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Examining profitability of Hammer candlestick pattern in Indian Stock Market

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ABSTRACT

This paper focuses exclusively on a single candlestick reversal pattern 'Hammer'. Its profitability is investigated by using daily data of Nifty 50 component stocks over the period from August 1, 1998 till December 31, 2017. Seven different trading strategies based on hammer are tested using bootstrapped skewness adjusted t-test and binomial test. The success of five trading strategies shows that hammer pattern has significant predictive power in Indian stock market. The study recommends that one should trade hammers of significantly larger size, keep the stop loss at the low of the hammer and exit the long positions within five trading days. The use of stop loss rule is advocated as it increases the profitability.

1. Introduction

The study of technical analysis uses past prices and trading volume to predict future direction of prices. Due to its simplicity and forecasting power, technical analysis is widely used by traders and trading advisors (Smidt, 1965; Tayler and Allen, 1992; Billingsley and chance, 1996; Bankhofer and Hilbert, 1999). The findings of academic studies investigating the profitability of trading strategies based on technical analysis have been mixed. Some of them have revealed the adverse performance of technical tools, a suggested by Levy (1971), Hofmann (1973), Malkiel (1996), Curcio et al. (1997), Mills (1997), Bessembinder and Chan (1998), Sullivan et al. (1999), Goldbaum (1999), Wang (2000), Day and Wang (2002), Dorfleitner and Klein (2002), Sullivan et al. (2003), Olson (2004) and Singh and Seth (2015), while others have strongly supported them for their superior returns, as reported by Treynor and Ferguson (1985), Sweeney (1986), Pruitt and White (1988), Lukac and Brorsen (1990), Brock et al. (1992), Blume et al. (1994), Balsara et al. (1996), Ito (1999), Ratner and Leal (1999), Lo et al. (2000), Detry and Gregoire (2001), Wong et al. (2003), Shen (2003), and Neely et al. (2012).

Dow Theory was believed to be the oldest as it dates back to 1884 (Edwards and Magee, 1997). But after the publication of first book on candlestick by Steve Nison in 1991, it became evident that candlestick charting has even longer history as it was used in Japan by Munehisahomma in 18th century to trade rice forward contracts (Nison, 1991). Candlestick charting makes use of patterns formed using open, high, low and close prices of a certain trading period to predict future price movements.

Its simplicity and popularity led to the first academic empirical back testing by Caginalp and Laurent in 1998. Since then, there has been enormous work on the profitability of various candlestick patterns focusing American, Japanese, European and Taiwanese stock markets and other asset classes. But the results have been mixed. Different patterns have performed in different manner in distinct markets. To the best knowledge of the author enough research has not been undertaken so far w.r.t candlestick patterns in Indian stock markets. Being a rapidly growing economy and an attractive destination for foreign portfolio investors coupled with mass domestic participation, the Indian stock markets have become a hot destination for venture capital funds, mutual funds, hedge funds, PMS (portfolio management services), private equity funds etc. Further, increased financial awareness has motivated people to directly invest and adopt stock trading as the full-time profession. Thus, there is a need to test this oldest trading technical school of thought in Indian context. This paper attempts to evaluate the profitability of one of the candlestick pattern named 'Hammer'. The study is conducted using daily data of all the stocks comprising Nifty 50 index at National Stock Exchange, India from August 1, 1998 till December 31, 2017.

2. Review of Literature

Numerous empirical studies have attempted to test the profitability of candlestick patterns by focusing on different financial markets. The study by Caginalp and Laurent (1998) is believed to be the first empirical work on candlesticks. They found strong support for candlestick patterns and concluded that they have significant predictive value in American markets. These results were by supported by the findings of Goo. et. al. (2007), Lu &Shiu (2011), Lu et al. (2012), Lu & Chen (2013), Lu (2014), Lu et. al. (2015) and Lu &Shiu (2016), who confirmed that they were successful in generating significant positive returns for traders. On the contrary, the findings ofFock (2005), Marshall et. al (2006, 2008), Horton (2009) and Duvinage et al. (2013) showed that they failed in generating any superior returns.

Thus, the academic literature gives mixed results on the profitability of various candlestick patterns by focusing on various financial markets like American, Japanese, European and Taiwanese. Compared to previous empirical work, our study extends the research in various aspects. Firstly, we focus comprehensively on only one candlestick patterns i.e. 'Hammer'. Secondly, its profitability is evaluated using distinct trading strategies over different holding time period, spanning from one till ten days based on their size and stop loss rules. Thirdly, it is done on Indian stock markets, on which to our

knowledge performance of candlestick patterns have not been studied so far.

3. Data, Candlestick and Research Methodology

This section explains the data used, candlestick charting and research methodology employed to conduct this empirical work. The data consists of daily opening, high, low and closing prices of individual stocks comprising Nifty 50 Index from August 1, 1998 till December 31, 2017, covering two bull and two bear periods. When a stock is replaced in Nifty 50, it is also replaced in this study. So, a stock which is in Nifty 50, is used for analysis in this study. The data is sourced from the website of national stock exchange, India and adjusted for corporate actions like bonus, split and rights issue.

3.1 Candlestick charting

A candlestick chart is constructed using open, high, low and closing price of the trading period, ranging from one minute to a decade, as shown in Fig. 1. However, it is more widely used on daily data. The opening and closing price are joined using a rectangular space called as body and its size depends upon the difference between the two prices. The color of the body is either white or black depending upon the relationship between opening and closing price. If opening price is higher than closing price, it is colored black (indicating bearishness) and if closing price is higher than opening price, it is colored white (indicting bullishness). The vertical lines above and below the body are called the shadows i.e. upper shadow and lower shadow, indicating the high and the low of the trading period.

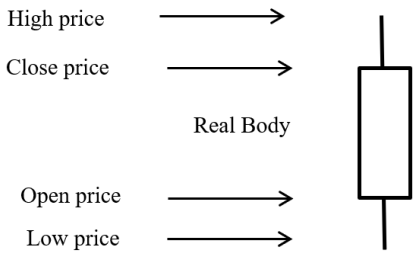

Fig.1 A white candlestick

The present study focusses on only one candlestick pattern i.e. hammer. Hammer, known as 'takuri' in Japanese, is candlestick reversal pattern formed after the downtrend, indicating that the price may not fall further. A candlestick is considered depicting hammer pattern, when it fulfills following three conditions as specified by Nison (1991) (Fig. 2).

1. The real body is at the upper end of the trading range. The color of the real body is not important.
2. A long lower shadow should be at least twice the height of the real body.
3. It should have no, or a very short, upper shadow.

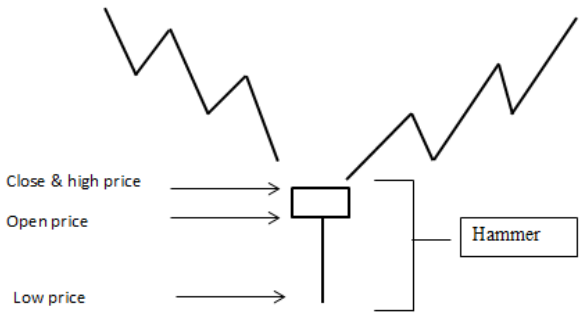

Fig. 2 A Hammer

The real body at the upper end of the trading range along with long shadow suggests that bears, who were hammering the market by creating selling pressure, from the beginning of the trading session, have lost their control to bulls, who have commenced buying in the market. As a result, price may start rising.

3.2 Identifying Trend

The primary task before detecting a hammer is to identify downtrend. For identifying downtrend, we follow the mathematical rule using moving averages given by Caginalp and Laurent (1998) and used by Goo et al. (2007), Shiu and Lu (2011), Lu et al. (2012) and Lu and Chen (2013). The three-day moving average at time t is defined as:

$$MA_3(t)= \frac{C(t-2)+C(t-1)+C(t)}{3}$$

Where C(t) refers to the closing price on day t.

A point t is considered to be in a downtrend, if MA_3 (t - 6) > MA_3 (t - 5) > MA_3 (t - 4) >….. > MA_3 (t), with at most one violation of the inequalities.

3.3 Research Methodology

The profitability of the hammer candlestick pattern is evaluated by assuming that a long position is made at the opening price on the day following the hammer pattern and held for one till ten days. The closing price of one till ten days is chosen as exit because all the previous studies have evaluated the profitability of candlestick patterns by holding them for one, three, five or ten days as suggested by Morris (1995) that candlestick analysis has value for the maximum period of ten days. One study by Goo et al. (2007) has evaluated the profitability by holding for all ten days i.e. first day till tenth day. Hence, we decided to determine profitability for all ten days and find the most profitable holding period. The profits are calculated by taking natural log of the closing price on the day of the exit divided by the opening price on the day following the hammer pattern. Also, we employ five per cent stop loss rule as recommended by Goo et al. (2007) that it improves the profitability of the pattern. In addition to it, we employ another stop loss rule of exiting the trade at hammers's low. The logic behind it is that price is continuing with downtrend and it has not led to trend reversal, so it is of no use to continue with long position. On the suggestions of Lu et al. (2012) to consider other dimensions of technical analysis along with candlesticks, we made an attempt to focus on the relative size of the candlestick because large candles show huge price action,

showing more fierce battle between bulls and bears. As a result, they may give better information and yield superior results. The candlestick size is determined by computing the proportion of trading range (i.e. difference between high and the low price of the day) with closing price. The performance of hammers having different size of at least five, ten, fifteen and twenty percent is determined separately. So, after considering above aspects, the profitability of hammer is assessed using different trading strategies as briefed in table 1.

To test the statistical significance of the profits generated by hammer, bootstrapped skewness adjusted t-test. The null hypothesis H_0: $\mu=0$ for the average return is used to test the statistical significance of profits earned upon the formation of candlestick pattern. If the average return is positive and null hypothesis is rejected, then the hammer is successful in generating significant returns. Also, the binomial test is employed to test the null hypothesis H_0: $p=0.5$ for the winning trades. It helps in testing whether the winning trades are as frequent as losing trades or not. If the ratio of winning rate of the trades is more than 0.5 and null hypothesis is rejected, then it shows that ratio of winning trades is superior over any random system.

Table 1
Details of all trading systems

Trading Strategy	Particulars
1	Testing the profitability by holding for all ten days i.e. first day till tenth day.
2	Testing the profitability by holding for all ten days i.e. first day till tenth day with stop loss of five per cent as suggested by Goo et al. (2007).
3	Testing the profitability by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.
4	Testing the profitability of only those hammers whose trading range is at least five percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.
5	Testing the profitability of only those hammers whose trading range is at least ten percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.
6	Testing the profitability of only those hammers whose trading range is at least fifteen percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.
7	Testing the profitability of only those hammers whose trading range is at least twenty percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.

4. Empirical Results

Table 2 reports the profitability of hammer on adopting trading strategy 1. Average return is found negative for all the holding periods. Thus, there is no evidence of superior returns. In four holding periods i.e. third, sixth, ninth and tenth day, average returns are significantly negative. Also, the winning rates do not seem to be significantly better than any random trading system. Thus, the trading strategy 1 based on the hammer pattern is strictly not recommended. These findings are consistent with those of Marshall at al. (2006, 2008) and Lu (2014).

Table 2
Results showing the profitability of hammer pattern on adopting trading strategy 1

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	3531	-0.0933(0.072)	47.61(0.005)*
2	3531	-0.1014(0.165)	49.39(0.48)
3	3531	-0.1788(0.045)*	49.67(0.711)
4	3531	-0.1837(0.079)	51.06(0.213)
5	3531	-0.1476(0.182)	50.50(0.893)
6	3531	-0.2524(0.031)*	51.06(0.213)
7	3531	-0.2017(0.105)	51.01(0.239)
8	3531	-0.1661(0.198)	50.52(0.545)
9	3531	-0.2874(0.046)*	50.1(0.92)
10	3531	-0.4745(0.001)*	50.67(0.439)

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test. * indicates statistical significance at 5% level.

Based on the findings of Goo et al. (2007) that the use of five per cent stop loss rule enhances the profitability of the trading strategy, we made an attempt to incorporate five per cent stop loss rule and see whether it improved the performance of hammer pattern or not. The results obtained in table 2 indicate that the five per cent stop loss rule failed miserably as the average returns were further deteriorated and became significantly negative. Also, winning rate was not pleasing and for one day holding period, it was significantly below fifty per cent. This leads to the conclusion that five per cent stop loss rule is not recommended to be used with hammer pattern in Indian stock market.

Table 3
Results showing the profitability of hammer pattern on adopting trading strategy 2

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	3531	-0.0933(0.063)	47.61(0.005)*
2	3531	-0.405(<0.01)*	47.07(0.001)*
3	3531	-0.4748(<0.01)*	46.84(<0.01)*
4	3531	-0.4404(<0.01)*	47.81(0.01)*
5	3531	-0.5001(<0.01)*	46.02(<0.01)*
6	3531	-0.5797(<0.01)*	45.91(<0.01)*
7	3531	-0.6036(<0.01)*	45.09(<0.01)*
8	3531	-0.6041(<0.01)*	44.38(<0.01)*
9	3531	-0.645(<0.01)*	43.08(<0.01)*
10	3531	-0.6939(<0.01)*	42.88(<0.01)*

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test. * indicates statistical significance at 5% level.

After the failure of above two strategies, another attempt was made to analyze the profitability of hammer but with stop loss being hammer's low. It means that a long position made on the formation of hammer is closed, if the price touches hammer's low on any day from day one till ten. If the stop loss is not triggered, the position is held for all the days. The logic behind exiting trading position at hammer's low is that price is continuing with downtrend and it has not led to trend reversal.

Table 4
Results showing the profitability of hammer pattern on adopting trading strategy 3

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	3471	-0.0251(0.589)	46.28(<0.01)*
2	3471	0.1813(<0.01)*	47.47(<0.01)*
3	3471	0.3362(<0.01)*	46.53(<0.01)*
4	3471	0.4554(<0.01)*	46.18(<0.01)*
5	3471	0.4791(<0.01)*	44.05(<0.01)*
6	3471	0.4393(<0.01)*	43.27(<0.01)*
7	3471	0.4514(<0.01)*	41.89(<0.01)*
8	3471	0.4844(<0.01)*	40.8(<0.01)*
9	3471	0.5013(<0.01)*	39.24(<0.01)*
10	3471	0.4779(<0.01)*	38.32(<0.01)*

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test. * indicates statistical significance at 5% level.

Hence, it is not wise to continue holding long position and one should immediately exit with small loss. On adopting this strategy, there is substantial improvement found in the profitability of hammer pattern as shown in table 4. Though winning rates are significantly less than fifty per cent, the average returns were positive and statistically significant for majority of holding periods (apart from one day holding period). Hence, despite poor winning rate, strategy was profitable as profits on winning trades were higher than the losses on loosing trades, thereby resulting in significant and positive average return.

So, the trading strategy 3 (as shown above) displays that significant profits can be made on the formation of hammer pattern. Now, it becomes imperative to maximize these profits further. This is done by focusing on only those hammers which are larger in size. So, keeping the entry and exit criteria same, only those hammers whose day's trading range is at least five percent of the closing price are now tested as shown in trading strategy 4. The results of the same can be seen from table 5. Only 1008 hammers are found to qualify the above condition. It is found that the profitability has increased only for four day holding period. For remaining nine different holding periods, profitability has reduced. Thus, this strategy suggests traders to make a long position on only that hammer whose size is at least five percent of the trading range and close it at the end of the fourth day as it results in significant profits.

Table 5
Results showing the profitability of hammer pattern on adopting trading strategy 4

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	1008	-0.0185(0.863)	49.5(0.777)
2	1008	0.1047(0.493)	48.71(0.431)
3	1008	0.3212(0.079)	48.91(0.508)
4	1008	0.4841(0.02)*	49.9(0.975)
5	1008	0.383(0.083)	46.53(0.03)*
6	1008	0.167(0.439)	46.23(0.018)*
7	1008	-0.0123(0.969)	44.64(<0.01)*
8	1008	-0.0688(0.787)	43.75(<0.01)*
9	1008	0.0467(0.849)	41.96(<0.01)*
10	1008	-0.0912(0.726)	41.17(<0.01)*

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test. * indicates statistical significance at 5% level.

Table 6 shows the result obtained on adopting trading strategy 5. This strategy involves trading only those hammers whose trading range is at least ten percent of the closing price. Like previous strategies, the trading position is held for all ten days i.e. first day till tenth day with stop loss being the hammer's low. The number of hammers is reduced to 248. It can be seen that the average profit has increased for first four days only but they are statistically insignificant. Similarly, the winning rate has increased for first four days but it is statistically insignificant. For remaining days, the winning rate is significantly poor. Thus, this trading strategy suggests traders to exit their long position by the end of third day as profitability starts reducing subsequently.

Table 6
Results showing the profitability of hammer pattern on adopting trading strategy 5

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	248	0.5542(0.069)	52.02(0.568)
2	248	0.5186(0.202)	52.02(0.568)
3	248	0.681(0.14)	50.4(0.949)
4	248	0.5833(0.256)	51.21(0.751)
5	248	0.1321(0.822)	45.97(0.228)
6	248	-0.5734(0.318)	46.37(0.28)
7	248	-1.1039(0.068)	43.95(0.065)
8	248	-0.9431(0.134)	43.95(0.065)

9	248	-0.5109(0.439)	46.37(0.28)
10	248	-1.1729(0.075)	42.74(0.026)

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test.

The result of trading strategy 6 is shown in table 7. This trading strategy involves making long position on only those hammers whose trading range is at least fifteen percent of the closing price. Only 95 hammers were found to satisfy this criterion. On holding the long position for all ten days i.e. first day till tenth day with stop loss being the hammer's low, there is significant improvement in profits over previous strategies. Along with winning rates, the average returns are significantly superior over any random system. The fifth day turns out to be the best day to exit.

Table 7
Results showing the profitability of hammer pattern on adopting trading strategy 6

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	95	1.8845(<0.01)*	65.26(<0.01)*
2	95	1.5907(0.026)*	62.11(0.023)*
3	95	2.5548(<0.01)*	65.26(<0.01)*
4	95	2.7128(0.013)*	68.42(<0.01)*
5	95	3.0129(0.015)*	66.32(<0.01)*
6	95	1.4016(0.234)	67.37(<0.01)*
7	95	0.4056(0.714)	56.84(0.218)
8	95	0.7829(0.492)	57.89(0.151)
9	95	1.2925(0.298)	60(0.064)
10	95	-0.1615(0.891)	53.68(0.538)

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test. * indicates statistical significance at 5% level.

Table 8 reports the result of trading strategy 7, which involves trading in only those hammers whose trading range is at least twenty percent of the closing price. The profitability is tested by holding the trading position for all ten days i.e. first day till tenth day with stop loss being the hammer's low. This strategy involves only 44 trades but the performance is far more superior to all the previously tested strategies. There is significant improvement in the winning rate as it is highest for one day holding period followed by five day holding period. The average return has enhanced significantly. It is found significant for first five days. The highest value of five day holding period shows that it is the best day to exit. So, any trading position should not be carried beyond five days.

Table 8
Results showing the profitability of hammer pattern on adopting trading strategy 7

Holding Period	No of Patterns	Average Returns	Winning rate (%)
1	44	2.9608(<0.01)*	77.27(<0.01)*
2	44	2.3951(0.02)*	59.09(0.291)
3	44	3.8136(<0.01)*	70.45(0.01)*
4	44	3.9725(0.04)*	72.73(<0.01)*
5	44	5.0663(0.01)*	75(<0.01)*
6	44	2.9855(0.173)	68.18(0.02)*
7	44	2.3234(0.261)	68.18(0.02)*
8	44	3.2597(0.161)	68.18(0.02)*
9	44	3.5631(0.142)	72.73(<0.01)*
10	44	1.1158(0.569)	59.09(0.291)

The table presents the average returns and winning rates for holding for one till ten days. The numbers in parentheses and brackets represent p-values of bootstrapped skewness adjusted t-test and binomial test. * indicates statistical significance at 5% level.

5. Conclusion

To our best knowledge, this is first research exclusively on a single candlestick pattern i.e. hammer. This study investigates its profitability by using daily data of Nifty 50 component stocks over the period from August 1, 1998 till December 31, 2017, covering two bull and two bear periods. The performance of seven different trading strategies based on hammer are tested using bootstrapped skewness adjusted t-test and binomial test. The study shows that a trading position should not be blindly made on the formation of 'Hammer' pattern as shown by table 1 as it may lead to losses, which is consistent with the findings of Marshal et al. (2006, 2008) and Lu (2014). The recommendations on the basis of performance of different trading strategies, based on hammer pattern are summarized below in table 9.

The superior performance of five trading strategies demonstrates that it has significant predictive power in Indian stock market. Our results support the findings of Caginalp and Laurent (1998), Goo et al. (2007), Lu et al. (2012), Lu and Chen (2013), Lu (2014), Lu et al. (2015) and Lu and Shiu (2016). It is recommended that one should trade hammers of significantly larger size, whilekeeping the stop loss at hammer's low and exiting long positions in five days The use of stop loss rule, as advocated by Goo et al. (2007), has increased the profitability of the hammer pattern. Thus, it is advocated to use stop loss to increase the profitability.

Table 9
Recommendations on the basis of performance of different trading strategies

Trading Strategy	Particulars	Recommended for trading or not
1	Testing the profitability by holding for all ten days i.e. first day till tenth day.	Not recommended
2	Testing the profitability by holding for all ten days i.e. first day till tenth day with stop loss of five per cent as suggested by Goo et. al. (2007).	Not recommended
3	Testing the profitability by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.	Recommended
4	Testing the profitability of only those hammers whose trading range is at least five percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.	Recommended
5	Testing the profitability of only those hammers whose trading range is at least ten percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.	Recommended
6	Testing the profitability of only those hammers whose trading range is at least fifteen percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.	Recommended
7	Testing the profitability of only those hammers whose trading range is at least twenty percent of the closing price, by holding for all ten days i.e. first day till tenth day with stop loss being hammer's low.	Recommended

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