

NUS INVESTMENT SOCIETY
Technical Report

A Panic-Selling Mean Reversion Trading Strategy

Alberto Costa^{1,2}, Galvin Ng Kai Wen², Daniel Yap Soon²
Goh Jun Hui², Liu Yiwen², Du Sibon², Bailey Stimac^{2,3}

¹Email: costa@arch.ethz.ch

¹ETH Zurich, Future Cities Laboratory, Singapore

²National University of Singapore

³Monash University, Australia

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Introduction

Equity markets are notoriously volatile. Most price movements can be attributed to the market reacting from news or events - such as profit warnings, talks about potential mergers and herd mentality. As a result, we observe the up and down turns of stock prices. Assuming this theory to be true, it would be possible to devise a profit-making trading strategy from the price correction phenomenon. Thus, our group has embarked on a trading strategy to ascertain the following hypothesis: one can profit from trading only with technical indicators and disregard the underlying fundamentals of the stock. The philosophy behind our strategy is to buy a stock or ETF (Exchange-Traded Fund) after a big drop in price, when everyone who wanted to sell their stock has done so. The remaining participants are investors willing to long the stock. During this period, the stock will be sufficiently low and ready for a rebound. This is when we enter a long position (buying low) and exit when our predetermined take profit is achieved, selling high.

In this report, we present the evaluation of this long-only trading strategy on U.S. equities and ETFs that exhibit oversold signals and therefore an opportunity to capitalise from, should a counter-reaction to the upside occur. The strategy was forward tested over a period of 7 months (30th October 2018 - 1st May 2019) through the Interactive Broker platform. We created a simulated margin trading account with an initial capital of 10,000 USD. Transaction costs were considered. Backtesting was carried out using Python and the Pandas library - we evaluated the performance of our strategy over 5 years of NASDAQ data (8th February 2013 - 7th February 2018). Both forward testing and backtesting showed that the strategy is profitable.

The rest of the report is organized as follows: in the Background section, we introduce the key concepts required to better understand our strategy. After that, we define the trading strategy by detailing position sizing, enter and exit rules, and also commenting a sample trade to make it clear how the strategy is executed. Backtesting and forward testing results are summarized in the Results section. Lastly, we present the conclusions and provide some remarks for future extensions.

Background

To test our hypothesis, we require the use of technical indicators as well as conditions that define our entry and exit points. To this end, we use the Williams % R, Average True Range (ATR), One White Soldier, and simple/exponential moving averages (SMA / EMA). Unless otherwise specified, we employ a daily time frame.

Candlesticks

Japanese candlesticks are commonly used to display prices of stocks. This is because they represent low, high, open, and close prices clearly. There are two main types of candlesticks: bullish, where the close price is above the open price, and bearish, where the close price is below the open price. The former is usually displayed in green and the latter in red. There is also another type of candlestick, called doji, where open and close prices are almost the same. Doji candlesticks are often represented in grey. The following picture summarizes the main features of bullish and bearish candlesticks.

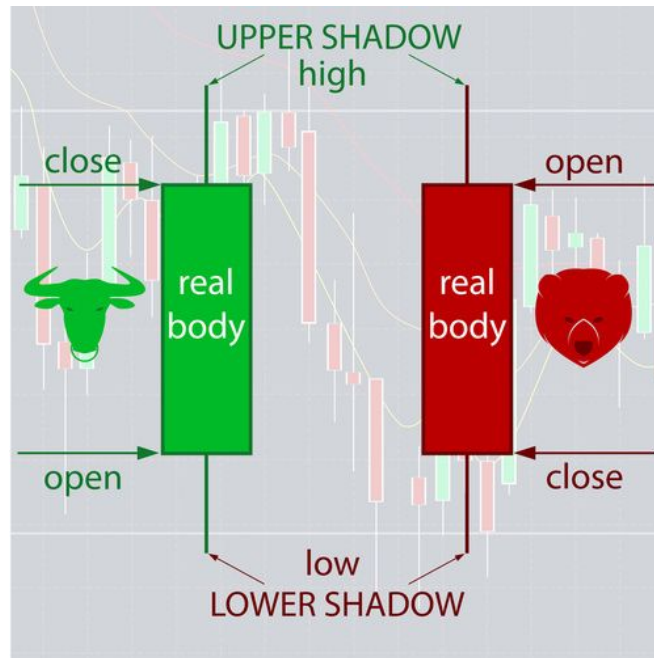


Figure 1: Bullish and bearish candlesticks¹

Williams % R

The Williams % R, or Williams % Range, is an oscillator that measures the extent a stock is overbought or oversold. It ranges between 0 and -100. A reading above -20 suggests the stock is overbought, while a value below -80 suggests oversold. A value rising above -80 may signal a price correction upwards of the underlying asset. Similarly, when the indicator is decreasing and has crossed -20, it signals a potential price correction downwards.

Ultimately, the underlying methodology involves comparing a stock's closing price to its high-low range over a given period (T), and is calculated using the formula below:

$$Williams \% R(T) = \frac{Highest\ High(T) - Close(0)}{Highest\ High(T) - Lowest\ Low(T)}$$

where

Highest High(T) = Highest price in the lookback period (last T candlesticks)

Close(0) = Latest closing price

Lowest Low (T) = Lowest price in the lookback period (last T candlesticks)



Figure 2: Example of Williams % R movements relative to stock price²

Average True Range (ATR)

The average true range (ATR) is a technical analysis indicator that measures market volatility. It is typically derived from the 14-day moving average of a series of true range indicators as follows (as notation, close(1) indicates the close price of the previous day):

$$TR(\text{True range}) = \max\{(\text{high} - \text{low}), \text{abs}(\text{high} - \text{close}(1)), \text{abs}(\text{low} - \text{close}(1))\},$$

$$ATR(n) = \frac{1}{n} \sum_{i=1}^n TR_i \quad TR_i \text{ is the } i^{\text{th}} \text{ day TR, } n \text{ is the desired number of days (e.g., 14)}$$

One White Soldier

The One White Soldier is a bullish reversal signal that is more significant after periods of persistent price declines. It is formed as a series of 2 candlesticks, the 1st being usually a red (bearish) candlestick and the 2nd being a green (bullish) candlestick that opens above the previous candle close and closes above the high of the previous candle. Additionally, the low of the bullish candle must be higher than that of the previous one. For the remaining of this report, the bearish candle in red is defined as candle(1) and the bullish candle in green is defined as candle(0). Accordingly, candle(1) occurs before candle(0) in an One White Soldier signal.

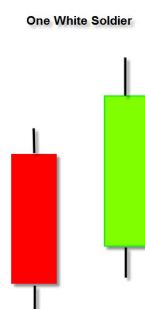


Figure 3: One White Soldier pattern³

Simple Moving Average (SMA)

SMAs are moving averages, calculated by adding the most recent close prices over a defined period of time, then dividing the result by the number of time periods. They can determine the trends of a given stock's price movements. Often, two or more different periods are compared against one another. For instance, the 50-day against the 200-day SMA. When the shorter period SMA crosses above the longer period SMA, this may be an indication of a reversal from a bear to a bull market and vice versa. Shorter time periods SMA are more sensitive to price changes and vice versa. To calculate SMA for a given number of time period(s), n:

$$SMA(n) = \frac{P_0 + P_1 + \dots + P_{n-1}}{n}$$

where P_t is price at time t. Usually, that price is the close. Note that we employ the same notation as before, i.e., P_0 is the close price of the last candle, P_1 is that of the previous one, and so on.



Figure 4: Example of a 50-day SMA⁴

Exponential Moving Average (EMA)

EMAs are moving average indicators that place greater weightage and significance on more recent data points, with the underlying assumption being that more recent data is more valuable than older data. Thus, EMAs are more responsive to price movements than SMAs. Like SMAs, EMAs are often used in pairs.

The formula to calculate EMA can be defined recursively as follows:

$$Smoothing = \frac{2}{(Selected\ Time\ Period + 1)}$$
$$EMA_{Today} = \left(P_{Today} * \left(\frac{Smoothing}{1 + Days} \right) \right) + EMA_{Yesterday} * \left(1 - \left(\frac{Smoothing}{1 + Days} \right) \right),$$

where the initial value of EMA (i.e., the least recent one) can be initialized to the closing price of the underlying asset at the corresponding time period.

Strategy

In this section we present the strategy in details and a real example to show how it works.

Position Sizing

To place orders, we adopt an Order-Cancel-Order approach, with a daily buy stop-limit order with predetermined Good-Till-Cancelled (GTC) take-profit and stop-loss prices calculated from the following:

$$\text{Sell limit} = \min \{ \text{previous swing high}, 50 \text{ SMA at candle } (0) \}$$

$$\text{Buy stop} = \text{high}(0) + 0.05$$

$$\text{Sell stop} = \min \{ \text{low}(1) - 0.05, \text{Buy stop} - 1 \text{ ATR}(14) \}$$

$$\text{Buy limit} = \text{buy stop} + 0.1 * (\text{buy stop} - \text{sell stop})$$

$$\text{Quantity (nr. of shares to buy)} = \text{floor} \left(\frac{1\% \cdot \text{Net Liquidation Value}}{\text{Buy stop} - \text{Sell Stop}} \right)$$

Sell limit is commonly known as take profit, sell stop as stop loss, buy stop is the lower bound of our buy order and buy limit is the upper bound of our buy order. The quantity of any trade is fixed at a 1% risk of our Net Liquidation Value (NLV), albeit adjustable according to one's risk appetite.

Note, swing high is a term used in technical analysis. It refers to a peak reached by an indicator or a security's price before a decline. A swing high forms when the high reached is greater than a given number of highs positioned around it. Previous swing high therefore refers to the most recent swing high before candle(1).

Specifically, we determine the previous swing high for any equity as follows:

1. Identify the most recent high candle (a maximum point) before candle(1). We denote it as candle(a) and the candle preceding and proceeding candle(a) as candle(b) and candle(c) respectively. Visually,



Figure 5: Swing high pattern⁵

2. If candle(c) is as in Figure 5, but candle(b) is engulfed within candle(a) i.e. $\text{low}(a) \leq \text{low}(b)$ and $\text{high}(b) \leq \text{high}(a)$, there are two possibilities. Starting from candle(b), if by looking backward it is possible to find another candle with lower high and lower low than candle(a) before finding a candle with higher high than candle(a), then candle (a) is still a valid swing high. Otherwise, it is not and one should look for the next most recent swing high pattern.

Notice that the stop loss is computed in order to ensure that the distance entry to stop-loss is at least 1 ATR. This is to avoid that the stop loss is hit by the normal volatility of the stock/ETF.

Conditions

Our strategy is applicable to most stock/ETF across the U.S. stock markets, as long as they satisfy the various conditions mentioned below:

1. Williams %R (10) < -80 for candle(1) or (0) 2. Williams %R (260) < -80 for candle(1) or (0)	The first two conditions ensure that both short term and long term sellers have sold their shares, resulting in an oversold situation.
3. low(0) > low(1) 4. close(0) > high(1) 5. candle(0) must be bullish 6. open(0) ≥ close(1)	These four conditions form the One White Soldier pattern, except that we also consider valid the case where candle(1) is bullish.
7. At least a 1:2 Risk-to-return ratio	We have chosen our risk-to-return ratio to be at least 1:2. A high risk-to-return ratio (e.g. 1:1) may be unfavorable as a winning rate of more than 50% is required to be profitable (excluding commissions). On the other hand, if we set a lower threshold (e.g. 1:5), few stocks/ETFs can pass the filtering. Hence, 1:2 represent a good trade-off between profitability and feasibility.
8. close(0) ≥ 5 USD	This is to avoid penny stocks.
9. Average volume of last 60 candles ≥ 150,000 (for stocks) or 100,000 (for ETFs)	This ensures the stocks we trade have sufficient liquidity.
10. $R = (\text{buy stop} - \text{stop loss}) \geq 1 \text{ ATR}^1$	This condition is to prevent us from closing our positions unnecessarily.
11. No earnings in the next 10 days	This limits potential gap-downs that may impair our performance.
12. low(1) is the lowest among the last 120 daily candles	This ensures the stock has reached its lowest over the past six months, increasing the chance the stock's price is soon to revert.
13. Entry stop ≥ 1R from 20 EMA at candle(0) 14. Entry stop ≥ 2R from 50 SMA at candle(0)	These two conditions are used to avoid buying when the price is too close to the moving averages that may represent resistance levels.

¹ To be precise, we do not know a priori the real entry price. As we use a buy stop-limit order, we expect it to be between the buy stop and the buy limit values. One could take the midpoint to get a more realistic value of R.

Position sizing, as mentioned in the preceding section, is then performed for the equities that satisfy these conditions.

To screen for the aforementioned conditions, we have employed the ThinkOrSwim platform and the ThinkScript language.

Sample Trade

We now present a workflow of executing a trade from start to end. Consider the ETF EWJ



Figure 6: ETF EWJ chart for trade to be executed on 27 Dec 2018⁶

From the aforementioned section on position sizing, we have

$$\text{Sell limit} = \min\{54.13, 54.27\} = 54.13 \text{ USD}$$

$$\text{Buy stop} = 50.20 + 0.05 = 50.25 \text{ USD}$$

$$\text{Sell stop} = \min\{48.99 - 0.05, 50.25 - 0.87\} = 48.94 \text{ USD}$$

$$\text{Buy limit} = 50.25 + 0.1 \cdot (50.25 - 48.94) = 50.38 \text{ USD}$$

$$\text{Quantity} = \text{floor}(0.01 \cdot 11572^2 / (50.25 - 48.94)) = 88 \text{ shares}$$

² At the point of execution, the Net Liquidation Value (NLV) of our simulated trading account was 11572 USD.

Following the aforementioned conditions,

- 1) It can be shown that William %R (10) < -80 at candle (1). In fact, William %R(10) = -97.47
- 2) William %R(260) = -99.17 at candle (1)
- 3) From Figure 6, the low of candle(0) > low of candle(1)
- 4) Similarly, it is observed that close of candle(0) > high of candle(1)
- 5) Since candle(0) is green in color, it represents a bullish candle
- 6) Clearly, the open of candle(0) > close of candle(1)
- 7) Risk-reward ratio was computed to be $2.96 > 2$
- 8) EWJ on 27 Dec 2018 is not a penny stock
- 9) It can be shown that the average volume of last 60 daily candles is greater than 100,000. In fact volume was always in the millions
- 10) $R = 50.25 - 48.94 = 1.31 > 1$ ATR = 0.87
- 11) There were no earnings to be declared in the next 10 days from 27 Dec 2018
- 12) It can be shown that the low of candle(1) was the lowest among the past 120 daily candles
- 13) Entry stop = 50.25 and 20 EMA at candle(0) = 52.42. Thus entry stop was more than 1 R from 20 EMA.
- 14) Also, 50 SMA at candle(0) was 54.27, thus entry stop was more than 2R from 50 SMA.

Therefore, EWJ is a valid trade and we should place our trade of 88 shares on 27 Dec '18. Eventually, EWJ reached our take profit price at 54.13.

A brief summary of this trade follows:

Holding period: 27 Dec 2018 - 17 Jan 2019 (21 days)

Ticker: EWJ

Quantity: 88

Entry: 50.27 USD

Exit: 54.13 USD

Total commissions: 2.07 USD

Realised net profit (including commissions): $88 * (54.13 - 50.27) - 2.07 = 337.61$ USD

Realised R: $(54.13 - 50.27) / (50.27 - 48.94) = 2.90^3$.

³ To be more precise, one could include commissions. In this case, the numerator would be the realised net profit (337.61 USD), whereas the denominator would be the total risk including commissions, i.e., $88 * (50.27 - 48.94) + 2.07 = 119.11$ USD. This way, the realised R would be $337.61 / 119.11 = 2.83$.

Results

We performed both forward and back testing on our strategy.

Forward Testing

Total R profit:	20.95
Win Rate:	51.85% (14/27)
Net Profit:	USD 2,664 (26.7%)

Forward testing was carried out from 30th October 2018 to 1st May 2019 with an initial capital of 10,000 USD. Since transaction costs were accounted for, we choose Interactive Broker as our trading platform for its minimal trading commission. The cumulative R for 27 trades is 20.95. Further, 14 of the 27 trades were profit-making and the total net profit is 2,664 USD.

Back Testing (5 years NASDAQ)

Backtesting results of our trading strategy against 5 years NASDAQ data, from 8th February 2013 to 7th February 2018, are as follows:

Total R profit:	11.46
Win Rate:	28.21% (22/78)

Conclusion

We would like to remark that our strategy is a low frequency trading strategy. Beginning traders may consider implementing this trading idea to their portfolio. From our forward testing, our strategy seems interesting since we have a relatively high profit rate of 26.7% while the return of S&P 500 in the same period is less than 9%. Moreover, our win rate was also above 50%. Of course, this is based on a small sample size, hence more data is required.

The backtesting is also showing that the strategy is profitable, even though the results are much less appealing. This may be due to the fact that we only tested NASDAQ stocks (we could not get other data), and that some of the conditions easy to check during forward testing were not so easy to code in an automatic backtesting. Some of them are the presence of gaps, that may be resistance levels, and earnings announcements.

It is also important to mention that during forward testing some trades exited before reaching the take profit price. Our team contacted Interactive Brokers and were informed that the problem was because these trades were odd-lots⁴. Another possible explanation is the lower accuracy of the demo platform compared to the real one. Nevertheless, these trades were profitable.

As a future work, we plan to have a better look at the backtesting results, to determine if we can get some insights for improving the performance of the strategy.

⁴ An odd lot is an order with less than 100 shares it is are not posted to the bid/ask data on exchanges. These orders are only filled when the exchange is able to submit them as a round lot, combined with other similar orders. This may have lead to the unexpected exit.

Bibliography and Additional Resources

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⁴<https://www.investopedia.com/terms/s/sma.asp>

⁵<https://forexsb.com/wiki/trading/swing-high-low>

⁶<https://www.tradingview.com/x/TSBNt1II/>

Video on candlesticks: <https://www.youtube.com/watch?v=6uj-ssgsXQk>

Video on types of orders: <https://www.youtube.com/watch?v=LnsEMAPqyFc>

Video on ATR: <https://www.youtube.com/watch?v=0kY80ur4784>

Video on One White Soldier: <https://www.youtube.com/watch?v=uKsr8bgu7vQ>

Video on position sizing: <https://www.youtube.com/watch?v=jQq3Vp6r7oc>