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By

Yuchang Zhang

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Approved by Professor Dalin Tang, Project Advisor

ABSTRACT

This IQP focused on developing a trend trading strategy for stock market investment. The strategy is called Indicator Trend Trading Strategy (ITTS). The goal of ITTS is to provide a simple method for individual investors to identify trend reversals in trend trading, minimizing risks while optimizing profits. ITTS used three stock indicators MACD, CCI and RSI to develop its trading strategies. A ten-week trading simulation was conducted using ITTS in trend trading. The results of the simulation were analyzed and used to verify the efficiency of ITTS.

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1 INTRODUCTION

1.1 Goal & Scope

The primary goal of the project is to develop a new trend trading strategy for stock market trading. The strategy is called Indicator Trend Trading Strategy (ITTS). I will first conduct research about stock market, the technique of trend trading and the role of mathematical indicators. Then I will conduct a trading simulation specifically dedicated to testing ITTS's efficiency in trend trading.

For the purpose of this project, the mathematical indicators that are chosen for study can be categorized into trend indicators and momentum indicators, including MACD (Moving Average Convergence Divergence), a trend indicator, and CCI (Commodity Channel Index) RSI (Relative Strength Index), both momentum indicators. The second chapter is dedicated to an in-depth research of each chosen indicator. Then, the project move on to phase two, a 10-week stock trading simulation with an initial investment of \$100,000, in which I will trade stock with trend trading strategy strictly based on the buy and sell signals of chosen indicators. This allow me to understand how each indicators perform, and how to apply them appropriately for analysis and decision making. And ultimately, I aspire to develop a trading strategy, ITTS, that optimizes profit and minimizes risk by combining multiple indicators in analysis.

1.2 General Approach

The phase one is research, during which I will spend the first two weeks to study three indicators individually by evaluating historical stock data, and highlighting any significance in correlations between stock trend and indicator behaviors. Each indicator will be examined by three cases:

small-cap, mid-cap and large-cap stocks. By the end of the research phase, all remarks will be analyzed, and a prototypic trading strategy will be developed for simulation.

At the beginning of phase two--simulation--I will select a short list of companies, up to eight in total, that will be used for trading purpose. The report will include the list of company and a description for each chosen company in Chapter 3, Company Selection. This will eliminate the unnecessary hazard of constantly searching from a huge variety of stocks for trading. The simulation will strictly follow the prototypic trading strategy developed in chapter 2.

Chapter 4 is dedicated to describe the trading simulation with an initial investment of 100k USD, for a defined period of 10-weeks. Each trade will be documented by its date, price per share, net cost or proceed. I will also comment on gains or losses resulted from correct and false signals obtained from each indicators. Additionally, the portfolio net worth will be analyzes to evaluate the performance of the trading strategy periodically. The trading strategy will be revised or improved depending on gains or losses. By the end of the simulation phase, a trend trading strategy involving multiple indicators that optimizes profit and minimizes losses can be finalized.

At the end, the report will summarize the trading strategy developed through the trading simulation. Contents that will be discussed include the advantages, disadvantages and limits of the trading strategy with supporting data.

1.3 Stock Market Definition

The stock market refers to the collection of markets and exchanges where the issuing and trading of equities (stocks of publicly held companies), bonds and other sorts of securities takes place, either through formal exchanges or over-the-counter markets. Also known as the equity market, the stock market is one of the most vital components of a free-market economy, as it provides companies with capital in exchange for giving investors a slice of ownership.^[1]

Trade in stock markets means the transfer for money of a stock or security from a seller to a buyer. This requires these two parties to agree on a price. Equities (stocks or shares) confer an ownership interest in a particular company. Participants in the stock market range from small individual stock investors to larger trader investors, who can be based anywhere in the world, and may include banks, insurance companies, pension funds and hedge funds. Their buy or sell orders may be executed on their behalf by a stock exchange trader.

The stock market allows companies to raise money by offering stock shares and corporate bonds. It lets investors participate in the financial achievements of the companies, making money through the dividends (essentially, cuts of the company's profits) the shares pay out and by selling appreciated stocks at a profit, or capital gain. (Of course, the downside is that investors can lose money if the share price falls or depreciates, and the investor has to sell the stocks at a loss.)

1.4 Trend Trading Technique

Trend trading was popularized in the 1980s when Richard Dennis and Bill Eckhardt recruited and taught a small group of traders, known as the Turtle Traders, a trend trading strategy that netted them more than \$100 million in profit. Galen Burghardt later showed that there was a 'very high' correlation between broad market indexes and trend-following commodity trading advisors, suggesting that trend trading was the predominant strategy used by technical traders in the commodity (and potentially other) markets.^[1]

Trend trading is a commonly used strategy, which assumes that a security will continue to move along its current trend and often contain a take-profit or stop-loss provision if there are any signs of a reversal. It can be used by short, intermediate or long-term traders. Regardless of their chosen time frame, traders will remain in their position until they believe the trend has reversed, although reversals may occur at different times for each time frame.

The fundamental principle of trend trading is buy low sell high, which requires knowing when to trade. The stock market has a sinuous nature, therefore in order to obtain profitable results, one must acquire both patience and correct interpretation of buy and sell opportunities. Stock traders who use trend trading strategy often take advantage of stock indicators to predict the future trends of a given stock, nonetheless, those indicators do not guarantee wins, instead they gave the “most likely” suggestion based on historical data. Indicators are mathematical modulations applied to historical statistics of a given stock. Depending on the types of indicators, some indicate current trend direction of a stock, whether it is uptrend or downtrend, which are called trend-following indicators, whereas other indicate momentum of current trend, that means if a current trend is likely to continue in its direction or reverse direction, which are called momentum indicators. Due to the variety of indicators, it is often hard to select suitable indicators that best describes every stock, as different indicators have different interpretations and give opposite predictions. Thus individual trend traders are often bewildered by the complexity involved when dealing with indicators and make mistakes at the end.

2 STOCK INDICATORS AND TRADING STRATEGY

This chapter thoroughly discusses the three stock indicators that will be used for simulation, including Moving Average Convergence Divergence (MACD), Commodity Channel Index (CCI), and Relative Strength Index (RSI). The research will first discuss the mathematical equations of the MACD indicator, as well as its interpretation in analysis, and application in sample stocks. Then the chapter will go continue on discussing CCI and RSI indicators in similar fashion.

2.1 MACD (Moving Average Convergence Divergence)

Moving average convergence divergence (MACD) is a trend-following momentum indicator that shows the relationship between two moving averages of stock prices. MACD indicator shows the current trend of stock price, and it also signals the momentum of the current trend, whether the price will continue in its current trend or reverse its direction.

From the mathematical perspective, a typical MACD indicator is determined by subtracting the 26-day exponential moving average (EMA) from the 12-day EMA. The concept of exponential moving average is similar to that of a simple moving average (SMA). Thus, to understand the MACD indicator, I first investigated the concept of a SMA and that of EMA.

2.1.1 Simple Moving Average (SMA)

The simple moving average (SMA) does not predict the price direction, but define the current trend of the price with a lag. SMA is calculated by taking the average of the current price tracing backwards over a defined period of time. For example, if the current market price is P_M , then the price of the previous day can be represented as P_{M-1} , similarly the price of n-days ago is P_{M-n} . The

SMA of n-days is calculated by adding the sum of prices starting from current day until n-days ago, then divide by the total number of n-days, this is summarized by the following equation:

$$SMA(n) = \frac{P_M + P_{M-1} + \dots + P_{M-(n-1)}}{n} = \frac{1}{n} \times \sum_{i=0}^{n-1} p_{M-i} \quad (2.1)$$

The characteristic of the SMA is that it is a smoother line compare to the real-time stock prices, because it is the average of the stock price over a period of time. The longer the defined period is, the smoother the line moves. Figure 2.1 shows an example of *Micron Technology, Inc.* (MU) with three SMA indicators, each representing a SMA (5-day) in red, SMA (15-day) in orange, and SMA (30-day) in green. Relatively, the red-line SMA (5) is the most sensitive representation of the price, and the green-line SMA (30) is the smoothest transition line among three SMAs, whereas the orange SMA lies in between.



Figure 2.1 SMA (5-day, 15-day, 30-day)

However, the downside of SMA is that it is a simple trend-following indicator with no predictability, that means it shows the current trend with a lag due to its mathematical nature. Looking at Eq.1, the SMA is the unweighted average of prices from n-days (each weighs $1/n$), as a result, even if a dramatic change in price or reverse in trend direction occurs, the unweighted SMA will not respond to the change instantaneously, but rather in a longer period of time. This characteristic of SMA can be found in Figure 1.1. Notice in the center of the graph, a continuous uptrend brings the price up till approximately \$50.00, signaling an overbought, then follows a steep downtrend that brings the price to \$40.00. This dramatic downtrend continued for five days with a total loss of 20% of its previous high \$50.00. However, if we look at the three SMA, only the SMA (5) responds to the downtrend in time, but the SMA (15) does not show a downtrend until the second big red candle, whereas the SMA (30) does not respond to the downtrend.

As a conclusion, the SMA is useful for determining current trend, however, it does not predict a moving momentum or reversal in trend direction.

2.1.2 Exponential Moving Average (EMA)

On the contrary, the exponential moving average (EMA) reduces the lag by applying more weight to more recent prices, as a result the exponential moving average is more responsive and sensitive towards recent price fluctuations. The EMA of a given day is calculated by adding EMA of the previous day to the product of the price change of current day multiplied with a weight factor. For example, in order to determine a n-day EMA from P_i to P_{i+10} , first a n-day SMA is determined prior to P_i , that is from P_{i-10} to P_{i-1} . The following set of equations represents the EMA calculation for the given example:

First, one must determine the SMA (n) as an initial value for determining EMA (i):

$$EMA(i-1) = SMA(n) = \frac{1}{n} \times \sum_{n=i-10}^{i-1} p_n \quad (2.2)$$

Then, the multiplier must be determined by the following formula:

$$multiplier = \frac{2}{n + 1} \quad (2.3)$$

Finally, the EMA (i) and the following days can be calculated consecutively by:

$$EMA(i) = [P_i - EMA(i - 1)] \times multiplier + EMA(i - 1) \quad (2.4)$$

The difference between a SMA and a EMA is shown in the following Figure 2.2. In Figure 2.2, both SMA and EMA of 50-days are plotted on the same graph. Comparatively, the EMA (in green) moves more sharply when the price fluctuates. The SMA moves slower and shows less of a change during price fluctuations.

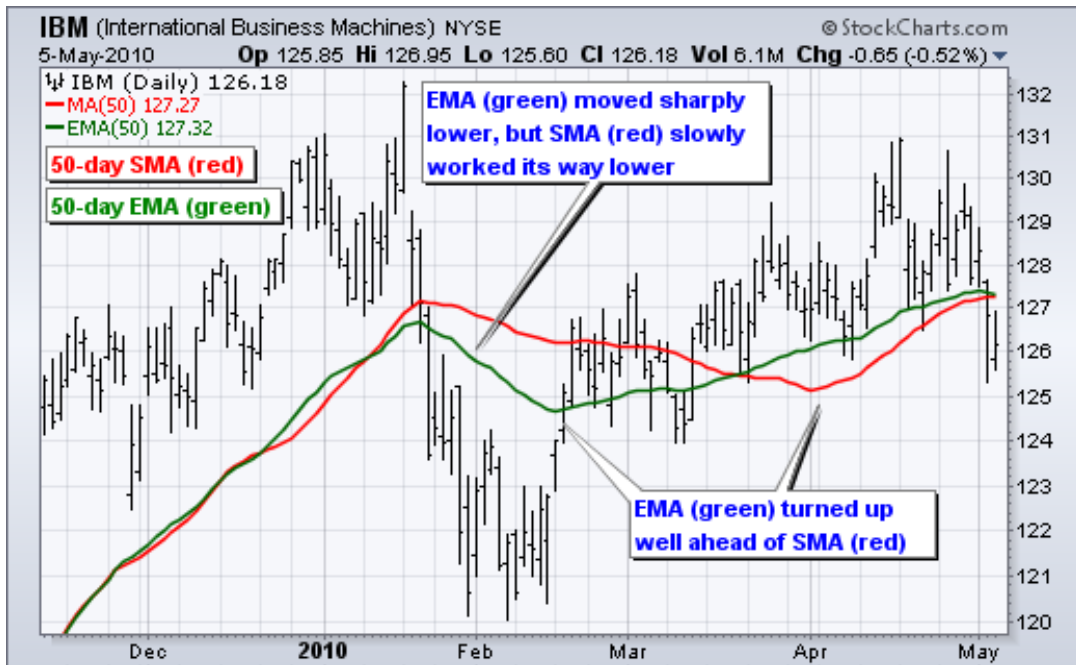


Figure 2.2 SMA (50-day) vs. EMA (50-day)

2.1.3 MACD Formula

A typical MACD is determined by subtracting a 12-day exponential moving average from a 26-day EMA. This can be denoted as MACD (26, 12). However, one might alter those two periods of times to adapt to different companies with more accurate predictions.

$$MACD(26, 12) = EMA(26 \text{ days}) - EMA(12 \text{ days}) \quad (2.5)$$

The use of the MACD line is often combined with a so-called “trigger” line. The trigger line is in fact a 9-day EMA of the MACD line.

$$\text{trigger line} = EMA(9 \text{ days})\{MACD(26,12)\} \quad (2.6)$$

When a MACD line and its trigger line are plotted, depending on the trend directions and price fluctuations, the MACD line and trigger line will “crossover” each other, representing buy and sell signals. An example of *Micron Technology, Inc. (MU)* is shown in Figure 2.3, in which the purple line represents macd, and the orange line represents the trigger line. Typically, macd crossing above the trigger line indicates a buy signal. On the contrary, if macd crosses below the trigger line, it indicates a sell signal. In Figure 2.3, there are some unclear sell signals during the uptrend, which will be further discussed in later sections.



Figure 2.3 MACD (26, 12, 9)

2.1.4 Examine with Historical Data

To investigate the characteristic of MACD, the companies listed below are chosen for research. I focused mainly on three high-tech companies, because of their outstanding performance during 2017--all of the chosen company had at least one uptrend of 30% gain. Each of them represents a small-cap, mid-cap, and large-cap high-tech company.

Table 2.1 Company Selection for Research

Symbol	Company Name	Field of Business	Market Cap
MU	Micron Technology, Inc.	Semiconductors Technology	50.496B (large cap)
SOXL	Direxion Daily Financial Bear 3X Shares	Semiconductors Technology	633.72M (small cap)
AMD	Advanced Micro Devices	Semiconductors Technology	12.4B (mid cap)

a. Micron Technology, Inc. (MU)

Micro Technology is a large-cap stock with a total market cap of 50.496B. Figure 2.4 shows MU of a defined period of approximately one month, starting from Dec 19, 2017 to Jan 27, 2018, with each candle representing 1 hour. A MACD (26, 12, 9) indicator is inserted to the left side of the image.

The graph closely resembles the signal reading techniques introduced previously. The macd line showed a total of 5 “crossovers” for the defined period of time, each of which correctly resembles a corresponding overbought or oversold point highlighted. On Dec 21 2017, the macd line crossed below the trigger line, indicating a sell signal. Then the stock price terminated its previous uptrend, and reversed to downtrend for 9 days consecutively. Starting Dec 28, 2017, the downtrend has not yet terminated, however, the macd line shows unclear buy signals. On Jan 1,

2018, the macd crossed above the trigger line, signaling an oversold and initiative of a new uptrend. As expected, the stock entered a new uptrend that brought the stock price from \$40.00 to \$46.50. As a conclusion, macd correctly predicts buy and sell signals with an accuracy of 80% for an uptrend large-cap stock.



Figure 2.4 MU with MACD (12, 26, 9)

b. Direxion Daily Financial Bear 3X Shares (SOXL)

SOXL is a Direxion Daily Financial Bear 3X Shares is a small-cap stock with a total market cap of 633.72M. Figure 2.5 shows the stock price for SOXL starting from May, 2017 until Feb, 2018, with each candle representing one day. Within this given time, the price of SOXL is brought from initially approximately \$75.00 to a climax of approximately \$190.00. According to Figure 2.5, there are six trends that can be identified within the given period of time. A MACD (12, 26, 9) is plotted to show buy and sell signals.

An up-trend can be identified starting from May 2017 up until June 10th 2017, which brought the price from \$75.00 up to around \$110. At the end of the uptrend, the MACD signal line crossed under the MACD, indicating an overbought and giving a sell signal. Since the first sell signal, the price entered its first downtrend that lasted from June 10th to July 10th, which brought the price back to around \$75.00. The downtrend terminated with the MACD crossing above the signal line, giving a buy signal and indicating an oversold. Starting from July 10th till end of Nov 2017, a continuous uptrend brought the price up to \$170.00, followed by the second overbought. However, the MACD did not show a clear sell signal this time, instead it showed multiple crossovers throughout the second uptrend. The second uptrend then terminated, and reversed into a second downtrend of a short period. In late Dec 2017, the MACD showed a new buy signal. As expected, the stock entered a third uptrend. Until the current day of Feb 2, the MACD crossed below the signal line, indicating a sell signal. Therefore, a new downtrend is expected to happen within short period of time. As a conclusion, for the specific target of a small-cap glooming high-tech stock, the MACD accurately describes the trend direction and predicts trend directions with 80% accuracy.



Figure 2.5 SOXL with MACD (12, 26, 9)

c. Advanced Micro Devices (AMD)

Advanced Micro Devices is a mid-cap stock with a total market cap of 12.4B. Figure 2.6 shows the stock price of AMD from Apr 2017 until Feb 2018 with a MACD (12, 26, 9) plotted. There are in total of five successful indications identified in the MACD plot. Compare to the previous cases with MU & SOXL, the MACD plot of AMD showed a higher chance for false signals relatively. According to Figure 2.6, multiple crossovers occurred prior to the arrival of overbought. This is due to speculative activities--periodic ripples.

On July 20th, the multiple crossovers terminated in the occurrence of an overbought, followed by a downtrend. Thus, this signal is unsuccessful--false signal. The 2nd signal is when MACD crossed above the signal line around Aug 30th, giving a clear buy signal. As a result, the stock entered its uptrend phase. However, multiple ripples occurred during this uptrend, resulting in two false sell signals of the MACD line. On Dec 14, 2017, the MACD indicated a successful buy signal. Consequently, the stock entered its new uptrend. Until the current day, Feb 2 2018, the MACD indicated a sell signal, thus, an incoming overbought is expected.

As a conclusion, the MACD did not work well for the mid-cap up-trend company, with approximately 50% accuracy. This can be potentially caused by several reasons including: the speculative activities (short-term investors), and potential reversal in general trend direction.

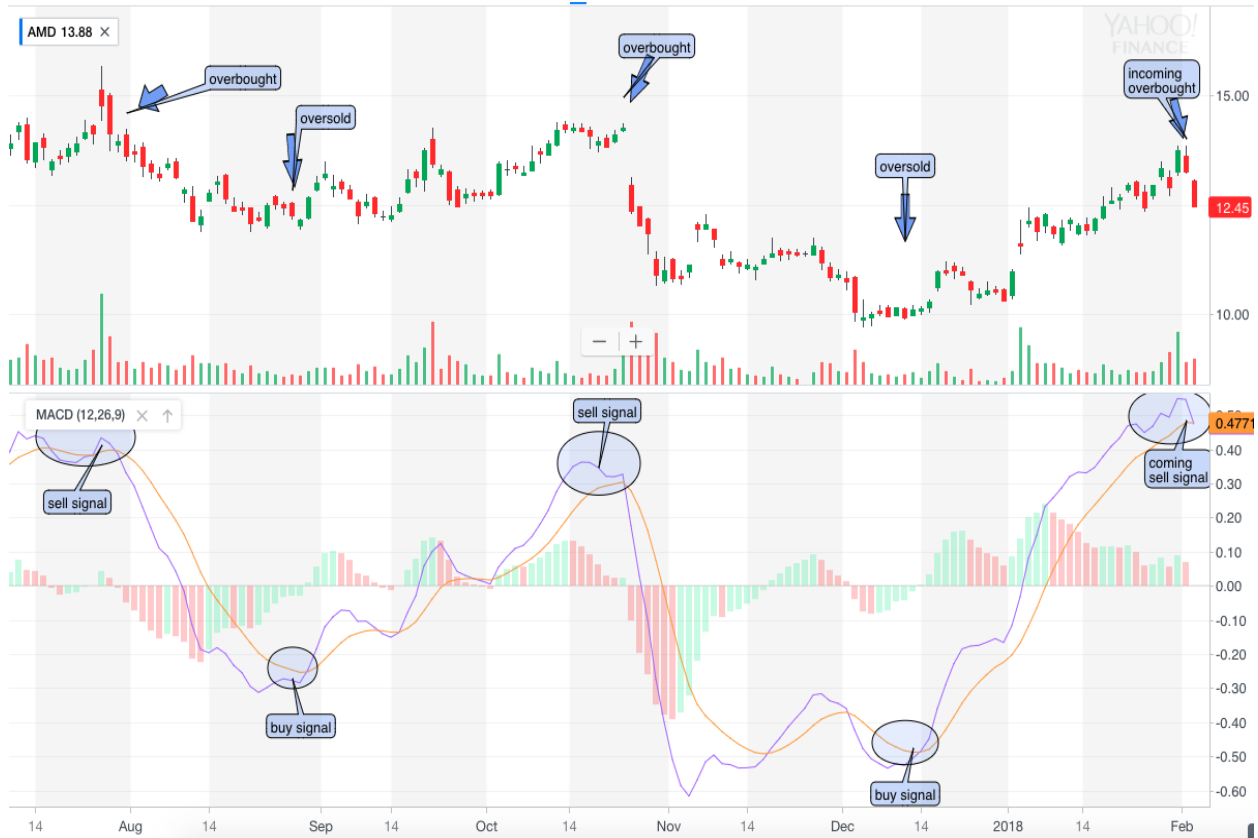


Figure 2.6 AMD with MACD (12, 26, 9)

2.1.5 Summary

The MACD line indicates buy signal when the MACD crosses above the signal line, on the contrary, it indicates sell signal when MACD crosses below the signal line. According to historical data analysis conducted on three high-tech companies with different cap sizes, the MACD predicts with higher accuracy for steady trend large-cap and small-cap stocks, with accuracy of approx. 80%, and it performs poorly for mid-cap stocks with more fluctuation and ambiguous trend direction.

2.2 CCI (Commodity Channel Index)

2.2.1 Definition

Commodity Channel Index (CCI) is a momentum oscillator indicator typically used to identify trend reversals and extremes. Professional traders use CCI to identify overbought and oversold of a given stock, whereby make decisions for pattern trading (day trades).

CCI is calculated as the difference between the typical price of a commodity and its simple moving average, then divided by the mean absolute deviation of the typical price.^[2] The CCI is then scaled by the inverse factor of 0.015 for ease of readability. The equation (2.7) shows the mathematical expression of CCI:

$$CCI = \frac{1}{0.015} \times \frac{p_t - SMA(p_t)}{\sigma(p_t)} \quad (2.7)$$

The typical price (p_t) is the arithmetic average of the high, low, and closing prices for a given period. For instance, the typical price for a period of one day would be the sum of H, L, and C divided by 3, as shown in the following expression:

$$p_t = \frac{H + L + C}{3} \quad (2.8)$$

The mean absolute deviation ($\sigma(p_t)$) is determined by taking the average of the sum of the absolute value of the difference between each data and the mean of that set of data. For example, if a set of one-day typical price over n days is given as $P = \{p_1, p_2, p_3, \dots, p_n\}$, the mean value and the would be determined by Eq (2.9), and the mean absolute deviation will be determined according to Eq (2.10):

$$m(P) = \frac{1}{n} \sum_{i=1}^n p_i \quad (2.9)$$

$$\sigma(p_t) = \frac{1}{n} \sum_{i=1}^n |p_i - m(P)| \quad (2.10)$$

The CCI is a momentum oscillator that has a typical range of data between +100 and -100. When the value of CCI exceeds +100, that is a general sign of overbought, on the contrary, when the value falls below -100, it signals an oversold. The CCI calculation typically covers data up till 14 days. If the number of days increases, the CCI will show smoother transition, vice versa sharper transition. At the same time, the upper and lower boundaries can be customized based on individual stock for higher accuracy. Figure 2.7 shows an example of CCI (14) vs CCI (35), both plotted for a chosen stock ASML. Comparatively, the 14-day CCI shows a more sensitive response for the price changes relative to the 35-day CCI.



Figure 2.7 CCI (14) vs CCI (35) plotted for ASML

2.2.2 Examine with Historical Data

The companies chosen for the study of CCI are the same as MACD. We will use MU, AMD, and SOXL to each represent the a case of large-cap, mid-cap, and small-cap stock.

a. Micron Technology, Inc. (MU)

In Figure 2.8, the stock price for MU along with a CCI (14) indicator are plotted for the chosen period of time from Nov 2017 to Feb 2018. In the graph, there are total of six significant trend reversals identified with corresponding CCI predictions.

On Nov 20th, the value of CCI exceeded 100, which successfully predicted an overbought of a previous uptrend, immediately followed by a dramatic trend reversal. On Dec 1st, the value CCI dropped below -100, indicating an oversold. As expected, the downtrend terminated and a reversal in direction occurred--the stock entered a new uptrend. On Dec 16th, the value of CCI reached 100, successfully predicted another overbought in the stock. Immediately the stock entered a downtrend. On Jan 1st 2018, the value of CCI briefly dropped below -100, and as expected, the stock experienced an oversold and reversed its trend direction. On Jan 5th, CCI exceeded 100, indicating an overbought. Respectively, the stock entered a new downtrend. Until recently (Feb 2018), the CCI dropped below -100, which shows the tendency for a upcoming oversold. This can be anticipated as a buy signal. As a conclusion, the CCI (14) correctly predicted all trend reversals for the large-cap stock (MU) with an approximate accuracy of 100% for the given period of time.



Figure 2.8 MU with CCI (14)

b. Direxion Daily Financial Bear 3X Shares (SOXL)

Figure 2.9 below shows the stock price for SOXL plotted with a 14-day CCI for the given period from Nov 2017 to Feb 2018. During this period, there are in total of seven trend reversals that are predicted by the CCI indicator, which are all successful.

On Nov 7th, the value of CCI exceeded 100 which indicated an overbought. The corresponding stock price reached a new high of \$165.00, soon after, the price dropped with small variation. On Nov 21, the value of CCI once again exceeded 100, and the corresponding stock price reached a new historical high, which resulted in an overbought. A trend reversal took place

and the price went down to a previous low. On Dec 1st, the CCI predicted an oversold. The price then entered a new uptrend and started to go back up. On Dec 20th and Jan 8th, the stock experienced two small overbought, which were all predicted by the CCI, however it did not exert a heavy effect on the stock trend. On Jan 17th, the CCI predicted an overbought, as a result, the stock reversed its trend. On a recent date (Feb 2nd 2018), the CCI dropped below -100, which is a sign for an upcoming oversold. This could potentially be a buy signal. Overall, the CCI give accurate response to the price extremes, and trend reversals for a small-cap stock company, with an accuracy of approximately 100% for the given period.



Figure 2.9 SOXL with CCI (14)

c. Advanced Micro Devices (AMD)

Figure 2.10 shows the stock price of AMD and a 14-day CCI plotted for the given period from Mar 2017, to Aug 2017. In the graph, there are in total of 6 trend reversals identified. On Apr 1st, the CCI exceeded 100, and an overbought occurred, then the trend reversed. On Apr 14, an oversold occurred and the downtrend ended and reversed into an uptrend. The CCI showed slight delay for five days, instead of giving an immediate prediction. Near the end of Apr and the beginning of May, a large red candle with a significant large volume has brought the price down from around \$14.00 to \$11.00, which marked an overbought of the previous uptrend, and initiated a downtrend. Both the overbought and oversold during this period of time are successfully predicted by the CCI. On June 10th and 23rd, the value of CCI predicted two temporary overbought. On average, the CCI predicted 5 out of 6 trend reversals with an approximate accuracy of 83% for the chosen mid-cap stock AMD.



Figure 2.10 AMD with CCI (14)

2.2.3 Summary

The CCI is a momentum indicator for a given period of time. Typically, it covers a 14-day period, and the larger the period, the smoother the transition becomes. When the CCI value exceeds 100, it signals a potential overbought. On the contrary, when CCI drops below -100, it signals a potential oversold.

For the three stocks chosen for research, which are MU, AMD, and SOXL, the CCI shows high accuracy (100%) towards predictions of trend reversals for large and small cap companies. It shows a little less accuracy (83%) for the mid-cap company. Both MACD and CCI showed less accuracy towards AMD, the mid-cap stock. This is probably due to its speculative activities, and frequent price fluctuations.

Special Note: One interesting aspect of the CCI is that, for all the listed stocks and overbought and oversold signals, the reversal do not happen immediately when the CCI enters +100 or -100, instead, when the CCI went back into the 100 ~ -100 region, such reversals occur.

2.3 RSI (Relative Strength Index)

2.3.1 Definition

The Relative Strength Index (RSI), developed by J. Welles Wilder, is a momentum oscillator that measures the speed and change of price movements.^[3] It indicates the strength of a trend and its momentum, whether it will continue in its current direction or terminate with a reversal. A typical RSI value is determined with 14 days of data. Similar to other indicators, the longer the period, the smoother the transaction becomes. The RSI determined by the following equations:

$$RSI(n) = 100 - \frac{100}{1 + RS(n)} \quad (2.11)$$

$$RS(n) = \frac{Gain_{Ave}(n)}{Loss_{Ave}(n)} \quad (2.12)$$

$$Gain_{Ave}(n) = \frac{1}{n} \times \sum_{i=1}^n Gain_i \quad (2.13)$$

$$Loss_{Ave}(n) = \frac{1}{n} \times \sum_{i=1}^n Loss_i \quad (2.14)$$

For practice purpose only, the table 2.2 shows a sample data set containing close price, price change, advance and decline of a period of 14 days of a hypothetical stock. First, the 14-day average gain and loss are calculated with Eq (2.13) and Eq (2.14). Then, the 14-day RS is calculated according to Eq (2.12), simply by dividing the average gain by the average lose. Finally, the 14-day RSI can be calculated based on Eq (2.11). The value of RSI for the given 14-day of data is 51.779. The steps are shown below:

$$Gain_{Ave}(14) = \frac{1.000 + 0.500 + 0.375 + 1.125 + 2.063 + 1.750 + 1.375}{14} = 0.5848$$

$$Loss_{Ave}(14) = \frac{0.6875 + 2.000 + 0.6875 + 0.250 + 0.5625 + 2.4375}{14} = 0.5446$$

$$RS(14) = \frac{0.5848}{0.5446} = 1.0738$$

$$RSI(14) = 100 - \frac{100}{1 + 1.0738} = 51.779$$

Table 2.2 Sample Data for RSI Calculation

	Close	Chg	Adva	Decl	AvgGain	AvgLoss	RS	RSI
	46.1250							
1	47.1250	1.0000	1.0000					
2	46.4375	-0.6875		0.6875				
3	46.9375	0.5000	0.5000					
4	44.9375	-2.0000		2.0000				
5	44.2500	-0.6875		0.6875				
6	44.6250	0.3750	0.3750					
7	45.7500	1.1250	1.1250					
8	47.8125	2.0625	2.0625					
9	47.5625	-0.2500		0.2500				
10	47.0000	-0.5625		0.5625				
11	44.5625	-2.4375		2.4375				
12	46.3125	1.7500	1.7500					
13	47.6875	1.3750	1.3750					
14	46.6875	-1.0000		1.0000	0.5848	0.5446	1.0738	51.779

A typical value of RSI indicator falls in between 70 and 30--when within this range, the current trend is considered to be still in progress. If the RSI value exceeded 70, it might indicate an incoming overbought, whereas if the value drops below 30, an oversold can be expected. Generally, if the RSI indicator reaches one of those two extremes, the stock will experience a corresponding reversal in its current trend, whereby it helps determine buy and sell signals.

Figure 2.11 shows an example stock with a 14-day RSI indicator plotted for period from Jan 2009 until Jan 2010. The stock showed a general uptrend during this year, starting from a low price around \$23.00 at Mar 2009. The uptrend continued throughout the year, as a result, the stock price increased to a new high of \$31.50 at Dec 2009, and reversed into a decline. Respectively, the RSI indicator dropped below 30, marking the oversold, and peaked at 70, marking an end to the uptrend. The corresponding RSI indicator showed quite an accurate prediction of the trend momentum.

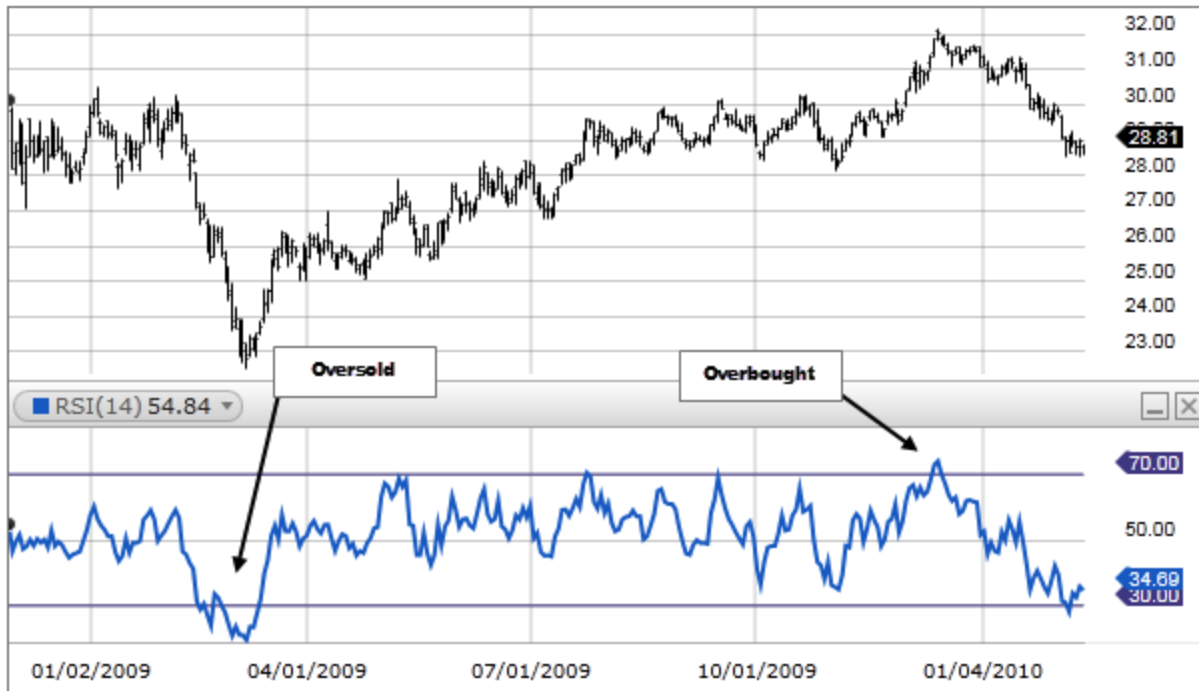


Figure 2.11 Example RSI (14) Indicator Plotted Over 1-year

2.3.2 Examine with Historical Data

a. Micron Technology, Inc. (MU)

Figure 2.12 shows the stock price for MU plotted with a 14-day RSI indicator over a period of two years. Within this time, the stock experienced a long lasting uptrend for more than one year. I have determined six points of interest in the stock price with respect to the 14-day RSI value underneath.

On Jan 2016, the RSI dropped below thirty with a significant difference, indicating an oversold in stock price. It was a successful signal, because it corresponded to a minimum in stock price. From this point onward, the stock has entered its uptrend. Until Jun 2016, the value of RSI has peaked 100, exceeding the overbought relative value by 30, sending a false signal for overbought, whereas the price of the stock has continued in its uptrend. Near the end of 2016 until Apr 2017, the RSI have exceeded the preset value 70 three times, among which none accurately indicated a reversal, instead, it indicated several local maximums. On June 2017, the uptrend has ended, and the price began to oscillate back and forth. Therefore, we consider this as an

overbought, and the RSI showed correct prediction. Overall, the RSI indicator has a poor accuracy of 33.3%, comparing to CCI (80% accuracy). The signals not only indicate reversals, but also regional maximums. Therefore, RSI is relatively less reliable.



Figure 2.12 MU plotted with RSI (14)

b. Direxion Daily Financial Bear 3X Shares (SOXL)

The graph in Figure 2.13 shows stock price for SOXL plotted with a 8-day RSI indicator over starting from Feb 2017 till Feb 2018. Within this period of time, there are in total of six trend reversals identified with corresponding RSI signals. There are five correct predictions by RSI combined with four miss-signals.

On Apr 2017, the first oversold occurred, with RSI value dropped below 30. Soon after this point, the stock entered its first uptrend. As the price went up, the RSI exceeded 70 and sent a false signal for overbought before the termination of this uptrend. However, on June 2017, the RSI once again reached 100 that predicted a reversal in trend. The stock price then went down until the second oversold occurred on July 2017. The corresponding RSI value dropped to 30, therefore it did not show a good indication of oversold. Within the next few month, the uptrend continued, until the price breached \$165.00 and ended in an overbought. During this time, the RSI gave several false signals that were not accurate. Then on Nov 2017, the stock entered a downtrend and the price dropped to \$133.00, which was correctly predicted by the RSI. During the next uptrend, the RSI once again gave false signal before the actual overbought. Finally, the price went up to \$180.00, and ended in an overbought. Overall, the RSI performed poorly in terms of giving correct buy and sell signals. It reflected not only the overbought and oversold, but also small fluctuations and regional max. It has an approximately 55.5% accuracy.



Figure 2.13 SOXL plotted with RSI (14)

c. Advanced Micro Devices (AMD)

Figure 2.14 below shows AMD plotted with RSI indicator over the period of time from Oct 2016, to Feb 2018. There are in total of nine reversals identified throughout this time. At the end of 2017, the price dropped to around \$7.00 as an oversold, and soon after the stock turned into an uptrend that brought the price up to around \$12.00, where it ended in a climax. Then small fluctuation occurred that brought the price down to an oversold around \$10.00. According to the RSI plot, when those two oversolds occurred the RSI value did not drop below 30. The stock then entered another uptrend that breached a new high of \$15.00. At this climax, the RSI exceeded 70 and

indicated a reversal. Then, the RSI signaled the oversold on May 2017, as well as the next oversold that happened on Nov 2017. However, towards the end of 2017, the RSI was not capable of showing corresponding sell signals for overbought.

Overall, the RSI predicted 3 correct reversals out of total of 9 reversals, along with 1 false signal and 5 other signals missing. It has a 33.3% accuracy. It is observed that the during an uptrend, the RSI tends to rapidly increase in value and reaches the signal value before the climax. At the same time, it is also sensitive to declines.



Figure 2.14 AMD plotted with RSI (14)

2.3.3 Summary

Based on the three cases discussed in previous section, it can be concluded that RSI performs poorly comparing to CCI, that it is not accurate in terms of determining trend reversals. It tends to

rapidly react to a trend of stock, therefore, ends up giving an early signal, or misses the signal completely. As a result, due to the poor performance of RSI indicator, I have decided to only use MACD for determining trend, buy and sell signal, along with CCI for determining the momentum of trends and potential reversals.

2.4 METHOD AND STRATEGY

As discussed previously in chapter 2, I will mainly use the MACD indicator along with CCI indicator to make trading decisions. The strategy that will be used is trend trading, which is an attempt to capture gains through analysis of an asset's momentum in a particular direction--buy low sell high. A buy signal is determined by MACD crossing above the signal line, as well as CCI dropping below -100, combining those two will optimize the possibility of an oversold. The sell signal will be determined when MACD crossing below the signal line, and CCI breaching 100, which triggers an overbought. This attempt is to capture the profit from investing in short term uptrends. Since the RSI indicator did not show the actual trend reversals, but rather send false signals ahead of time, RSI will be used as a reference to analyze the potential occurrence of a reversal, as well as to trade short-term regional climaxes.

For the next eight weeks, the simulation will be initiated following the trading strategy determined above. Each transaction will be documented for analysis. The simulation will include weekly portfolio overviews, with the hypothetical initial investment of \$100k.. The goal of this simulation is to verify the effectiveness of the trading strategy developed with MACD and CCI, with corroborative data to support such strategy. From the simulation, I will also gain experience and learn the principles of trading stock.

3 COMPANY SELECTION

This chapter will provide an introduction of the companies that are selected for the simulation, with a brief statement of each company, its market size, and their past performance.

The simulation is designed to test the trading strategy comprehensively over a variety of company selections, for this lab purpose, I have chosen in total of eight different companies of different cap sizes. Table 3.1 below summarizes key characteristics of small, mid and large caps. The cap-size is determined by the net worth of the stock value, and it indicates the volatility of price and growth potential of a given stock, in which high volatility indicates higher risks and low stability. The volatility is also proportional to the growth potential. Typically a small-cap has more room for growth, whereas a large-cap has less room for stock growth, but due to its market size it tends to be more stable and less risky.

Small-cap describes stocks that have net worth from 250 million USD up to 2 billion USD with high volatility factor and high growth potential. A mid-cap describes companies that worth 2 billion USD up to 10 billion USD with intermediate volatility and growth potential. Large cap concludes stocks that worth 10 billion+ USD, and have less volatility and growth potential. For the section below, I have chosen companies that best describe all three cap-sizes.

Table 3.1 Market Capitalization

Cap Size	Value Range	Volatility	Growth Potential
Small-Cap	\$250M → \$2B	High	High
Mid-Cap	\$2B → \$10B	Intermediate	Intermediate
Large-Cap	\$10B +	Low	Low

I have specifically targeted a list of companies that have potential growth in 2018. Those companies are listed in table 3.1 below, the data is collected based on Feb 9, 2018.

Table 3.2 Company Selection for Advanced Simulation

#	Symbol	Name	Market Cap	Current Price	52-week High	52-week Low
1	BABA	Alibaba	453.3B (large)	\$176.6	\$206.2	\$100.1
2	SOXL	Direxion Daily Semiconduct Bull 3X ETF	721.1M (small)	\$133.4	\$187.4	\$66.1
3	MU	Micron Technology, Inc.	46.7B (large)	\$40.37	\$49.9	\$22.6
4	RAD	Rite Aid Corporation	2.1B (mid)	\$2.01	\$6.15	\$1.38
5	AMD	Advanced Micro Devices, Inc.	10.91B (large)	\$11.31	\$15.65	\$9.70
6	BIDU	Baidu, Inc.	74.8B (large)	\$215.67	\$274.97	\$166.00
7	RRC	Range Resources Corporation	3.104B (mid)	\$12.71	\$33.57	\$11.93
8	INCY	Incyte Corporation	17.83B (large)	\$84.50	\$153.15	\$80.85

3.1 BABA

Alibaba Group Holding Limited, through its subsidiaries, operates as an online and mobile commerce company in China and internationally. The company operates in four segments: Core Commerce, Cloud Computing, Digital Media and Entertainment, and Innovation Initiatives and Others. It operates Taobao Marketplace, a mobile commerce destination; Tmall, a third-party platform for brands and retailers.^[4] It is a large-cap technology stock of in total \$453.3B USD net worth. I chose this stock is mainly because of its outstanding earning report in the past year which led to its steady growth in 2017. As shown in Figure 3.1, except the 1st quarter earnings report where the actual earning barely reaches its estimation, the actual earning of all other three quarters of 2017 beat their estimations, at large by a factor of 30%. Therefore, I expect it to continue its steady growth in the year of 2018 with a relatively low risk factor.



Figure 3.1 BABA Earning Report 2017

3.2 SOXL

SOXL operates investment seeks daily investment results, before fees and expenses, of 300% of the daily performance of the PHLX Semiconductor Sector Index. The fund, under normal circumstances, invests at least 80% of its net assets (plus borrowing for investment purposes) in financial instruments that provide daily leveraged exposure to the index and/or exchange-traded funds ("ETFs") that track the index. The index measures the performance of domestic companies engaged in the design, distribution, manufacture and sale of semiconductors.^[5]

I have traded SOXL stock over the year of 2017, from which I have made over 80% profits. SOXL stock is a small-cap, thus it is highly volatile with high growth potential. According to Figure 3.2, the company had an increasing amount of investment return over the past few years. Therefore, it is chosen for the simulation with an expectation of growth for 2018.

Annual Total Return (%) History

Year	SOXL	Category
2017	141.55%	N/A
2016	123.30%	N/A
2015	-20.72%	N/A
2014	96.16%	11.70%
2013	155.14%	63.86%
2012	3.69%	30.50%
2011	-47.94%	-18.23%
2010	N/A	34.12%

Figure 3.2 Annual return of SOXL

3.3 MU

Micron Technology, Inc. provides semiconductor systems worldwide. The company operates through four segments: Compute and Networking Business Unit, Storage Business Unit, Mobile Business Unit, and Embedded Business Unit. It offers DDR3 and DDR4 DRAM products for computers, servers, networking devices, communications equipment, consumer electronics, automotive, and industrial applications, and etc. It has large amount of consumers that it conducts business with, and has a high reputation as a semiconductor manufacturer.

I have had trading experiences with it for 2017, from which I was able to make 50% profit. The reason that I chose MU is its high performance in earning reports over the four quarters of 2017, as shown in Figure 3.3, which directly indicates the strength and capability of the company. Figure 3.3 shows the earnings report of MU steadily increased over the course of 2017. Additionally, MU is a large-cap stock, therefore it is relatively more steady and less risky, at the same time its outstanding management and business will ensure its continuous growth in 2018.



Figure 3.3 MU Earning Report 2017

3.4 RAD

Rite Aid Corporation, through its subsidiaries, operates a chain of retail drugstores in the United States. The company operates through Retail Pharmacy and Pharmacy Services segments. The Retail Pharmacy segment sells prescription drugs; and a range of other merchandise, such as over-the-counter medications, health and beauty aids, personal care items, cosmetics, household items, food and beverages, greeting cards, seasonal merchandise, and other every-day and convenience products.^[6] The reason that I chose RAD is because its potential reversal in stock trend. For the past year of 2017, RAD stock has experienced a dramatic decline in stock price that brought the price from \$8.00 down to \$2.00. As shown in Figure 4.4, the price shows an exponential decay that showed tendency to slow down. A 50-day and a 120-day moving average are plotted with respect to the price. As shown in the lower right corner of Figure 3.4, the moving averages crossed and both dropped below the stock price, forming a support. Therefore, the stock is expected to have a reversal in stock trend in 2018.



Figure 3.4 RAD Price Chart 2017 Plotted with MA (50) and MA (120)

3.5 AMD

Advanced Micro Devices, Inc. operates as a semiconductor company worldwide. Its primarily offers x86 microprocessors as an accelerated processing unit (APU), chipsets, discrete graphics processing units (GPUs), and professional graphics; and server and embedded processors, and semi-custom System-on-Chip (SoC) products and technology for game consoles, and etc.^[7] AMD is also a large-cap company that had a significant growth during the year of 2017. It is another option for more steady low-return investment. Additionally, AMD is very suitable for short-term pattern trading, thus it is a good practice for oscillator indicator such as CCI, as well as trend indicator MACD. Figure 3.5 below shows several buy and sell patterns of AMD for 2017.

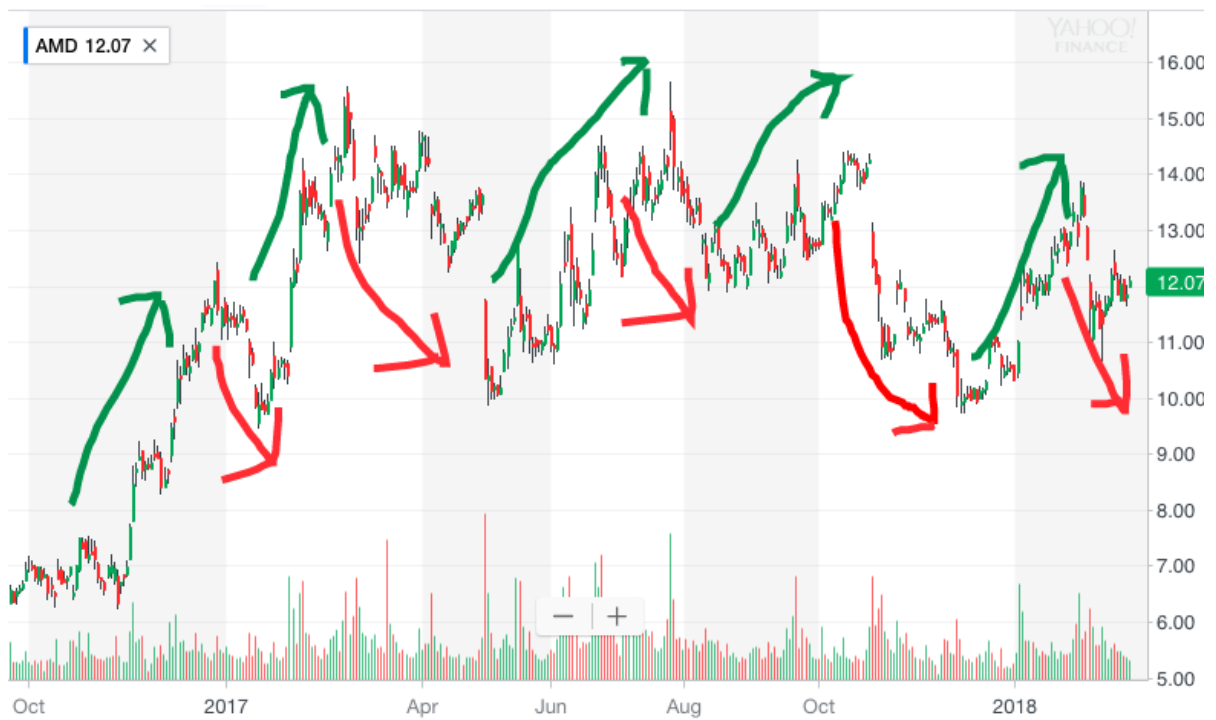


Figure 3.5 AMD Price Chart of 2017

3.6 BIDU

Baidu, Inc. provides Internet search services in China and internationally. It operates through three segments: Search Services, Transaction Services, and IQiyi. It offers Chinese language search platform on its Baidu.com Website that enables users to find relevant information online, including Web pages, news, images, documents, and multimedia files through links provided on its Website; and transaction platform, including Nuomi.com to connect online and offline services provided by third-parties.^[8] [

Baidu is large-cap company that showed steady growth over the past few years, with increasing annual revenue, indicating its strength and potential to continue in its growth trend. According to Figure 3.6, the quarterly earnings reports of 2017 consistently beat their estimated numbers, therefore, BIDU is expected to have potential growth in 2018.



Figure 3.6 Baidu Earning Report and Annual Revenue

3.7 RRC

Range Resources (RRC) is an independent natural gas and oil company, one of the most active drillers in Pennsylvania, including Marcellus Shale. According to analysts, it is expected to have an growth of +85.4% for the year 2018.^[9] RRC is a mid-cap company with a market cap of \$3.28B. The current and previous trend of RRC showed a continuous decline for over the past two years (2016 and 2017) and expected to see a reversal in trend direction in 2018. As shown in Figure 3.7, the stock price has dramatically dropped from a previous high of \$45.00 all the way down to the current low of \$12.00. However, the 50-day moving average and 120-day moving average are still above the current stock price and, “compressing” the price. It also indicates that the current down-trend has not yet reached its bottom. Therefore, I have taken it into consideration, and waits for the good opportunity to buy-in.



Figure 3.7 RRC Stock Price of 2-years with MA (50) and MA (120)

3.8 INCY

Incyte (INCY) is a large-cap biotech firm that engages in discovery, development and sale of drugs, including profitable JAKAFI, a treatment for patients with myelofibrosis, a rare bone marrow disorder. Recent stock drop to a 52-week low marks good entry point for company given its robust drug pipeline. Its historical price over 2 years are shown in Figure 3.8 below. Additionally, stock analysts also suggested a potential growth of INCY in the year of 2018. Buy-in opportunities will be determined with the indicators CCI and MACD.



Figure 3.8 INCY Price Chart of 2 Years

4 SIMULATION

This chapter includes the 8-week stock trading simulation conducted with an initial investment of 100,000 USD. Weekly trading activities, explanations and discussions on the transaction details and portfolio overview are provided.

4.1 Week 1

4.1.1 Trading Activities

Table 4.1 recorded the three trading activities that I have made on Feb 12. Since the beginning of Feb 2018, the Stock market as a whole entered a downtrend. Both Dow Jones and Nasdaq indicators have decreased in value by roughly 20%, therefore creating a good buy-in opportunity. Three stocks have been purchased at equivalent costs of \$20k each to lower the risks, which are SOXL, AMD, and RAD. The total cash available after the trading is \$34,999.5.

Table 4.1 List of Trading Activity of Week Feb 11

Date	Symbol	buy/ sell	Price	Shares	Net Cost/ Proceeds	Profit/Loss	Total Cash	Total Profit
02/12/18							100000	
02/12/18	SOXL	buy	141.61	150	-21241.5		78758.5	0
02/12/18	AMD	buy	11.72	2000	-23440		55318.5	0
02/12/18	RAD	buy	2.03	10000	-20300		35018.5	0

4.1.2 Activity Details

Figure 4.1 shows the stock price of SOXL plotted with 14-day CCI indicator and a MACD indicator for a three month period. The SOXL stock has entered a downtrend since Jan 21st, and the price dropped from around \$180.00 to a low of \$140.00. The highlighted section of CCI values from the Feb 1st till Feb 12 shows a negative volume below -100, indicating an oversold. Relatively, the MACD indicator is showing the tendency to crossover, which has a potential to turn into a buy signal. Therefore, an analysis for oversold can be concluded, and a purchase of SOXL stock has been made on Feb 12 of equivalent price \$20k.



Figure 4.1 SOXL Buy-signal Analysis

Figure 4.2 below shows the stock price of AMD plotted with a 14-day CCI value and MACD(12,26,9) indicator. The highlighted CCI shows a signal for oversold around Feb 12. This is also a result from the Feb downtrend of 2018. Similar to SOXL, the CCI showed an oversold signal, but the MACD did not. However, the MACD shows slight tendency for a crossover buy-signal in the short future. Therefore, a purchase was made on Feb 12, 2018.



Figure 4.2 AMD Buy-signal Analysis

In Figure 4.3 below, the 14-day CCI value has dropped below -100, indicating a market oversold for the stock RAD. Additionally, the MACD indicator also shows tendency of convergence in a short future. The stock has dropped from a previous high of \$2.30 to a low of \$2.00. As a conclusion, a buy-in decision was made on Feb 12 at the low of \$2.00.



Figure 4.3 RAD Buy-signal Analysis

4.1.3 Portfolio Overview

Figure 4.4 below shows a plot of gain of total assets (purple) overview vs. that of SPY (blue) index for the past month. The percentage gain of total assets is calculated by subtracting the initial assets of \$100,000 from the total assets of portfolio at a given time, then divide the difference by the initial \$100,000. This can be shown by equation 4.1.

$$\%gain = \frac{networth - initial}{initial} \times 100\% \quad (4.1)$$

The purchases were made on Feb 12, since then the portfolio fluctuates as price changes. Until the market close of Feb 16 2018, the total assets has gained 3.23%.

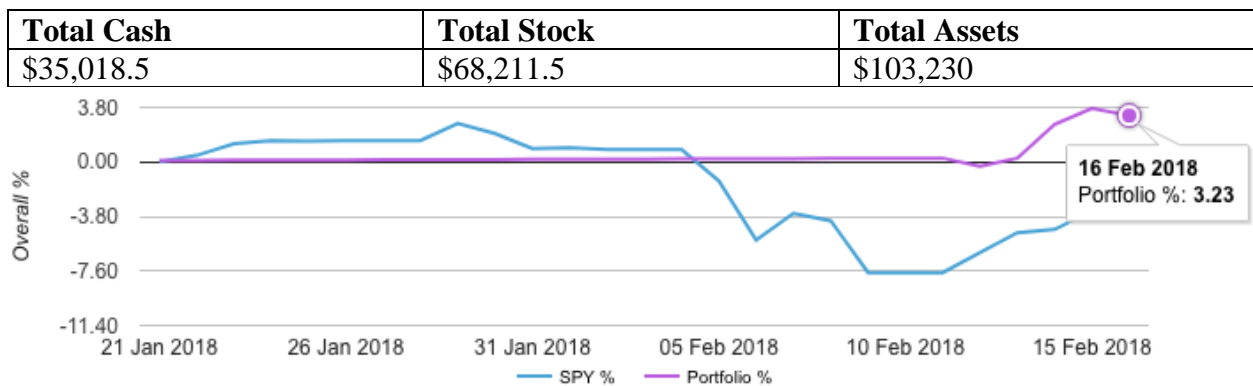


Figure 4.4 Portfolio Overview of Week 1

4.1.4 Weekly Analysis & Conclusion

Based on the overview of portfolio, the buy-in decisions were accurately predicted with the use of CCI and MACD indicator. A total investment of roughly \$60k were made, with \$40k remaining as cash. As a result, the gain of total assets achieved 3.23%, which is a satisfactory result. For the next week, I will keep watching out for new buy-in opportunities, as well as sell signals for stock that have been purchased.

4.2 Week 2

4.2.1 Trading Activities

There is no trading activities for this week, as the stocks purchased from last week did not show clear signals of overbought, as well as other stocks did not show good buy-in opportunities.

4.2.2 Activity Details

Figure 4.5 shows the RAD price plotted with CCI and MACD indicators. RAD has increased from the buy-in price of \$2.03 to a current price of \$2.09, resulting in an investment return of 2.96%. The CCI indicator showed a small spike on Feb 20, however, this is disregarded due to the fluctuation nature of CCI. On the contrary, the MACD showed a tendency of unclear buy-in signal. As a conclusion, the sell signal is yet to come. Figure 4.6 plots the AMD stock price vs MACD and CCI indicators. According to Figure 4.6, the CCI did not show a sell-signal, and the MACD showed a tendency for incoming buy-signal. Shortly after the purchase of SOXL stock, which is shown in Figure 4.7, the MACD indicator showed buy-signal, with CCI idle. Therefore, a decision was made to keep all three stocks for now.



Figure 4.5 RAD with MACD (12,26,9) and CCI (14)



Figure 4.6 AMD with MACD (12,26,9) and CCI (14)



Figure 4.7 SOXL with MACD (12,26,9) and CCI (14)

4.2.3 Portfolio Overview

Figure 4.8 below summarizes the profile overview until the market close on Friday, Feb 23. The total assets has reached a new high of %5.00. Comparing to the result of the previous week, 3.23%, the portfolio slightly increased by 2.00%.

Total Cash	Total Stock	Total Assets
\$35,018.5	\$70,151.5	\$105,170

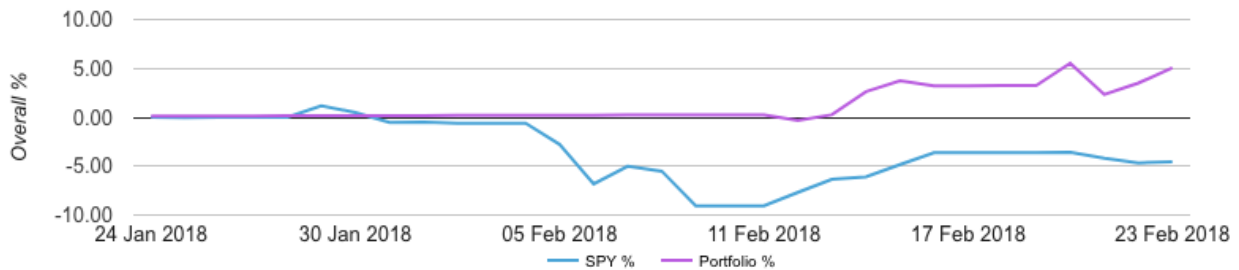


Figure 4.8 Portfolio Overview of Week 2

4.3 Week 3

4.3.1 Trading Activities

For the week of Feb 25, previously invested stocks, including RAD, SOXL and AMD, all reached points of overbought and turned into downtrends, as predicted by CCI and MACD indicators. Overall, the entire stock market have experienced a loss on average, as characterized by Dow Jones down by 4.00% and Nasdaq down by 2.00%. Therefore, I have sold the RAD, SOXL and AMD at the overbought, with each gained moderate amount of profit since the initial investments were made.

Table 4.2 List of Trading Activity of Week Feb 25

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
02/27/18	RRC	buy	13.58	2000	-27160		7858.5	
02/27/18	RAD	sell	2.05	10000	20500	200	28358.5	200
02/27/18	SOXL	sell	177.14	150	26571	5329.5	54929.5	5529.5
03/02/18	AMD	sell	11.46	2000	22920	-520	77849.5	5009.5
03/02/18	INCY	buy	86	350	-30100		47749.5	5009.5

4.3.2 Activity Details

The first transaction is the purchase of RRC. As shown in Figure 4.9, the MACD (12,26,9) indicator plotted with respect to RRC stock price has crossed above the signal line, indicating an oversold. Therefore, an amount of 2000 shares of RRC were purchased on Feb 27 at the price of \$13.58 per share, resulting in a net cost of \$27,160. The 14-day CCI indicator shows a slight chance of oversold as its value breached above +100 towards the end of this week. Therefore, for the next week, I will keep track of the CCI indicator, and make sell decisions accordingly.



Figure 4.9 RRC Trading Detail of Week Feb 25

The second transaction of this week is the sale of RAD. Initially, in total of 10,000 shares of RAD were purchased at \$2.03 per share, because of the oversold predicted by the CCI. On Feb 27 the indicators have predicted a trend reversal, as the CCI indicator breached above +100, followed by the MACD crossing below the signal line. It is safe to conclude that the trend reversal will occur very shortly with certainty. Therefore, I have sold RAD and were able to obtain a profit of \$200 US dollars, as shown in Figure 4.10 below.

At the end of week of Feb 25, the CCI indicator once again dropped below -100, indicating a potential oversold. If the CCI value were able to converge back to -100 and form an enclosed area below the -100 trigger line, an overbought can be expected. As a conclusion, I will reinvest into RAD possibly sometime next week.



Figure 4.10 RAD Trading Detail of Week Feb 25

The initial investment of 150 shares of SOXL were purchased on Feb 12 at a price of \$141.61, as the 14-day CCI formed an oversold signal below the -100 trigger line. According to Figure 4.11, the stock price then continued to increase as expected until the occurrence of a trend reversal. This

is also predicted by the CCI indicator, as its value breached +100 trigger line then converged at the line. As a result, I have sold all 150 shares of SOXL at the overbought price \$177.14. From which I made a profit of \$5329.50, roughly 25.00%. This is the most significant gain among all investments so far, as the CCI indicator closely resembles the trend reversals.



Figure 4.11 SOXL Trading Detail of Week Feb 25

The fourth transaction this week is the sale of AMD on Mar 2nd at a price of \$11.46. The initial investment were made at \$11.72 per share, as the CCI indicator predicted an oversold on Feb 12th. The indicator then showed an overbought signal on Feb 27th, therefore, I have sold the stock. However, the investment experienced a net loss of \$-520.00. According to Figure 4.12, the CCI then continued to decrease until the market close on Friday Mar 2nd, reaching the -100 oversold trigger line. Likely another investment in AMD will be made next week, depending on the performance of the overall stock market and the two stock indicators.



Figure 4.12 AMD Trading Detail of Week Feb 25

Last, an investment of INCY was made on Mar 2nd of a total amount of \$30,100. This decision was made for two reasons, first MACD signal has emerged from its trigger line, indicating a potential growth, second the CCI indicator formed a convergence area below -100, also indicating an oversold, as shown in Figure 4.13.



Figure 4.13 INCY Trading Detail of Week Feb 25

4.3.3 Portfolio Overview

According to Figure 4.14, since the first investment on Feb 12 the portfolio has increased in total assets by nearly 7.23% from its initial value of \$100,000. This proves that the trading strategy used so far is very successful.

Total Cash	Total Stock	Total Assets
\$47,749.5	\$59,480.5	\$107,230

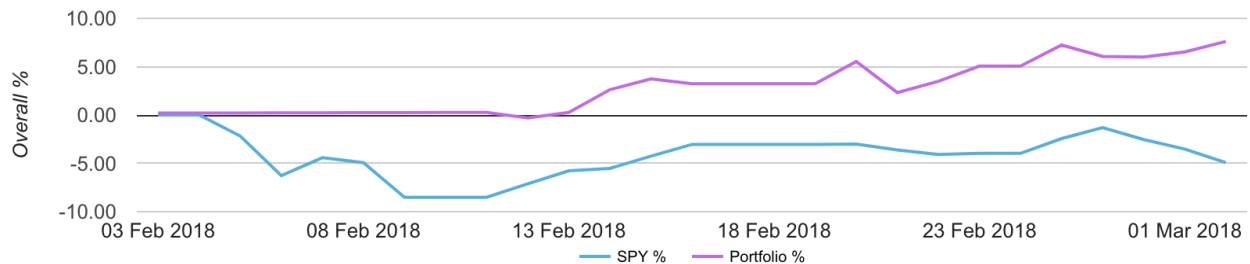


Figure 4.14 Portfolio Overview of Week 3

4.3.4 Weekly Analysis & Conclusion

The portfolio overview shows a positive eight percent in return shows the accuracy of the predictions made by CCI and MACD, therefore, there will not be any significant changes to the current trading strategy. As the doubt of stock that has been currently growing on social media and over the news, I will be more careful in terms of monitoring the trends and making predictions of the market. As discussed previously, there are some incoming buy-in chances that are expected to occur in the next week, as well as sell signals for RRC and INCY.

4.4 Week 4

4.4.1 Trading Activities

This week is the fourth week of simulation, during which the tech stock index, NASDAQ, has retrieved a 10% gain after the tumble of the third week. As the NASDAQ index continuously increased throughout the week, most stocks have signaled an incoming overbought. For this reason, I converted all stocks back to cash and made \$11,223.00 profit so far. For the next week, I will wait for the next buy-in opportunity signaled by CCI and MACD.

Table 4.3 List of Trading Activity of Week Mar 3

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
Previous week							47749.5	5009.5
03/08/2018	RRC	sell	15.25	2000	30,500	3,340	78,249.50	8,350
03/09/2018	INCY	sell	94.21	350	32,973.50	2,873.50	111,223.00	11,223

4.4.2 Activity Details

The first trade I made this week is to sell RRC stock. According to Figure 4.15 below, the stock was first purchased at an oversold price of \$13.58 per share, on Feb 27th. Until Mar 8th, RRC has entered an up-trend and the stock price is brought up to \$15.25 per share. As shown in Figure 4.15, the 14-day CCI breached the +100 line and almost converged at the line, which was a signal of overbought. As a result, I sold all RRC, and made a 12.3% profit from this single investment, which is equivalent to \$3,340.



Figure 4.15 RRC Trading Detail of Week Mar 3

The second trade of this week was to sell the INCY stock. Figure 4.16 shows the buy-in date and sell date, as well as the CCI indicator. This investment was originally purchased on Mar 2nd when the CCI indicator converged a closed-area under -100 “oversold” signal line. The average cost was \$86.00 per share. The stock then entered an up-trend as predicted by the CCI indicator. As the stock continued to grow throughout the week, the value of CCI soon breached +100 signal line, which could indicate the potential of a reversal in trend direction. Due to this reason, I sold all INCY stock on Mar 9th, at a price of \$94.21 per share. The profit gained from this investment in total is \$2,873.50, approximately 9.5% return.



Figure 4.16 INCY Trading Detail of Week Mar 3

4.4.3 Portfolio Overview

Figure 4.17 shows the portfolio overview until the end of week 4. The investments made so far were all successful, resulted in a net gain of 11.49% of the initial \$100,000, equivalent to \$11,223, which beat the net gain of NASDAQ index by approximately 0.5%.

Total Cash	Total Stock	Total Assets
\$111,223	\$0	\$111,223

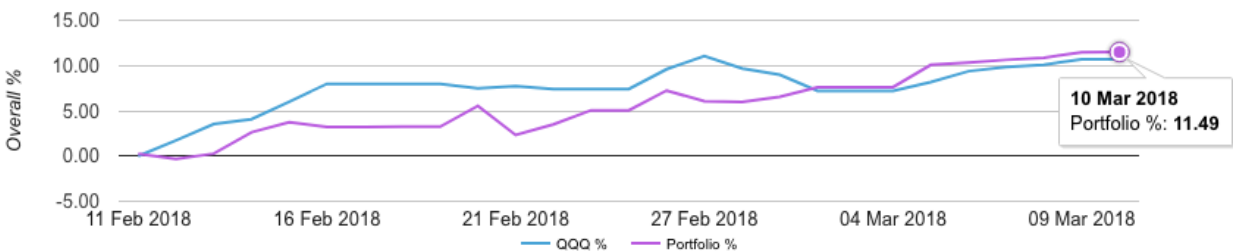


Figure 4.17 Portfolio Overview of Week 4

4.4.4 Weekly Analysis & Conclusion

Until this point, all the trades made in simulation precisely followed the trading strategy determined in chapter 3, which was buy in at “oversold” signals and sell out at “overbought” signals produced by CCI and MACD. So far, the MACD has not yet showed a good indication of trend reversals, because most of the time the MACD showed an ambiguous crossover at the signal line, whereas the CCI indicator clearly marked the reversals.

In chapter 3, the goal is set to achieve a 20%+ profit by the end of the 10-week simulation. Relatively, the portfolio has already achieved 11.29% prior to the mid time. Therefore, I will not change the trading strategy, and I can expect a 30%+ net return by the end.

4.5 Week 5

4.5.1 Trading Activity

This week is the fifth week of simulation, during which the market as a whole experienced a correction throughout the week. This downtrend can be characterized by the Dow Jones (DJI) index dropping 400 points, and the NASDAQ (IXIC) index dropping 200 points. DJI is a cumulative index for industrial stocks, therefore it characterizes the average of stocks in the market. On the other hand, The NASDAQ characterizes the average trend for tech stocks. According to Figure 4.18 and Figure 4.19, DJI index dropped approximately -1.6%, with both MACD indicator and CCI indicator signaling overbought, whereas the IXIC index dropped roughly -1.99% throughout the week.

As a result, all of the companies selected for simulation experienced different level of corrections. There were no obvious buy-in opportunities presented as the market continued in its previous downtrend. Table 4.4 shows the trades conducted this week, which are the buys and sells

of RAD. There are some mistakes made for this week, because of my misinterpretation of CCI and MACD predictions.

Table 4.4 List of Trading Activity of Week Mar 11

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
03/14/2018	RAD	buy	1.73	20000	-34,600		76,623.00	11,223
03/15/2018	RAD	sell	1.64	18000	29,520		106,143.00	11,223
03/15/2018	RAD	buy	1.67	18000	-30,060	-540	76,083.00	10,683



Figure 4.18 Dow Jones Index of Week Mar 11



Figure 4.19 NASDAQ Index of Week Mar 11

4.5.2 Activity Details

Figure 4.20 shows the price of RAD with 20-day CCI and MACD indicators plotted respectively. On mar 14th, the CCI indicator has climbed up and showed a tendency of crossing above the 100 signal line. Therefore, I assumed that the trend was approaching a reversal, even though the MACD has not yet shown a clear buy-in signal. Frankly, this was a mistake as the trend continued to decline later this week. On Mar 15th, the CCI continued to decrease and showed no tendency of converging at -100 signal line, which meant that the reversal in direction was yet premature. As a result, I sold 80% of stocks purchased on the previous day. Then I realized the CCI would converge and give the buy-signal soon after, so I reinvested the initial amount.



Figure 4.20 RAD Buy-signal Analysis

4.5.3 Portfolio Overview

Figure 4.21 shows the portfolio overview of this week. The overall gain of total assets has decreased from its previous high of 11% down to 8.56% by the end of this week. This is because of the mistakes made this week of misinterpreting stock indicators.

Total Cash	Total Stock	Total Assets
\$76,083	\$32,477	\$108,560

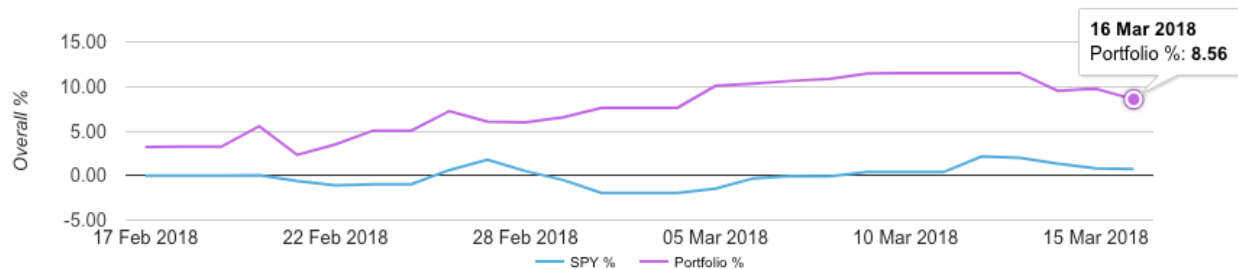


Figure 4.21 Portfolio Overview of Week 5

4.5.4 Weekly Analysis & Conclusion

This week the stock market experienced a general decline, and the portfolio has decreased by 3.00%, resulted from immature assumptions prior to the occurrence of actual signals. As an important lesson learned, in future simulation I have to wait for the buy and sell signals to complete prior to making trading decision, this will help avoid unnecessary lost.

4.6 Week 6

The claim made by Donald Trump on Tuesday about initiating the trade war against China has showed its major impact not only in escalating the political tension between the two superpowers, but also in striking the US economy. As the stock market tumbled down throughout this week, both Dow Jones and NASDAQ indexes did not hold their grounds. According to Figure 4.22, Dow Jones index, has dramatically fallen down by 1000 points to \$23,553, a 3-month low.



Figure 4.22 Dow Jones Index of Mar 18, 2018

Relatively, Figure 4.23 shows that the NASDAQ index was slammed down by 1400 points, breached below \$7000 points to a 1-month low. Both of those indexes signaled an ominous forecast towards the future trends. This could potentially mean that the 7-year blooming economy since Obama has officially ended. The stock market is now suspended at a very critical position of 7-year all-time high. This specifically makes all future investments much more riskier. With even a minor miss maneuver, the economy might turn into a hazard such as the one in 2008.



Figure 4.23 NASDAQ Index of Week Mar 18, 2018

4.6.1 Trading Activities

The table 4.5 summarizes trades made during this week. As discussed previously, the tumble of US stock market has made difficult to determine the future trends, and as a result I have made several mistakes in trading that cost major decline of profit. There was no good buy-in opportunity as of this week.

Table 4.5 List of Trading Activity of Week Mar 18

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
3/19/18	AMD	Buy	11.44	2600	-29,744		46,339.00	10,683
3/22/18	AMD	Sell	10.96	2600	28,496	-1,248	74,835.00	9,435
3/22/18	RAD	Buy	1.52	20000	-30,400		44,435.00	9,435

4.6.2 Activity Details

Last week, an investment of AMD stocks was made due to the miss-signal of CCI. As shown in Figure 4.24 below, the CCI has converged at Mar 16, and gave a misleading oversold signal, which caused me to buy in on Mar 19. However, soon after the signal was completed the stock did not show a tendency of up-trend, instead the CCI continued to breach -100, whereas the MACD indicator diverged even more. This signaled that the stock is still in the process of declining, and has not yet reached an oversold. As a result, I sold the stocks immediately on Mar 22nd, in order to minimize the loss.



Figure 4.24 AMD Analysis with CCI and MACD

Figure 4.25 shows the stock RAD plotted with MACD and CCI indicators. As observed, the RAD continued to decline for the last month, and recently reached a previous low of \$1.50 per share. On Mar 21st, the CCI indicator converged at -100, meaning that this could be a potential oversold. As a result, I bought 20,000 shares of RAD on Mar 22nd. This transaction, however, had the same ideology as “double up” in playing blackjack. Which is to invest more money due to a seemingly probable return.



Figure 4.25 RAD Analysis with CCI and MACD

4.6.3 Portfolio Overview

Due to the decline of the entire stock market, the gain of total assets declined from the previous 11% down to 4.31% as of this week. However, the portfolio still outperformed the SPY index by a small difference.

Total Cash	Total Stock	Total Assets
\$44,435	\$59,875	\$104,310

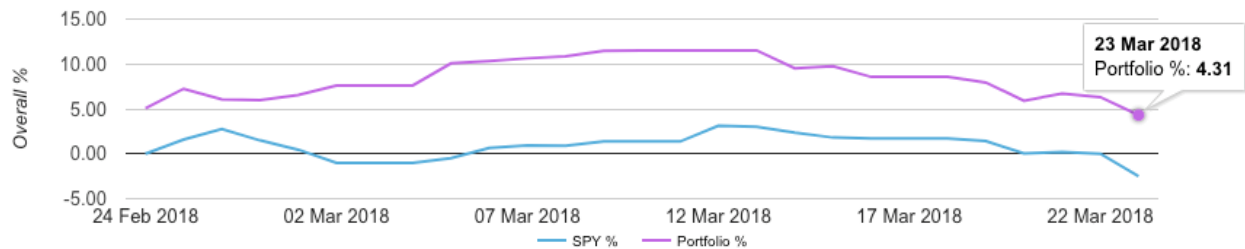


Figure 4.26 Portfolio Overview of Week 6

4.6.4 Weekly Analysis & Conclusion

I did not make a significant amount of trades this week due to the tumble of stock market, which also resulted in loss of profit. I believe at this point, actions must be taken to re-evaluate the stock market and to determine the future trends. As the stock market continue to decline, it is likely that the portfolio might break-even, or eventually start losing. After all, when the big indexes tumble and the stock market falls, there will be no exception or luck in any stocks.

4.7 Midterm Analysis – Week 7

This is the seventh week of simulation, and so far no new investments were made this week. As the simulation process has elapsed over half of its course, this subchapter is dedicated to sum up the trading investments so far, as well as to provide a comprehensive midterm simulation analysis.

4.7.1 Portfolio Overview

According to Figure 4.27, the gain of total assets recorded at Mar 30th was 11.94%, as it recovered from the previous low of 4.31%. This is mostly due to the only stock holding of RAD. As discussed previously, the RAD continued to fall through out week 6, and reversed trend direction on Mar 27th and continued in an up-trend.

Total Cash	Total Stock	Total Assets
\$44,435	\$67,505	\$111,940

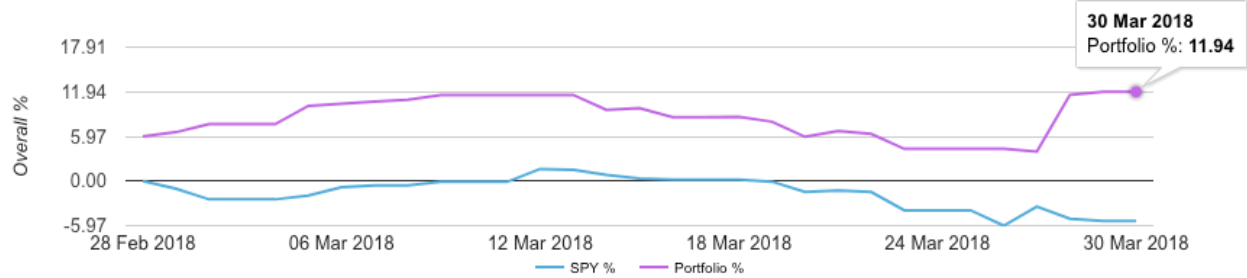


Figure 4.27 Portfolio Overview of Week 7

4.7.2 Trading History

Table 4.6 shows the daily trading activities starting from Feb 12th, until the day when the last trade was made, Mar 22nd. All trades were based on the buy and sell principle determined in previous chapter, that is, using CCI convergence signals combined with MACD crossover signals to determine overbought and oversold. Among those trades, most of them were profitable, with few exceptions. This means that the trading principle is not flawless. Additionally, an important lesson is that the influence of the entire stock market as a whole cannot be neglected. When the big market falls, everyone losses.

Table 4.6 Midterm Trading History

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
02/12/18							100,000.00	0
02/12/18	SOXL	buy	141.61	150	-21,241.50		78,758.50	0
02/12/18	AMD	buy	11.72	2000	-23,440		55,318.50	0
02/12/18	RAD	buy	2.03	10000	-20,300		35,018.50	0
02/27/18	RRC	buy	13.58	2000	-27,160		7,858.50	0
02/27/18	RAD	sell	2.05	10000	20,500	200	28,358.50	200
02/27/18	SOXL	sell	177.14	150	26,571	5,330	54,929.50	5,530
03/02/18	AMD	sell	11.46	2000	22,920	-520	77,849.50	5,010
03/02/18	INCY	buy	86	350	-30,100		47,749.50	5,010
03/08/18	RRC	sell	15.25	2000	30,500	3,340	78,249.50	8,350
03/09/18	INCY	sell	94.21	350	32,973.50	2,873.50	111,223.00	11,223
03/14/18	RAD	buy	1.73	20000	-34,600		76,623.00	11,223
03/15/18	RAD	sell	1.64	18000	29,520		106,143.00	11,223
03/15/18	RAD	buy	1.67	18000	-30,060	-540	76,083.00	10,683
03/19/18	AMD	Buy	11.44	2600	-29,744		46,339.00	10,683
03/22/18	AMD	Sell	10.96	2600	28,496	-1,248	74,835.00	9,435
03/22/18	RAD	Buy	1.52	20000	-30,400		44,435.00	9,435

4.7.3 Gain and Loss Analysis

The table 4.7 shows a list of complete investments, that means it records the investments that were bought and then sold for cash, categorized by Stock symbols. Then the information including price bought, price sold, shares owned and total profit was recorded for each complete investment. This is to better analyze what triggered each buy and sell decisions, and to gain understanding of the performance of buy and sell indicators case by case.

As shown in table 4.7, in total of six complete trades were made during this period of time, that is six purchases and six sales (this does not include the stocks that were purchased and still holding). Four out of six investments are profitable, whereas the other two are not.

Table 4.7 List of Investments (buy and sell)

Investments	Holding Period	Symbol	Shares	Price Bought	Price Sold	Profit
1	02/12 - 02/27	SOXL	150	141.61	177.14	5,330.00
2	02/12 - 03/02	AMD	2000	11.72	11.46	-520
3	02/12 - 02/27	RAD	10000	2.03	2.05	200
4	02/27 - 03/08	RRC	2000	13.58	15.25	3,340.00
5	03/02 - 03/09	INCY	350	86	94.21	2,873.50
6	03/19 - 03/22	AMD	2600	11.44	10.96	-1,248

The first trade, dated on Feb 12th until Feb 27th, was an investment in SOXL of 150 shares purchased at \$141.61 per share and sold at \$177.14 per share, in total this trade gained \$5,330 profit. According to Figure 4.28, the buy-decision was made with reference to the CCI oversold signal occurred on Feb 12th, and the sell-decision was then made on 27th because of CCI overbought signal. During this period of time, the MACD only indicated a buy signal. The actual overbought occurred much later than the sell date, as the price continued to go up after I sold the stock, which means if I waited for the MACD signal the profit would have been further increased. However, comparatively the CCI indicator gives more immediate response, whereas the MACD gives signals with some delay.



Figure 4.28 Investment-1: SOXL

Figure 4.29 shows the second investment made in AMD, which was a unprofitable investment of 2000 shares purchased at \$11.72 per share and sold at \$11.46 per share, lost in total of \$520. The buy and sell decisions were made according to CCI buy and sell signals, whereas the MACD predicted a continuous downtrend. As a conclusion, it is a mistake to ignore the MACD signal.



Figure 4.29 Investment-2: AMD

Figure 4.30 shows the third investment made in RAD with a profit of \$200. The stock was purchased on Feb 12th and sold on Feb 27th. According to Figure 4.30, the price peaked and reversed into a downtrend around Feb 20th, on which I should have sold the stock to make better profit. As a conclusion, this mistake is due to lack of immediate response to the CCI sell signal. Additionally, the MACD indicator performed poorly and did not show a clear signal during this period of time.



Figure 4.30 Investment-3: RAD

Figure 4.31 shows a profitable investment of 2000 shares of RRC. The stock was purchased at \$13.28 per share and sold on \$15.25 per share, obtained in total of \$3,340 profit. Both CCI and MACD indicator showed clear buy and sell signals, with CCI sending signals sooner than MACD. The buy decision was made after both CCI and MACD showed oversold signal. However, the best buy date of the stock was right after the CCI oversold signal, which would extend the profit further more. This investment once again, proved that the CCI gives more immediate signals than MACD.



Figure 4.31 Investment-4: RRC

Figure 4.32 shows the fifth investment of INCY, first purchased on Mar 2nd and then sold on Mar 9th. This time, the MACD signal clearly showed a lag in both buy and sell signals. Relatively, the CCI signal was much more accurate. The buy-decision was made right after the CCI oversold signal, and sell-decision was made after CCI overbought signal.



Figure 4.32 Investment-5: INCY

The sixth investment was a mistake that cost a loss of \$1,248 in profit. I decided to buy in AMD on Mar 19th but immediately sold on Mar 22nd. As shown in Figure 4.33, the CCI showed a false oversold signal on the 17th, and then continued to decrease which meant that the downtrend was not finished yet. The mistake of the buy-decision was caused by ignoring the MACD signal. As shown in Figure 4.33, the MACD continues to diverge, meaning that there was no indication of trend reversal. However, the loss was minimized by realizing the mistake and making the right decision immediately. As a result, I have to not only look at CCI indicator, but also to take MACD indicator into consideration.



Figure 4.33 Investment-6: AMD

4.7.4 Future Investment Opportunities

Figure 4.34 and 4.35 each shows the stock analysis with CCI and MACD indicators of BIDU and AMD. Both of those stocks have the potentials to embrace a bounce-back in the near future. As the stock market continued to fall throughout the last week, BIDU has hit its previous low and the CCI indicator has approached the -100 oversold signal line. Similarly, the AMD has fallen dramatically throughout the previous weeks and potentially hit its trend reversal. Therefore, I will wait until the signal of MACD for both of those stocks and make corresponding buy-decisions.



Figure 4.34 BIDU



Figure 4.35 AMD

4.7.5 Conclusion

As a conclusion for the midterm simulation analysis, some mistakes were made due to ignoring MACD, as well as the influence of the entire stock market. Therefore, in future simulations, the tendency of making decision only regarding to CCI indicator needs to be changed in order to minimize losses and maximize profits. The trading strategy developed so far does not need to be changed.

4.8 Week 8

This is the eighth week of simulation, and I used approximately 97.50% of total buy power, leaving about 2.5% money capital in cash. This allows the portfolio to trade at its full potential. The stock market crashed dramatically in the past few weeks as the direct result of the trade war between USA and CHN, and ongoing tariffs. However, I also believe that a decline with such dramatic amplitude could also engender the rise of bounce-back. The following subchapters discusses the trading details of this week.

4.8.1 Trading Activities

Table 4.8 shows a list of trading activities of week 8. The total cash available by the end of this week was \$2,526.40. The RAD investment was sold to free up some money capital to spend elsewhere. This is mostly because the investment in RAD weighs a significant portion of total money capital, and the fact that it does not seem to have the immediate tendency to bounce back anytime soon. Comparatively, there were other stocks that had better opportunities, but the money was tied to RAD. Therefore, the RAD was sold with a loss for the optimized outcome.

Table 4.8 List of Trading Activities of Week 8

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
04/03/18	QD	buy	11.86	2,600	-30,836.00		13,599.00	9,435
04/03/18	TSLA	buy	270.97	50	-13,548.50		50.50	9,435
04/04/18	RAD	sell	1.61	40,000	63,590.00	-1,410.00	63,640.50	8,025
04/05/18	SOXL	buy	135.18	230	-30,312.50		33,328.00	8,025
04/06/18	BIDU	buy	225.74	140	-30,801.60		2,526.40	8,025

4.8.2 Activity Details

The first trade of this week was the purchase of 2600 shares of QD stock at the price of \$11.86 per share. This transaction cost in total of 30,836 USD. Figure 4.36 below shows the buy signal analysis, according to which the decision was made. On the bottom of Figure 4.36, the value of 14-day CCI indicator converged at the -100 signal line on Apr 1st to complete an oversold signal.

Additionally, the MACD indicator also showed tendency of crossing over, as the gap between the MACD (in purple) and the signal line (in orange) reduced. The previous dramatic decline of QD lasted for approximately three weeks, and slowly began to reduce in slope, which could indicate a potential reversal in trend.



Figure 4.36 QD Buy Signal Analysis

The second trade activity was the purchase of TSLA. TSLA had an outstanding return in the year of 2017. As the stock continuously reaching new highs, TSLA eventually overtook the title of the largest automobile company in the US, from its predecessor, Ford. Due to the recent, TSLA has fallen 30% at worst and created new buy-in opportunity. According to Figure 4.37. the MACD indicator crossed over on Apr 5th, signaling an oversold. ON Apr 3rd, the CCI indicator converged at -100 signal line, again, signaling an oversold. Therefore, this creates the ideal buy-in opportunity. In total of 50 shares were purchased at the price of \$270.97 per share.



Figure 4.37 TSLA Buy Signal Analysis

The RAD stocks were sold with a loss. Figure 4.38 below shows the stock price of RAD with MACD and CCI plotted, additionally 50-day (in purple) and 120-day (in green) moving averages were plotted with the price. As noted in the top right corner of Figure 4.38, the previous 50-day MA crossed below 120-day MA, which means the previous crossover (50-day above 12-day) was inefficient, and both of those MAs were unable to form a support to the stock price. “Support” means that the stock price does not break below the moving average line. Therefore, the moving average visually looks like it is “supporting” the stock price. This could only mean that RAD is dangerous and unpredictable right now, regardless of MACD and CCI buy signals. As a result, I sold RAD due to the ominous prediction, and used the money to invest elsewhere.



Figure 4.38 RAD Sell Signal Analysis

I then used the money to invest in SOXL and BIDU. Those two stocks were falling previously as the market fell, both of whom, were brought down by significant percentage to potential trend reversals.

According to Figure 4.39, the SOXL price has reached the 240-day (annual) MA, and the annual MA successfully formed support. The 14-day CCI indicated a buy-signal as noted in the bottom right of Figure 4.39. Even though MACD not yet showed oversold signal, judging from its previous oversold signals approximation (dotted line), an soon-to-occur oversold can be expected.

According to Figure 4.40, BIDU was down 80 points from the previous decline, and formed a solid support with its annual moving average, similar to that of SOXL. The CCI showed an oversold signal at the end of March, with its value crossing above -100 signal line. Its MACD value closely resembles similar traits to that of SOXL. If a straight line is drawn to cover its previous buy-signals, the current value of MACD falls right on the line, that means the MACD is ready to give a buy-signal. As a result, I invested equivalent amount of capital in SOXL and BIDU.



Figure 4.39 SOXL Buy Signal Analysis



Figure 4.40 BIDU Buy Signal Analysis

4.8.3 Portfolio Overview

As shown in Figure 4.41, the portfolio (in purple) was roughly down by 2.00% to an overall 8.16% gain this week, comparing to SPY index (in blue), which also dropped by roughly 2% of the reference on Mar 07th.

Total Cash	Total Stock	Total Assets
\$2,526.40	\$105,633.6	\$108,160

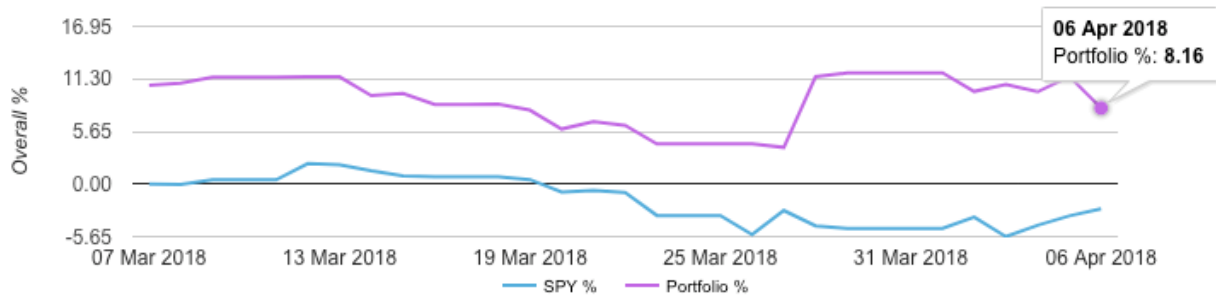


Figure 4.41 Portfolio Overview of Week 8

4.8.4 Weekly Analysis & Conclusion

This week the portfolio did not experience any significant gain or loss, instead it was somewhat stable for the past few weeks. Some minor changes including selling RAD to free up the money capital seems unclear whether it would be positive or negative, however, the money was used in new investments with more explicit indications of success. All the investments made so far did not result in noticeable returns, neither did they lose dramatically. Therefore, the strategy will remain the same.

4.9 Week 9

As the simulation approaches the end, the stock market also slowly stabilized and began to recover from its previous tumble. I did three trades this week with my portfolio buy power, that is equivalent to the initial amount of \$100,000. Some stock brokers allow customers to purchase stocks of an equivalent value of up to double of the initial cash. That means, I can purchase up to \$200,000 worth of stock with the \$100,000 initial cash.

4.9.1 Trading Activities

Table 4.9 summarizes three trades made this week, including two purchases of JD and AMD with each approximately equivalent to \$30,000, and the sale of QD. Those trades used up all the \$100,000 initial cash, and used a “borrowed” buy power of \$31.112.

Table 4.9 Trading Activities of Week 9

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
4/11/18	JD	buy	40.75	750	-30,562.50		-28,036.10	8,025
4/12/18	AMD	buy	9.96	3,000	-29,880.00		-57,916.10	8,025
4/12/18	QD	sell	10.31	2,600	26,804.00	-4,032.00	-31,112.10	3,993

4.9.2 Activity Details

Figure 4.42 shows the stock price of JD plotted along with MACD and CCI indicators. The stock was purchased on Apr 11th at a price of \$40.75 per share. Figure 4.42 shows that the MACD (in purple) crossed above the signal line (in orange), which gives an oversold signal. Additionally, the 14-day CCI indicator also converged at -100



Figure 4.42 JD Buy Signal Analysis

oversold signal line and showed an uptrend momentum. The price of JD also experienced some downtrend previously, and seems like it has reached a potential trend reversal. Therefore, the stock is expected to have the potential to incline from this point forward.

The AMD stock was purchased on Apr 12th at a price of \$9.96 per share. Figure 4.43 shows similar indication to that of JD stock—both MACD and CCI showed oversold signal, which indicated that the stock price would likely to go up in the coming days, and it is expected to have some upward momentum.



Figure 4.43 AMD Buy Signal Analysis

Figure 4.44 shows the sell signal of QD from its MACD signal. The MACD signal has signaled a sell signal previously around Mar 14th, and then continue to drop in value. This means that the price has not yet reached the “bottom” and has the momentum to continue to decrease in value. Therefore, I sold the QD to minimize the loss.



Figure 4.44 QD Sell Signal Analysis

4.9.3 Portfolio Overview

According to Figure 4.45, the gain of total assets has experienced minor fluctuations. By the end of this week, the portfolio has experienced an overall gain of 10.00%, slightly outperformed the SPY 500 index.

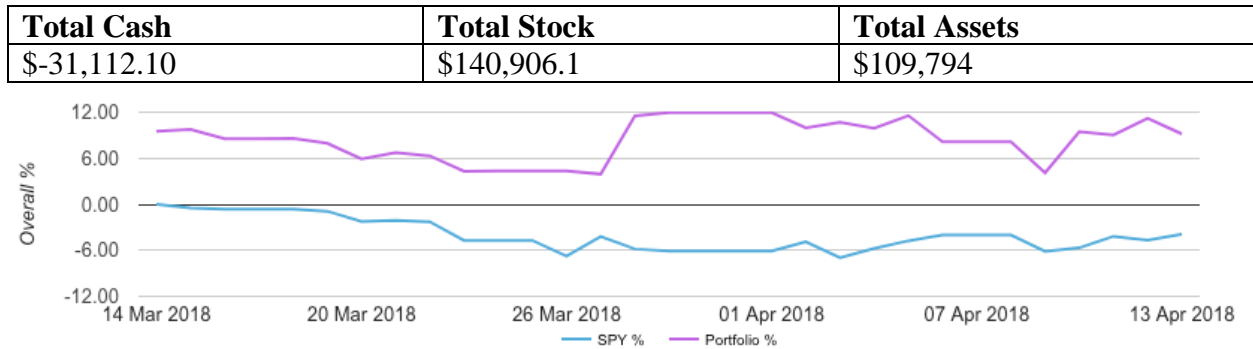


Figure 4.45 Portfolio Overview of Week 9

4.9.4 Weekly Analysis & Conclusion

This is the second last week of the simulation, and the net worth of portfolio increased by 10.00%. Based on the results of the previous weeks (week 5-9), the portfolio first declined as the stock market tumbled for almost a month, however, with the timely decisions being made, the loss has been reduced to minimum. As the stock market slowly retrieved in the past few weeks, I was able to break even some previous losses.

All the trades conducted so far followed the exact same trading strategy, this allows me to evaluate the efficacy of the trading strategy by the end of the simulation.

4.10 Week 10

For the final week of stock simulation, the stock market first continued to recover from the previous low occurred in week 8. From Monday to Wednesday, the NASDAQ was up 300 points and Dow Jones was up 500 points. However, later on this Thursday the stock market tumbled down and continued to decrease until the end of this week. During this period of time, I sold all stocks in various dates and converted all in cash.

4.10.1 Trading Activity

As shown in Table 4.10, on Apr 16th and 17th, I purchased three stocks, QD BABA and MU, with the remaining buy power (\$100,000 in total of extra buy power) of the portfolio. After which, the remaining cash resulted in -\$90,577.60. Starting on Apr 17th, I started withdrawing cash from the simulation profile. By Apr 20th, all stocks were sold for cash.

Table 4.10 Trading Activity of Week 10

Date	Symbol	buy/sell	Price	Shares	Net Cost/Proceeds	Profit/Loss	Total Cash	Total Profit
04/16/18	TSLA	sell	290.91	50	14,545.50	997.00	-16,566.60	4,990
04/16/18	QD	buy	10.55	2,000	-21,100.00		-37,666.60	4,990
04/17/18	BABA	buy	179.04	150	-26,856.00		-64,522.60	4,990
04/17/18	MU	buy	52.11	500	-26,055.00		-90,577.60	4,990
04/17/18	SOXL	sell	160.37	230	36,884.00	6,571.50	-53,693.60	11,562
04/18/18	MU	sell	53.20	500	26,600.00	545.00	-27,093.60	12,107
04/19/18	BIDU	sell	237.05	140	33,187.00	2,385.40	6,093.40	14,492
04/19/18	JD	sell	39.50	750	29,625.00	-937.50	35,718.40	13,554
04/19/18	AMD	sell	10.10	3,000	30,300.00	420.00	66,018.40	13,974
04/20/18	QD	sell	10.70	2,000	21,400.00	300.00	87,418.40	14,274
04/20/18	BABA	sell	178.63	150	26,794.00	-62.00	114,212.40	14,212

4.10.2 Activity Details

The first purchase was made on Apr 16th. I bought 2000 shares of QD at \$10.31 per share. Prior to the purchase, the 14-day CCI has given a clear signal indicating an oversold, with the MACD indicator showing a tendency to cross above the signal line. As noted in Figure 4.46, both signals were marked around the buy in date, which meant it was a good buy-in opportunity.



Figure 4.46 QD Buy Signals

Figure 4.47 shows the buy-in signals of the second purchase made this week, which was 150 shares of BABA at \$179.04 per share. The CCI first signaled an overbought with the green cross-section below -100 signal line, followed by the MACD crossing above the signal line. Therefore, both indicators have given a “go” sign and the purchase was made on Apr 17th.

The third purchase was 500 shares of MU at \$52.11 per share. The signals were shown in Figure 4.48. A week ago, the CCI gave an oversold buy signal, however, the MACD indicator said otherwise. Therefore, I have waited until Apr 17th, on which the MACD gave an unclear crossover which was actually a false signal.



Figure 4.47 BABA Buy Signals



Figure 4.48 MU Buy Signals

Later on this week, according to Table 4.10, I sold stocks including: SOXL, MU, BIDU, JD, AMD, QD and BABA and received corresponding profits shown in Table 4.10 from each trade, and officially finished the trading simulation.

4.10.3 Portfolio Overview

Figure 4.49 shows the percentage gain of total assets vs percentage gain of SPY index. By the end of the simulation (Apr 19th), the portfolio has increased by a total of 14%, and relatively the SPY was only able to break even comparing to a reference date (Mar 20th). This proves that the indicator trend trading strategy used in this simulation is effective and less risky.

Total Cash	Total Stock	Total Assets
\$-114,212.4	\$0	\$114,212.4

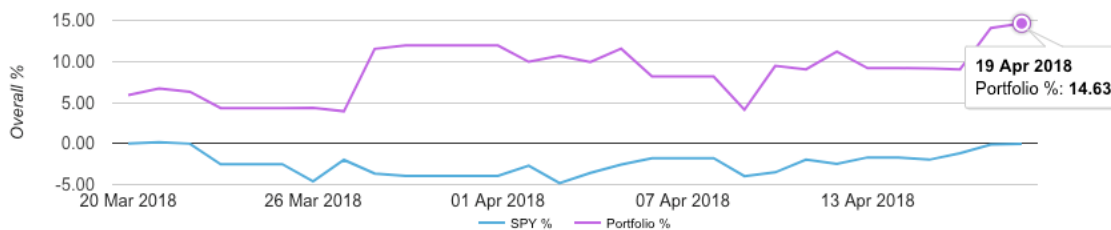


Figure 4.49 Portfolio Overview of Week 10

4.10.4 Weekly Analysis & Conclusion

At this point the simulation process is finished. The trading activities in this simulation are conducted according to the method of ITTS. Even though the stock market tumbled down at the end of this week, I was still able to sell the stocks on time and obtained some profits through each trade with the appropriate signals. The portfolio experienced a percentage gain of 14.63% of its initial value of \$100,000, which is quite a significant gain for a ten-week period of time.

5 RESULT AND ANALYSIS

The 10-week simulation used the MACD and CCI indicator triggered trend trading strategy. This chapter 5 is dedicated to evaluate the efficacy of the indicator-based trend trading strategy. For this purpose, I put together a list of buy and sell trading decisions made in the simulation for statistical analysis. I mainly evaluate the characteristics of MACD and CCI indicators including their responsiveness and percentage error in determining trends. Corresponding plots will be provided to help visualize the results.

Table 5.1 summarizes all 16 complete trades (buy and sell) conducted during the simulation, each with corresponding buy and sell signals. The Profit column states the amount of profit generated by each investment. The Buy Signal and Sell Signal columns will be notated as one of the following: M (MACD signal), M-F (MACD false-signal), C (CCI signal), C-F (CCI false-signal), B (CCI and MACD signals) or B-F (CCI and MACD false-signals). *Note: The indicators were used to determine trend reversals for trading, therefore, a false-signals is determined if the signal does not correctly signify a trend reversal.*

Figure 5.1 shows a pie chart of the distribution of profitable investments (resulted in positive profit) vs nonprofitable investments (resulted in negative profit) using the data provided from Table 5.1. This demonstrates the indicator trend trading strategy used in simulation resulted in approximately 63% profitable trades, and 38% non-profitable trades. Therefore, it proves the efficiency of the trading strategy. If the strategy is repeatedly used in trading, theoretically it will result in more profitable investments than nonprofitable ones over time and have a steady gain.

Table 5.1 List of Investments with Buy/Sell Indicators

	Holding Period	Symbol	Shares	Price Bought	Price Sold	Profit	Buy Signal	Sell Signal
1	02/12 - 02/27	SOXL	150	141.61	177.14	5330.00	C	C
2	02/12 - 03/02	AMD	2,000	11.72	11.46	-520.00	C	C, M-F
3	02/12 - 02/27	RAD	10,000	2.03	2.05	200.00	C	B
4	02/27 - 03/08	RRC	2,000	13.58	15.25	3340.00	M	C
5	03/02 - 03/09	INCY	350	86.00	94.21	2873.50	B	C
6	03/19 - 03/22	AMD	2,600	11.44	10.96	-1248.00	C-F	C
7	03/14 - 04/04	RAD	40,000	1.73	1.61	-1410.00	C-F	N
8	04/03 - 04/12	QD	2,600	11.86	10.31	-4032.00	C-F	C
9	04/03 - 04/16	TSLA	50	270.97	290.91	997.00	B	N
10	04/05 - 04/17	SOXL	230	135.18	160.37	6571.50	C	C, M-F
11	04/06 - 04/19	BIDU	140	225.74	237.05	2385.40	B	C
12	04/11 - 04/19	JD	750	40.75	39.50	-937.50	B-F	M
13	04/12 - 04/19	AMD	3,000	9.96	10.10	420.00	B	C
14	04/16 - 04/20	QD	2,000	10.55	10.70	300.00	B	N
15	04/17 - 04/20	BABA	150	179.04	178.63	-62.00	B	C
16	04/17 - 04/18	MU	500	52.11	53.20	545.00	C	C

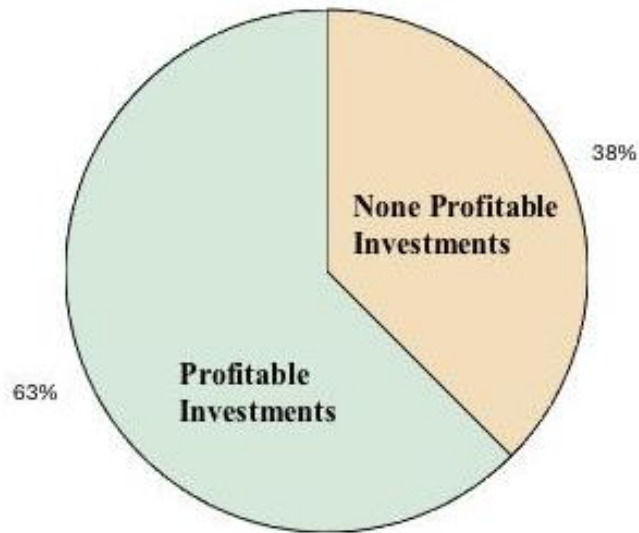


Figure 5.1 Good vs Bad Investments Distribution

Indicator Responsiveness

The indicator responsiveness (in percentage) measures how frequently the indicator gives signals for buy or sell decisions. The responsiveness is calculated by dividing the total number of signals over the total number of trades (including buy and sell) as shown in equation (5.1).

$$\text{Responsiveness} = \frac{\#signals}{\#activities} \times 100\% \quad (5.1)$$

Figure 5.2 shows a bar chart of number of signals received during the simulation. Frankly, the majority of the signals were given by CCI indicator, 27 signals in total, which means CCI is the relatively more responsive indicator between those two. It is the rarest for both indicators to give signals simultaneously.

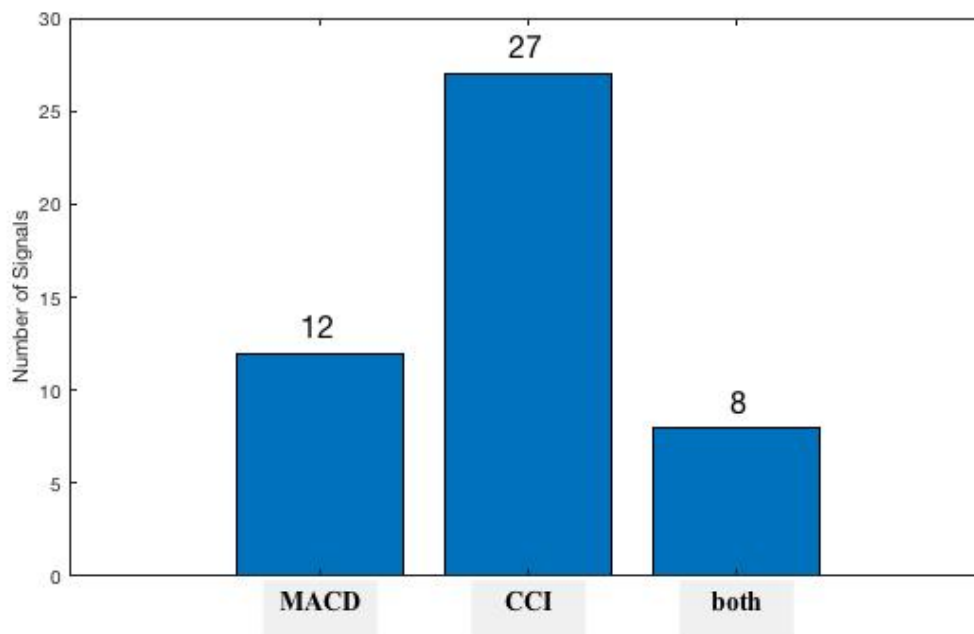


Figure 5.2 Number of Signals Occurred in Simulation

Table 5.2 shows the responsiveness of indicators MACD and CCI calculated with the data provided in Table 5.1. There are 16 investments, hence, 32 trading activities including buys and sells, among which the MACD has signaled in total of 12 times, CCI 27 times relatively. Cumulatively, MACD has 37.5% responsiveness and CCI has a much higher value of 84.4%. This means that the CCI gives almost twice as much signals than MACD does in trend trading analysis.

Table 5.2 Indicator Responsiveness

Indicators	Responsiveness
MACD	$Responsiveness = \frac{12}{32} \times 100\% = 37.5\%$
CCI	$Responsiveness = \frac{27}{32} \times 100\% = 84.4\%$
Both	$Responsiveness = \frac{8}{32} \times 100\% = 25.0\%$

Indicator Percentage Error

The indicator percentage error gives a brief description of how accurate the indicator predicts the buy and sell opportunities. This helps us to identify the accuracy of each indicators. The percentage error is calculated by dividing the total number of false-signals over the total number of signals then multiplies by 100%, as shown in equation (5.2).

$$\%error = \frac{\#false_signals}{\#signals} \times 100\% \quad (5.2)$$

According to Table 5.1, among the listed 16 investments, or equivalently 32 trading activities, there were in total of 3 false-signals among in total of 12 signals given by MACD indicator, whereas the CCI indicator has given 4 false-signals out of 27 signals.

Therefore, the percentage error can be determined as shown in Table 5.3. MACD indicator has a slightly larger percentage error of 25%, whereas CCI indicator has 14.8% and 12.5% for both

indicators. Figure 5.3 shows the %errors of those three scenarios plotted relative to each other in a bar chart, with x-axis being the type of indicator and y-axis being %error. According to Figure 5.3, the prediction of buy and sell signal is most accurate when both indicators give signals, that means it is the best time to trade. However, considering that MACD being the more irresponsive indicator of the two, one can also make trading decisions regarding only to CCI signals, which also has a low percentage error of 14.8%.

Table 5.3 Indicator Percentage Error

Indicators	Percentage Error
MACD	$\%error = \frac{3}{12} \times 100\% = 25.0\%$
CCI	$\%error = \frac{4}{27} \times 100\% = 14.8\%$
Both	$\%error = \frac{1}{8} \times 100\% = 12.5\%$

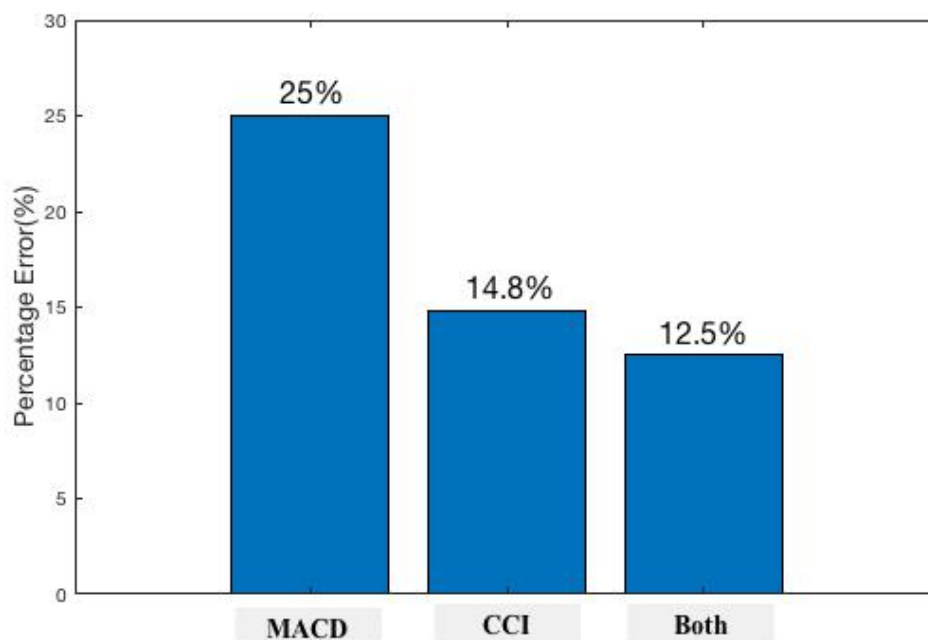


Figure 5.3 Bar Chart of Percentage Error

6 CONCLUSION

Through the course of this project I first conducted a research of the trend-following indicator MACD, and the momentum indicators CCI and RSI. As a result of the research, I discovered that the MACD is more commonly used by professionals due to its duo-abilities to indicate both the trend direction and the trend momentum. Additionally, I came to a conclusion that RSI can be very volatile, thus making it harder to read its signals considering its complexity. Therefore I decided to focus on the two main indicators MACD and CCI to develop an indicator trend trading strategy that involves one trend-following indicator and one momentum indicator. The strategy is to buy and sell when any of the two indicators signals an opportunity. The signals are interpreted as following: MACD crossing below its 9-day EMA signals an overbought (sell signal), whereas crossing above signals an oversold (buy signal); CCI forming an enclosed area above +100 line signals an overbought, whereas the enclosed are below -100 line signals an oversold.

I started the trading simulation with an initial investment of \$100,000 to experiment the indicator trend trading strategy. In the end, the portfolio has increased in total by 14%. Based on the analysis in chapter 5, 63% out of total investments made turned out to be profitable. Hence, the statistics proves that the indicator trend trading strategy will result in a stead profit if used repeatedly. More specifically, MACD indicator is less responsive than the CCI, and very rarely do both indicators signal at the same time. In terms of accuracy, when both indicators give signal it is the most ideal opportunity to trade.

ITTS Method

Therefore, I recommend to use the indicator trend trading strategy according to the five rules:

1. Buy signals are identified when CCI converges at -100 trigger line, or MACD crosses above its 9-day EMA line.
2. Sell signals are identified when CCI converges at +100 trigger line, or MACD crosses below its 9-day EMA line.
3. Buy and sell according to CCI signals, because CCI actively produces more signals with a responsiveness of 84.4%, and a percentage error of 14.8%.
4. If MACD gives a signal that says otherwise, then reconsider the trade or lower the amount. This is because MACD is less active with a responsiveness of 37.5%, and less accurate with a percentage error of 25%.
5. When both indicators give signals, trade a larger amount. Because it has the lowest percentage error of 12.5%.

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