the X-Y strategy for a sample period of n days = n – x – y. Thus for the 20-10 strategy, number of winner or loser portfolios = 1635-10-20 = 1605

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stocks for last 20 days are calculated using the formula:

$$\text{Return} = \frac{(P_{21} - P_1)}{P_1}$$

Where P_{21} represents the adjusted closing price of the stock on 21th January, 2007 or D_{21} and P_1 represents adjusted closing price of the stock on 1st January, 2007 or D_1. Based on the cumulative returns, the stocks are arranged in descending order. The strategy involves going long in the top decile scrips and taking a short position in the bottom decile. It is to be noted that a long/short portfolio is constructed by going long on the winner portfolio and short on the loser portfolio. This is done on a daily basis and the step is repeated 1605 times for the period starting January 2007 and ending on July, 2013 as mentioned above.

3.8 Persistence Period

After the winner portfolio is identified for D_{21} for a lookback period of 20 days, the following calculations are to be done for a persistence period of 10 days.

Step 1: Calculate the cumulative returns for all stocks selected in winner portfolio (top decile of the selected stocks based on returns in lookback period) across a period of 10 days (persistence period) beginning from D_{21}:

$$Return = \frac{(P_{31} - P_{21})}{P_{21}}$$

Where P_{31} represents the adjusted closing price of the stock on D_{31} and P_{21} represents adjusted closing price of the stock on D_{21}

Returns of the Top decile of stocks (Winner portfolio) during the persistence period between **D_{21} and D_{31}**

(Refer table 3)

Where $R_{21,1}$: Represents the returns of stock 1 on the formation date D_{21}.

Step 2: Take the arithmetic mean of the returns given by the stocks in the winner portfolio during the persistence period

The arithmetic mean **AR_{21}**is given by **Average ($R_{21,1}$, $R_{21,2}$, $R_{21,3}$……. $R_{21,10}$)**

For instance, if the portfolio is to be formed for 21st January (Formation date) and the strategy is 20-10, then the winner portfolio us selected on the basis of the returns given in the last 20 days. And the average daily returns for the winner portfolio are calculated for the next 10 days.

$$Formation\ Date = Start\ Date + Lookback\ Period$$

$$End\ Date = Formation\ Date + Persistence\ Period$$

Thus, 1st January is the "Start Date" and 31st January is the "End date"

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Step 3: Increment the starting date by one such that so that the Formation Date and End date are increased by one as well. As a result, the next Start Date is 2nd Jan, Formation Date is 22th January and the next End date is 1st Feb.

Step 4: Go back to step one. Earlier the winner portfolio was selected on the basis of the performance of the stocks in the period between 1st January and 21st January. Now, after incrementing the start date by 1, the winner portfolio will be selected on the basis of the performance of the stocks between 2nd January and 22nd January. Similarly, the returns during persistence period are calculated between 22nd Jan and 1st Feb unlike before.

Returns of the Top decile stocks (Winner portfolio) during the persistence period between **22nd Jan and 1st Feb**

(Refer table 4)

Where $R_{22,1}$: Represents the returns of stock 1 and on the formation date D_{22}

And **AR_{22} = Average ($R_{22,1}$, $R_{22,2}$, $R_{22,3}$……. $R_{22,10}$)**

Step 5: After getting the mean returns for all possible formation dates, such that there is a mean return associated with each formation date for the winner portfolio, take the average of all such means for the winner portfolio.

The table obtained is shown below:

(Refer table 5)

Where

$R_{21,3}$: Represents the return given by stock 3 when formation date is D_{21}

$AR_{21,W}$: Represents the arithmetic mean across all the stocks in the winner's portfolio when the formation date is D_{21}.

The whole exercise is repeated for the loser's portfolio such that we get the following table for the arithmetic mean corresponding to each day.

(Refer table 6)

Overall Mean for winner's portfolio = $OM_{20,10,W}$ = Average ($AR_{21,W}$, $AR_{22,W}$, $AR_{23,W}$, ……..., $AR_{1624,W}$, $AR_{1625,W}$)

where $OM_{20,10,W}$: Represents overall mean for a lookback period of 20, persistence period of 10 for the winner portfolio. Similarly,

Overall Mean for loser's portfolio = $OM_{20,10,L}$ = Average ($AR_{21,L}$, $AR_{22,L}$, $AR_{23,L}$, ……..., $AR_{1624,L}$, $AR_{1625,L}$)

Where $OM_{20,10,L}$: Represents overall mean for a lookback period of 20, persistence period of 10 for the loser portfolio..

Since a long position is taken in the winner's portfolio and a short position is taken in the loser's portfolio, the above found arithmetic

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returns are subtracted to get the **Arithmetic Mean Difference.**

(Refer table 7)

Then, the arithmetic mean of the AMD is calculated using the formula

$OMD_{20,10}$ = Average (AMD_{21}, AMD_{22}, AMD_{23}, ……, AMD_{1625})

Also,

$OMD_{20,10} = (OM_{20,10,\,W} - OM_{20,10,\,L})$

Where 20 represents the lookback period and 10 represents the persistence period.

The value obtained is divided by the persistence period to get the daily difference in return between the winner's and loser's portfolio also referred to as the Daily Overall mean difference (DOMD). So,

$DOMD_{20,10} = OMD_{20,10}/10$

Similarly,

$DOM_{20,10,\,W} = OM_{20,10,\,W}/10$

Where $DOM_{20,10,\,W}$ represents the daily overall mean for the winners' portfolio for a persistence period of 10, lookback period of 20.

This whole process explained above is repeated for all possible strategies i.e. all possible combinations of lookback and persistence period with the following constraints:

1. The lookback period varies from 1 to 400
2. The persistence period varies from 1 to 100
3. The persistence period is always less than the lookback period

The above constraints result in a total number of 34,950 strategies or 34,950 possible combinations of lookback period and persistence period. A table is generated containing the difference in returns (DOMD) for all possible combinations of persistence and lookback periods.

(Refer table 8)

Where $DOMD_{100,1}$ represents the daily overall mean difference when lookback period is 100 and persistence period is 1. Also "-" represents no value or not applicable since according to the constraints, persistence period should be less than the lookback period. The numbers in the leftmost column represent the lookback period and the numbers in the topmost row represents the persistence period.

(Refer table 9)

Where $DOM_{100,1,\,W}$: Represents the daily overall mean for the winners' portfolio when lookback period is 100 and persistence period is 1. "-" represents no value or not applicable since according to the constraints, persistence period should be less than the lookback period.

3.9 Test of Significance

Efficient but weak market leads to the difference between DOM_W-DOM_L to be equal

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to zero. However, the momentum hypothesis simply implies that the value DOM_W-DOM_L must be greater than zero. DOM values obtained earlier are used to test this hypothesis. An important point to be taken into consideration before the analysis is to take note of the returns of momentum portfolio which is defined as the difference between the winner portfolio (W) and the loser portfolio (L). For the existence of momentum profits, the condition to be fulfilled is the outperformance of the winner portfolio as compared to the loser portfolio irrespective of flow of the market. Let us understand this through the following two scenarios.

Scenario 1: Market Goes Up

Supposedly**,** the entire market goes up significantly, say by 20%. Consequently, the winner as well as loser portfolios would generate a positive return. This is where the difference comes whereby the winner portfolio would outperform even the market and may earn 22% returns whereas the loser portfolio would underperform the market and may earn only 18%. As a result, the momentum portfolio or the long/short portfolio i.e. W- L would yield a return of 22% – 18% = 4%

Scenario-2: Market Goes Down

Now, considering the exact opposite of scenario 1, supposedly**,** the entire market goes down by say 20%. In such a case, the winner as well loser portfolios would generate negative returns. However, this time around, the winner portfolio might lose only 18% while the loser portfolio might underperform and may go further down by 2% leading to a cumulative 22% negative return. Therefore, the momentum portfolio i.e. W - L would yield a return of -18% -(-22%) = 4%. Hence, an important point to be noted is that irrespective of direction of market movement, the momentum portfolio (W minus L) would generate absolute positive return of 4%. This is also known as a zero beta or non-directional strategy.

3.10 Other scenarios:

Some other scenarios are also tested by changing the winner and loser portfolios:

1. Shorting Nifty instead of the bottom 10 stocks to form the loser's portfolio.
2. Selecting the 2nd decile of stocks i.e. stocks ranked between 11 to 20 as the winner portfolio instead of the top decile.
3. Repeating step 2 for the 3rd decile of stocks i.e. stocks ranked between 21 and 30

4. Result & Analysis

Six strategies are possible on the basis of above mentioned scenarios:

(Refer table 10)

Where in $S_{1B,7}$:1 represents the winner's portfolio which is the top decile of stocks and

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B represents the loser's portfolio which is the bottom decile of stocks. 7 represents the time period in years whose data is used for the simulation. Similarly,

In $S_{2N,7}$: 2 represents the winner's portfolio which is the 2nd decile of stocks and N represents the loser's portfolio which is Nifty.

The best possible combination of lookback and persistence period along with the return for each of the above strategies is shown in the table below:

(Refer table 11)

The table above contains all the strategies where the bottom decile of stocks constitutes the loser portfolio. And clearly, there is not much difference in the Annual returns (AOMD) among the strategies mentioned in the table above.

(Refer table 12)

The table above contains all the strategies where the nifty forms the loser portfolio. And clearly, there is not much difference in the Annual returns (AOMD) here either. However, the strategies employing Nifty as the loser portfolio offer significantly higher returns than the strategies that employ the bottom decile of stocks as the loser portfolio. Graphs of the strategies discussed above are shown below.

(Refer Chart 1,2,3,4,5 & 6)

In the graphs shown above, the x-axis represents the lookback period and the y-axis represents the persistence period. The color scheme is different for each graph and depends on the return or DOMD (Daily overall mean difference) given by the long/short portfolio[9] for the given combination of lookback and persistence period.

Since, according to the constraints, the persistence period should always be less than the lookback period, a value of 0 is used as the return whenever persistence period is greater than the lookback period. This is done to generate the graphs which are shown above. So for a persistence period of 1 and lookback period of 0, the return is 0. Similarly, for a persistence period of 2 and lookback period of 1, the return is 0. Hence, all the combinations of lookback and persistence period in the leftmost triangular portion of all the heat maps shown above, have the value 0 and are accordingly, colored.

When the winner's portfolio consists of the top decile of stocks and the loser's portfolio consists of the bottom decile or the nifty ($S_{1B,7}$

[9] An investing strategy of taking long positions in stocks that are expected to appreciate and short positions in stocks that are expected to decline simultaneously.

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and $S_{1N,7}$), the highest annual returns or AOMDs (>10%) given by the long/short portfolio are concentrated in a small area. However, as we move to the other deciles i.e. when the winner's portfolio consists of the 2nd Decile ($S_{2B,7}$ and $S_{2N,7}$) or the 3rd decile ($S_{3B,7}$ and $S_{3N,7}$), the highest AOMDs (>10%) become dispersed and are no longer concentrated. Implying that though the strategies employing lower deciles as the winner's portfolio might offer as high AOMDs as the strategies employing top decile as the winner's portfolio, the chances of incurring losses are as high as chances of making a profit since the regions offering good AOMDs are surrounded by regions offering lower AOMDs which obviously increases the risk. This is not the case in strategies $S_{1B,7}$ and $S_{2N,7}$ since the regions offering the highest returns (top 1%) among all possible combinations of lookback period and persistence period are surrounded by the next highest (top 2%) which are surrounded by the next highest (i.e. top 5%) and so on. This is shown in the table below and the color scheme used is:Green: Top 10 values

- Red: Top 50 values
- Black: Top 1% values (DOMDs)
- Yellow: Top 2% values
- Pink: Top 5% values
- Orange: Top 10% values

(Refer Chart 7,8)

As can be seen in the tables above, green is surrounded by red which is surrounded by black, which in turn is surrounded by green in the strategies $S_{1N,7}$ and $S_{1B,\ 7}$. However, the strategies $S_{3N,7}$ and $S_{3B,7}$ have a lot more dispersion and are a lot riskier.

4.1 Equity Lines

Equity lines represent the value of a portfolio over time. Assuming an initial investment of INR100, the graphs below shows how it evolves over time when invested in the winner's portfolio and the loser's portfolio. The x axis represents the days.

(Refer chart 9)

The graph represents the strategy $S_{1N,7,7}$. It shows the portfolio value over time for the lookback period of 85 and persistence period of 25. This combination gives the best DOMD as discussed earlier. The equity line shows that if INR 100 were invested using this combination of lookback period and persistence period from the beginning i.e. 1st January, 2007, then the value of the winner' portfolio by July, 2013 would have been INR 250. The investment is done using overlapping portfolios where by

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INR 4[10] is invested each day in the winner's portfolio[11]. Each day, the return on the winner's portfolio is found and multiplied by 100 (total investment), to get daily returns which are added to get the cumulative return.

A similar strategy is used for the investment in Nifty (loser's portfolio) where INR 4 is invested in Nifty each day. From day 250 onwards, the winner and loser portfolio's value starts going down which is obviously a consequence of the financial crisis 2008-09 but the winner's portfolio outperforms the nifty even during that period.

(Refer chart 10)

The graph above represents the equity line for the strategy $S_{2N,7}$. The lookback period of 69 and persistence period of 14 which gives the best DOMD has been used for the graph. There is a downward trend in the portfolio value from day 250 onwards which is due to the financial crisis but the winner's portfolio (2nd Decile) still outperforms Nifty.

(Refer chart 11)

The above chart represents the equity line for strategy $S_{3N,7}$ for the lookback and persistence period combination of 393 and 84 respectively. To answer the question as to whether the superior returns derived by investing in loser portfolio is just the compensation of higher risk or there is presence of genuine momentum profits, we calculate the average betas of the winner and loser portfolios during the test period. For the 6 strategies, being tested, the average betas are found for the combination of lookback and persistence period giving the highest returns (DOMDs).

(Refer table 13)

The winner and loser portfolio betas are not significantly different from each other across all the strategies. In fact, the difference in betas is too small to be even considered in the strategies that have nifty as the loser portfolio (**$S_{1N,7}$, $S_{2N,7}$ and $S_{3N,7}$).** Hence, the superior returns observed in momentum portfolio cannot be attributed only to compensation for higher risk.

4.2 **Back testing**To check reliability of the results obtained above, the best lookback[12] and persistence period are found using data from

[10] INR 4 is invested in the winner's portfolio each day for a period of 25 days (i.e. the persistence period). After 25 days, a total of INR 100 would have been invested in the winner's portfolio. On the 26th day, the INR 4 invested of day 1 or D_1 will be reinvested in the winner's portfolio which will be the top 10 stocks based on the returns of the last 85 days, hence the stocks in the winner's portfolio will be different this time than the stocks that constituted the winner's portfolio when the investment was done on day 1.

[11] The winner's portfolio consists of the top 10 stocks on the basis of the returns in the lookback period (i.e. 85)

[12] Best lookback and persistence period refers to the combination giving the highest DOMD

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the following 3-year time periods instead of the whole 7 years of data used earlier.

(Refer table 14&15)

In $S_{1N,3}$,3 represents the time period of the data used for running the simulation.

The DOMD given by the best lookback period and persistence period of the strategies $S_{1N,7}$ and $S_{1B,7}$ is found for $S_{1N,3}$ and $S_{1B,3}$

(Refer figure 16 &17)

Clearly, the above combination of lookback and persistence period no longer offer the best excess returns but still offer positive returns. Also, the 2013-15 data which represents data from January,2013 to December 2015 has not been considered while finding the optimum combination of lookback and persistence period found earlier using 7 years of data. But the optimum combination of lookback period still offers positive returns for 2013-15 period. Hence, it can be concluded that momentum trading does work even in the Indian market.

5. Implementation issues

Majority of studies undertook on momentum investment strategy, assume

- Zero-cost portfolios
- Zero transaction costs,
- Ability to short-sale the desired stocks

The studies also ignore the impact of block deals on prices as well as the constraints imposed by regulations. However, these factors play a crucial role in implementation of momentum-based strategies. These factors have been classified as avoidable and unavoidable below:[13]

5.1 Unavoidable Factors

Acceptability and scalability of momentum investment strategies is largely limited due to the explicit trading costs and price pressures which arise with trading large blocks.

5.1.1. Short Sale

In case of short sale, the shorted-stock is borrowed by the short-seller from a lender. In case of a recall by the lender, the portfolio manager takes up an additional transaction costs. This is done in order to maintain his short position in the security, thereby reducing the return of the portfolio. In short, the borrowing cost and the probability of stock recall makes it difficult for the portfolio manager to exploit short-selling possibilities.

5.1.2. Futures market

Futures market provides the manager with another mechanism to short an individual stock. Its advantages include, low transaction costs and high liquidity.

5.2. Avoidable factors

[13] Bushee and Raedy (2005) divided these factors into two main categories—unavoidable, and avoidable. Though many researchers before them have researched solely on one or the other factor affecting the strategy, have been explained in this section.

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5.2.1. Maximum portfolio weight constraint

In accordance with Indian regulations, a mutual fund scheme cannot invest more than 10 percent of its NAV in the equity shares of any company except in the case of an index fund or an industry-specific scheme. This can further be explained by an example: In the strategy explained in this paper if we have 80 stocks which have to be divided into ten deciles, then we will have eight stocks each in the winner and a loser portfolio. Now, if we have to create equally weighted winner or loser portfolios, we will be required to invest more than 10% in each stock which is obviously not allowed under the current regulations. This can however be taken care of by creating portfolios of more than ten stocks.

5.2.2. Fund management characteristics

Mutual funds usually manage their portfolios using equally weighted investments or market capitalization-weighted investments. While equally weighted portfolios tend to favour smaller firms (as it does not differentiate stocks based on their relative size), the market-cap weighted portfolios tend to be dominated by larger stocks. A portfolio manager can however avoid such limitations by choosing an efficient screening process. For instance, in this study, we have used equally weighted portfolios which eliminated the potential bias (exerted by small cap stocks) by using only the stocks listed on Nifty and those trading in the futures market.

6.Future Scope

Instead of selecting the winner portfolio only on the basis of the returns given by the stocks, other strategies such as incorporating fundamental analysis while selecting the top 10 stocks etc. can make momentum trading even more awarding.

7. Conclusion

There is strong evidence of momentum profit for the short-term formation-test period. For each of the trading strategies S_{1N}, S_{1B}, S_{2N}, S_{2B}, S_{3N} and S_{3B}, we found presence of momentum profits. Further, it was found that the average risk of the winner portfolios was not significantly different to loser portfolio, thus proving evidence that the superior momentum returns are not only due to compensation for higher risk. In other words, there is empirical evidence against weak form of market efficiency in the Indian market. These results are consistent with those of the seminal studies by *Jegadeesh and Titman* (1993, 2001) and *De Bondt & Thaler* (1985, 1987 and 1990) in the US markets. To conclude, the study provides a strong evidence of short-term profits through the use of momentum strategy.

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List of Tables:

Table 1:

Date	**Notation**
1st January 2007	Day 1 or D_1
2nd January 2007	Day 2 or D_2
3rd January 2007	Day 3 or D_3
-------	-------
-------	-------
29th July 2013	Day 1634 or D_{1634}
30th July 2013	Day1635 or D_{1635}

Table 2:

Date	**Adjusted Closing Price**
1st January 2007	P_1
2nd January 2007	P_2
3rd January 2007	P_3
-------	-------
-------	-------
29th July 2013	P_{1634}
30th July 2013	P_{1635}

Table 3:

Scrips	**Return**

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Stock 1	$R_{21,1}$
Stock 2	$R_{21,2}$
Stock 3	$R_{21,3}$
Stock 4	$R_{21,4}$
Stock 5	$R_{21,5}$
Stock 6	$R_{21,6}$
Stock 7	$R_{21,7}$
Stock 8	$R_{21,8}$
Stock 9	$R_{21,9}$
Stock 10	$R_{21,10}$

Table 4:

Scrips	**Return**
Stock 1	$R_{22,1}$
Stock 2	$R_{22,2}$
Stock 3	$R_{22,3}$
Stock 4	$R_{22,4}$
Stock 5	$R_{22,5}$
Stock 6	$R_{22,6}$
Stock 7	$R_{22,7}$
Stock 8	$R_{22,8}$
Stock 9	$R_{22,9}$
Stock 10	$R_{22,10}$

Table 5:

Scrips/ Formation Date	**Day 21**	**Day 22**	**Day 23**		**Day 1624**	**Day 1625**
Stock 1	$R_{21,1}$	$R_{22,1}$	$R_{23,1}$	-------	$R_{1624,1}$	$R_{1625,1}$
Stock 2	$R_{21,2}$	$R_{22,2}$	$R_{23,2}$	-------	$R_{1624,2}$	$R_{1625,2}$
Stock 3	$R_{21,3}$	$R_{22,3}$	$R_{23,3}$	-------	$R_{1624,3}$	$R_{1625,3}$

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Stock 10	$R_{21,10}$	$R_{22,10}$	$R_{23,10}$	-------	$R_{1624,10}$	$R_{1625,10}$
Arithmetic Mean	$AR_{21, W}$	$AR_{22, W}$	$AR_{23, W}$	-------	$AR_{1624, W}$	$AR_{1625, W}$

Table 6:

Portfolio	**Day 21**	**Day 22**	**Day 23**		**Day 1624**	**Day 1625**
Winner	$AR_{21, W}$	$AR_{22, W}$	$AR_{23, W}$	-------	$AR_{1624, W}$	$AR_{1625, W}$
Loser	$AR_{21, L}$	$AR_{22, L}$	$AR_{23, L}$	-------	$AR_{1624, L}$	$AR_{1625, L}$

Table 7:

Portfolio	**Day 21**	**Day 22**	**Day 23**		**Day 1624**	**Day 1625**
Arithmetic Mean Difference	$AMD_{21} = AR_{21, W} - AR_{21, L}$	$AMD_{22} = AR_{22, W} - AR_{21, L}$	$AMD_{23} = AR_{23, W} - AR_{21, L}$	-------	$AMD_{1624} = AR_{1624, W} - AR_{21, L}$	$AMD_{1625} = AR_{1625, W} - AR_{21, L}$

Table 8:

	1	**2**	**3**	**….**	**99**	**100**
1	-	-	-	-	-	-
2	$DOMD_{2,1}$	-	-	-	-	-
3	$DOMD_{3,1}$	$DOMD_{3,2}$	-	-	-	-
4	$DOMD_{4,1}$	$DOMD_{4.2}$	$DOMD_{4.3}$	-	-	-
…..	….	….	….	…..	….	….
99	$DOMD_{99,1}$	$DOMD_{99,2}$	$DOMD_{99,3}$	…..	-	-
100	$DOMD_{100,1}$	$DOMD_{100,2}$	$DOMD_{100,3}$	…..	$DOMD_{100,99}$	-
101	$DOMD_{101,1}$	$DOMD_{101,2}$	$DOMD_{101,3}$	….	$DOMD_{101,99}$	$DOMD_{101,100}$
….	….	……	……	…..	……	…..
397	$DOMD_{397,1}$	$DOMD_{397,2}$	$DOMD_{397,3}$	….	$DOMD_{397,99}$	$DOMD_{397,100}$
398	$DOMD_{398,1}$	$DOMD_{398,2}$	$DOMD_{398,3}$	….	$DOMD_{398,99}$	$DOMD_{398,100}$

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399	$DOMD_{399,1}$	$DOMD_{399,2}$	$DOMD_{399,3}$	….	$DOMD_{399,99}$	$DOMD_{399,100}$
400	$DOMD_{400,1}$	$DOMD_{400,2}$	$DOMD_{400,3}$	….	$DOMD_{400,99}$	$DOMD_{400,100}$

Table 9:

	1		**2**	**….**	**99**	**100**
1	-		-	-	-	-
2	$DOM_{2,1,\ W,}$		-	-	-	-
3	$DOM_{3,1,\ W}$		$DOM_{3,2,\ W}$	-	-	-
4	$DOM_{4,1,\ W}$		$DOM_{4.2,\ W}$	-	-	-
…..	….		….	…..	….	….
99	$DOM_{99,1,\ W}$		$DOM_{99,2,\ W}$	…..	-	-
100	$DOM_{100,1,\ W}$		$DOM_{100,2,\ W}$	…..	$DOM_{100,99,\ W}$	-
101	$DOM_{101,1,\ W}$		$DOM_{101,2,\ W}$	….	$DOM_{101,99,\ W}$	$DOM_{101,100,\ W}$
….	….		……	…..	……	…..
397	$DOM_{397,1,\ W}$		$DOM_{397,2,\ W}$	….	$DOM_{397,99,\ W}$	$DOM_{397,100,\ W}$
398	$DOM_{398,1,\ W}$		$DOM_{398,2,\ W}$	….	$DOM_{398,99,\ W}$	$DOM_{398,100,\ W}$
399	$DOM_{399,1,\ W}$		$DOM_{399,2,\ W}$	….	$DOM_{399,99,\ W}$	$DOM_{399,100,\ W}$
400	$DOM_{400,1,\ W}$		$DOM_{400,2,\ W}$	….	$DOM_{400,99,\ W}$	$DOM_{400,100,\ W}$

Table 10:

S.NO	**Winner's Portfolio**	**Loser's Portfolio**	**Strategy**
1	1st Decile (1-10) stocks	Bottom Decile of Stocks	$S_{1B,7}$
2	1st Decile (1-10) stocks	Nifty	$S_{1N,7}$
3	2nd Decile (1-10) stocks	Bottom Decile of Stocks	$S_{2B,7}$
4	2nd Decile (1-10) stocks	Nifty	$S_{2N,7}$
5	3rd Decile (1-10) stocks	Bottom Decile of Stocks	$S_{3B,7}$
6	3rd Decile (1-10) stocks	Nifty	$S_{3N,7}$

Table 11:

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Strategy	Lookback Period	Persistence Period	Daily Return	AOMD[14]= DOMD X 250
$S_{1B,7}$	79	14	0.0465%	11.6000%
$S_{2B,7}$	76	7	0.045%	11.20000%
$S_{3B,7}$	76	7	0.046%	11.50000%

Table 12:

Strategy	Lookback Period	Persistence Period	Daily Return	AOMD= DOMD X 250
$S_{1N,7}$	85	25	0.0621%	15.5000%
$S_{2N,7}$	69	14	0.056%	14.0000%
$S_{3N,7}$	393	84	0.054%	13.5000%

Table 13:

Strategy	$S_{1B,7}$	$S_{1N,7}$	$S_{2B,7}$	$S_{2N,7}$	$S_{3B,7}$	$S_{3N,7}$
Lookback Period	79	85	76	69	76	393
Persistence Period	14	25	7	14	7	84
Daily Return	0.05%	0.06%	0.05%	0.06%	0.05%	0.05%
Loser's Portfolio	Bottom Decile	Nifty	Bottom Decile	Nifty	Bottom Decile	Nifty
Winner's Portfolio	1st Decile (Top 10%)	1st Decile (Top 10%)	1st Decile (Top 10%)	1st Decile (Top 10%)	1st Decile (Top 10%)	1st Decile (Top 10%)
Loser's Portfolio Beta	1.3	1	1.2	1	1.2	1

[14] AOMD is the Annual Overall mean difference

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Winner's Portfolio Beta	0.95	1.05	0.937	1.01	0.98	1.1

Table 14: $S_{1N,3}$

Time Period	**Lookback Period**	**Persistence Period**	**DOMD**
2007-09	85	33	0.14%
2008-10	324	66	0.10%
2009-11	360	9	0.092%
2010-12	234	19	0.075%
2013-15	**231**	**98**	**0.09%**

Table 15: $S_{1B,3}$

Time Period	**Lookback Period**	**Persistence Period**	**DOMD**
2007-09	90	20	0.095%
2008-10	76	21	0.046%
2009-11	364	10	0.16%
2010-12	260	83	0.086%
2013-15	**351**	**80**	**0.2%**

Table 16: $S_{1N,3}$

Time Period	Lookback Period	Persistence Period	DOMD
2007-09	85	25	0.13%
2008-10	85	25	0.086%
2009-11	85	25	0.065%
2010-12	85	25	0.036%
2013-15	**85**	**25**	**0.021%**

Table 17: $S_{1B,3}$

Time Period	Lookback Period	Persistence Period	DOMD
2007-09	79	14	0.08%

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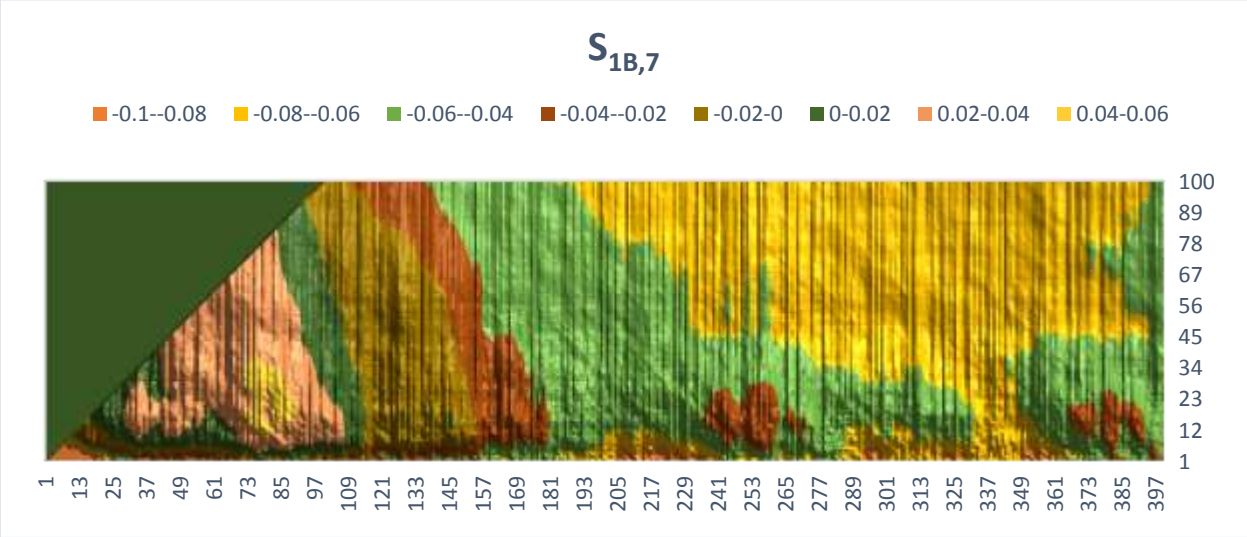
2008-10	79	14	0.036%
2009-11	79	14	0.056%
2010-12	79	14	0.018%
2013-15	**79**	**14**	**0.032%**

List of Charts

Chart 1:



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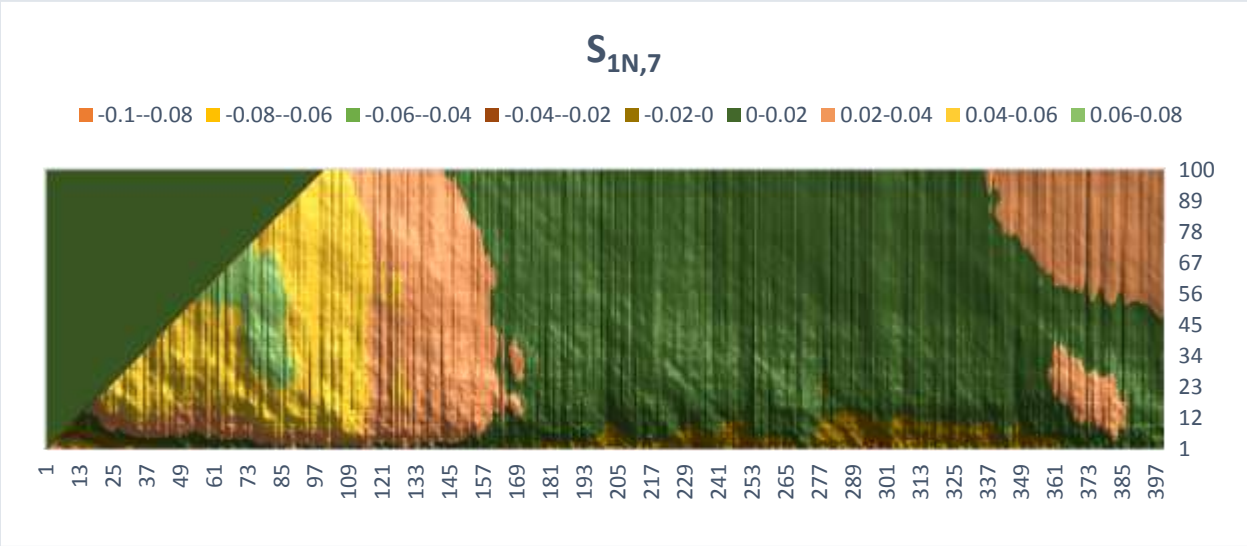

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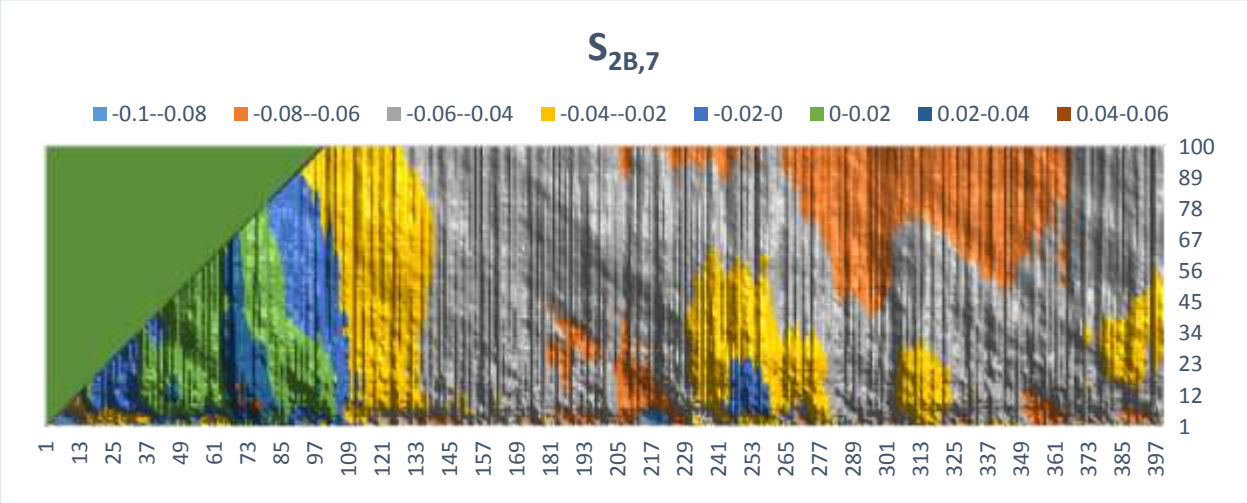
Chart 3:



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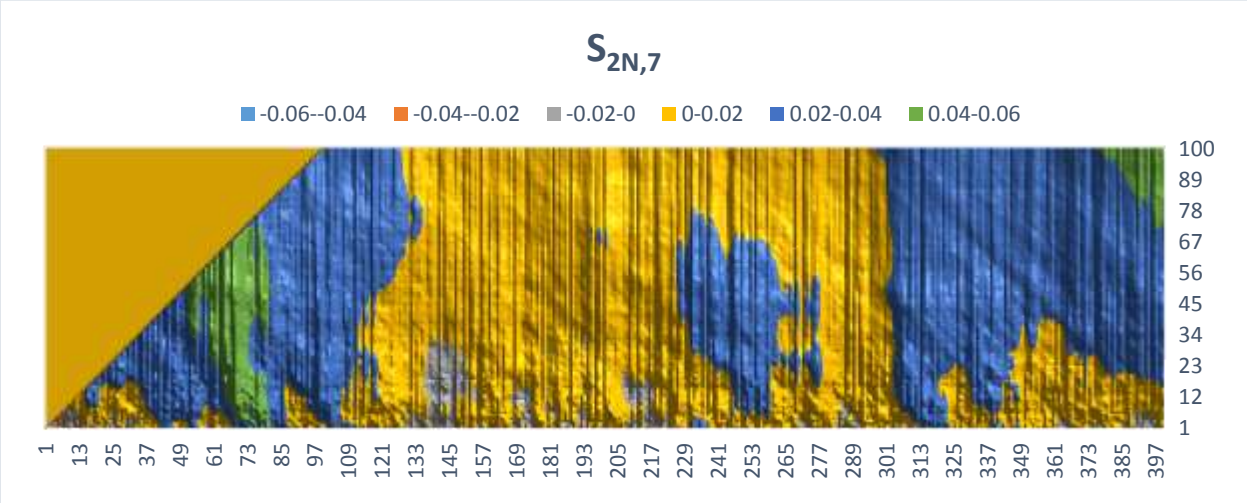

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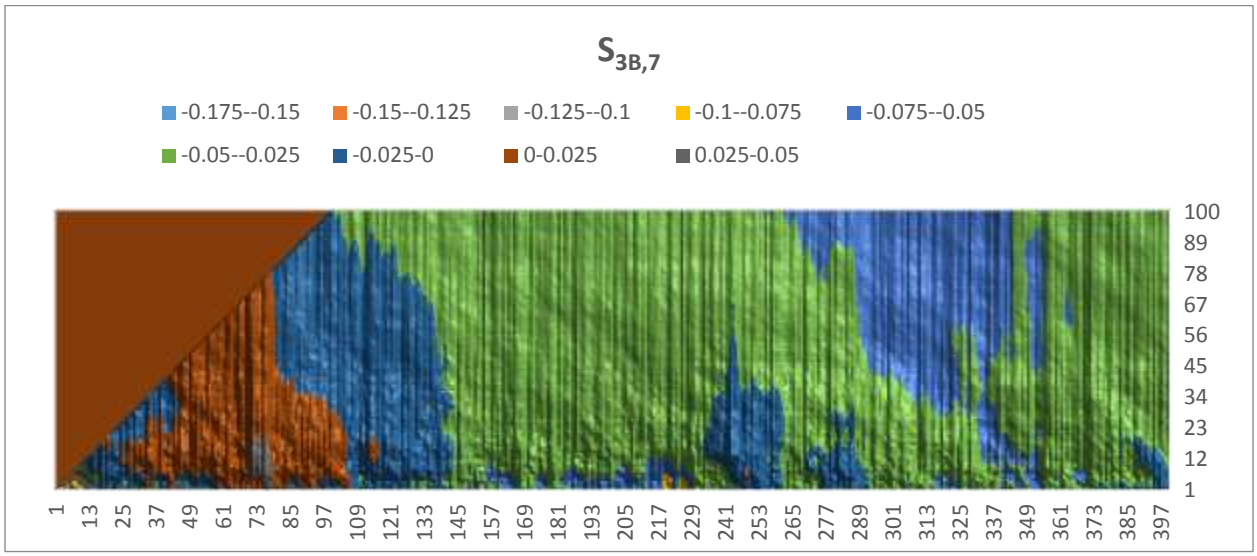

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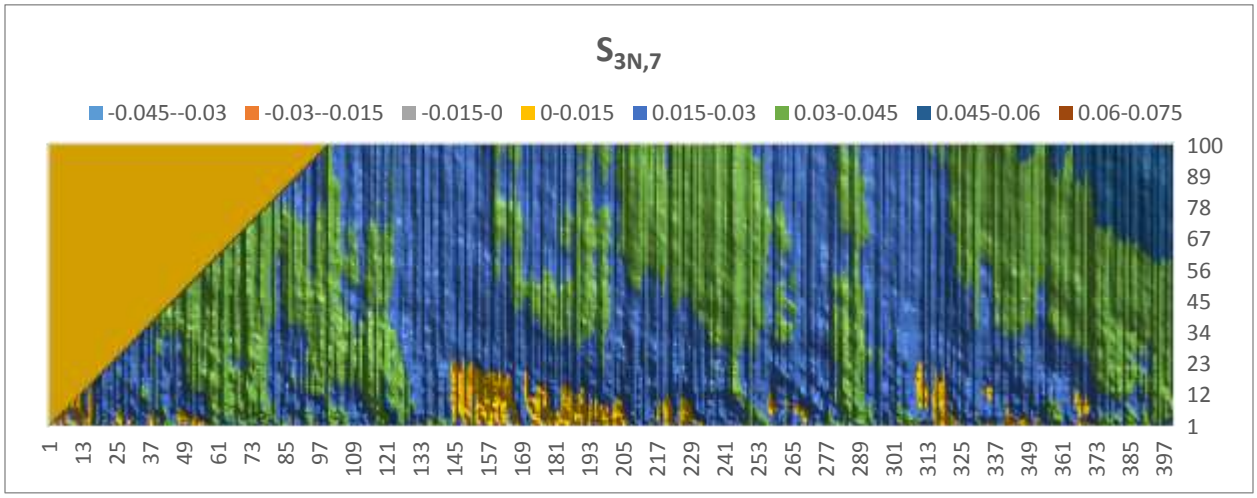

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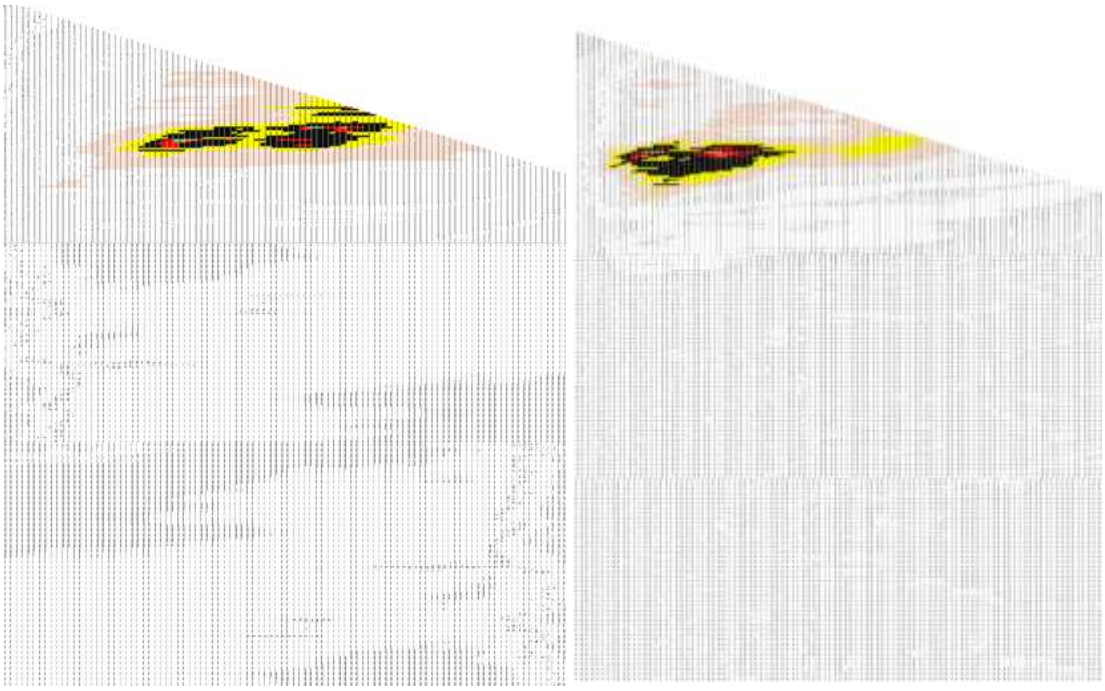
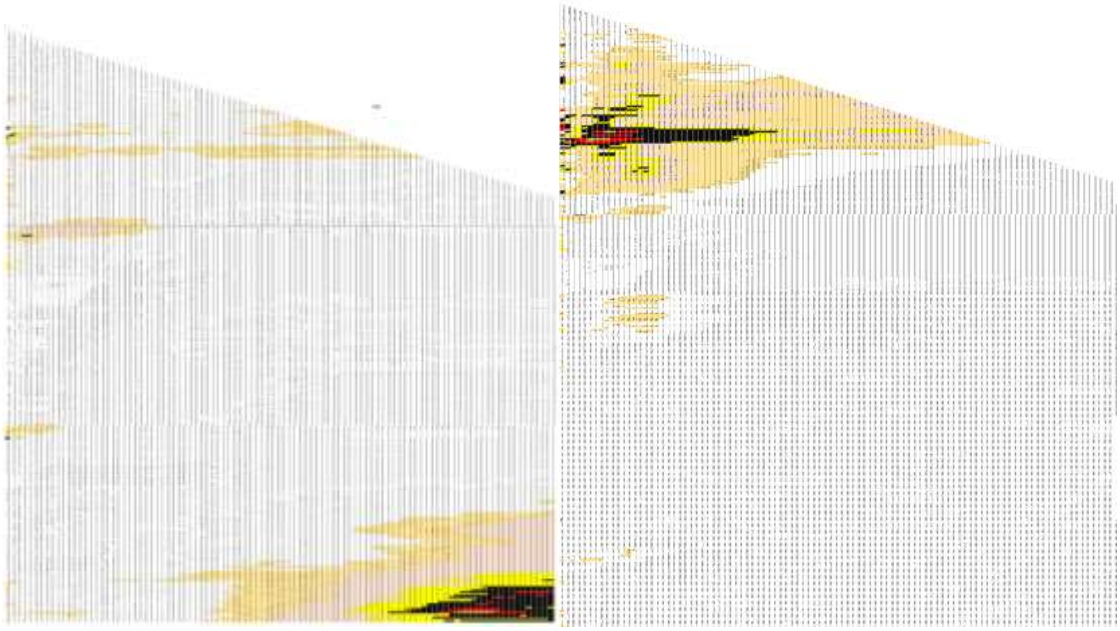
Chart 7:



: **$S_{1N,7}$** **$S_{1B,7}$**

Chart 8:



$S_{3N,7}$ **$S_{3B,7}$**

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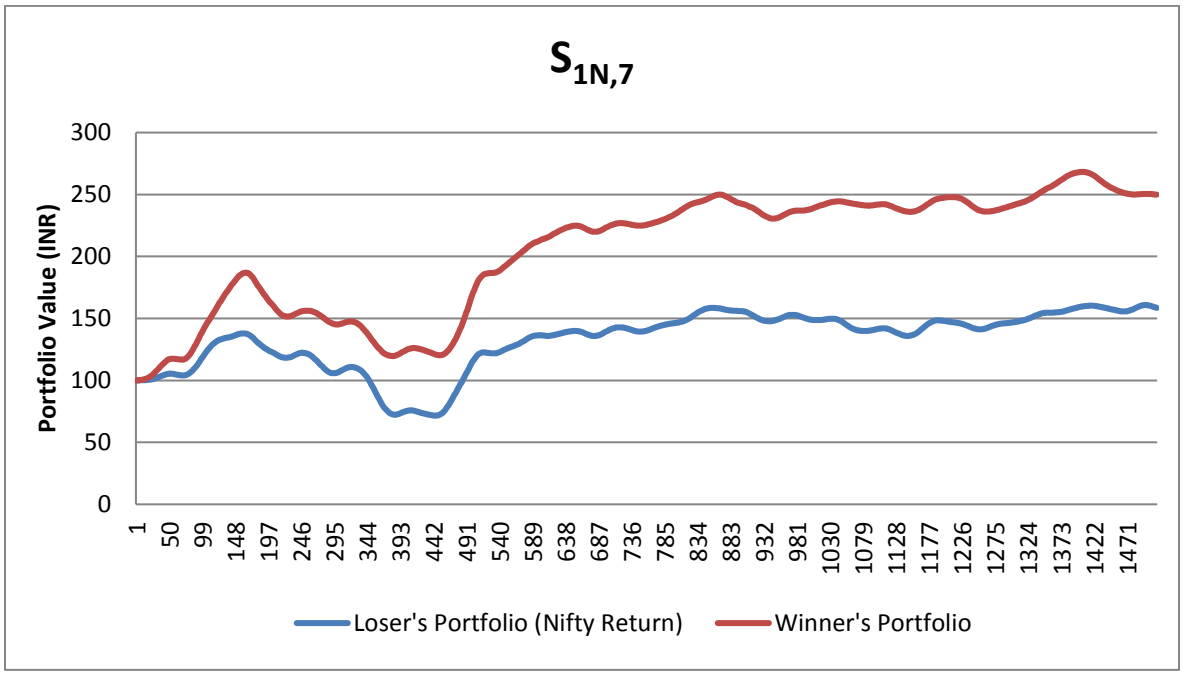
Chart 9



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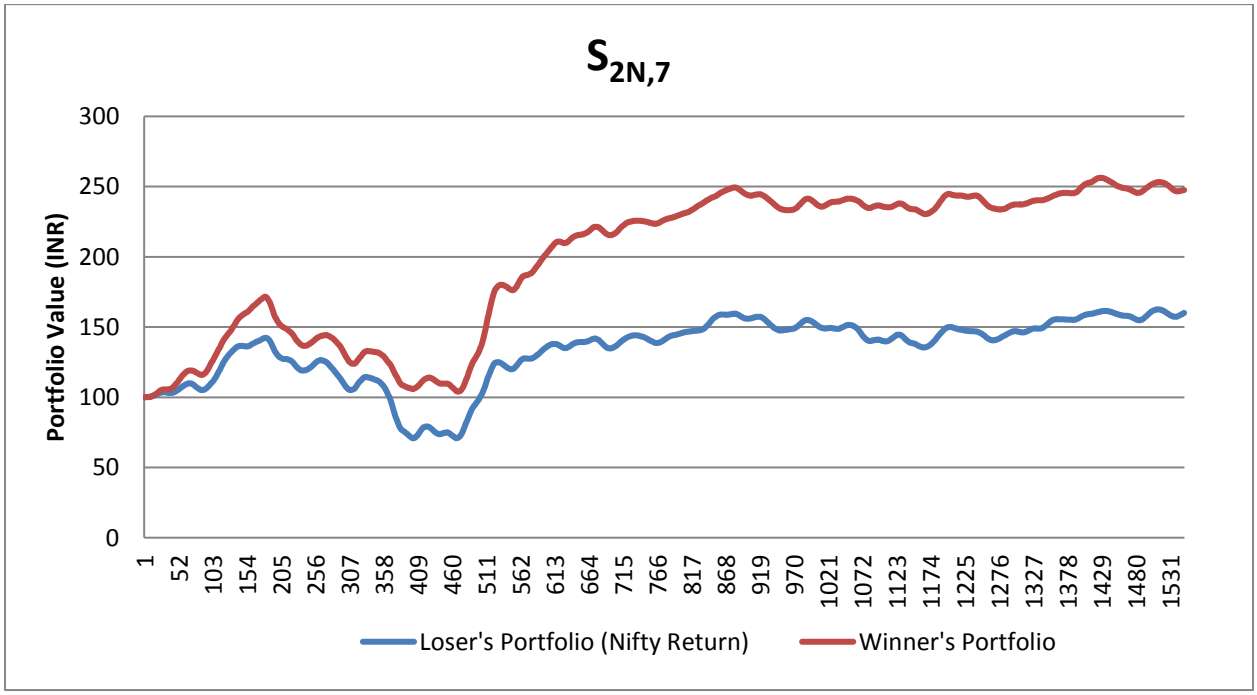

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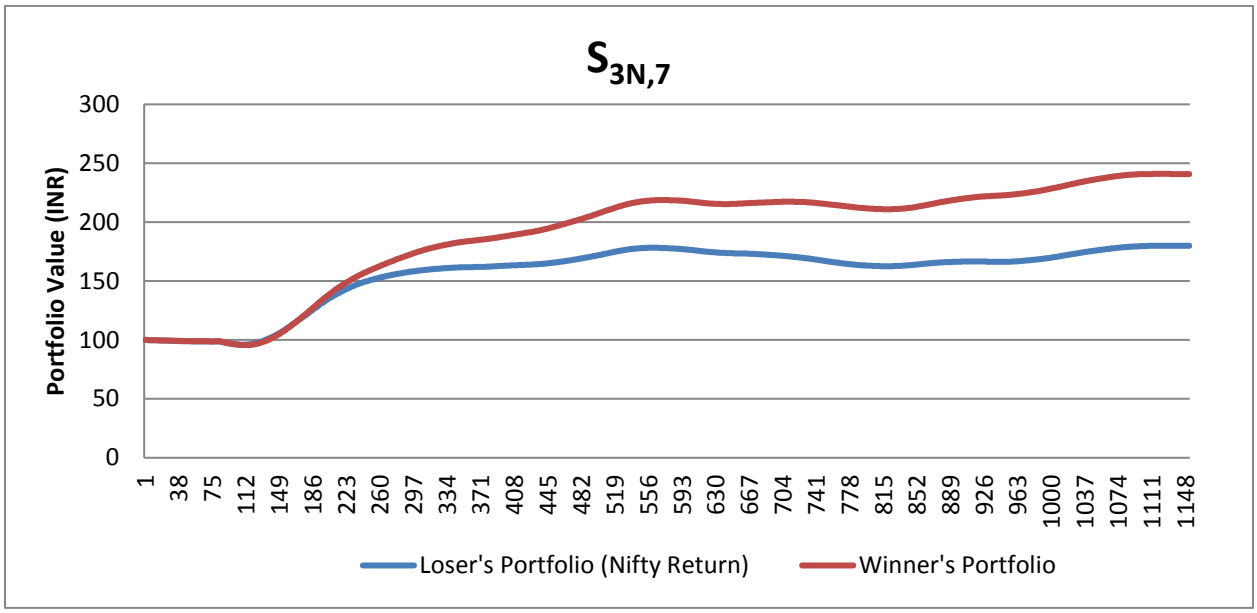
Chart 11:



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List of stocks

1	ARVIND	BIOCON	HINDPETRO	MRF	SUNTV
2	HINDZINC	CESC	HINDUNILVR	M&M	SYNDIBANK
3	IOC	CANBK	HDFC	MARUTI	TATACHEM
4	WIPRO	CENTURYTEX	ICICIBANK	MCLEODRUSS	TATACOMM
5	ACC	CIPLA	IDBI	NTPC	TCS
6	ABIRLANUVO	CROMPGREAV	IDFC	ONGC	TATAGLOBAL
7	ALBK	DABUR	IFCI	OFSS	TATAMOTORS
8	AMBUJACEM	DIVISLAB	ITC	ORIENTBANK	TATAPOWER
9	ANDHRABANK	DRREDDY	INDIACEM	PTC	TATASTEEL
10	APOLLOTYRE	EXIDEIND	IOB	PETRONET	TECHM
11	ASHOKLEY	FEDERALBNK	IGL	PNB	TITAN
12	ASIANPAINT	GAIL	INDUSINDBK	RANBAXY	UCOBANK
13	AUROPHARMA	GMRINFRA	INFY	RCOM	ULTRACEMCO
14	AXISBANK	GODREJIND	JSWSTEEL	RELIANCE	UNIONBANK
15	BANKBARODA	GRASIM	JPASSOCIAT	RELINFRA	UNITECH
16	BANKINDIA	HCLTECH	JPPOWER	SSLT	UPL
17	BATAINDIA	HDFCBANK	JINDALSTEL	SRTRANSFIN	MCDOWELL-N
18	BHARATFORG	HAVELLS	KTKBANK	SIEMENS	VOLTAS
19	BHEL	HEROMOTOCO	KOTAKBANK	SBIN	YESBANK
20	BPCL	HEXAWARE	LICHSGFIN	SAIL	ZEEL
21	BHARTIARTL	HINDALCO	LUPIN	SUNPHARMA	