Development and Analysis of Trading Strategies Using William %R, Momentum, Relative Strength Index, Directional Movement Index, and Rate of Change

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1.ABSTRACT

Five functions were developed first to implement, and graph five stock indicators used in this project (William %R, Directional Movement Index, Relative Strength Index, Rate of Change, and Momentum Index) with user-set parameters. Five functions were created to simulate trading strategies with different indicators calculated by the previous algorithms respectively and generate the trading result for each ETF. Another five functions were then developed for each indicator and used to run through all the possible trading strategies with different indicators' parameters and buy or sell signals. After that the optimal indicators' parameters and buy or sell signals were obtained for each ETF. Four groups of different categories optimal indicators' parameters and buy or sell signals were then tested on SPY ETF (S&P 500) against simple buy and hold strategy. Results show that the performance of the optimal indicators' parameters and buy or sell signals obtained from our training data applied successfully to SPY ETF and on average outperformed the simple buy and hold strategy indicating that there must be patterns among setting the optimal indicator parameters and buy or sell signals for trading ETFs.

2.INTRODUCTION

When it comes to investing, although individual investors have the motive to invest in the market, time and resources constraints often become their limit to study the market and execute trades at the correct timing. However, with the help of technical analysis, investors are able to conduct a thorough forecast on future price movements based on the past price movements within stock charts and make proper trading decisions with technical indicators.

In 2007, legendary investors Warren Buffett made a $1 million bet against Protégé Partners that hedge fund wouldn't outperform an S&P index fund, and he won. Therefore, this project is aimed to find the patterns among the parameters of widely used indicators, and its corresponding buy or sell signals and provide individual investors the optimal trading strategy for trading "Warren Buffett" recommended country index ETFs. The project was achieved through a python program, and this report will further explain in detail what primary function this program did and how it achieved the objective.

2.1 System

All coding functions in this project were developed based on a stock analysis program (Stoxy) created by Prof. David Rossiter. The program was developed under python and several libraries were applied including Pandas data reader, Matplotlib and Numpy. The python development environment used here was Spyder.

2.2 Assumption

1. All values mentioned in this report are quoted in USD.
2. The initial amount for investment in each scenario was $1,000,000
3. The applicability of those strategies was only tested for a long-term investment with approximately eleven and a half years. A long-term investment was assumed to be:
    - An investor puts in $1,000,000 at the beginning, trades according to the buy or sell signal generated by the indicators and then takes out the money at the end.
    - The very first order has to be a buy order.
    - When a buy order was set, the entire amount-at-hand to spend was spent on purchasing the maximum quantity of ETF at the closing price of that day.
    - When a sell order was set, the entire quantity of ETF purchased was sold at the closing price of that day.

- Quantities are positive integers only.
- When a buy order has been set, the next order has to be a sell order. Conversely, when a sell order is set, the next order has to be a buy order.

4. 14 country index ETFs were chosen to be the training data for my project and 4 categories groups of optimal indicators parameters and buy or sell signals were formed to test the trading strategies performance on SPY. Those 14 index ETFs and SPY are proper training and testing data considering those countries are the largest economies in the world and a decent representation of the overall market behavior. Therefore, the results of this project are a good benchmark for future country index ETFs trading.

Table 1: List of ETFs chosen for this project

REGION	ETF (COUNTRY)	DESCRIPTION
ASIA	EWH (HONG KONG)	iShares MSCI Hong Kong index Fund
	GXC (CHINA)	SPDR IX SHS FUN/S&P CHINA ETF
	EWJ (JAPAN)	iShares MSCI Japan index ETF
EUROPE	EWU (UNITED KINGDOM)	iShares MSCI United Kingdom Index
	EWG (GERMANY)	iShares MSCI Germany ETF
	VGK	Vanguard FTSE Europe index ETF
USA	VTI (ALL USA)	Vanguard Total Stock Market ETF
	IWM	iShares Russell 2000 Index
	OEF	iShares S&P 100 index
	QQQ	PowerShares QQQ Trust
	DIA	SPDR Dow Jones industrial average ETF
	RSP	Guggenheim S&P 500 Equal Weight ETF
	IOO	iShares S&P Global 100 index
	IVV	iShares S&P 500 index
	SPY (S&P 500)	SPDR S&P 500 ETF

3.PROCESS FLOW

This project utilized the following steps in the following order:

1. Get data for all ETFs from Yahoo! Finance
2. Generate and perform the technical Indicators with different parameters (E.g., RSI 10, RSI 20, DMI 10, DMI 20 …)
3. Find the best-performed indicators parameters and buy sell signals for each ETFS (going through all the possible inputs)

4. Assign ETFs and its corresponding optimal indicators parameters into four categories of groups and simulate the trade with each indicator's group average parameters and buy or sell signals on SPY (S&P 500 ETF)
5. Compare the above result 4) with a simple buy and hold strategy on SPY.

At first, all the relevant data was gathered from Yahoo Finance. Then five python functions (WMRProfitLossOneStock, DMOProfitLossOneStock, RSIProfitLossOneStock, ROCProfitLossOneStock, and MTMProfitLossOneStock) were executed to generate and perform the technical indicators with different parameters and different buy or sell signals to figure out the optimal parameters (time interval) and signals to trade specific stocks (ETFs). After, all the optimal parameters of best performed indicators (WMR, RSI, MTM and ROC) of each ETF were assigned into four categories of groups (all the training ETFS, ETFs with similar buy and hold annualized return as SPY, western countries index ETFs, and all optimal parameters excluding outliers) and tested on SPY (S&P 500 ETF). Moreover, to test the effectiveness of the optimal indicators parameters and buy or sell signals, profit results of the above groups were compared and tested against simple buy and hold strategy. In the end, trading strategies using the optimal parameters and buy or sell signals generally outperformed simple buy and hold strategy by 2% to 5%.

4.OBTAIN DATA

The data for all the ETFs were downloaded from Yahoo Finance. Data can be directly added from Yahoo Finance by using the add function on Stoxy. Since the data was downloaded from the Yahoo Finance, the data had a set time frame. Based on the available data for each of the ETFs, an around 11-and-a-half-year dataset was found to be the largest common data range. Hence, the data ranges from 23rd March 2007 to 9th November 2018.

4.1 Assumptions

1. A 1-year horizon consists of 252 trading days (accounting for holidays).

2. An 11.6-year interval was chosen based on the ETFs used for this project. (Since the financial crisis happened during this period, this timeframe can be a good representation of how real macro economy really behave)
3. This project used daily data for the actual trading days only.

5.TECHNICAL INDICATORS AND TRADING STRATEGIES

INDICATORS AND TRADING STRATEGIES USED IN THIS PROJECT:

5.1 William %R Index (WMR)

William %R is a type of momentum indicator that moves between 0% and 100%. It gained renown as an indicator because of its capability to measure overbought and oversold levels in the sense that being able to anticipate when market reversals may occur is invaluable for analysts and traders. Thus, this indicator is widely used to find entry and exit points in the market.

In the William %R formula, highest high represents the highest price over the look-back period N and the lowest low is the lowest price over what is known as the look-back period. Determining the look-back period is the first step a trader need to take. After, the indicator can be used to help determine whether market is near the high or the low, or in the middle.

Trading Strategy:
Traders would set -x as a signal of stock being overbought (sell signal)
And -y as a signal of stock being oversold (buy signal), so when William %R (N) surpasses -x, traders would sell and when WMR(N) drops below -y, traders would buy. Traditional settings set the time frame of William %R to 14 days, use -20 as the overbought threshold and -80 as the oversold threshold. These levels can be adjusted to suit analytical needs and security characteristics. My goal of this project is to find the optimal parameters for trading country index ETF especially S&P 500 ETF.

Formula:

Look-back period = N

%R = (Highest High – Close) / (Highest High – Lowest Low) * -100

Lowest Low = Lowest low for the look-back period N

Highest High = Highest high for the look-back period N

%R is multiplied by -100 in order to correct the inversion and move the decimal.

In order to find the ideal look-back period N, overbought and oversold signals which help generate the largest return for specific ETFs. I created a code that would sort them out. (see next page Figure 1)

My code worked in the following way: (Nested for loop was used)

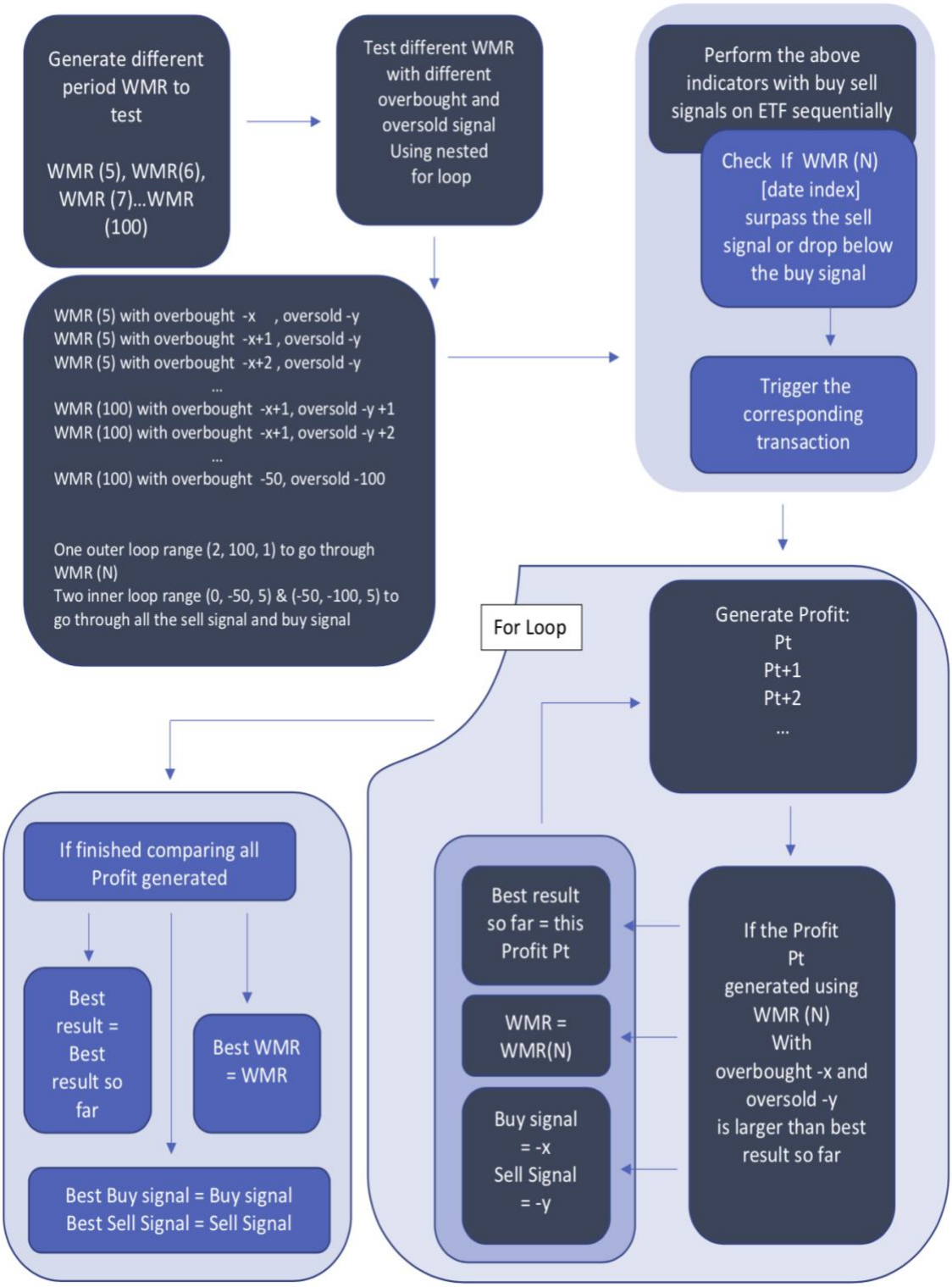


Figure 1: Process flow of the code used to sort optimal William %R inputs

5.2 Directional Movement Index (DMI) & Directional Movement Oscillator (DMO)

Legendary trader and author J. Welles Wilder Jr. introduced the directional movement index, or DMI, in 1978. The intention for this indicator is to help traders measure the strength and direction of a price movement so they could avoid inappropriate entry or exit market timing. The DMI is composed of two different standard indicators, one negative being -DMI and one positive being +DMI, that are always being used alongside. +DMI presents the changes between today's high price and yesterday's high price while -DMI presents the changes between today's low price and yesterday's low price. Directional Movement Oscillator (DMO) is a directional movement oscillator that converts the two lines of DMI (+DMI and -DMI) into a single oscillator that fluctuates above and below zero which is often used as an indicator that identify uptrend or downtrend.

Formula:
First, calculate the +DI and -DI in order to find +DMI and -DMI, and then, calculate the DMO. Traders need to first determine the look-back period N days

To calculate the +DI and -DI we need to find the +DM and -DM (Directional Movement).
+DM and -DM are calculated using the High, Low and Close.

Following Calculation:
Calculate the True Range (TR), +DI, and –DI for each period:
True Range is the greater of:
(Current High – Current Low, Absolute value of Current High – Previous Close, Absolute value of Current Low – Previous Close)
+DM
If Current High – Previous High > Previous Low – Current Low
Then +DM = the greater of Current High – Previous High OR 0

-DM

If Previous Low – Current Low > Current High – Previous High

THEN –DM = the greater of Previous Low – Current Low OR 0

If +DM AND -DM are both negative

Then both +DM and –DM = 0

If +DM AND -DM are both positive AND +DM > -DM

Then +DM = Current High – Previous High and –DM = 0

Else If +DM < -DM

Then +DM = 0 and –DM = Previous Low – Current Low

Smooth the True Range, +DI, and –DI using Wilder's smoothing technique.

Formula:

Present TR = Previous Day TR (N) * (N-1/ N) + Present +TR (1/N)

Present +DI (N) = Previous Day +DI (N) * (N-1/ N) + Present +DM* (1/N)

Present - DI (N) = Previous Day -DI (N) * (N-1/ N) + Present -DM* (1/N)

/*

The very first calculations for +DI(N), -DI(N) and TR(N) are simple N-period averages.

+DI(N) = Sum of +DM over the past N periods / N.

-DI(N) = Sum of -DM over the past N periods / N.

+TR(N) = Sum of TR over the past N periods / N.

*/

Divide the smoothed +DI by the smoothed True Range and multiply by 100

+DMI (N) = +DI(N) / TR(N) *100

Divide the smoothed –DI by the smooth True Range and multiply by 100

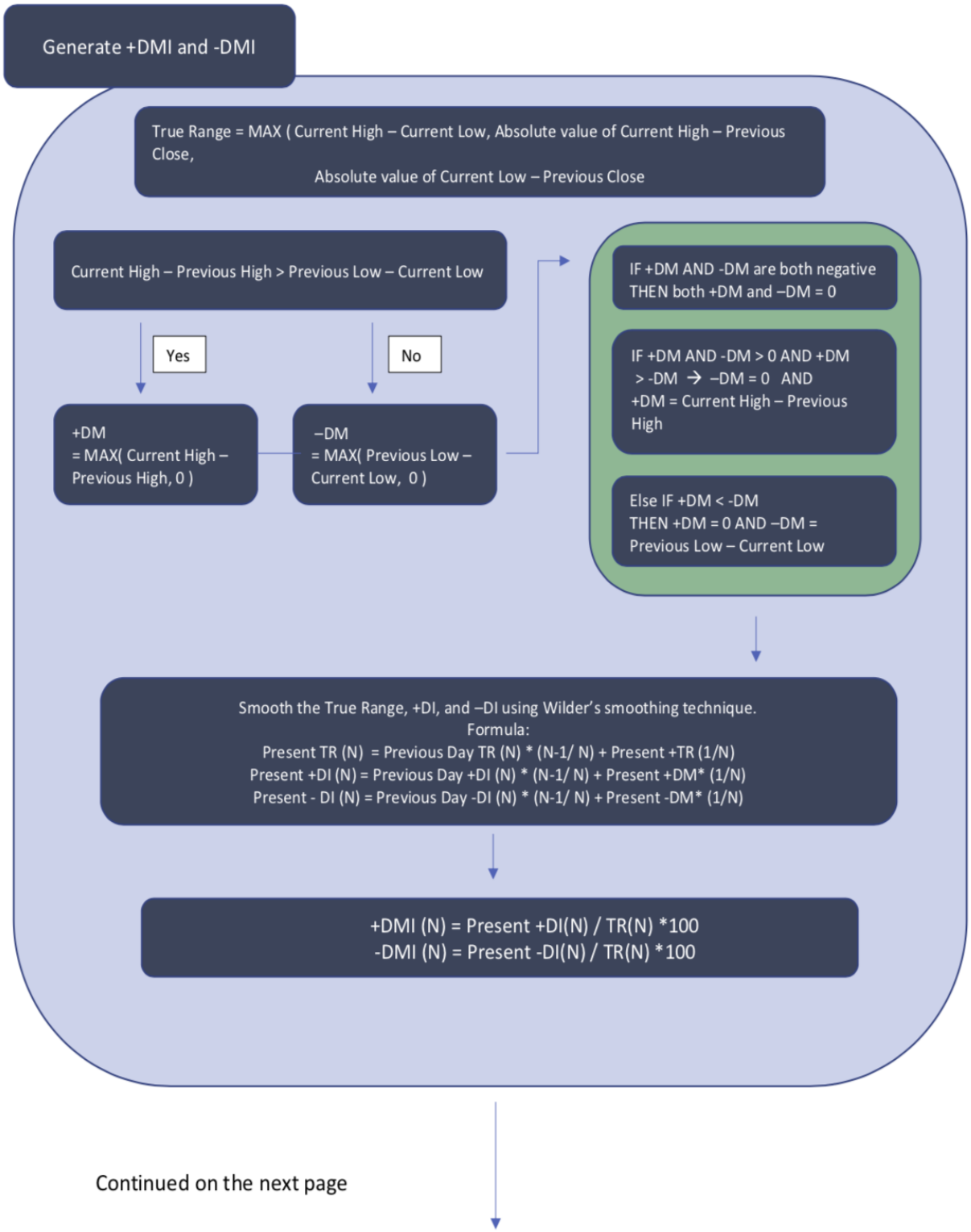
-DMI (N) = -DI(N) / TR(N) *100

Next calculate the Directional Movement Oscillator (DMO), By subtracting -DMI from the +DMI.

Trading Strategy:

When DMO went from negative to positive, traders would treat it as an uptrend signal and buy. When DMO went from positive to negative, traders would treat it as a downtrend signal and sell. In order to find the ideal look-back period N days which help generate the largest return for each ETF. I created a code that would sort out N. (see next page Figure 2)

The code worked in the following way:



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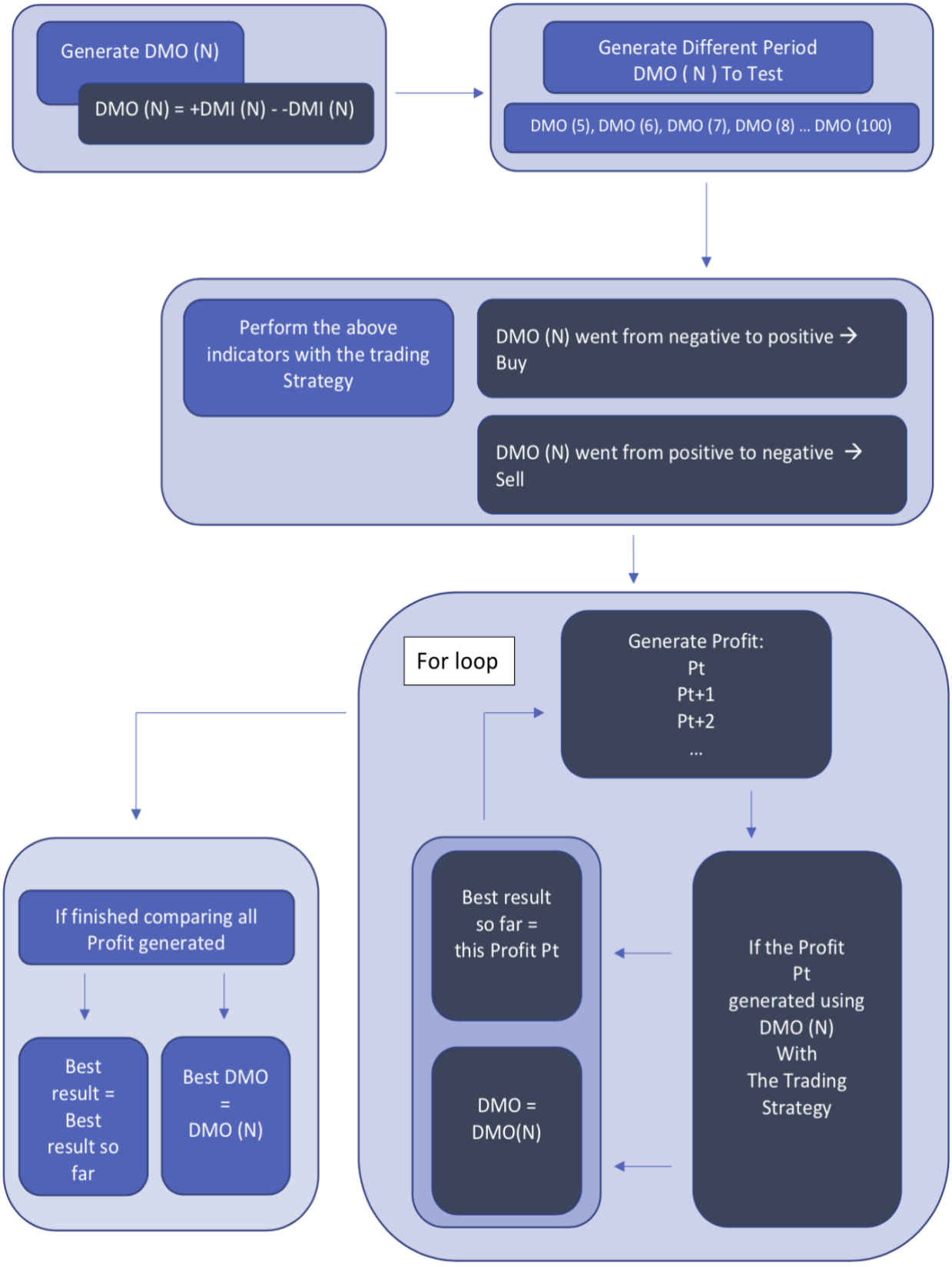

Figure 2: Process flow of the code used to sort optimal DMI inputs

5.3 Relative Strength Index (RSI)

RSI, probably the most popular indicator, is a momentum oscillator that measures the speed and change of price movements in order to assess overbought or oversold conditions in the market. RSI oscillates between 0 and 100 and is often used as an indicator of buy and sell timing.

Formula:

RSI can be broken down into its basic components: RS, Average Gain, and Average Loss. This RSI calculation is based on N days periods set the user. Losses are expressed as positive values, not negative values.

The very first calculations for average gain and average loss are simple N period averages.

First Average Gain = Sum of Gains over the past N periods / N.

First Average Loss = Sum of Losses over the past N periods / N.

The second, and subsequent, calculations are based on the prior averages and the current gain loss:

Average Gain = [(previous Average Gain) x (N-1) + current Gain] / N.

Average Loss = [(previous Average Loss) x (N-1) + current Loss] / N.

RS = Average Gain / Average Loss

RSI = 100 – 100 / (1 + RS)

Trading strategy:

To utilize RSI on trading, Traders will need to decide the look-back period N days first, then set the overbought signal X and oversold signal Y, thus when RSI go from below the overbought signal X to above X, traders will sell; When RSI go from above-oversold signal Y to below Y, traders will buy.

According to Wilder who developed RSI, RSI is considered overbought when above 70 and oversold when below 30. Since I believe these levels can be adjusted

to suit specific analytical needs and security characteristics. My goal of this project is to find the optimal inputs for trading country index ETF especially S&P 500 ETF. In order to find the ideal look-back period N, overbought and oversold signals which help generate the largest return for each ETF. I created a code that would sort them out. (see next page Figure 3)

The code worked in the following way: (Nested for Loops were used)

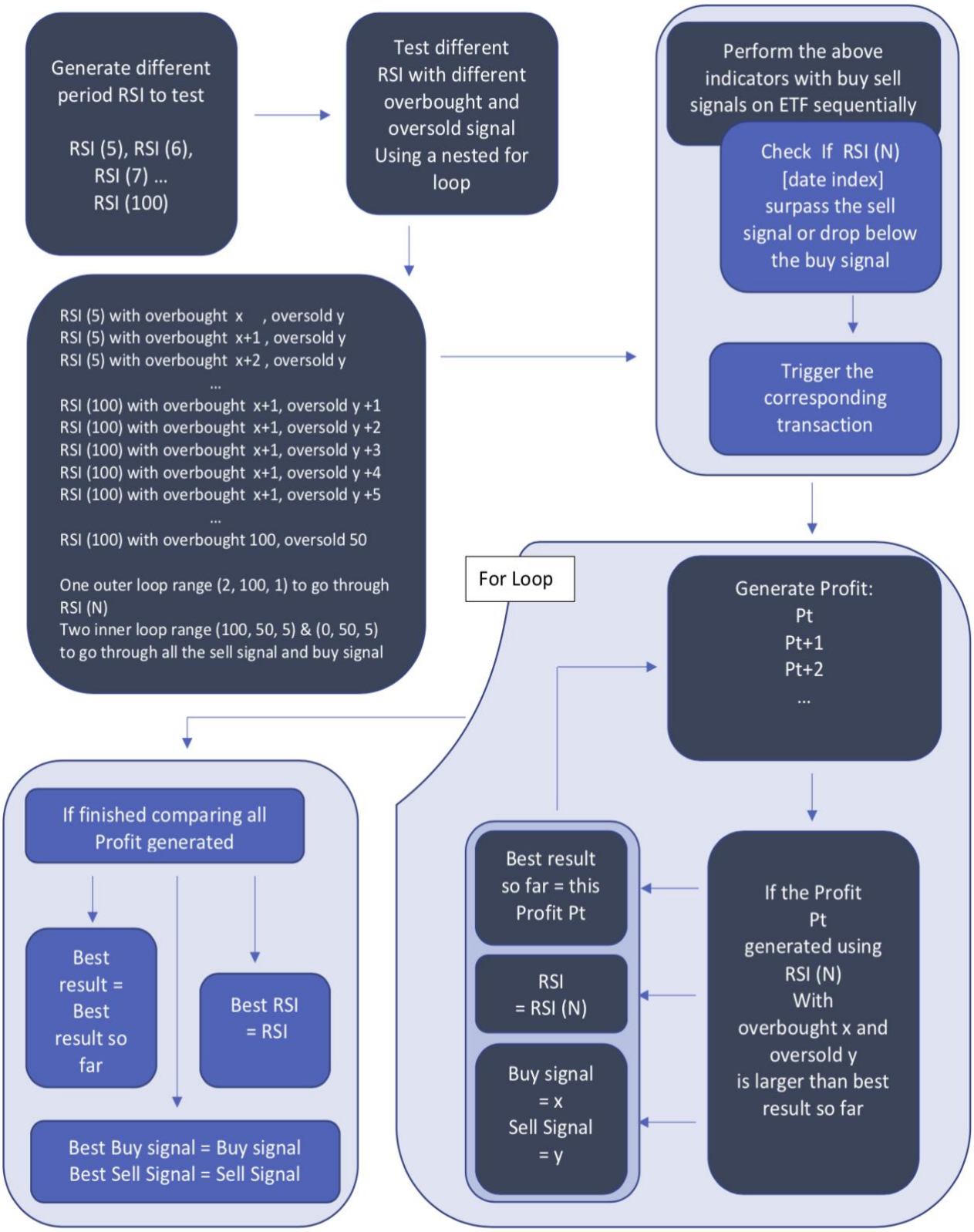

Figure 3: Process flow of the code used to sort optimal RSI inputs

5.4 Rate of Change (ROC)

The Rate-of-Change (ROC) indicator is a pure measurement of momentum oscillation. The intention of this indicator is to assess the percent change in price between a specific time interval. The most common use of this indicator is to identify overbought and oversold condition in the market. Normally a sudden rise in the ROC signals a sharp price advance while a sudden drop indicates abrupt price plunge. Besides, prices are considered bullish as long as ROC is larger than zero and bearish when ROC stays below zero.

Formula:
The calculation of ROC is based on N days periods set by the user.
ROC = [(Close - Close N periods ago) / (Close N periods ago)] * 100

Trading strategy:
To utilize ROC on trading, traders will need to determine the look-back period N days first, in order to enter and exit the market at the proper timing. When ROC (N) goes from negative to positive, an uptrend signal will be triggered and buy transaction will be executed; and when ROC (N) goes from positive to negative, a downtrend signal will be triggered and sell transaction will be processed. Since I believe the time interval N can be adjusted to suit specific analytical needs and security characteristics. My goal is to find the optimal inputs for trading country index ETFs especially S&P 500 ETF. In order to find the ideal look-back period (N) which helps generate the largest return for each ETF. I created a code that would sort them out by simulating all the trading situations. The code worked in the following way (see next page Figure 4).

The code worked in the following way:

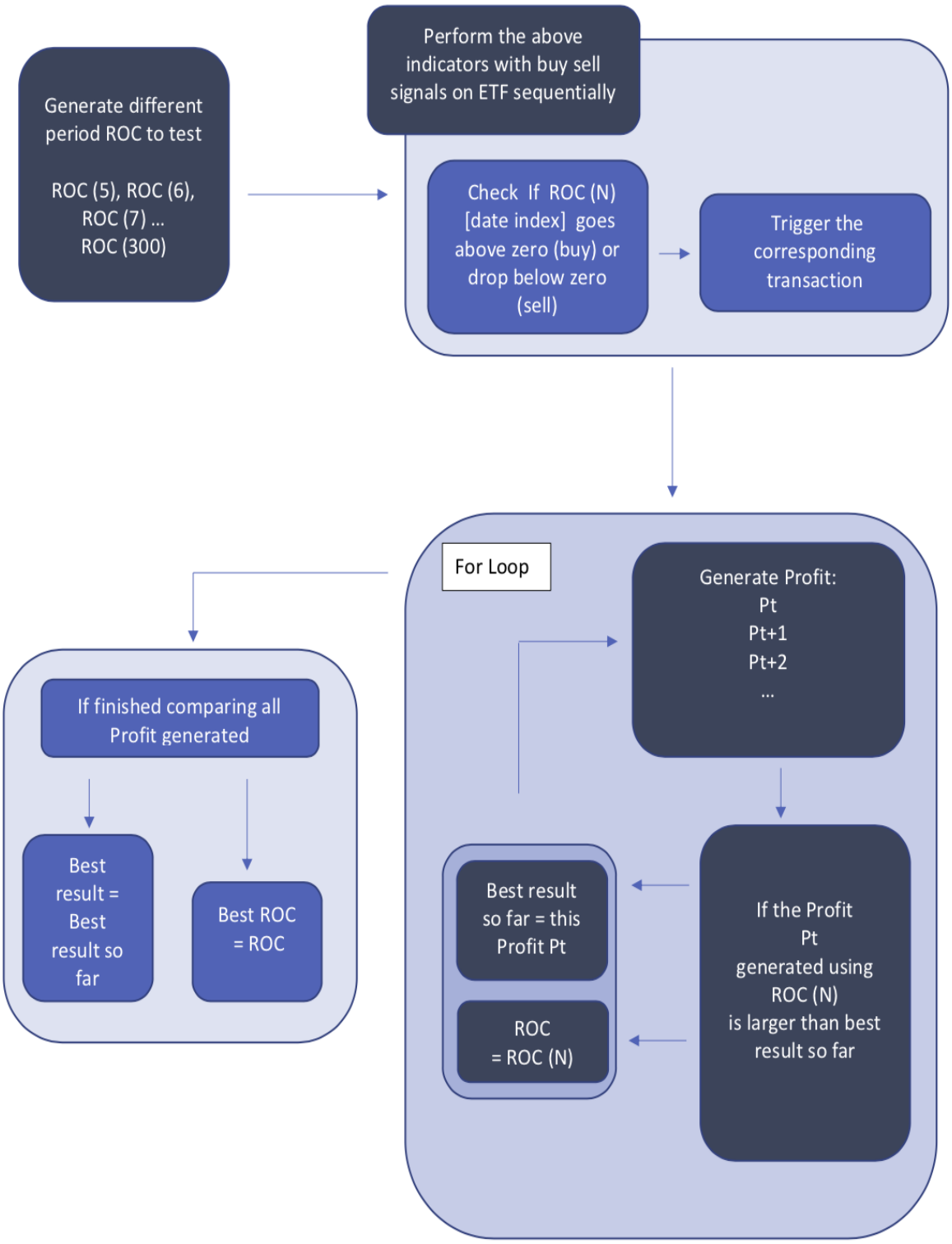

Figure 4: Process flow of the code used to sort optimal ROC inputs

5.5 Momentum (MTM)

The Momentum indicator is simply measuring the differences between the current price and the price in the past. The comparison is made for a certain period specified by the trader. The formula of this indicator is quite simple and straightforward, making it popular among nonprofessional individual investors. The market is considered in the uptrend when the indicator goes up alongside with its specified period (decided by trader) of simple moving average goes from negative to positive. The market is considered bearish when the indicator declines alongside with its specified period of simple moving average drops below zero.

Formula:
Momentum = Latest close - Specified close
where the specified period is any previous price close specified by the trader.

Trading Strategy:
To use momentum indicator in trading, traders will need to decide the look-back period (N days) for the indicator first, then decide the specified period of simple moving average for the indicator, in order to enter and exit the market at the proper timing. When MTM (N days) increases and X-day simple moving average of MTM goes above zero, an uptrend signal will be issued, and a buy transaction will be executed; when MTM (N days) decreases and X-day simple moving average of MTM drops to negative, a downtrend signal will be triggered, and a sell transaction will be processed. Since I believe the time interval N and X can be adjusted to suit specific analytical needs and security characteristics. My goal is to find the optimal inputs for MTM to trade country index ETFs especially S&P 500 ETF. To figure out the ideal look-back period N and time interval X for calculating simple moving average, which helps generate the largest return for each ETF, I created a code that would sort them out by simulating all the trading possibilities. The code worked in the following way (see next page Figure 5).

The code worked in the following way:

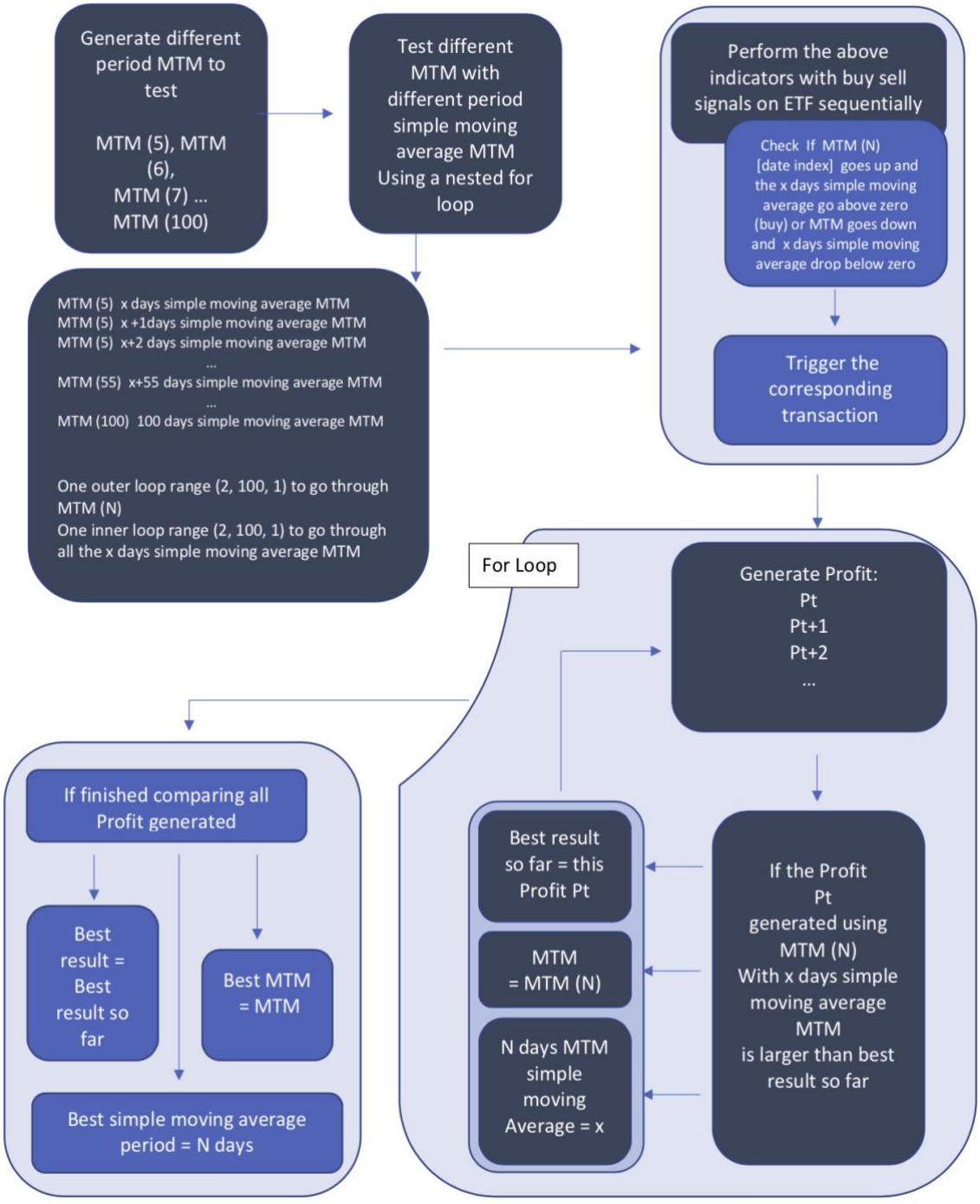

Figure 5: Process flow of the code used to sort optimal MTM inputs

6.RESULTS

6.1 Trading simulation results of each ETF

After finishing the trading simulations of each ETF. Simulations period started from 23rd March 2007 to 9th November 2018. The optimal parameters of each ETF were obtained and summarized in the following (figures 6). Since trading strategies, which used DMO indicator as signals, underperformed the simple buy and hold strategy and other indicators, the DMO indicator was not taken for further investigation in this project. (Average simple buy hold strategy could yield 3.62% annualized return while average return on strategies using DMO was only 3.05%)

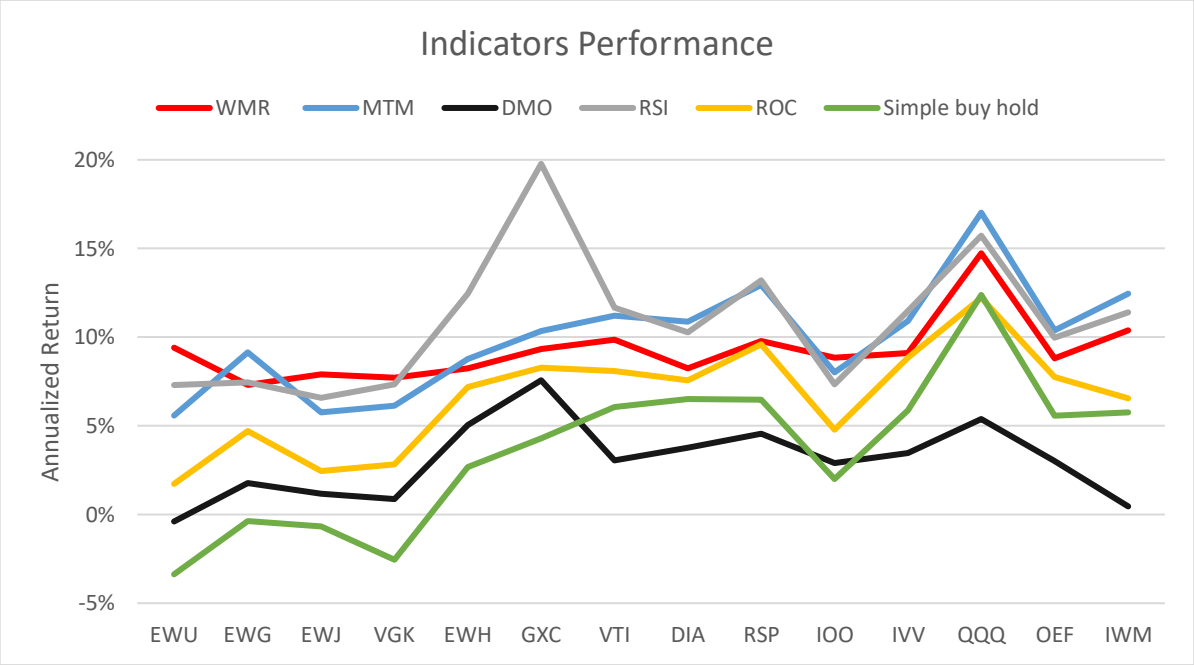

Figure 6: Indicators Performance on each ETF

The best four performing indicators: William %R, Momentum, RSI, and ROC were then chosen to conduct further testing. The optimal parameters of the best four performing indicators for each individual ETF were summarized in the following Tables.

Table 2: ETFs and its corresponding best performing WMR parameters

ETFs	Simple buy & hold Annualized Return	WMR (N) Annualized Return	WMR Optimal Time Interval N Used (days)	Optimal Buy Signal Used	Optimal Sell Signal Used
EWH	2.68%	8.24%	6	-95%	-20%
GXC	4.30%	9.33%	65	-60%	0%
EWJ	-0.67%	7.92%	16	-95%	-40%
EWU	-3.37%	9.42%	12	-90%	-20%
EWG	-0.37%	7.31%	8	-90%	-45%
VGK	-2.54%	7.73%	12	-95%	-40%
VTI	6.05%	9.87%	14	-90%	-15%
IWM	5.77%	10.37%	13	-90%	-15%
OEF	5.59%	8.79%	14	-95%	-20%
QQQ	12.38%	14.73%	34	-90%	0%
DIA	6.52%	8.23%	8	-100%	0%
RSP	6.49%	9.79%	14	-95%	-5%
IOO	1.99%	8.85%	12	-90%	-20%
IVV	5.86%	9.10%	14	-95%	-20%
Average	3.62%	9.26%	17.29	-90.36%	-18.93%

Table 3: ETFs and its corresponding best performing RSI parameters

ETFs	Simple buy & hold Annualized Return	RSI (N) Annualized Return	RSI Optimal Time Interval N Used(days)	Optimal Buy Signal Used	Optimal Sell Signal Used
EWH	2.68%	12.44%	47	35	65
GXC	4.30%	19.77%	20	30	75
EWJ	-0.67%	6.58%	5	25	65
EWU	-3.37%	7.32%	11	35	55
EWG	-0.37%	7.44%	5	40	55
VGK	-2.54%	7.35%	6	30	60
VTI	6.05%	11.67%	54	35	65
IWM	5.77%	11.39%	47	35	65
OEF	5.59%	9.97%	17	25	85
QQQ	12.38%	15.73%	26	25	100
DIA	6.52%	10.26%	20	25	85
RSP	6.49%	13.21%	32	30	70
IOO	1.99%	7.34%	6	25	60
IVV	5.86%	11.47%	5	10	95
Average	3.62%	10.85%	21.5	28.93	71.43

Table 4: ETFs and its corresponding best performing MTM parameters

ETFs	Simple buy & hold Annualized Return	MTM (N) Annualized Return	MTM Optimal Time Interval N Used (days)	X-day Used to Calculate simple moving average
EWH	2.68%	8.78%	5	42
GXC	4.30%	10.34%	11	6
EWJ	-0.67%	5.75%	10	32
EWU	-3.37%	5.58%	53	19
EWG	-0.37%	9.16%	46	6
VGK	-2.54%	6.12%	6	67
VTI	6.05%	11.23%	7	92
IWM	5.77%	12.45%	6	40
OEF	5.59%	10.40%	8	33
QQQ	12.38%	17.02%	60	20
DIA	6.52%	10.86%	40	5
RSP	6.49%	12.95%	7	87
IOO	1.99%	8.01%	6	55
IVV	5.86%	10.93%	95	11
Average	3.62%	9.97%	25.71	36.79

Table 5: ETFs and its corresponding best performing ROC parameters

ETFs	Simple buy & hold Annualized Return	ROC (N) Annualized Return	ROC Optimal Time Interval N Used (days)
EWH	2.68%	7.20%	43
GXC	4.30%	8.27%	41
EWJ	-0.67%	2.45%	131
EWU	-3.37%	1.73%	140
EWG	-0.37%	4.70%	102
VGK	-2.54%	2.83%	138
VTI	6.05%	8.11%	110
IWM	5.77%	6.54%	184
OEF	5.59%	7.76%	122
QQQ	12.38%	12.22%	120
DIA	6.52%	7.55%	155
RSP	6.49%	9.61%	133
IOO	1.99%	4.80%	153
IVV	5.86%	8.84%	122
Average	3.62%	6.62%	121

6.2 Distribution of ETFs and its Corresponding Optimal Indicators Parameters

Given the above summary, the distribution of the optimal indicators' parameters was summarized in the following figures. Some clear patterns among the optimal inputs for three indicators (WMR, RSI, ROC) could be observed from the below histograms. For example, the patterns among optimal time intervals used to calculate William %R fell in the range of 12 days to 18 days and optimal WMR values set to trigger buy orders were in-between -90% to -95%. Optimal WMR values set to trigger sell order were in-between -25% to -15%. Other patterns include:

1. Optimal look back period for RSI fell in-between 5 days to 15 days.
2. Optimal RSI values used as buy signals were in the range of 23 to 30.
3. Optimal RSI values used as sell signals lay in range of 50 to 65.
4. Optimal look back period for ROC were in the range of 120 days to 132days.

By identifying the patterns from those training ETFs historical datasets, we can get a better understanding of the optimal parameters and how the ideal value should be set for further study and trading in the future. (see the following figures)

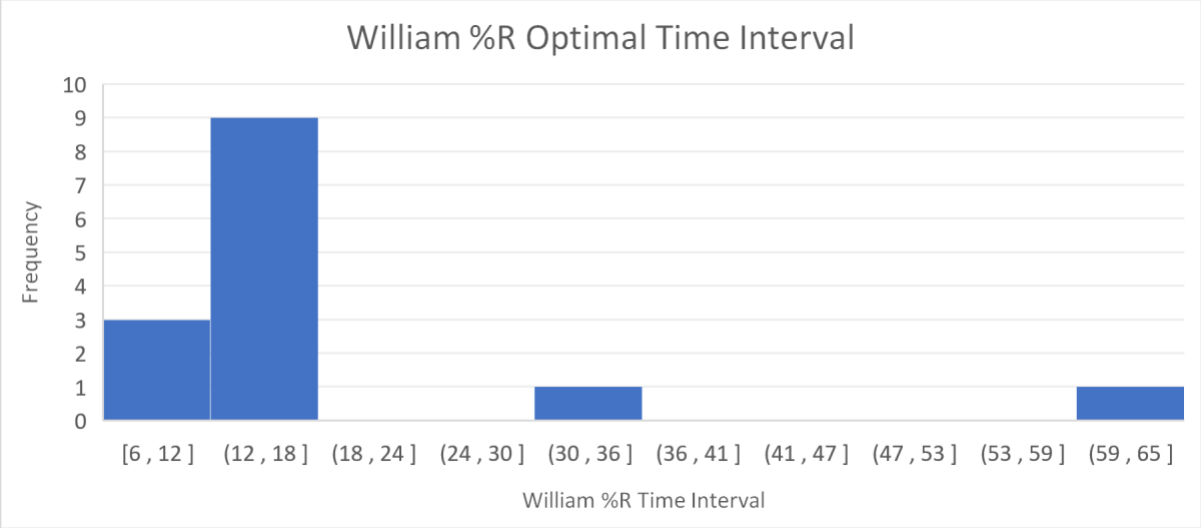

Figure 7: Distribution of WMR optimal time interval

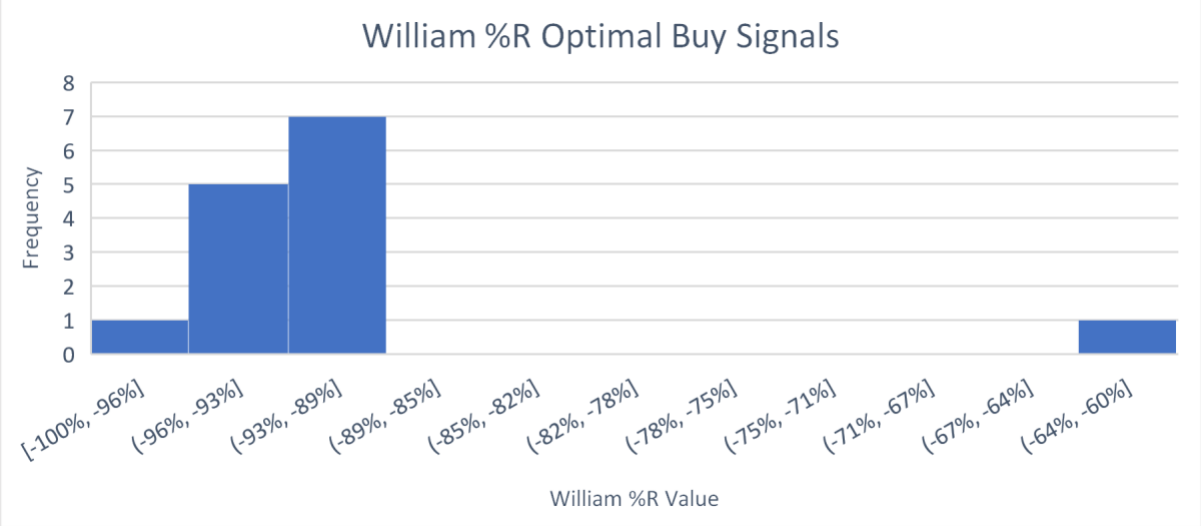

Figure 8: Distribution of optimal WMR buy signals

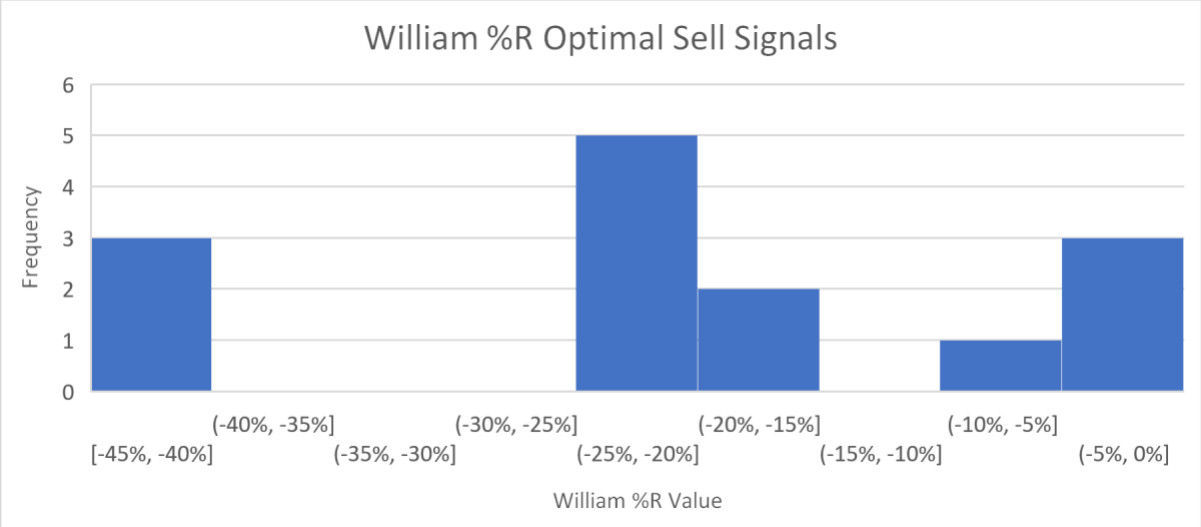

Figure 9: Distribution of optimal WMR sell signals

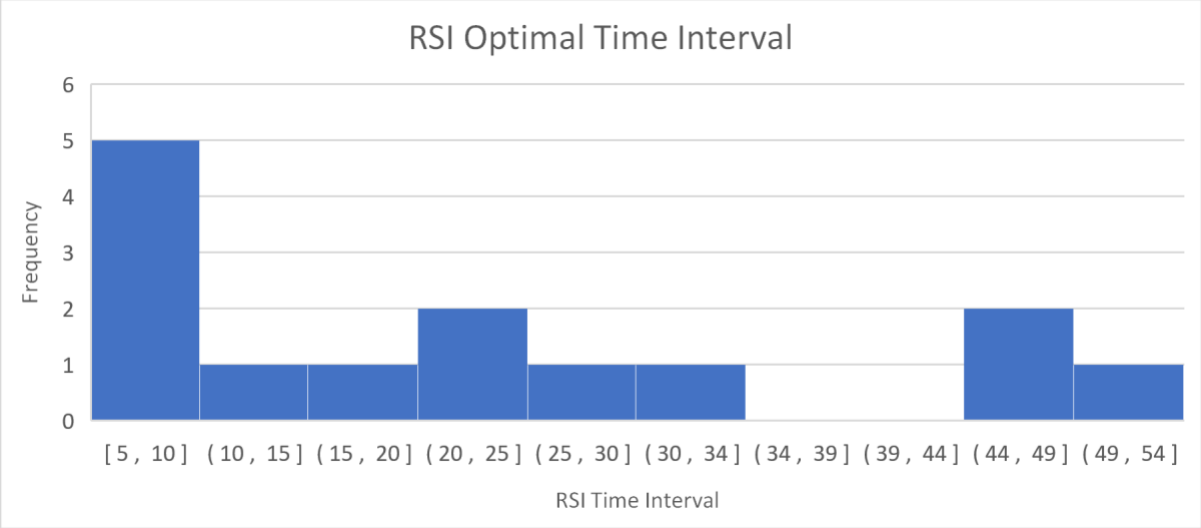

Figure 10: Distribution of optimal RSI time interval

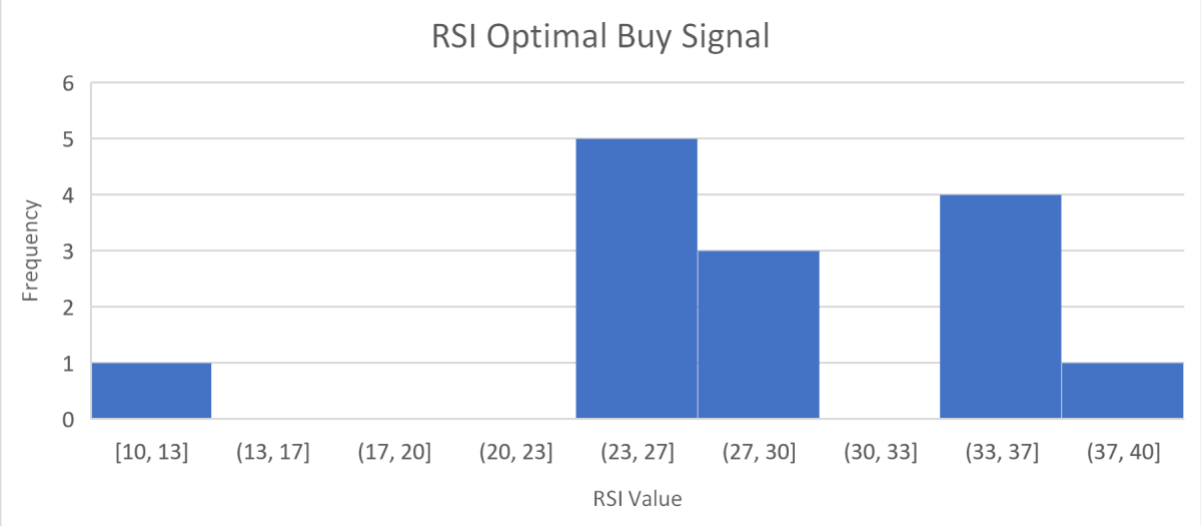

Figure 11: Distribution of optimal RSI buy signals

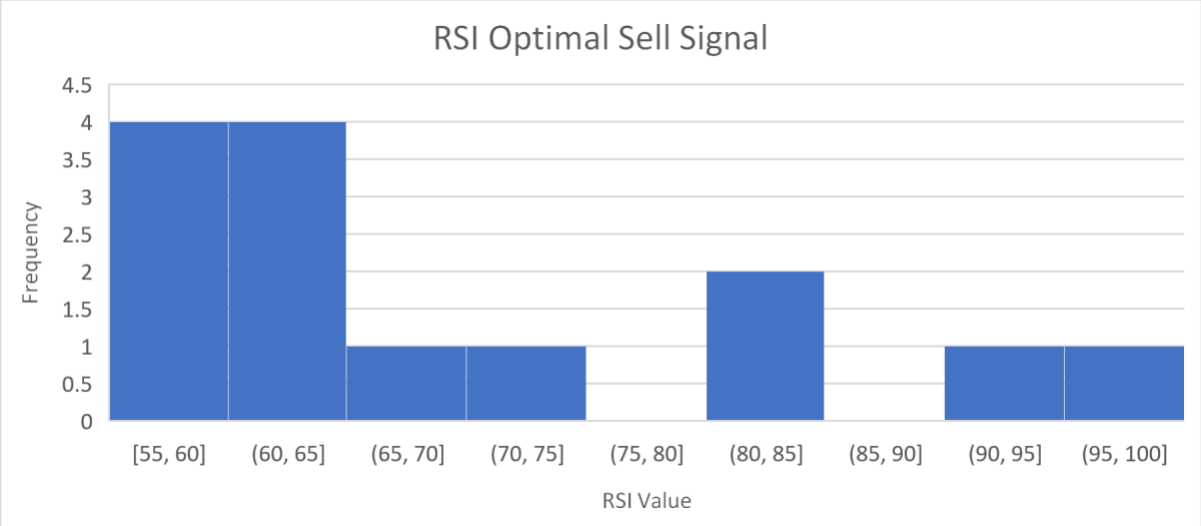

Figure 12: Distribution of optimal RSI sell signals

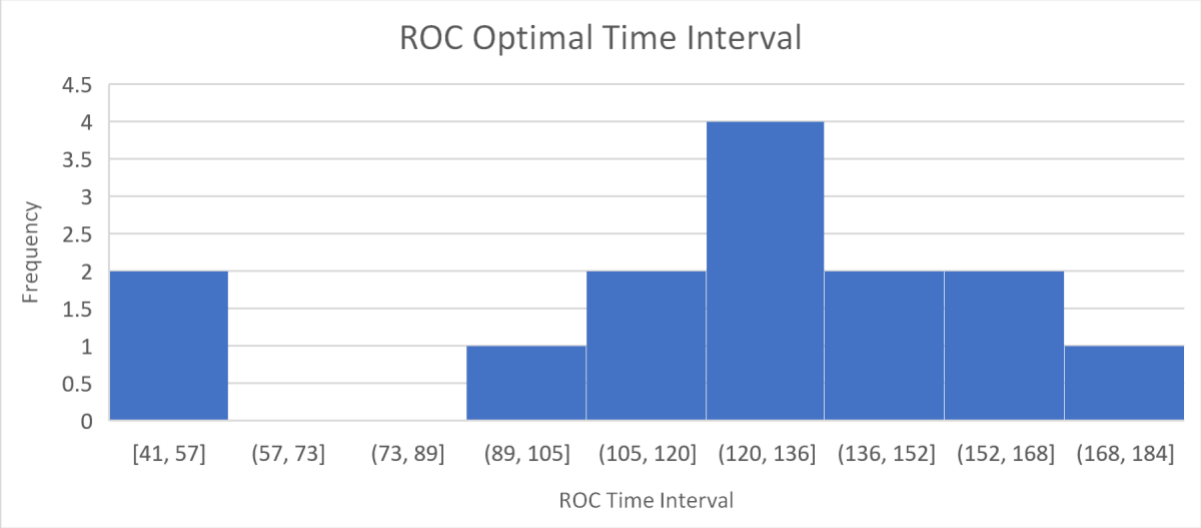

Figure 13: Distribution of optimal ROC time interval

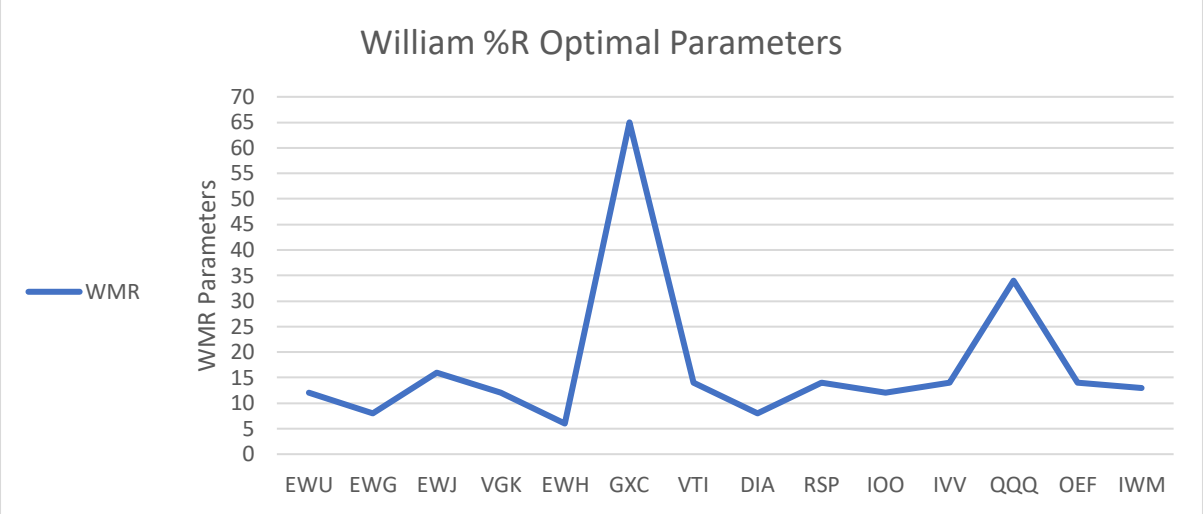

Figure 14: Optimal WMR time interval of each ETF

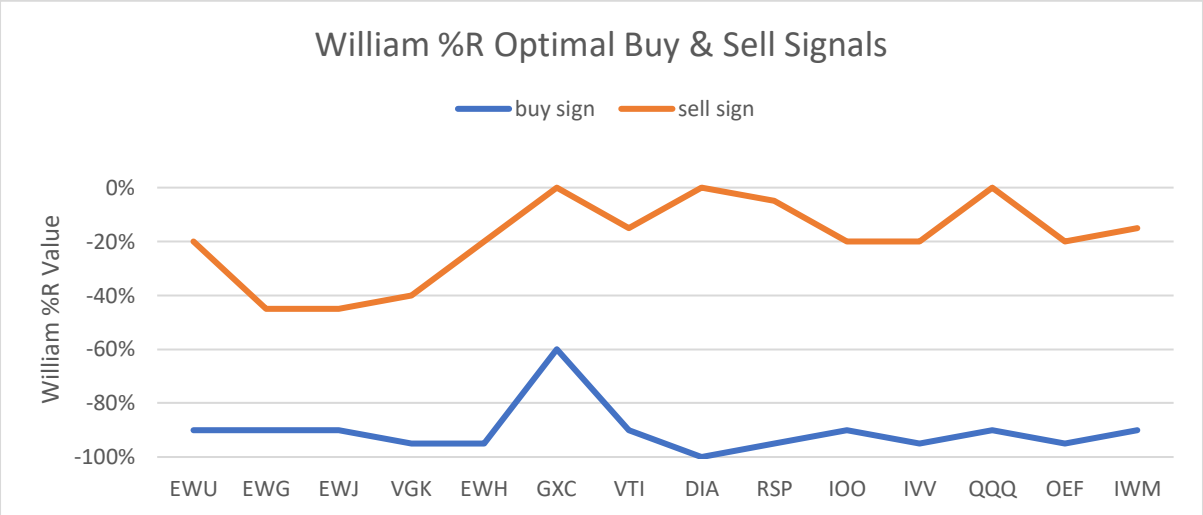

Figure 15: Optimal WMR buy & sell signals of each ETF

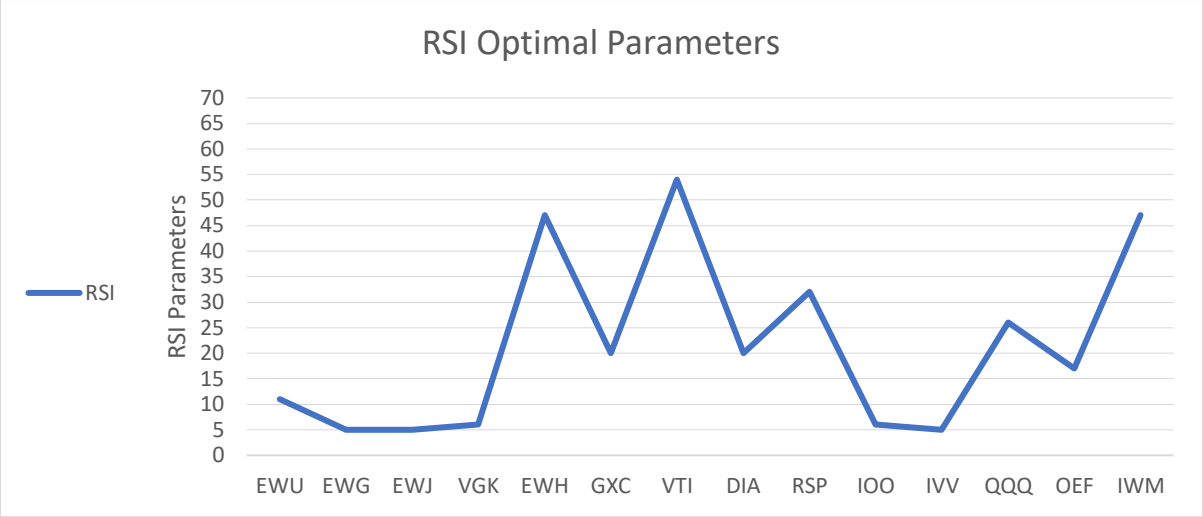

Figure 16: Optimal RSI time interval of each ETF

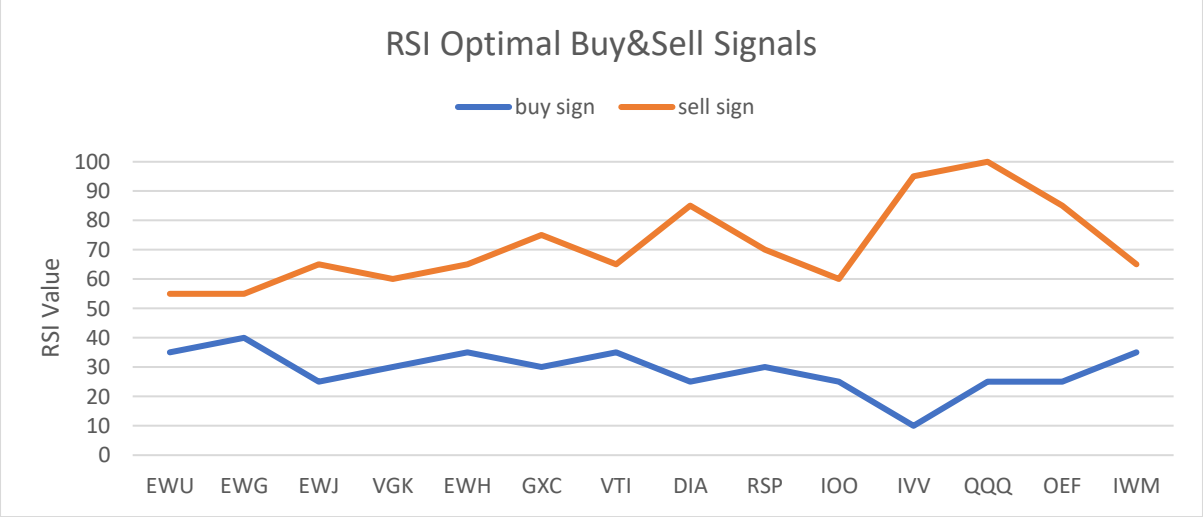

Figure 17: Optimal RSI buy & sell signals of each ETF

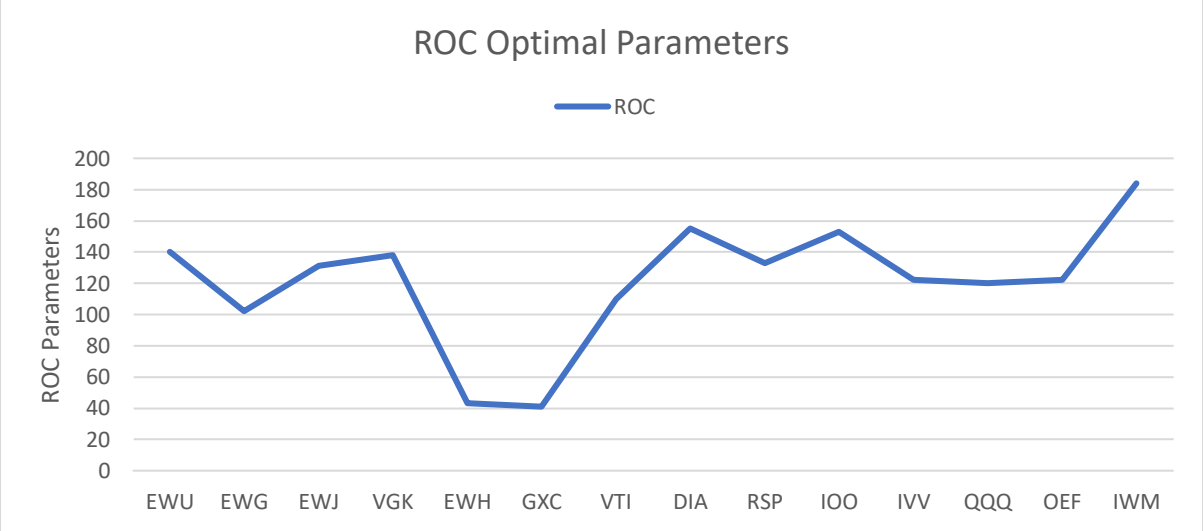

Figure 18: Optimal ROC time interval of each ETFs

7.TESTING ON S&P 500 INDEX ETF

The best four performing indicators: William %R, Momentum, RSI, and ROC were then chosen to conduct further testing on SPY (S&P 500 ETF) to backtest the applicability of the optimal results and form a guidance on how the indicators parameters should be determined. Each ETF and its corresponding optimal indicators' parameters were assigned into four categories of groups.

Group 1: This group only took ETFs, which had similar simple buy and hold annualized return as SPY, into account to concentrate on markets that shared similar growth scale.

Group 2: This group simply included all the ETFs.

Group 3: This group considered only western countries index ETFs in the sense that they shared similar market characteristic and fluctuation which may yield better results.

Group 4: This groups took in all the optimal parameters and screened out the outliers to reduce noisy data.

After, I took a simple average of the optimal parameters of four different groups and simulated the trade using those average indicators' parameters group by group to measure the applicability of those numbers. The trading simulation period was from 23rd March 2007 to 9th November 2018 based on the largest data range. The testing results were organized and showed in the below tables and figures. The highlighted parts in the following table are strategies, which outperformed simple buy & hold strategy on SPY, using the group's average indicators' parameters as their indicators' inputs and group's average buy sell signals as their buy sell signals. (for comparison)

Table 6: The trading simulation results of SPY

	Group 1	Group 2	Group 3	Group 4
Simple Buy Hold Annualized Return on SPY	5.86%	5.86%	5.86%	5.86%
WMR Annualized Return	7.74%	4.87%	8.64%	7.01%
Average Time Interval Used	13	17	14	13
Average Buy Signal Used	-94%	-90%	-93%	-93%
Average Sell Signal Used	-13%	-19%	-18%	-17%
RSI Annualized Return	10.49%	8.46%	6.75%	7.20%
Average Time Interval Used	29	22	21	14
Average Buy Signal Used	27	29	29	29
Average Sell Signal Used	78	71	72	83
ROC Annualized Return	6.72%	6.71%	5.48%	5.48%
Average Time Interval Used	138	121	134	134
MTM Annualized Return	0%	4.35%	0%	0%
Average Time Interval Used	27	26	30	8
Average X-Day Used to Calculate Simple Moving Average	45	37	40	52

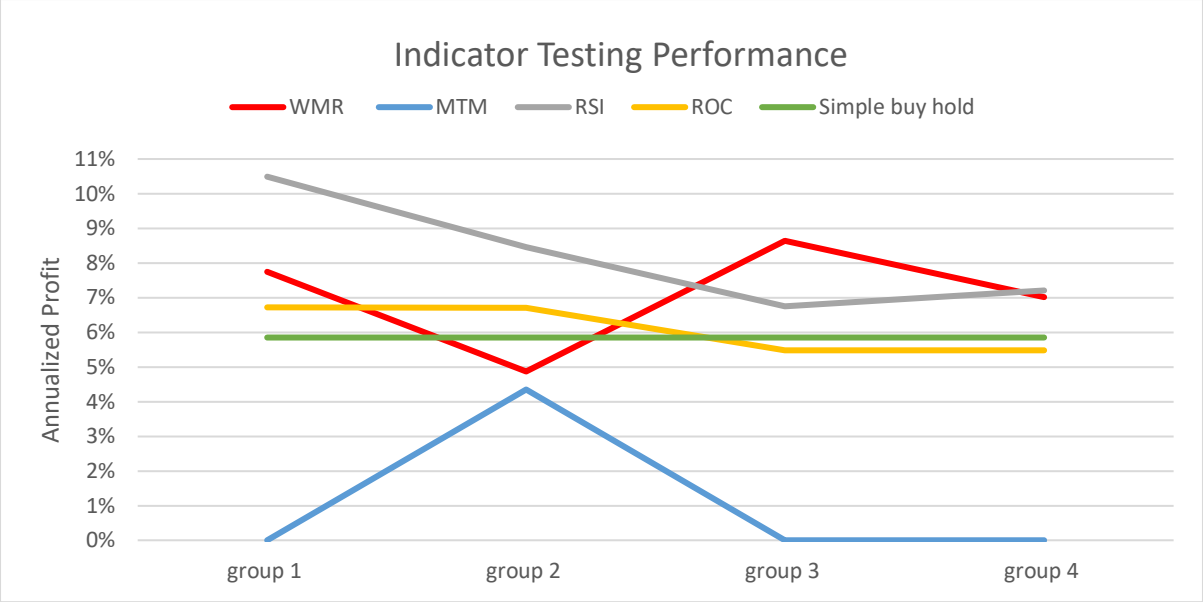

Figure 19: Trading simulation results and simple buy hold result on SPY

As we can see from the diagrams above, the results showed that regardless of the groups tested, trading strategies using William %R and RSI outperformed strategies using ROC and MTM as trading indicators. Besides, trading strategies utilizing WMR and RSI generally yielded a much better return in comparison with simple buy hold, indicating that those two indicators are optimal and suitable to initiate a buy or sell signal. Thus, according to the project results, the optimal trading indicators for trading SPY (S&P 500 index) are using 14 days look back period William %R indicator with buy signal equals to -93% (WMR value) and sell signal equals to -18% (WMR value); and RSI with 29-day time interval, indicating buy signal when RSI value equals 27 and sell signal when RSI value equals 78. Strategies utilizing ROC were not recommended in the sense that they only gave an average annual return of 6.09% which was only 0.24% higher than simple buy and hold strategy that gave an annual return of 5.85%.

8.CONCLUSION

Results show that William %R and RSI are the best two performing indicators out of five indicators tested in this project. To be able to forecast and signal correct market reversal timing, proper parameters of indicators and correct buy or sell signal are needed. Thus, the goal of this project is to figure out the optimal inputs for trading

country index ETF especially S&P 500 ETF. Several programming functions were developed to sort out the answer. According to the results of the trading simulations, the optimal trading indicators for trading SPY (S&P 500 index) are using:

- WMR 14 days with buy signal -93% and sell signal -18% which gave an annual return of 8.64% was 2.79% higher than simple buy and hold strategy which yielded an annual return of 5.85%.
- RSI 29 days with buy signal 29 and sell signal 78 which gave an annual return of 10.49% was 4.64% higher than simple buy and hold strategy which yielded an annual return of 5.85%.

Moreover, considering different market characteristics and the patterns observed among the optimal parameters from the above trading results, a much-generalized conclusion on the ideal range of the parameters and buy or sell signals of both William %R and RSI for trading country index ETFs should be:

- WMR (12 days to 18 days) with buy signal (WMR values from -90% to -95%) and sell signal (WMR values from -20% to -25%)
- RSI (15 days to 20 days) with buy signal (RSI values from 25 to 30) and sell signal (RSI values from 75 to 85)

In conclusion, from the trading simulations results of the ETFs tested in this project. We can see that by following the optimal indicators' parameters and initiating trade according to their corresponding optimal buy or sell signals within the tested range of dates (from 23rd March 2007 to 9th November 2018), Strategies which used WMR as indicator could gain on average 9.26 % annual return which was 5.64% higher than simple buy and hold strategy that on average yielded 3.62% annual return; Strategies using RSI as indicator could generate on average 10.85% annual return which was 7.23% higher than simple buy and hold strategy that yielded 3.62% return annually. Both indicating that those two technical indicators are optimal and suitable to initiate a buy or sell signal.

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10.APPENDIX

All the indicators were graphed and compared to diagrams from Tradingview to ensure the quality of this project https://www.tradingview.com/chart/nEn9KYXB/

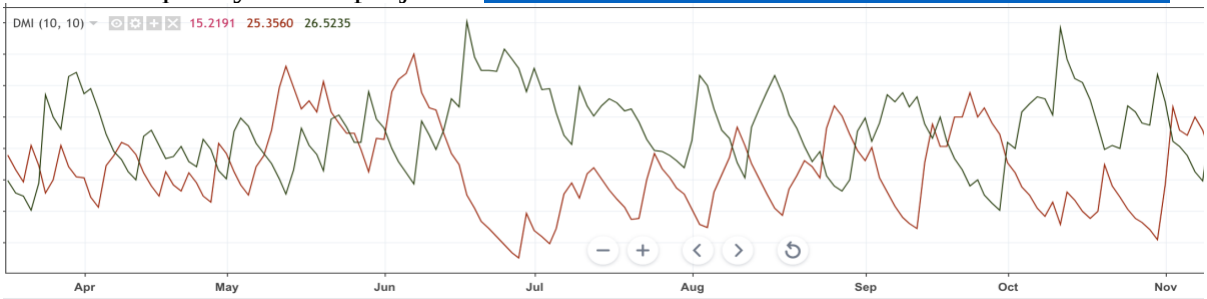

Figure 20: Diagram of DMI 10 (stock: HK2800) from Tradingview

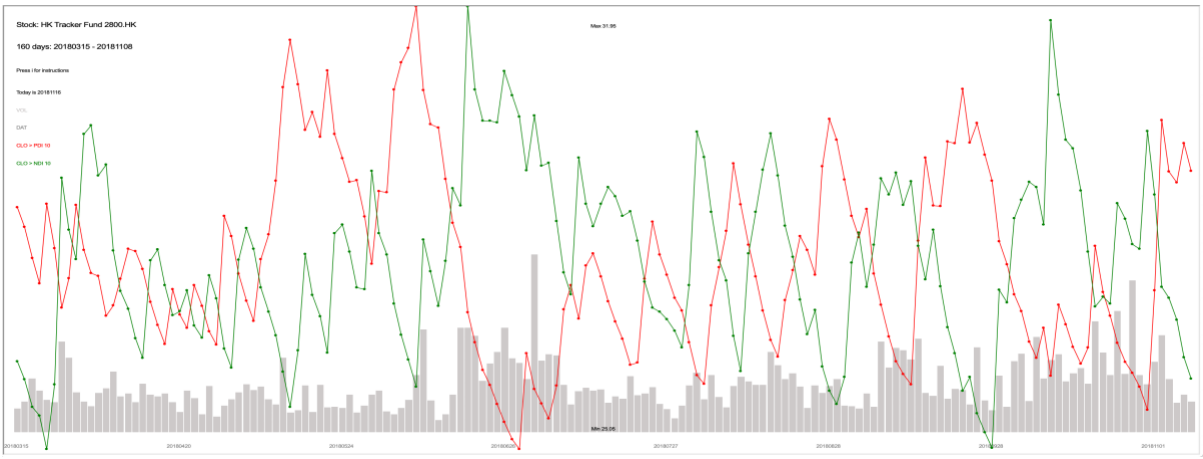

Figure 21: DMI 10 (stock: HK2800) graphed using Stoxy

Figure 22: Diagram of WMR 14 (stock: HK2800) from Tradingview

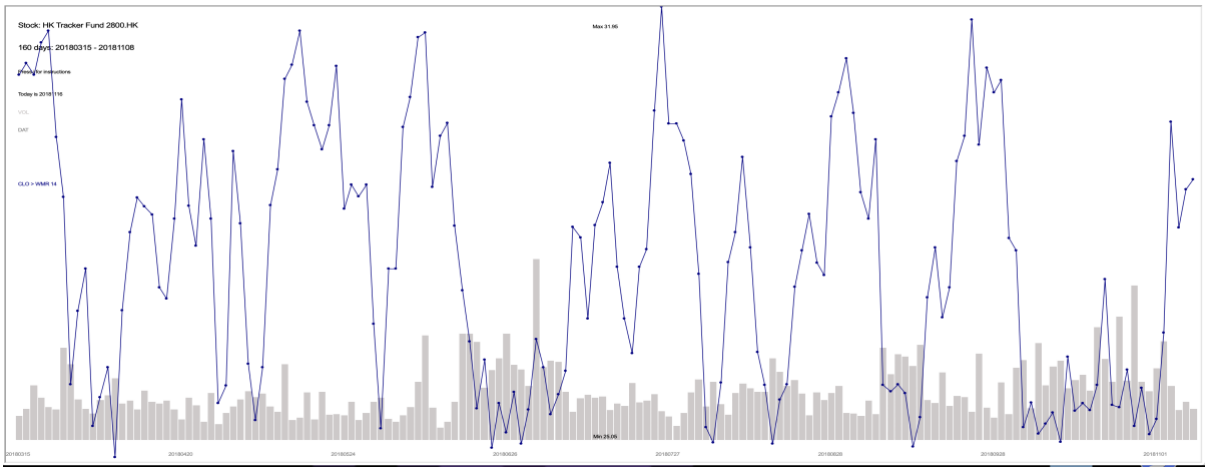

Figure 23: WMR 14 (stock: HK2800) graphed using Stoxy

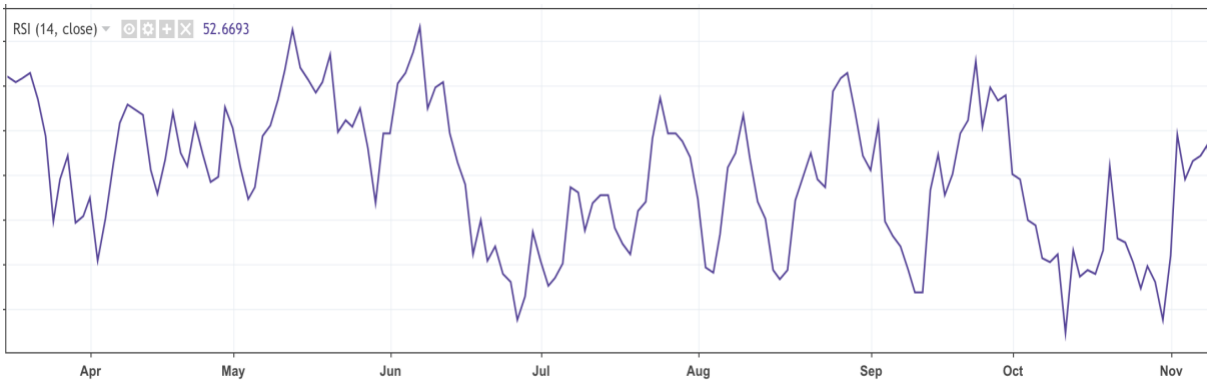

Figure 24: Diagram of RSI 14 (stock: HK2800) from Tradingview

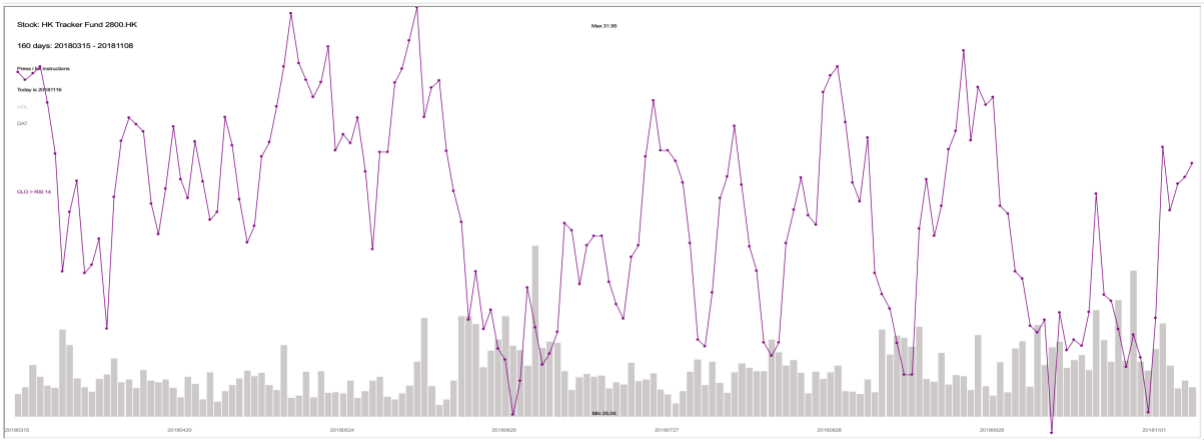

Figure 25: RSI 14 (stock: HK2800) graphed using Stoxy

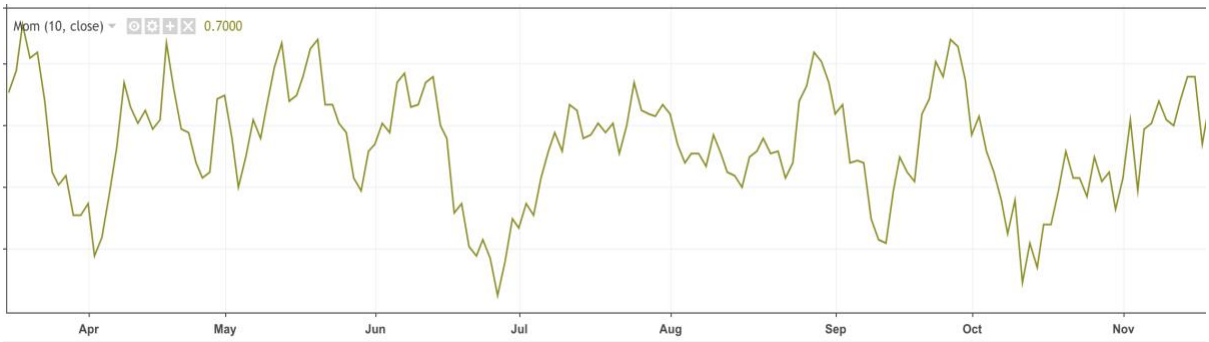

Figure 26: Diagram of MTM 10 (stock: HK2800) from Tradingview

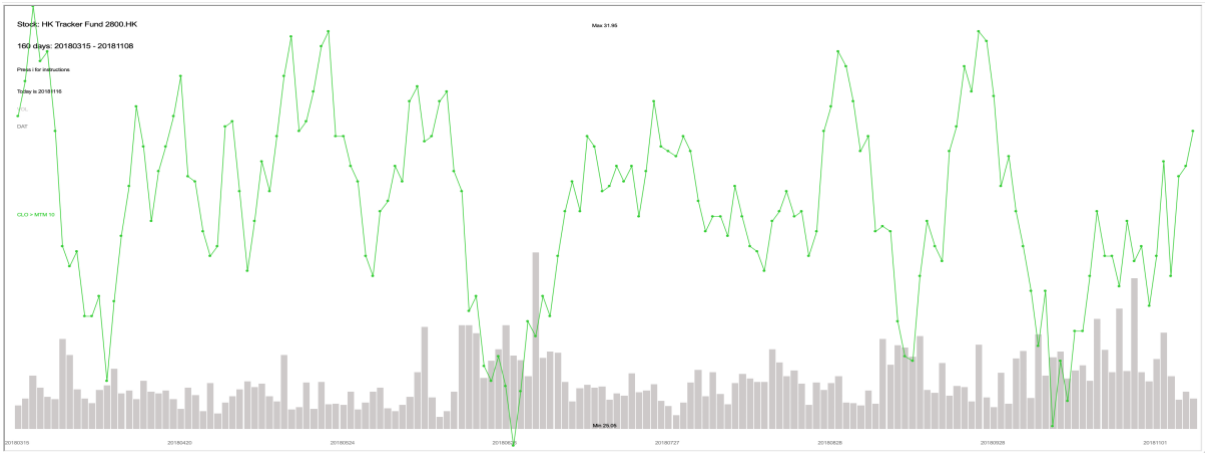

Figure 27: MTM 10 (stock: HK2800) graphed using Stoxy

Figure 28: Diagram of ROC 9 (stock: HK2800) from Tradingview

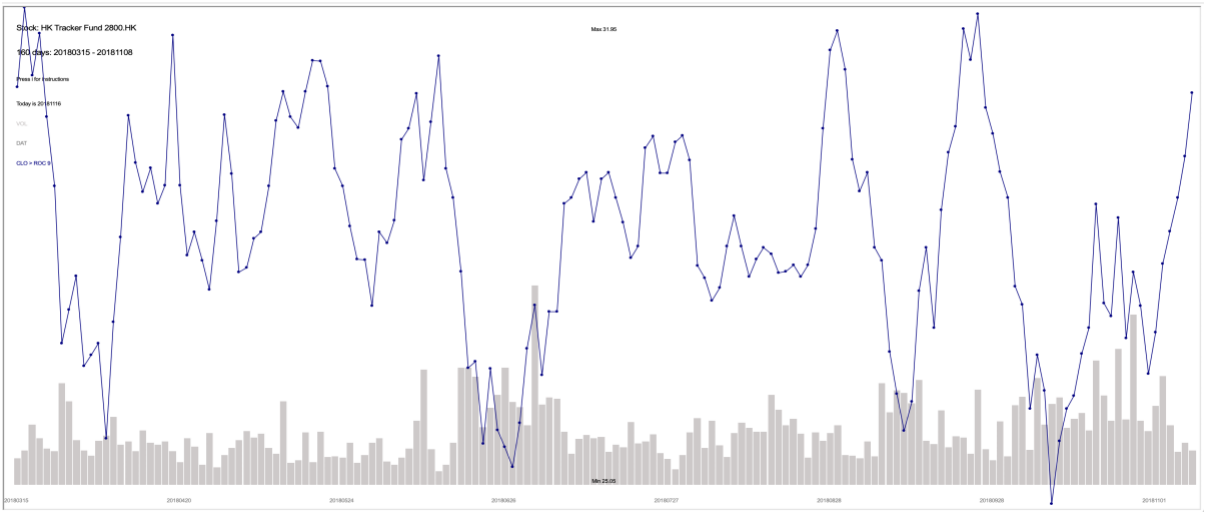

Figure 29: ROC 9 (stock: HK2800) graphed using Stoxy