

**Development and Analysis of Three Stage Filtering
Strategy using MACD and Stochastics
for Trading in the Stock Market**

NOH, Sang Hyun

Supervised by: Dr. David Rossiter

COMP 4971C - Independent Work

Department of Computer Science and Engineering

The Hong Kong University of Science and Technology

Fall 2021

Abstract

This research will discuss the development and effectiveness of Three Stage Filtering strategy on the stock market. As it can be shown in the name, the Three Stage Filtering strategy has three different stages of examination to establish a trading bias, retracements against the bias, and the timing of entries and exits. The first stage uses Moving Average Convergence Divergence (MACD) Histogram to identify the long-term (weekly) trend of the market. The second stage uses a stochastics oscillator to find the oversold or overbought state in a shorter period of time (daily). The third stage is to find the exact moment of buying or selling, depending on the results from the first two stages. This gives a buy signal when the indicators show that a stock is oversold while it is in the rising trend, and a sell signal when a stock is overbought while it is in the falling trend. By applying the strategy to different ETFs on the NYSE market, this project aims to test if the filtering stages using multiple indicators is more effective than using a single indicator. The total return and its drawdown is also compared with the 'buy and hold' strategy. As a result, it was discovered that the Three Stage Filtering strategy has less maximum drawdown than 'buy and hold' in any market. Applications to S&P 500, Dow 30, and sector ETFs showed that the strategy works typically well for ETF securities. By analyzing the returns of different variable values, it is discovered that it is effective to use 3 day MACD Histogram, 8 day %K and 3 day %D.

Table of Contents

Abstract	2
Table of Contents	3
Table of Figures	5
1. Introduction	6
1.1 Stock Market and ETFs	6
1.1.1 S&P 500 (NYSE: SPY)	6
1.1.2 Dow 30 (NYSE: ^DJI)	6
1.2 Market Indicators	6
1.3 Trend Indicators	7
1.3.1 Simple Moving Average	7
1.3.2 Exponential Moving Average	8
1.3.3 MACD	8
1.3.4 MACD Histogram	9
1.4 Stochastics Oscillator	9
1.5 Three Stage Filtering strategy	10
1.6 CAGR	11
1.7 Maximum Drawdown	11
1.8 Objective	11
2. Methodology	12
2.1 Data Collection	12
2.2 First Stage: Market Tide	13
2.3 Second Stage: Market Wave	14
2.4 Third Stage: Entry Technique	15
3. Data Analysis	19
3.1 Result	19
3.2 Variables: Timeframes for each Stage	21
3.3 Evaluation of Three Stage Filtering on S&P 500	23
4. Testing on other ETFs or individual stocks	24
4.1 Testing on Dow 30	24
4.2 Testing on 11 different sectors in NYSE	26
4.2.1 Energy: XLE	26
4.2.2 Materials: XLB	26
4.2.3 Industrials: XLI	26
4.2.4 Consumer Discretionary: XLY	26

4.2.5 Consumer Staples: XLP	26
4.2.6 Health Care: XLV	27
4.2.7 Financials: XLF	27
4.2.8 Information Technology: SMH	27
4.2.9 Communication Services: XTL	27
4.2.10 Utilities: XLU	27
4.2.11 Real Estate: IYR	27
4.3 Average CAGR from individual companies in S&P 500	28
5. Application to other markets	29
5.1 Testing on cryptocurrency: Bitcoin	29
5.2 Testing on cryptocurrency: Ethereum	29
6. Conclusion	30

Table of Figures

Figure 1. <i>S&P 500's historical data (in blue) and SMA 200 (in purple) from 2000</i>	7
Figure 2. <i>S&P 500's historical data (in blue) and EMA 60 (in purple) from 2021</i>	8
Figure 3. <i>MACD line, Signal line, and MACD Histogram</i>	9
Figure 4. <i>Stochastics oscillator of S&P 500 from 2021</i>	10
Figure 5. <i>Graph of collected data vs Graph of real data for comparison (S&P 500)</i>	12
Figure 6. <i>First Stage for S&P 500 showing EMA for 10 weeks and MACD</i>	14
Figure 7. <i>Second Stage for S&P 500 showing EMA for 10 weeks and Stochastics oscillator</i>	15
Figure 8. <i>Third Stage for S&P 500 showing buy (red) and sell (blue) signals (from 2000)</i>	17
Figure 9. <i>Third Stage for S&P 500 showing buy (red) and sell (blue) signals (from 2021)</i>	18
Figure 10. <i>Return of Three Stage Filtering (blue line) using standard parameters</i>	20
Figure 11. <i>The buying and selling points, red shows buy and blue shows sell</i>	21
Figure 12. <i>6 Heatmaps showing area of best CAGR values from altering variables</i>	22
Figure 13. <i>Best return of Three Stage Filtering for S&P 500</i>	23
Figure 14. <i>6 Heatmaps showing area of best CAGR for Dow 30</i>	24
Figure 15. <i>Best return of Three Stage Filtering on Dow 30 compared to real data</i>	25
Table 1. <i>Data of S&P 500 from 2000</i>	12
Table 2. <i>Entry technique in Three Stage Filtering</i>	16
Table 3. <i>Buying and Selling point according to the Three Stage Filtering Strategy</i>	19
Table 4. <i>CAGR and Maximum drawdown of different strategies</i>	20
Table 5. <i>Average CAGR and Drawdown of every individual company in S&P 500</i>	28

1. Introduction

1.1 Stock Market and ETFs

The stock market is always volatile and the return from the investment is always unpredictable. Exchange Traded Fund (ETF) is a type of security which holds a basket of individual stocks that is being traded in the stock market. ETFs have relatively low risk due to its diversification, and it can be traded just like regular stocks as its share price fluctuates all day unlike other mutual funds.

1.1.1 S&P 500 (NYSE: SPY)

Standard and Poor's 500, or S&P 500, is the well-known example of an ETF, which tracks the whole market index. Performance of 500 large companies listed on the New York stock exchange (NYSE) is used to evaluate its price, and each of them have different weights. It is often used as a benchmark of the U.S. stock market.

1.1.2 Dow 30 (NYSE: ^DJI)

Another common U.S. stock market benchmark is the Dow Jones Industrial Average (DJIA), or Dow 30 in short. The combined stock of 30 large, publicly traded companies determine its price. While having the same objective as a market index, DJIA and S&P 500 are different in size and their calculation methods.

1.2 Market Indicators

Market Indicators can be divided into three categories: trend indicator, oscillator, and others. Moving Average or MACDs are the trend indicators, which are used to establish a trading bias. They are efficient when the market is dynamic, but can give wrong signals when it is in the flat market. Stochastics or RSI are the oscillators, which shows the relative location of the current price compared to the past few days. Oscillators are useful in the flat market to capture the turning point, but it tends to move ahead of actual price. Other indicators predict the intensity of a bull or bearish market.

1.3 Trend Indicators

1.3.1 Simple Moving Average

Simple Moving Average (SMA) calculates the average of a selected range of prices, usually closing prices, by the number of periods in that range.

$$SMA = \frac{P_1 + P_2 + P_3 + \dots + P_N}{N}$$

P = price, N = number of days

SMA changes daily by removing the oldest price and adding a new price from the stock. If SMA drops, it doesn't necessarily mean that the recent price has dropped as it could be because of the change in the oldest data. Every price that is used for calculation has equal weight which could lead to distortion of recent prices. SMA of 200 days of S&P 500 from 2000 is shown in Figure 1.



Figure 1. S&P 500's historical data (in blue) and SMA 200 (in purple) from 2000

1.3.2 Exponential Moving Average

Exponential Moving Average (EMA) is a more sophisticated type of moving average that places a greater weight on recent data.

$$EMA = P_{today} \times K + EMA_{yesterday} \times (1 - K)$$

$$K: \frac{2}{N + 1}, N = \text{number of days}, P_{today}: \text{Today's price}$$

EMA_{yesterday}: Yesterday's EMA

EMA has two advantages over SMA. First, the fluctuation of price is reflected well because the recent data is heavily weighted. Second, old data's significance decreases gradually, so the EMA doesn't change rapidly. Increase in EMA means it is uptrending, so it gives a good 'buy' signal. Decrease in EMA means it is downtrending, so it gives a good 'sell' signal.

EMA of 60 days for S&P 500 is shown in Figure 2.



Figure 2. S&P 500's historical data (in blue) and EMA 60 (in purple) from 2021

1.3.3 MACD

There are two lines in the Moving Average Convergence Divergence (MACD) chart, one is the MACD line (solid line) and the other is the signal line (dotted line). When the two lines cross, the trading signal is made. MACD shows the relationship between two moving averages, by subtracting 26-period EMA from the 12-period EMA. The signal line is simply the 9-Period EMA of the MACD.

$$MACD = 12\text{-Period EMA} - 26\text{-Period EMA}$$

When the MACD line crosses above the signal line, it means there is a buying trend, and vice versa. The image of MACD and its signal line for S&P 500 is shown in Figure 3.

1.3.4 MACD Histogram

MACD Histogram describes the buy or sell signal better than MACD because it also shows the strength of the trend of trading.

$$\text{MACD Histogram} = \text{MACD line} - \text{Signal line}$$

If MACD Histogram is below zero, it gives a buy signal and when it is above zero, it gives a sell signal. Also, the MACD Histogram's gradient change could also be taken into account. The best signal from the MACD Histogram would be when gradient is positive and it is below zero. The image of MACD Histogram for S&P 500 is shown in Figure 3.

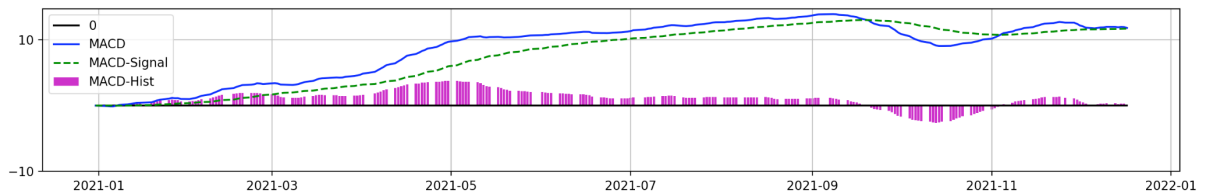


Figure 3. MACD line, Signal line, and MACD Histogram

1.4 Stochastics Oscillator

Stochastics is a type of oscillator, locating the closing price of a particular day into a range of its price over a given period of time. If the 14-day Stochastics give 70, it means that the price is located at 70th quantile between the minimum and maximum data in the past 14 days. Commonly, if the stochastics is above 80 it shows an overbought situation and if it is below 20 it shows an oversold situation. Stochastics is composed of two lines, %K showing fast line and %D showing slow line. %K is commonly set as 14 days.

$$\%K = \frac{C_{today} - L_n}{H_n - L_n} \times 100$$

C_{today} : Closing price for today, n = range of days

H_n : Highest in n day, L_n : Lowest in n day

%D is calculated by smoothing the %K value. 3 days are used commonly.

$$\%D = \frac{(C_{today} - L_n) \text{ for 3 days}}{(H_n - L_n) \text{ for 3 days}} \times 100$$

Stochastics work well when the market moves within a box pattern, but once the market is in an uptrend or downtrend it could give false signals. When the market is in uptrend, stochastics will think that the market is in an overbought signal and therefore give sell signals, but the market could continue rising. Therefore, it should be used together with the long term trend indicators like MACD Histogram. The image of stochastics oscillator is shown in Figure 4.

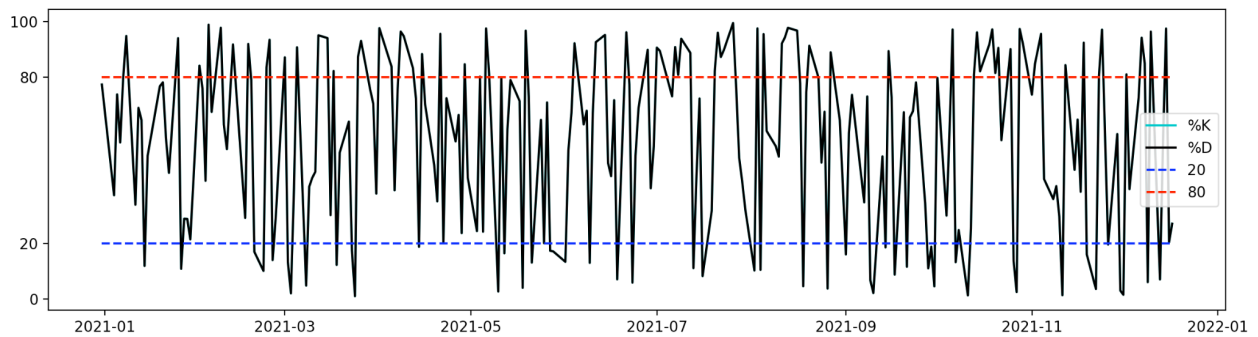


Figure 4. Stochastics oscillator of S&P 500 from 2021

1.5 Three Stage Filtering strategy

The Three Stage Filtering strategy uses the trading bias and retracements learnt using the aforementioned indicators. It has three different stages of filtering to find the exact moment for trading. Trend indicators and oscillators sometimes give opposing signals in the same market. For example, when the market is uptrending, the trend indicator gives a ‘buy’ signal, but oscillators consider the stock to be in overbought and give a ‘sell’ signal. This shows how the use of a single indicator can give a lot of false signals. Therefore, the strategy supplements the shortcomings of using a single indicator by combining a trend indicator and oscillator.

The biggest dilemma in the stock market is that the stock could be perceived as uptrending or downtrending depending on different timeframes. For example, the daily chart can be rising while the weekly chart shows a decrease, or vice versa. Therefore, the Three Stage Filtering strategy compares indicators in different timeframes to pinpoint the moment of trading.

1.6 CAGR

Compound Annual Growth Rate (CAGR) is the ratio that provides a constant rate of return over the time period. It is one of the most accurate ways to determine returns that can vary overtime. High CAGR indicates high return from the investment.

$$CAGR = \left(\frac{E_v}{B_v} \right)^{\frac{1}{n}} - 1 \times 100$$

B_v : Beginning Value, E_v : Ending Value, n : number of years

1.7 Maximum Drawdown

Maximum Drawdown is the maximum observed loss before a new peak is attained. It indicates the downside risk over a time period.

$$\text{Maximum Drawdown} = \frac{V_T - V_P}{V_P}$$

V_P : Peak Value, V_T : Trough Value

1.8 Objective

This research project aims to test if three stages using multiple indicators is more effective than using a single indicator. It also aims to beat the ‘buy and hold’ strategy if possible. The effectiveness is tested using CAGR and drawdown.

2. Methodology

2.1 Data Collection

In this research, we try to determine the effectiveness of the Three Stage Filtering strategy on the stock market, so real data from the stock market was collected. To start with, the major NYSE market index, S&P 500, was selected since it gives an overview of the whole market in the past years.

Table 1. Data of S&P 500 from 2000

Date	Open	High	Low	Close	Adj Close	Volume
1999-12-31	146.84375	147.5	146.25	146.875	98.156005859375	3172700
2000-01-03	148.25	148.25	143.875	145.4375	97.19529724121094	8164300
2000-01-04	143.53125	144.0625	139.640625	139.75	93.39431762695312	8089800
2000-01-05	139.9375	141.53125	137.25	140.0	93.56147003173828	12177900
2000-01-06	139.625	141.5	137.75	137.75	92.05775451660156	6227200

Historical prices from 2000 of the S&P 500 were acquired from Yahoo Finance in US dollars. It is saved as a csv file which contains daily information of date, opening price, lowest price, highest price, closing price, adjusted closing price, and the volume of transaction. For testing of Three Stage Filtering strategy, daily close prices were used.

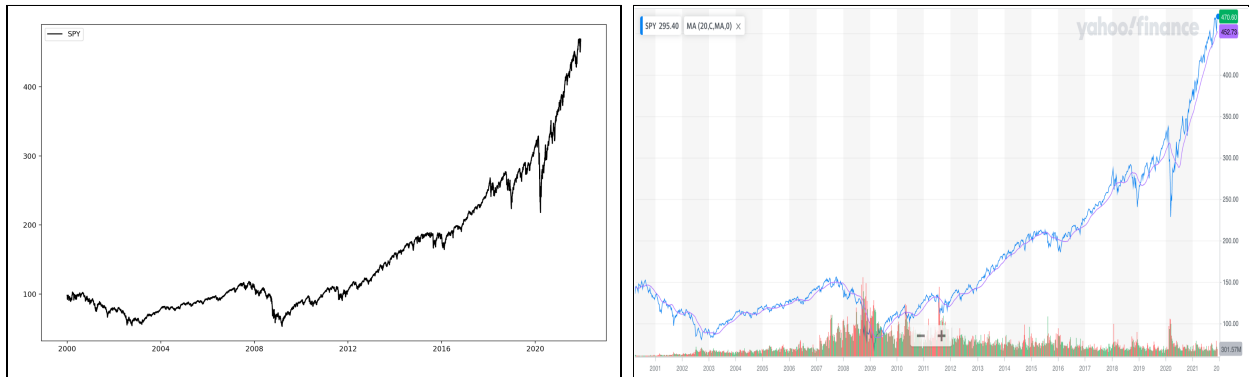


Figure 5. Graph of collected data vs Graph of real data for comparison (S&P 500)

2.2 First Stage: Market Tide

The purpose of the first stage is to analyze the long term chart, the market tide. This can identify the trading bias of the market. In the first stage, it analyzes a larger time frame compared to the time frame in interest. Timeframes in the stock market can be divided into months, weeks, days, hours, and 10-minutes. In this research, we are interested in the daily transaction because we collected the daily closing from 2000. Hence, the goal is to analyze the weekly chart and its trend.

There are three options of action for traders, which are to buy, to sell, or to observe. In the first stage of the strategy, we can eliminate one option. When it is perceived to be in uptrend, traders can either buy or observe, and when it is perceived to be in downtrend, traders can either sell or observe.

All of the aforementioned trend indicators like SMA, EMA, MACD, MACD histogram can all be used here to analyze the market tide. According to the research, MACD Histogram is said to be the most effective method to track the market trend, so the MACD Histogram was calculated. However, in order to acquire the MACD Histogram, all the other indicators like SMA, EMA, MACD are needed, so in the end all of the trend indicators were calculated.

They are calculated by:

1. Find 60 day EMA which is equivalent to 12 week EMA
2. Find 130 day EMA which is equivalent to 26 week EMA
3. Find MACD line by subtracting 130 day EMA from 60 day EMA
4. Find 9 week (45 days) EMA of MACD to use as the Signal line
5. Find MACD Histogram by subtracting Signal line from MACD line

The result is shown in Figure 6, the blue line is the real data of S&P 500 from 2000, and the purple line is the EMA for 10 weeks (50 days) for reference. The small chart below is the figure for MACD, showing the MACD line in blue, Signal line in dotted green, and the MACD Histogram is the small purple bar chart within the figure.

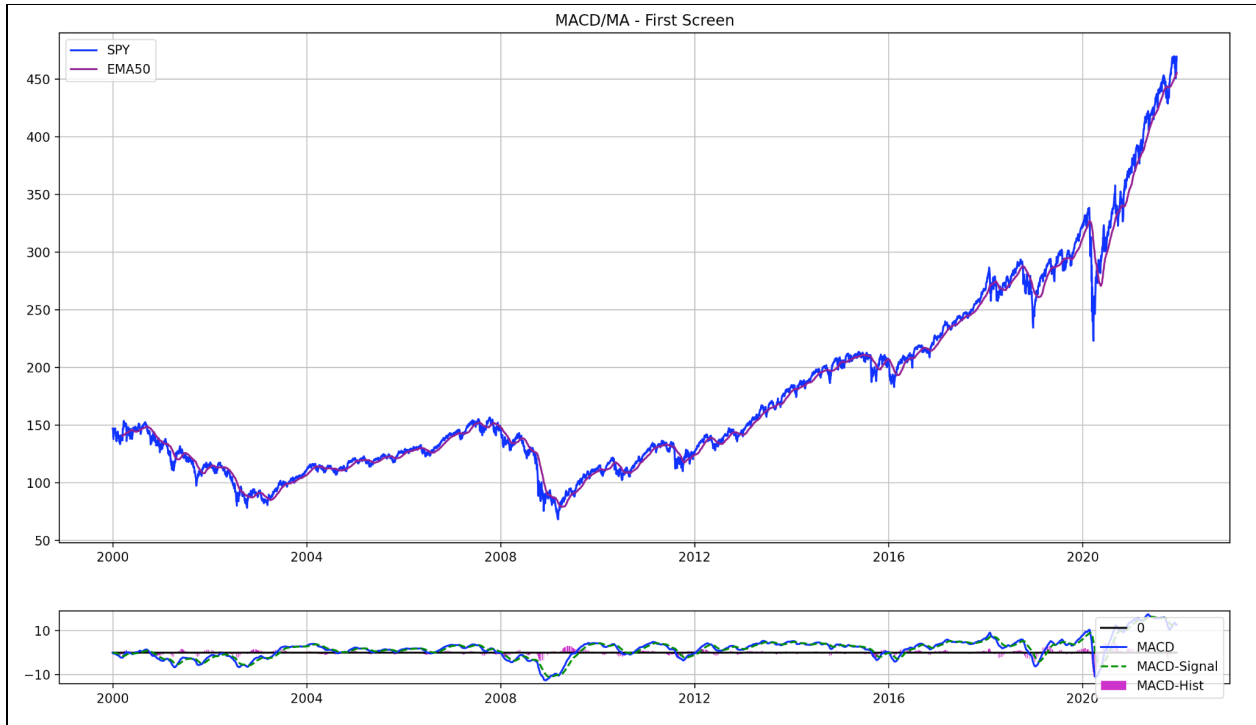


Figure 6. First Stage for S&P 500 showing EMA for 10 weeks and MACD

2.3 Second Stage: Market Wave

In the second stage, we use oscillators to track the market wave that opposes the general trend. Oscillators give ‘buy’ signals when it perceives that the market is downtrending, and give ‘sell’ signals when it perceives that the market is uptrending. Therefore in this research, the oscillators are used to find a moment when the weekly trend is uptrending and the daily chart is dropping.

We use the stochastics oscillator, and 5 days (1 week) were used to calculate the %K which is the fast line, and 1 day is used to calculate the %D which is the slow line. This is because the timeframe in interest is daily, and we would like to see the daily situation if it is overbought or oversold in order to make transaction signals frequently.

They are calculated by:

1. Find maximum value in 5 days.
2. Find minimum value in 5 days
3. Find %K and %D
4. Draw line with $x=0, 20, 80, 100$ as a baseline for stochastics

The result is shown in Figure 7, where the chart above shows the same result as the first stage and the chart below shows the stochastics. Because in our initial research, we set 1 day to calculate %D, so it gives the same result as %K. Here, when the stochastics is above 80, it can be perceived as an overbought situation and when it is below 20, it can be perceived as an oversold situation.

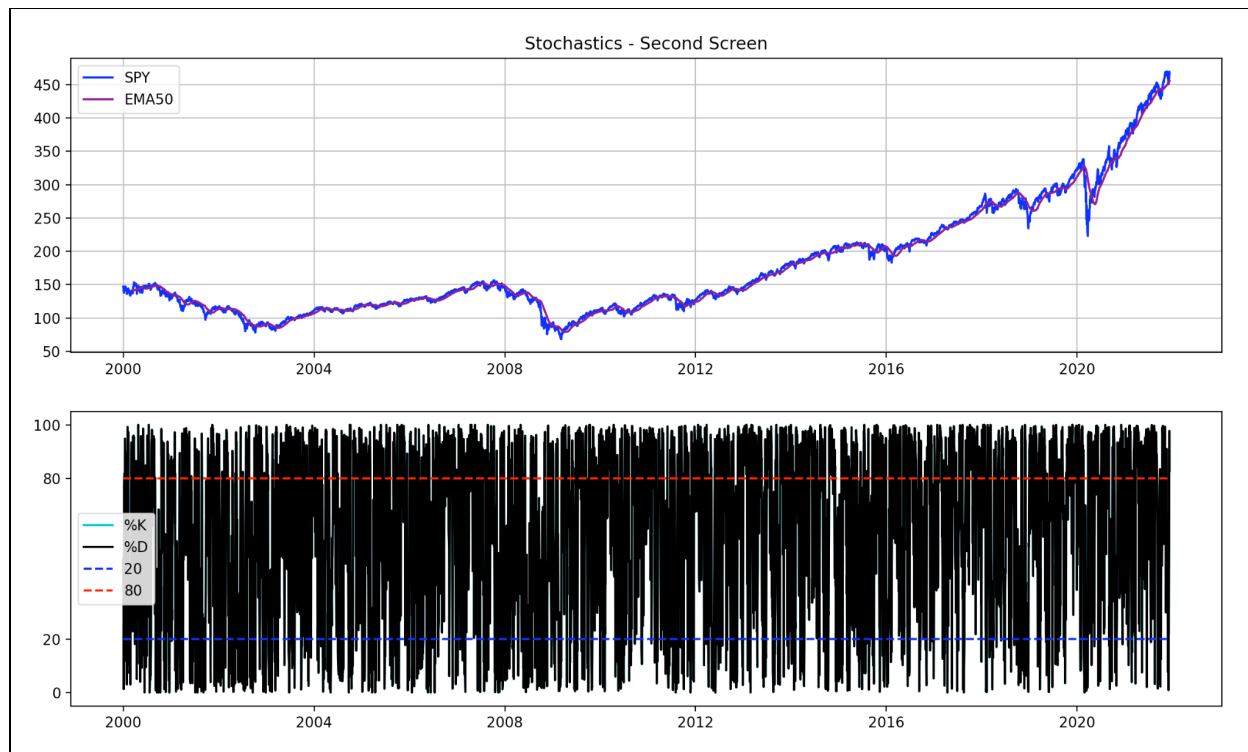


Figure 7. Second Stage for S&P 500 showing EMA for 10 weeks and Stochastics oscillator

2.4 Third Stage: Entry Technique

The third stage doesn't require a chart or indicator, but it only uses an entry technique to make a trading signal. It combines the data acquired from the earlier two stages to determine to buy, sell or observe. If the weekly trend is rising and the daily oscillator falls below 20, then the 'buy' signal will be created. Likewise, if the weekly trend is dropping and the daily oscillator goes above 80, then the 'sell' signal will be created. This is because if the general chart is rising but there is a sudden drop in price due to an oversold situation, then it is a good chance to buy. Also, if the general chart is dropping but there is a sudden increase in price due to an overbought situation, then it is a good chance to sell. These are shown in Table 2.

Table 2. *Entry technique in Three Stage Filtering*

Weekly trend	Daily Oscillator	Action
Rise	Rise	observe
Rise	Fall	Buy
Fall	Fall	observe
Fall	Rise	Sell

Here, we have multiple options to decide which indicator and criteria for interpreting the weekly and daily trend. For weekly trends, we can use SMA, EMA, MACD, or MACD Histogram. For oscillators, the only option we have is stochastics, but we need to determine the level for identifying an overbought or oversold situation. In this research, MACD Histogram and 20,80 levels for stochastic oscillators are selected for investigation.

They are calculated by:

1. When the MACD Histogram is above 0 and %D falls below 20, signal 'buy' using the red triangle facing upwards
2. When the MACD Histogram is below 0 and %D falls above 80, signal 'sell' using the blue triangle facing upwards

The result is shown in Figure 8, and the detail of the result will be discussed further below. There are multiple signals generated, which is sufficient to compare the overall data with the 'buy and hold' strategy.

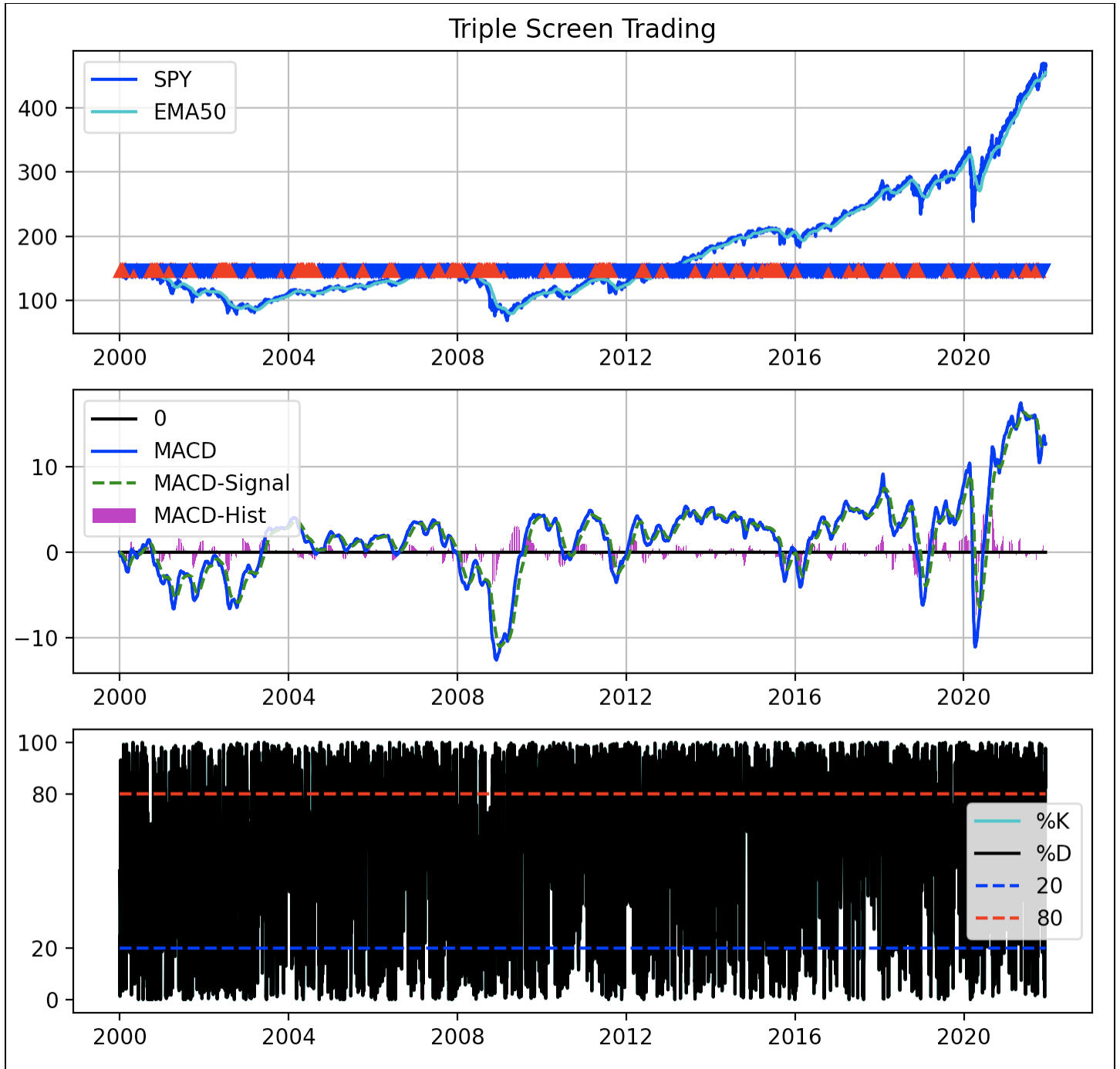


Figure 8. Third Stage for S&P 500 showing buy (red) and sell (blue) signals (from 2000)

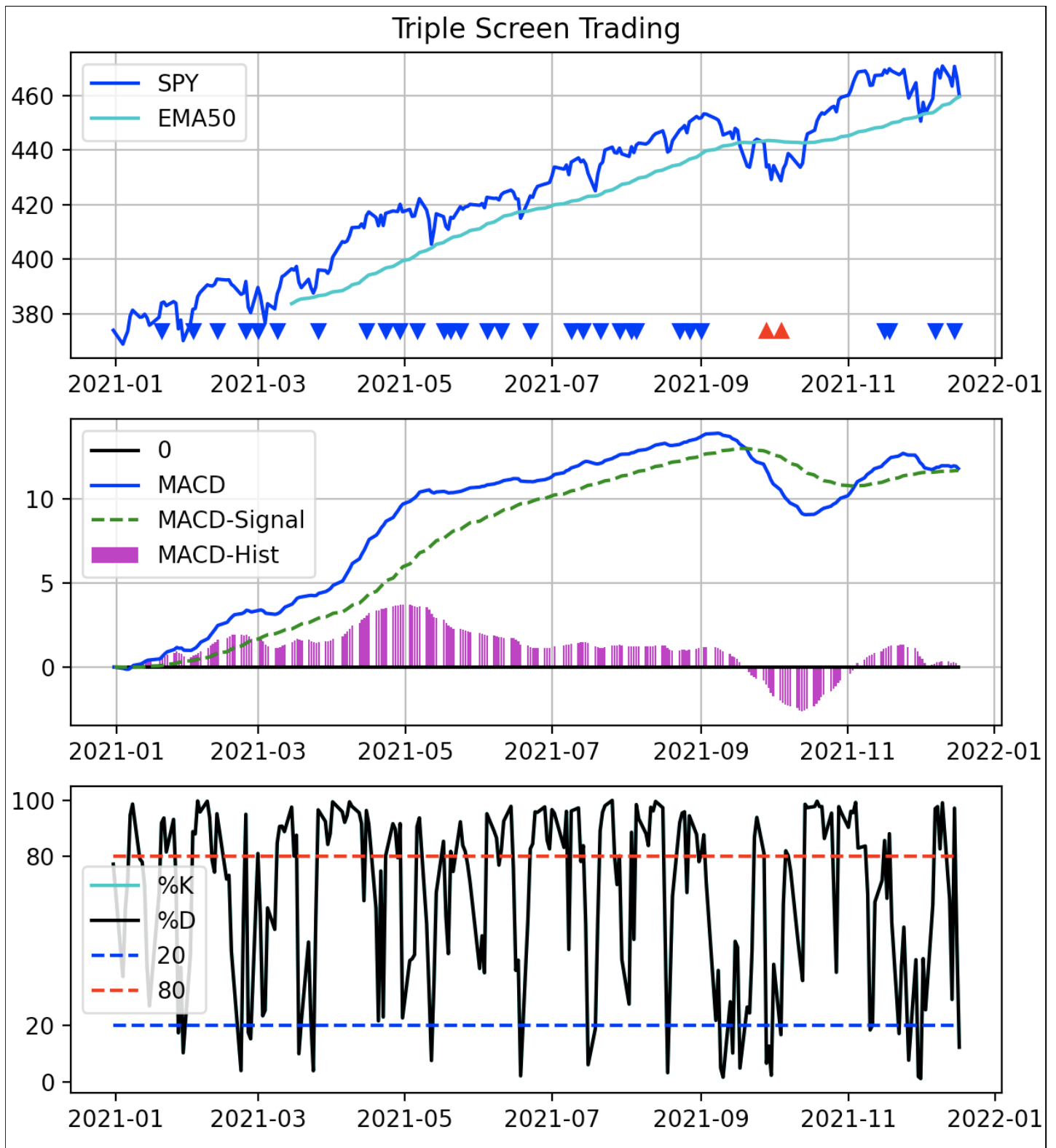


Figure 9. Third Stage for S&P 500 showing buy (red) and sell (blue) signals (from 2021)

3. Data Analysis

3.1 Result

There were 554 signals generated in total, most of which had successive signals that followed from the earlier signal. There are multiple ways to handle this, but for simplicity, it is considered that the stock will be bought after the first ‘buy’ signal, and it will be sold once the ‘sell’ signal is given. So the significant signals are the signals that are different from the earlier signal, and there are 78 significant signals in total. The date of buying or selling, and the closing price of that day is shown in Table 3.

Table 3. Buying and Selling point according to the Three Stage Filtering Strategy

	Date	Buy	Sell
0	2000-01-04	139.75	0
1	2000-04-07	0.0	151.4375
2	2000-05-23	138.0	0
3	2000-06-13	0.0	147.59375
4	2000-09-26	142.40625	0
5	2001-02-01	0.0	137.92999267578125
6	2001-03-09	123.36000061035156	0
7	2001-05-04	0.0	127.33999633789062
8	2001-08-21	115.81999969482422	0
9	2001-11-13	0.0	114.55000305175781
10	2002-05-06	105.47000122070312	0
11	2002-10-23	0.0	90.19999694824219
12	2003-02-12	82.0999984741211	0
13	2003-04-02	0.0	88.12000274658203

With the data above, it is possible to compare the CAGR and the maximum drawdown with ‘buy and hold’ strategy. Three Stage Filtering’s total return gave 233.76% from 2000 to 2021, with a **CAGR of 5.38%**. It’s maximum drawdown was calculated to be -39.01%. The ‘buy and hold’ strategy over the past 21 years gave a total return of 217.51%, with a CAGR of 5.15%. It’s maximum drawdown was calculated to be -56.47%. It can be seen that the Three Stage Filtering gives better CAGR and drawdown level, although the difference isn’t significant. It is also compared with other methods which use single indicators, EMA, Stochastics, and MACD Histogram. The data acquired is shown in Table 4.

Table 4. CAGR and Maximum drawdown of different strategies

	Total Profit	CAGR	Maximum Drawdown
Strategy 1: Three Stage Filtering	233.76%	5.38%	-39.01%
Strategy 2: Buy and Hold	217.51%	5.15%	-56.41%
Strategy 3: EMA	47.42%	1.70%	-28.03%
Strategy 4: MACD Histogram	181.55%	4.60%	-32.56%

The data shows that the Three Stage Filtering gives the most profit and a relatively small drawdown compared to the ‘buy and hold’ strategy. The mechanism of combining two indicators for giving trade signals in Three Stage Filtering is definitely more effective than using a single indicator like EMA or MACD Histogram. It also shows that MACD Histogram is a much more sophisticated indicator than EMA.

Exact trading points of the return of Three Stage Filtering is shown in Figure 10 and 11.



Figure 10. Return of Three Stage Filtering (blue line) using standard parameters



Figure 11. The buying and selling points, red shows buy and blue shows sell

3.2 Variables: Timeframes for each Stage

The result from Three Stage Filtering strategy does not show significant difference to ‘buy and hold’ strategy in terms of CAGR, so some methods to improve the strategy were devised. There are plenty of variables that were involved in the Three Stage Filtering strategy. Variables that can be changed are listed below.

1. Number of days for MACD Histogram calculation
2. Number of days to find maximum and minimum value for %K calculation
3. Number of days for %D calculation

The same mechanism of Three Stage Filtering was tested using different variable values, which is shown in the heatmap of Figure 12. There are 6 heatmaps in total, and each of them used a different number of days for MACD Histogram calculation starting from 1 to 6. Each heatmap has x-axis with varying %D calculation and y-axis with varying %K calculation. They show the CAGR achieved from each application for strategy. The brighter the color, the higher CAGR value it has.

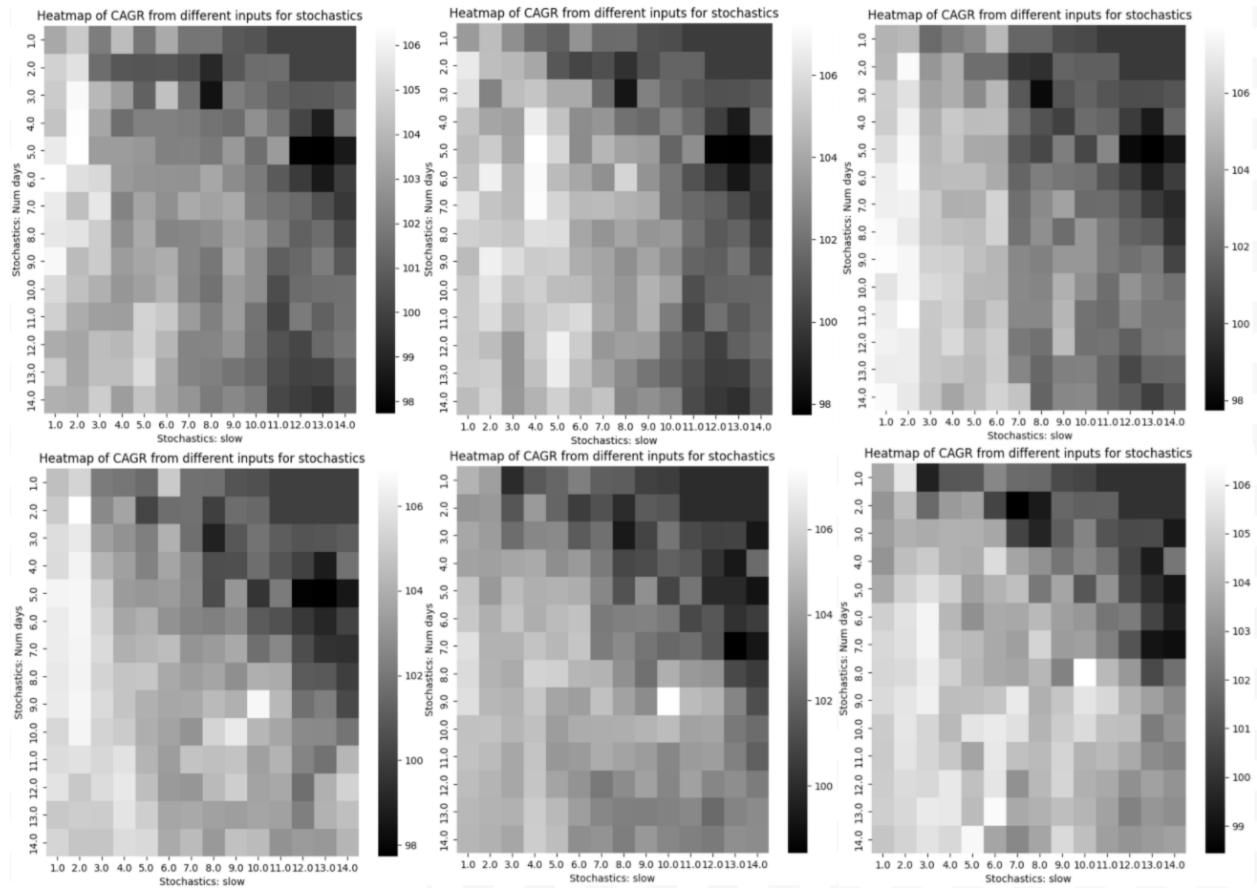


Figure 12. 6 Heatmaps showing area of best CAGR values from altering variables

Different values used for MACD Histogram calculation can be considered to show similar results as the 6 heatmaps have a similar area where it is darker (lower CAGR). It can be seen that the highest CAGR value in every heatmap is greater than 160. They show some similarity that a relatively high CAGR is given when the number of days for %D calculation is low at around 1 to 3. It tends to give higher CAGR when %K is around 9 to 12.

The best data from different variable values is from the 3 day MACD Histogram calculation, as it showed the most cases that beat the ‘buy and hold’ strategy. In fact, some of the data exceeded the ‘buy and hold’ strategy by a significant margin.

Among the 3 day MACD Histogram, the Three Stage Filtering strategy with 11 days for %K calculation and 2 days for %D calculation showed the best result, giving a total percentage change of 457.85% in 21 years. This has a CAGR of 7.76% which is 2.5% higher than ‘buy and hold’, and its maximum drawdown was still relatively low at -37.89%. The graph showing the result is shown in Figure 13.

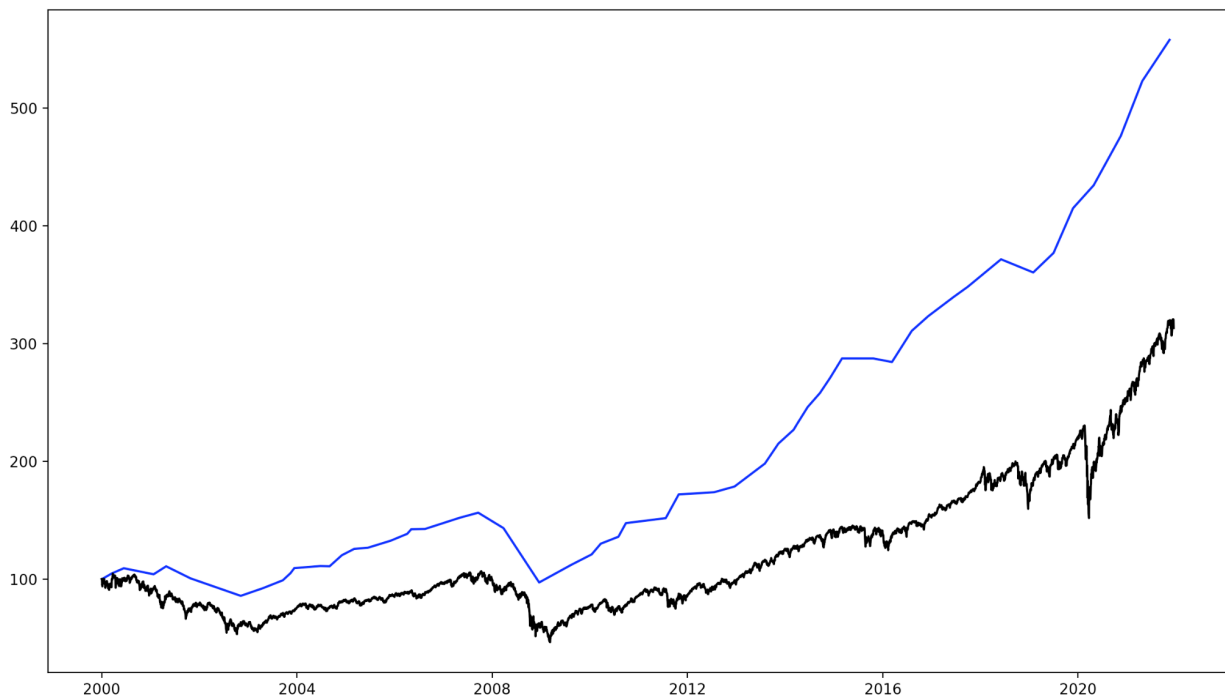


Figure 13. Best return of Three Stage Filtering for S&P 500

3.3 Evaluation of Three Stage Filtering on S&P 500

The Three Stage Filtering strategy applied to the S&P 500 using the MACD Histogram and Stochastics oscillator is shown to be very effective, especially after changing the variables that are most suitable for S&P 500. However, because the strategy was tested on the existing historical data instead of actual investment on the market, the effect on the unknown volatile market can give different results. Yet, almost all Three Stage Filtering strategies including the initial trial gave returns instead of losing money, and it often beats the ‘buy and hold’ strategy. The Three Stage Filtering strategy can now be tested on other markets to test its effectiveness.

4. Testing on other ETFs or individual stocks

Three Stage Filtering strategy was tested on other ETFs like Dow 30, which is another type of major NYSE index tracking ETF. It is also tested on various types of ETFs on different sectors which includes energy, materials, industrials, consumer discretionary, consumer staples, health care, financials, information technology, communication services, utilities and real estate.

4.1 Testing on Dow 30

The testing with 3 day MACD Histogram, 11 days %K and 2 days for %D that gave best results for the S&P 500 were used to be tested on Dow 30. It showed 340.87% in total return over 21 years, and its CAGR was 6.66%. This was much better than the ‘buy and hold’ strategy as it recorded a total return of 210.99% and CAGR of 5.06%.

Similar approach was taken like the S&P 500 to consider different inputs on variables, and the 6 heatmaps are shown in Figure 14.

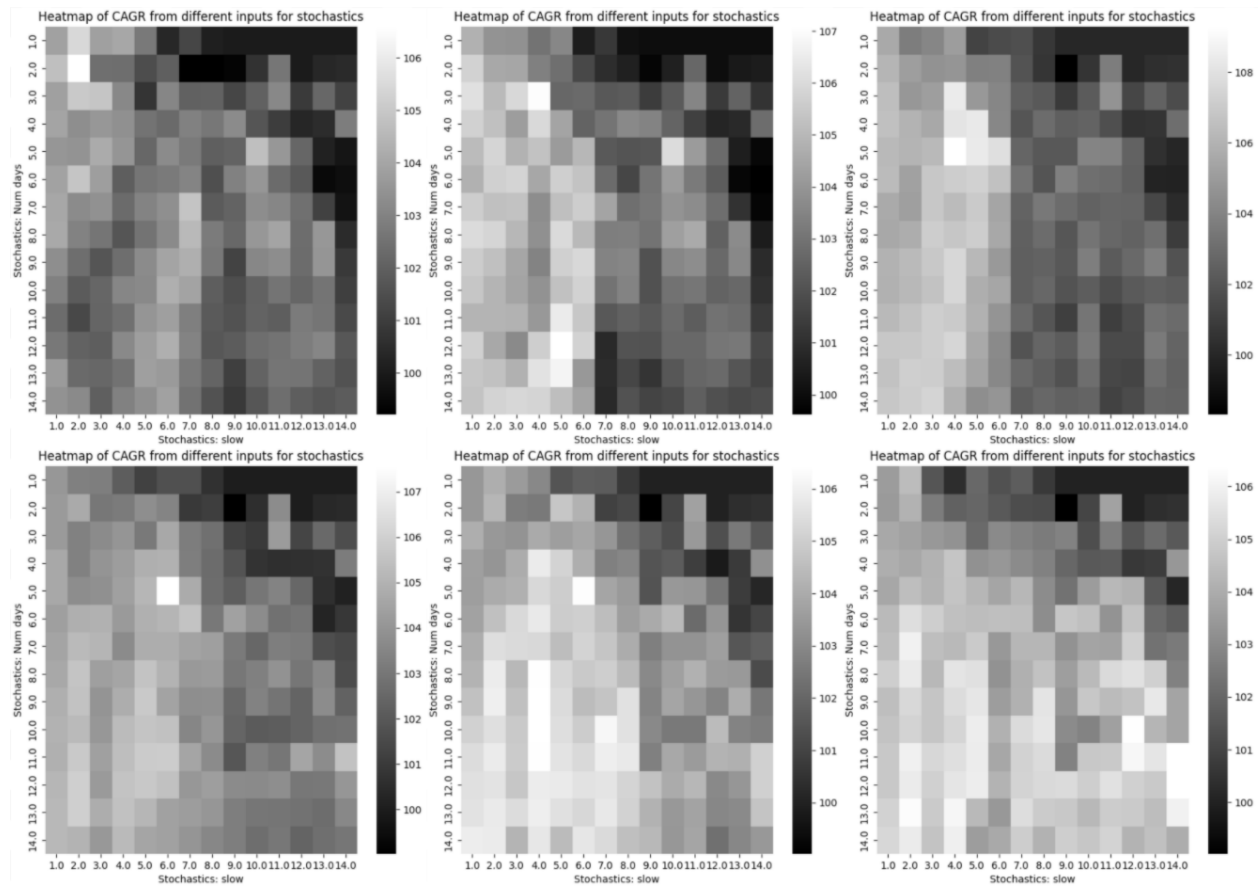


Figure 14. 6 Heatmaps showing area of best CAGR for Dow 30

The best data was achieved from the second table with 3 day MACD Histogram calculation, and 5 days for %K calculation and 4 days for %D calculation. It gives a total return of 670.70% and a CAGR of 9.28%. It's drawdown was only -18.04%. This is much better than the 'buy and hold' strategy as the CAGR is around 4% better.

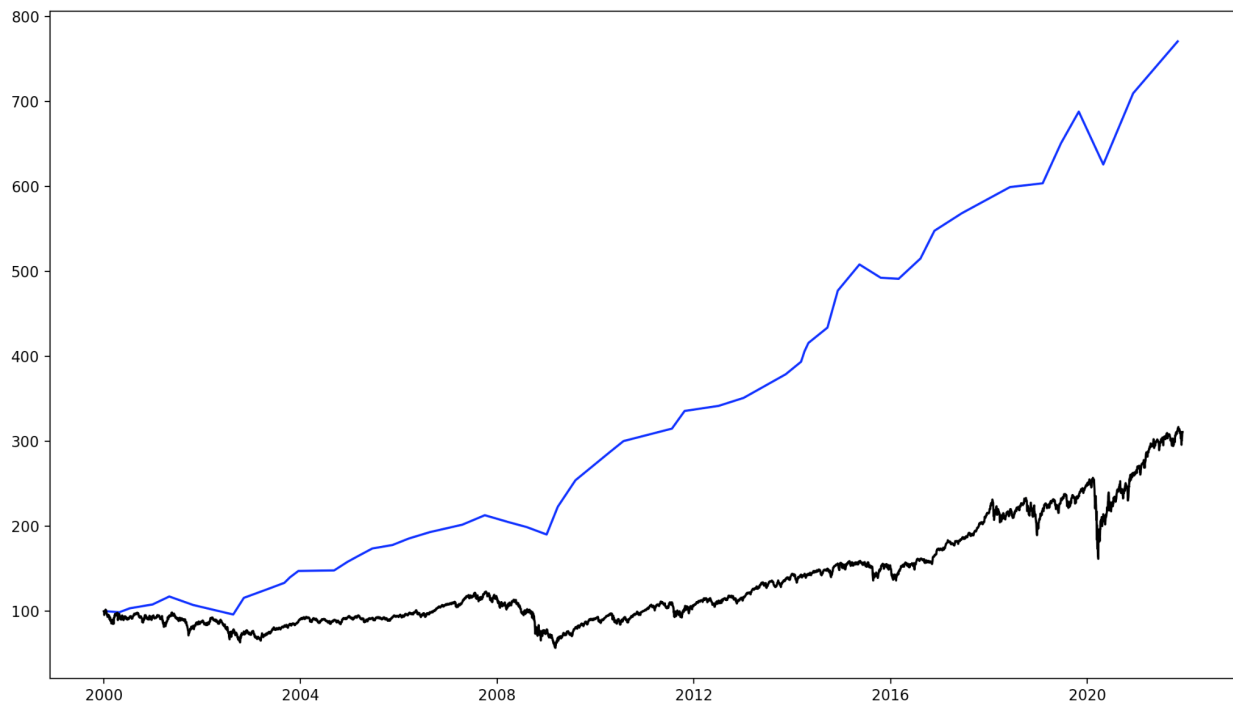


Figure 15. Best return of Three Stage Filtering on Dow 30 compared to real data

From the heatmap of both S&P 500 and Dow 30, there is some similarity between the two. However, it is noteworthy that the variables for the best data were similar where S&P 500 used 3,11,2 and Dow 30 used 3,5,4. To solve the problem of overfitting, the average value of these two sets of variable values from S&P 500 and Dow 30 were found. This reduces the danger of overfitting, which can be caused by relying on a single data point. Therefore, we can say that variable values with 3 day MACD Histogram, 8 day %K and 3 day %D can be used for Three Stage Filtering strategy. These variables were used to be tested on ETFs of different types of sectors in NYSE.

4.2 Testing on 11 different sectors in NYSE

4.2.1 Energy: XLE

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	405.74%	7.30%	-38.26%
Buy and Hold	103.55%	3.14%	-76.73%

4.2.2 Materials: XLB

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	177.11%	4.53%	-43.90%
Buy and Hold	230.61%	5.34%	-60.72%

4.2.3 Industrials: XLI

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	431.36%	7.53%	-27.02%
Buy and Hold	251.81%	5.62%	-63.34%

4.2.4 Consumer Discretionary: XLY

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	1148.78%	11.60%	-18.40%
Buy and Hold	547.31%	8.46%	-60.13%

4.2.5 Consumer Staples: XLP

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	284.66%	6.03%	-17.35%
Buy and Hold	229.86%	5.32%	-37.81%

4.2.6 Health Care: XLV

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	188.31%	4.71%	-22.02%
Buy and Hold	348.94%	6.75%	-40.58%

4.2.7 Financials: XLF

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	422.64%	7.45%	-34.79%
Buy and Hold	101.85%	3.10%	-83.75%

4.2.8 Information Technology: SMH

<i>From 2000-06-05</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	-2.43%	-0.11%	-78.31%
Buy and Hold	214.28%	5.34%	-85.92%

4.2.9 Communication Services: XTL

<i>From 2011-01-07</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	98.79%	6.44%	-29.36%
Buy and Hold	94.70%	6.24%	-32.63%

4.2.10 Utilities: XLU

<i>From 2000-01-03</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	201.77%	4.92%	-25.60%
Buy and Hold	151.31%	4.09%	-55.67%

4.2.11 Real Estate: IYR

<i>From 2000-06-19</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	85.95%	2.86%	-54.71%
Buy and Hold	218.00%	5.40%	-76.51%

11 sectors in NYSE were tested with the 3 day MACD Histogram, 8 day %K and 3 day %D as the variable values of the Three Stage Filtering strategy. All of the data showed that the drawdown of the Three Stage Filtering strategy is lower than the ‘buy and hold’ strategy, proving one reason why this strategy is successful. Also, out of the 11 tests on different sectors 7 tests succeeded to beat the ‘buy and hold’ strategy for CAGR. Some beat significantly especially in the energy sector.

4.3 Average CAGR from individual companies in S&P 500

Every individual company in the S&P 500 was tested with the Three Stage Filtering strategy. The average of every data with equal weights were calculated. All historical data from 2000 were used.

Table 5. Average CAGR and Drawdown of every individual company in S&P 500

	Total Profit	CAGR	Drawdown
Three Stage Filtering	394.28%	7.13%	-42.89%
Buy and Hold	217.51%	5.15%	-56.41%

It is tested that only 47 of the 492 individual stocks in S&P 500 ended up with losing money from the Three Stage Filtering strategy, which is less than 10% of whole stocks. Considering the better CAGR value and maximum drawdown, it can be concluded that the Three Stage Filtering strategy gives a solid return.

5. Application to other markets

5.1 Testing on cryptocurrency: Bitcoin

<i>From 2014-09-17</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	105.82%	9.44%	-58.67%
Buy and Hold	11344.33%	78.80%	-83.40%

5.2 Testing on cryptocurrency: Ethereum

<i>From 2000-06-19</i>	Total Profit	CAGR	Drawdown
Three Stage Filtering	743.73%	35.62%	-56.78%
Buy and Hold	144277.68%	182.72%	-93.96%

The application of Three Stage Filtering strategy is shown to be not effective by the charts above. While the 'buy and hold' strategy's CAGR value exceeds any stocks that are invested in this paper, the CAGR for Three Stage Filtering only achieved 9.44 and 35.62 percent. This shows that Three Stage Filtering is not suitable for the cryptocurrency market. But this shows well that Three Stage Filtering strategy always has a better drawdown level than 'buy and hold' of any market.

6. Conclusion

Development and analysis of the Three Stage Filtering strategy showed that testing on every market produces return. The total return consistently gave greater return than using a single indicator for testing. From the testing on S&P 500 and Dow 30, it is discovered that the variable values to use in the Three Stage Filtering strategy is 3 day MACD Histogram, 8 day %K and 3 day %D. The use of the variables granted a 2.5% better CAGR value compared to 'buy and hold' strategy for the benchmarks of the U.S. stock market. Applications to sector ETFs and individual stocks showed that the strategy works well for the stock market. Applications to cryptocurrency didn't perform competently to 'buy and hold' strategy. However, in every single application of the strategy, the drawdown was less than the 'buy and hold' strategy, which can be considered as the biggest advantage of this strategy.