The University of Hong Kong
Department of Statistics and Actuarial Science
STAT3609 The Statistics of Investment Risk

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Group Project

Group 2
< Candlestick Analysis: Prediction of Hong Kong and Korean Stock Market Trend >

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Declaration: The work has not been used for any other courses by any of the members.

I. Background

I.1. Introduction

Candlestick pattern, one of the technical analysis tools, has been taking reference by investors and traders to determine the price directions. In this project, candlestick patterns are explored whether they are applicable to the real financial market, and hence discover any difference in the patterns' significance between Hong Kong and Korean financial markets.

I.2. Candlestick

A candlestick pattern is one of the technical indicators in technical analysis. First of all, technical analysis is a trading discipline adopted to explore or evaluate investments and identify trading opportunities by analyzing historical trading data of any securities using technical indicators (HAYES, 2020).

There are lots of technical indicators such as moving average, support and resistance level. Candlestick patterns are also commonly used because of its simplicity in concept and application. In this section, symbols, meanings and usages of candlesticks will be introduced, followed by specific candlestick patterns.

I.2.1. Basics

A candlestick is a kind of price chart which displays the high, low, opening and closing prices of a stock or security for a specific period (HAYES, 2020). Figure I.1.1.1 below takes Period=1 as an example to illustrate its composition.
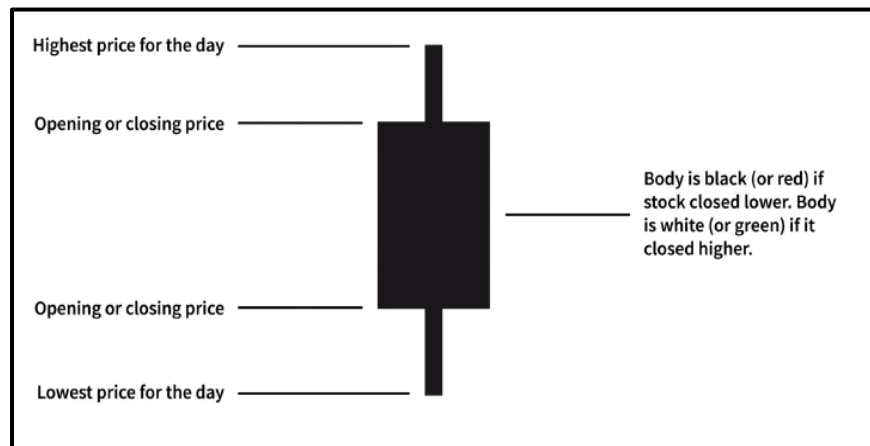

Figure I.2.1.1 Composition of a Candlestick Chart

The head of a candlestick is the highest price for the day, while the bottom is the lowest price. The rectangular box is called a body. The head and the bottom of a body are the opening or closing price. Their actual positions are determined by whether the day (Period = 1) is bullish or bearish. If it is bullish, the upper one will be closing price and the lower one will be opening price, vice versa. The condition of the day is also shown in a candlestick. The body is empty when the market is bullish, while it is filled when the market is bearish. Therefore, many summary statistics can be obtained by simply looking at this little candlestick.

To further elaborate, Figure I.2.1.2 (Rolf, 2019) illustrates a simplified version of the path of the security on the corresponding day. Nevertheless, when combining a series of candlesticks, a path with a longer period of the stock can be explained, like in Figure I.2.1.3 (Rolf, 2019).
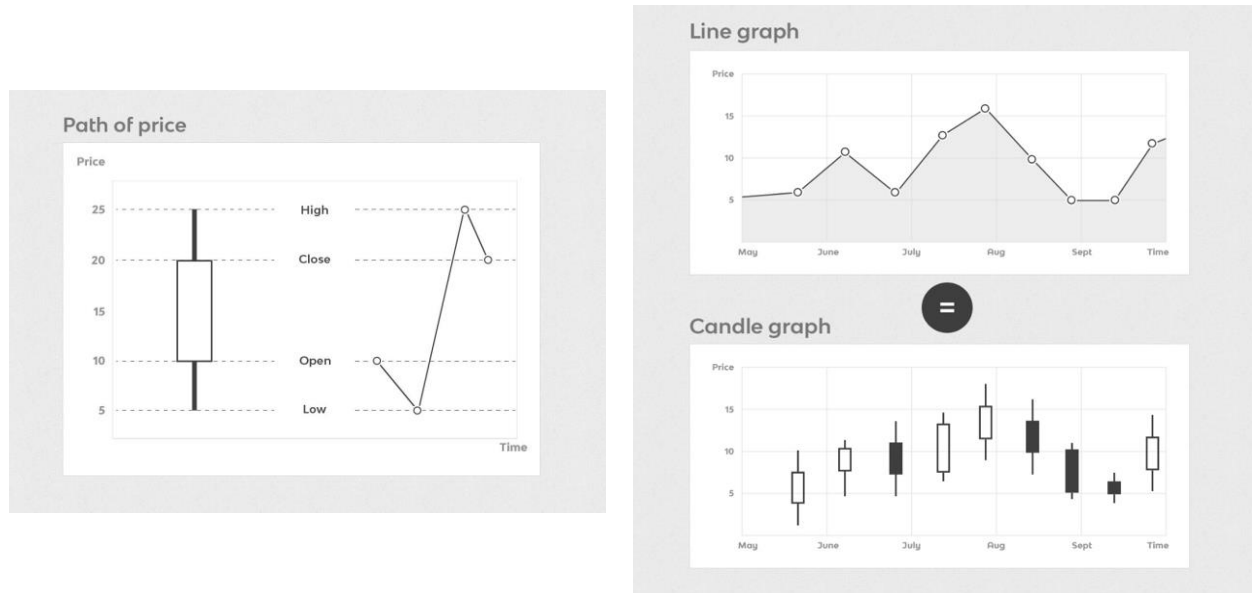

Figure I.2.1.2 *Path of stock price*   ***Figure I.2.1.3*** *Connected candlestick ling graph*

I.2.2. Candlestick Patterns

A combination of numbers of candlestick charts is called a candlestick pattern. Candlestick patterns make candlestick itself more useful than only the open-high, low-close bars or simple path of the price (Farley, 2020). By observing candlesticks build patterns, investors can predict the future market trend or momentum. For example, the price of the stock is likely to rise for a period of time if a candlestick pattern Inverted Hammer is found.

There are a lot of candlestick patterns that can be used to make profitable financial decisions, including long the securities, short or even short sell the securities, buy some derivatives, etc.

Some investors believe candlestick patterns are a reliable indicator. However, are they, actually? From the nature of future prediction using historical data, there will not be any indicators with 100% certainty, otherwise, the market would be weak form efficient. Therefore, this project is an attempt to test the accuracy and significance of the prediction, and applicability of different patterns in different financial markets.

I.2. Indices

I.2.1.Hang Seng Index

Hang Seng Index is a market-value-weighted index record and monitors daily changes of the largest companies of the Hong Kong stock market. It is the main indicator of the overall market performance in Hong Kong. Its constituent stocks include Tencent, Swire and MTR.

I.2.2. KOSPI 50 Index

Korea Composite Stock Price Index 50 is a market-value-weighted index and representative stock market index of South Korea. KOSPI has over 880 components. Top 3 stocks are Samsung Electronics, SK Hynix and LG Chem. KOSPI 50 is chosen over KOSPI 200 to match with the number of stocks with HSI. The advantage is its price change has little discrepancy with KOSPI200, a more commonly used index and the weight of top 50 stocks among 200 stocks is high.

II. Methodology

Before explaining each step, basic terms in Python would be explained in advance. The application was done by Python coding on Jupyter Notebook. Jupyter Notebook is a web application often used in data science since it allows live code running (refer to the html code file attached). *Pandas* is a Python library for data analysis, and it uses *dataframe* as the primary 2-dimensional data structure with labelled rows and columns.

II.1. Data Collection

Daily open, high, low, and close (ohlc) price and the corresponding date was required for the project. Any open-source files in any format, such as csv and json could be processed in Python. Major financial websites such as Yahoo finance, investing.com, Wall Street Journal, etc. would be the primary target for data searching. The preferable time range was around one decade.

II.2. Data Preparation

From the raw data collected from the external sources, data needed to be cleansed and modified for further process. First, two basic price dataframes of indices were constructed from the data files. Then, unnecessary columns should be dropped and the data frames should be unified to descending order by the date column.

II.2.1. Candlestick Chart

Before further modification, candlestick charts would be drawn with *mpl_finance* library to show the general price change.

II.2.2. Candlestick Pattern Recognition

The library *TA-Lib* supports diverse technical analysing functions of financial market data, such as volume indicators, momentum indicators, etc (mrjbq7, n.d.). Among those, pattern recognition functions would be used in this project. There are 61 defined pattern functions in TA-Lib which take ohcl prices as input and return positive or negative integers. A positive integer indicates bullish pattern, a negative integer indicates bearish pattern, and null value indicates no such pattern is found. The results of one pattern would be recorded as one column of a new dataframe, so that finally there are 61 columns and every row indicates one day.

Furthermore, different t-test would be done for bullish and bearish patterns. Therefore, by the sign of values in the dataframe, the dataframe would be separated into two datasets, one for bullish patterns and another for the bearish patterns. Then, to analyse only the meaningful patterns, the ones with occurrences of less than 25 were dropped out from each dataset.

Yet, the integers from TA-Lib are rather meaningful in this project. Simple return defined as the equation below would be used in the t-test in Section II.3.

$$R = \frac{P_1 - P_0}{P_0} = \frac{P_1}{P_0} - 1$$

Therefore, simple return values should replace the integers or null values from the previous dataframe.

II.3. T-test

One sample t-test (one-tailed) was used to determine whether the average simple return of a specific candlestick pattern is statistically different from a hypothesized population mean.

II.3.1 Assumption

There are mainly four assumptions for the one sample t-test. First, the dependent variables (in this project, simple returns) are continuous. Second, the data are independent of each other. Also, the dependent variables should be approximately normally distributed. We talk about the one-sample t-test only requiring approximately normal data because it is quite robust to violations of normality, meaning that the assumption can be a little violated and still provide valid results. Since the sample size is limited to be 25 or above, this requirement is considered to be satisfied. Lastly, there should be no significant outliers, which can reduce the accuracy of the test.

To ensure the validity of normality assumption, a quantile-quantile (Q-Q) plot which shows the distribution of the data against the expected normal distribution was used. For normally distributed data, observations should lie approximately on a straight line. If the data is not normal, the points form a curve that deviates markedly from a straight line. Figure II.3.1.1 and Figure II.3.1.2 show the Q-Q plots of 5-day simple returns of HSI and KOSPI50 respectively and the plots are generated using the python library. All the patterns approximately lie on a straight line which indicates the normality assumption is valid.
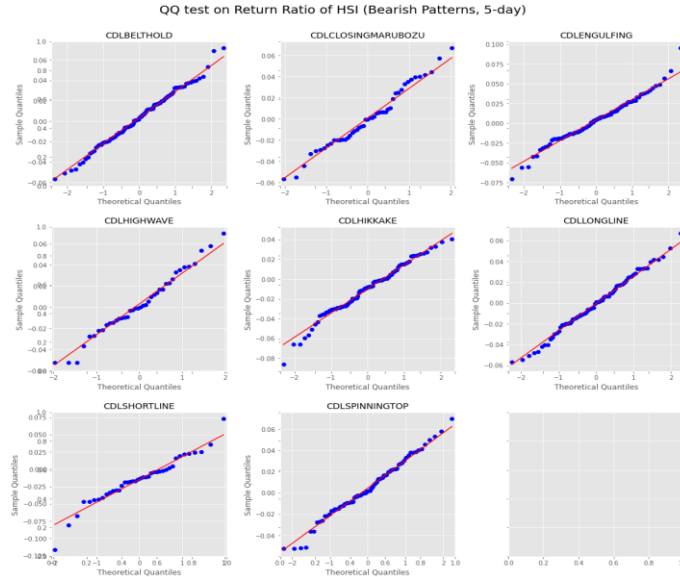

Figure II.3.1.1 *Q-Q plot of returns for HSI bearish patterns (for 5-day return)*

QQ test on Return Ratio of KOSPI50 (Bearish Patterns, 5-day)
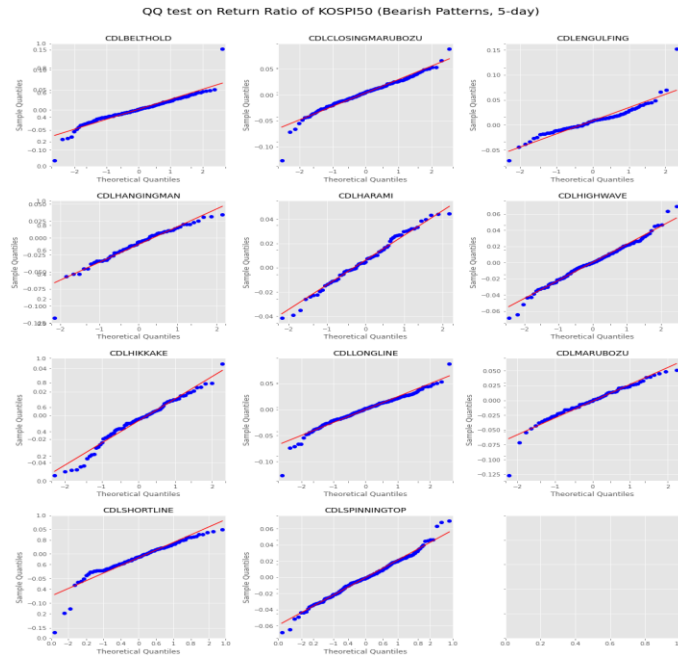
Figure II.3.1.2 *Q-Q plot of returns for KOSPI50 bearish patterns (for 5-day return)*

Furthermore, some boxplots of data were generated to check if there are significant outliers that violate the t-test assumption. Figure II.3.1.3 and Figure II.3.1.4 show boxplots of HSI and KOSPI50 simple returns for some patterns. Since there are only few outliers which can be ignored and thus it can be assumed that there is no significant outlier in the data.

Figure II.3.1.3 *Boxplots of simple returns for some patterns observed in Hang Seng Index*

Figure II.3.1.3 *Boxplots of simple returns for some patterns observed in KOSPI50*

II.3.2 Hypotheses

The thresholds were defined for each of short and long term prediction which refer to 5-day simple returns and 250-day simple returns 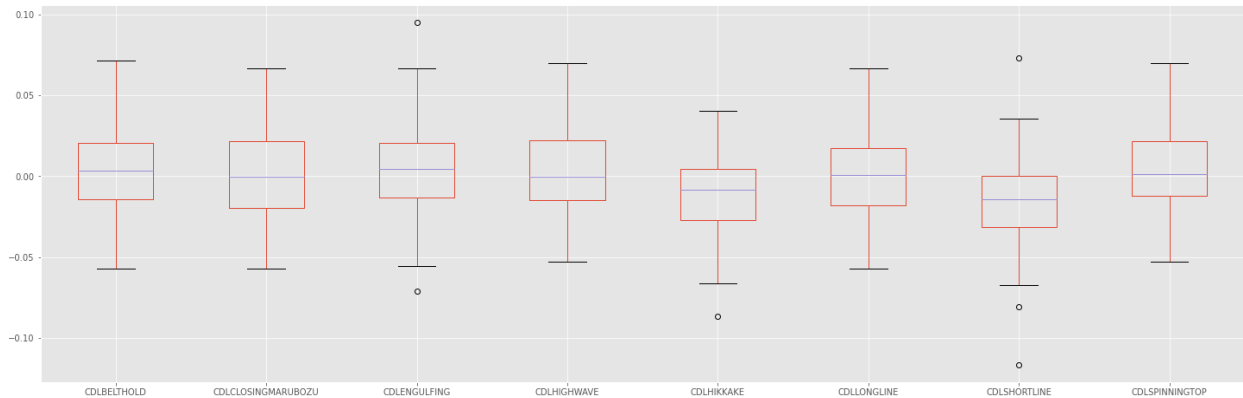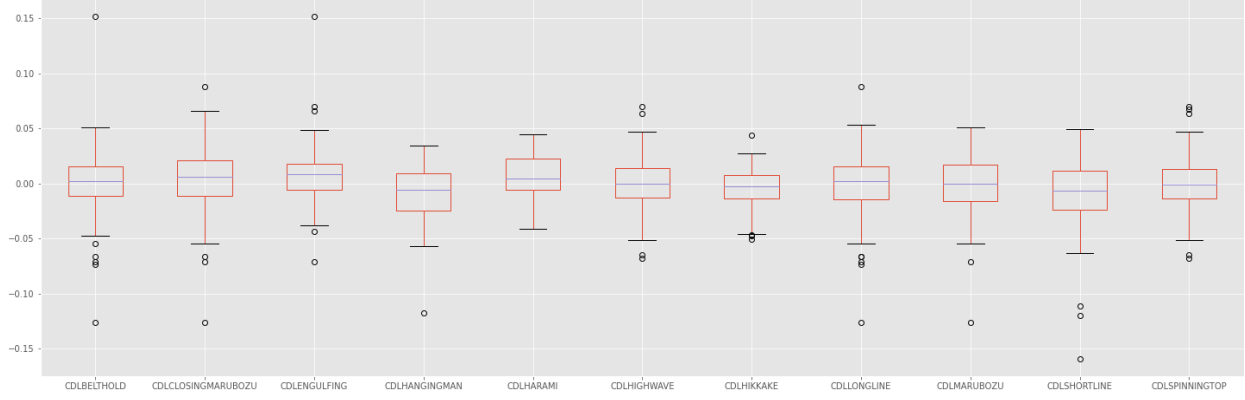respectively. The population mean (μ) is hypothesized to be 0.1% for short-term return and 5% for long-term return. Now, the hypotheses for bullish and bearish patterns are:

$$H0 : \mu = \underline{R} \qquad\qquad H0 : -\mu = \underline{R}$$
$$H1 : \mu < \underline{R} \qquad\qquad H1 : -\mu > \underline{R}$$
$$< \text{Bullish test} > \qquad < \text{Bearish test} >$$

II.3.3 Test statistic

The test statistic for one sample t Test is denoted as t, which is calculated using the following formula:

$$t_{bull} = \frac{\underline{R} - \mu}{s_{\underline{R}}}$$

$$t_{bear} = \frac{\underline{R} - (-\mu)}{s_{\underline{R}}}$$

$$s_{\underline{R}} = \frac{s}{\sqrt{n}}$$

$$t_{crit,\ bull} = t_{0.05,\ df}$$

$$t_{crit,\ bear} = -t_{0.05,df}$$

where
μ = Proposed constant for the population mean,
$\underline{R}$ = Sample mean,
n = Sample size (i.e., number of observations),
s = Sample standard deviation,
$s_{\underline{R}}$ = Estimated standard error of the mean,

If t_{bull} is greater than $t_{crit,bull}$ or t_{bear} is smaller than $t_{crit,bear}$ at 5% level, the null hypothesis is rejected and it can be concluded that there is significant evidence to identify an increasing or decreasing market trend after the pattern is found.

III. Result

III.1. Data Collection

Daily price data of HSI and KOSPI50 for 9 years from the day of data collection (6 Nov 2020 to 7 Nov 2011) were collected from Yahoo finance and finance.com in csv file formats. The range was selected since it was the maximum range of KOSPI 50 data available. Some additional data other than ohlc prices and date such as volume were included.

III.2. Data Preparation

III.2.1. Candlestick Chart
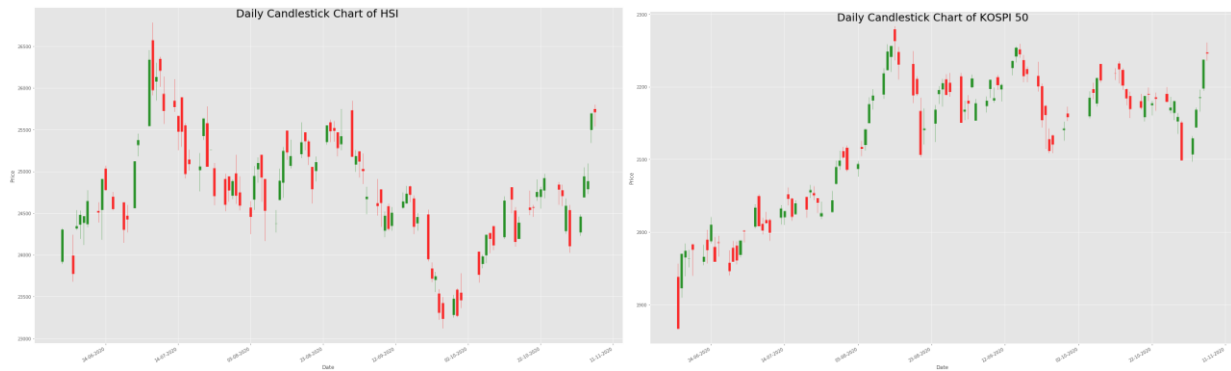
Figure III.2.1.1. *Daily Candlestick Chart of HSI(left) and KOSPI50(right)*

Figure III.2.1.1. shows the candlestick chart of recent 100 days. KOSPI 50 had rapidly recovered from the deep bottom in early 2020 due to COVID19.

III.2.2. Dataframe for Test

From the original data with date and ohcl prices, the simple returns for the days the patterns found constructed to bullish and bearish dataframe separately. Since different parameters in t-test would be applied to short and long term data, daily, weekly and annual dataframes for bullish and bearish of HSI and KOSPI50 had been constructed in total.

	CDLBELTHOLD	CDLCLOSINGMARUBOZU	CDLENGULFING	CDLHIGHWAVE	CDLHIKKAKE
5	NaN	NaN	0.014626	NaN	NaN
12	NaN	NaN	NaN	0.007525	NaN
13	NaN	NaN	NaN	0.001112	NaN
15	NaN	NaN	0.009448	NaN	NaN
16	-0.020617	NaN	NaN	NaN	NaN

Figure III.2.2.1. *First few rows and columns of daily HSI bearish dataframe*

III.3. Test results

III.3.1 Bearish patterns found in Hang Seng Index

Figure III.3.1.1 and III.3.1.2 are the results of one sample t-test on short term and long term simple returns of the Hang Seng Index respectively. If t-ratio is smaller than the critical value, we reject the null hypothesis and therefore this means the average simple return for short term trade is less than -0.1% and the average simple return for long term trade is less than -5% at a 5% significance level. As a result, we can see that for short term prediction, **Hikkake** and **Shortline** patterns are the most meaningful patterns. For long term prediction, **Shortline** and **Spinning Top** appeared to be the most powerful predictors.

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	103	0.003478	102	0.025580	0.002520	1.776688	-1.659930
CDLCLOSINGMARUBOZU	47	0.000790	46	0.028368	0.004138	0.432642	-1.678660
CDLENGULFING	100	0.004087	99	0.026270	0.002627	1.936635	-1.660391
CDLHIGHWAVE	40	0.002984	39	0.029388	0.004647	0.857309	-1.684875
CDLHIKKAKE	93	-0.010012	92	0.024509	0.002541	-3.545858	-1.661585
CDLLONGLINE	81	-0.000533	80	0.026295	0.002922	0.159714	-1.664125
CDLSHORTLINE	40	-0.014959	39	0.033277	0.005262	-2.653045	-1.684875
CDLSPINNINGTOP	77	0.004357	76	0.026181	0.002984	1.795336	-1.665151

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	67	-0.046756	66	0.065218	0.007968	0.407172	-1.668271
CDLCLOSINGMARUBOZU	34	-0.044867	33	0.069792	0.011969	0.428860	-1.692360
CDLENGULFING	84	0.039796	83	0.145922	0.015921	5.639935	-1.663420
CDLHIGHWAVE	26	-0.068436	25	0.071158	0.013955	-1.321062	-1.708141
CDLHIKKAKE	88	0.035519	87	0.133707	0.014253	5.999987	-1.662557
CDLLONGLINE	54	-0.050959	53	0.066336	0.009027	-0.106185	-1.674116
CDLSHORTLINE	29	-0.074793	28	0.069251	0.012860	-1.928013	-1.701131
CDLSPINNINGTOP	56	-0.070470	55	0.079352	0.010604	-1.930387	-1.673034

Figure III.3.1.1   *Figure III.3.1.2*

5-day bearish return statistics of HSI   *250-day bearish return statistics of HSI*

III.3.2. Bearish patterns found in KOSPI 50 Index

Figure III.3.2.1 and Figure III.3.1.2 show the results of t-test on short term and long term simple returns of the KOSPI50 Index respectively. We used the same bearish rejection criterion. For short term prediction, **Hanging man, Hikkake** and **Shortline** appeared to be the most powerful indicators whereas **none of the patterns** in long term prediction appeared to be effective.

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	228	0.001504	227	0.024939	0.001652	1.515840	-1.651594
CDLCLOSINGMARUBOZU	182	0.003686	181	0.025924	0.001922	2.438657	-1.653316
CDLENGULFING	95	0.008234	94	0.026557	0.002725	3.388918	-1.661226
CDLHANGINGMAN	62	-0.009676	61	0.026350	0.003346	-2.592591	-1.670219
CDLHARAMI	67	0.006236	66	0.020482	0.002502	2.892016	-1.668271
CDLHIGHWAVE	142	0.000271	141	0.022386	0.001879	0.676688	-1.655732
CDLHIKKAKE	87	-0.004628	86	0.018865	0.002023	-1.794003	-1.662765
CDLLONGLINE	224	-0.000075	223	0.024881	0.001662	0.556307	-1.651715
CDLMARUBOZU	78	-0.001377	77	0.028460	0.003222	-0.117082	-1.664885
CDLSHORTLINE	117	-0.008144	116	0.031257	0.002890	-2.472274	-1.658096
CDLSPINNINGTOP	225	-0.000411	224	0.021650	0.001443	0.407934	-1.651685

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	208	0.017062	207	0.124947	0.008663	7.740800	-1.652248
CDLCLOSINGMARUBOZU	163	0.025740	162	0.135523	0.010615	7.135187	-1.654314
CDLENGULFING	83	0.027172	82	0.142679	0.015661	4.927661	-1.663649
CDLHANGINGMAN	54	0.025010	53	0.151821	0.020660	3.630659	-1.674116
CDLHARAMI	58	0.038528	57	0.141609	0.018594	4.761081	-1.672029
CDLHIGHWAVE	124	0.047239	123	0.135920	0.012206	7.966536	-1.657336
CDLHIKKAKE	78	0.007846	77	0.142523	0.016138	3.584580	-1.664885
CDLLONGLINE	205	0.008328	204	0.121114	0.008459	6.895347	-1.652357
CDLMARUBOZU	73	0.009246	72	0.103190	0.012077	4.905527	-1.666294
CDLSHORTLINE	106	0.028687	105	0.155927	0.015145	5.195563	-1.659495
CDLSPINNINGTOP	199	0.035653	198	0.140544	0.009963	8.597230	-1.652586

Figure III.3.2.1   *Figure III.3.2.2*

5-day bearish return statistics of KOSPI 50   *250-day bearish return statistics of KOSPI 50*

III.3.3. Bullish patterns found in Hang Seng Index

Figure III.3.3.1 and III.3.3.2 are the results of t-test on short term and long term simple returns of the Hang Seng Index respectively. When testing bullish patterns, we use a bullish rejection criterion that rejects the null hypothesis if t-ratio is greater than the critical value. Rejecting the null hypothesis implies that the average simple return for short term trade is greater than 0.1% and the average simple return for long term

trade is greater than 5% at a 5% significance level. As a result, **Hammer** pattern is shown to be the most meaningful short-term predictor. For long- term prediction, **none of the patterns** appeared to be a powerful predictor.

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	56	0.002547	55	0.027237	0.003640	0.425062	1.673034
CDLCLOSINGMARUBOZU	68	-0.001225	67	0.025767	0.003125	-0.711999	1.667916
CDLDOJI	94	0.001018	93	0.028347	0.002924	0.006052	1.661404
CDLENGULFING	46	-0.004548	45	0.018779	0.002769	-2.003627	1.679427
CDLHAMMER	29	0.009313	28	0.021541	0.004000	2.078269	1.701131
CDLHARAMI	33	-0.011675	32	0.026996	0.004699	-2.697148	1.693889
CDLHIGHWAVE	34	-0.004660	33	0.024991	0.004286	-1.320704	1.692360
CDLHIKKAKE	92	0.000755	91	0.019727	0.002057	-0.119335	1.661771
CDLLONGLEGGEDDOJI	88	0.000389	87	0.028135	0.002999	-0.203603	1.662557
CDLLONGLINE	77	0.003023	76	0.025219	0.002874	0.703966	1.665151
CDLRICKSHAWMAN	64	-0.001578	63	0.030375	0.003797	-0.678883	1.669402
CDLSHORTLINE	45	-0.000096	44	0.030959	0.004615	-0.237482	1.680230
CDLSPINNINGTOP	75	-0.003815	74	0.026670	0.003080	-1.563429	1.665707

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	39	-0.073637	38	0.082366	0.013189	-9.374214	1.685954
CDLCLOSINGMARUBOZU	48	-0.070863	47	0.083145	0.012001	-10.071069	1.677927
CDLDOJI	63	-0.069885	62	0.075422	0.009502	-12.616452	1.669804
CDLENGULFING	41	0.014671	40	0.142766	0.022296	-1.584536	1.683851
CDLHAMMER	22	-0.085480	21	0.069901	0.014903	-9.090798	1.720743
CDLHARAMI	24	-0.068575	23	0.068559	0.013995	-8.472898	1.713872
CDLHIGHWAVE	27	-0.053955	26	0.081957	0.015773	-6.590898	1.705618
CDLHIKKAKE	82	0.064590	81	0.147929	0.016336	0.893148	1.663884
CDLLONGLEGGEDDOJI	62	-0.067746	61	0.074086	0.009409	-12.514337	1.670219
CDLLONGLINE	55	-0.073057	54	0.072671	0.009799	-12.558293	1.673565
CDLRICKSHAWMAN	44	-0.056404	43	0.074087	0.011169	-9.526673	1.681071
CDLSHORTLINE	26	-0.073366	25	0.085158	0.016701	-7.386816	1.708141
CDLSPINNINGTOP	56	-0.069703	55	0.071403	0.009542	-12.545353	1.673034

Figure III.3.3.1 — *5-day bullish return statistics for HSI*

Figure III.3.3.2 — *250-day bullish return statistics for HSI*

III.3.4. Bullish patterns found in KOSPI 50 Index

Figure III.3.4.1 and Figure III.3.4.2 show the results of t-test on short term and long term simple returns of the KOSPI50 Index respectively. We apply the same bullish rejection criterion. For short term prediction, **Inverted Hammer** appeared to be the most powerful indicator whereas **none of the patterns** in the long term prediction appeared to be effective.

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	193	0.002733	192	0.020312	0.001462	1.184973	1.652829
CDLCLOSINGMARUBOZU	207	0.000858	206	0.021615	0.001502	-0.094499	1.652284
CDLDOJI	293	-0.000059	292	0.023916	0.001397	-0.757744	1.650089
CDLDRAGONFLYDOJI	28	-0.004233	27	0.026129	0.004938	-1.059844	1.703288
CDLENGULFING	61	-0.003885	60	0.021358	0.002735	-1.786308	1.670649
CDLHAMMER	62	0.005475	61	0.021291	0.002704	1.654818	1.670219
CDLHARAMI	93	-0.007042	92	0.019278	0.001999	-4.022946	1.661585
CDLHARAMICROSS	32	-0.004218	31	0.017000	0.003005	-1.736472	1.695519
CDLHIGHWAVE	132	0.001829	131	0.026216	0.002282	0.363423	1.656569
CDLHIKKAKE	105	-0.000778	104	0.017958	0.001753	-1.014532	1.659637
CDLHOMINGPIGEON	45	-0.005551	44	0.019911	0.002968	-2.207200	1.680230
CDLINVERTEDHAMMER	41	0.010729	40	0.018530	0.002894	3.361812	1.683851
CDLLONGLEGGEDDOJI	277	-0.000281	276	0.024140	0.001450	-0.882869	1.650393
CDLLONGLINE	242	0.002306	241	0.022171	0.001425	0.916610	1.651201
CDLMARUBOZU	75	-0.001833	74	0.022039	0.002545	-1.113400	1.665707
CDLMATCHINGLOW	44	-0.001218	43	0.021933	0.003307	-0.670789	1.681071
CDLRICKSHAWMAN	221	-0.000171	220	0.024754	0.001665	-0.703506	1.651809
CDLSHORTLINE	110	-0.004013	109	0.027526	0.002624	-1.910126	1.658953
CDLSPINNINGTOP	216	0.002086	215	0.024383	0.001659	0.654724	1.651972
CDLTAKURI	28	-0.004233	27	0.026129	0.004938	-1.059844	1.703288

	n	mean	df	std	se	t ratio	t critical
CDLBELTHOLD	171	0.040722	170	0.145065	0.011093	-0.836349	1.653866
CDLCLOSINGMARUBOZU	185	0.039412	184	0.138611	0.010191	-1.038957	1.653177
CDLDOJI	266	0.040073	265	0.132043	0.008096	-1.226205	1.650624
CDLDRAGONFLYDOJI	25	0.004740	24	0.137298	0.027460	-1.648222	1.710882
CDLENGULFING	56	0.036005	55	0.131164	0.017528	-0.798456	1.673034
CDLHAMMER	54	0.016422	53	0.122482	0.016668	-2.014535	1.674116
CDLHARAMI	82	0.016106	81	0.119951	0.013246	-2.558770	1.663884
CDLHARAMICROSS	28	0.014050	27	0.128505	0.024285	-1.480333	1.703288
CDLHIGHWAVE	119	0.032425	118	0.130946	0.012004	-1.464156	1.657870
CDLHIKKAKE	91	0.046700	90	0.146869	0.015396	-0.214365	1.661961
CDLHOMINGPIGEON	38	0.011386	37	0.120644	0.019571	-1.973005	1.687094
CDLINVERTEDHAMMER	36	0.061187	35	0.132020	0.022003	0.508412	1.689572
CDLLONGLEGGEDDOJI	250	0.035694	249	0.134624	0.008514	-1.680241	1.650996
CDLLONGLINE	212	0.039580	211	0.139208	0.009561	-1.089815	1.652107
CDLMARUBOZU	70	0.033700	69	0.153985	0.018405	-0.885656	1.667239
CDLMATCHINGLOW	41	-0.014335	40	0.116886	0.018255	-3.524306	1.683851
CDLRICKSHAWMAN	199	0.039722	198	0.135535	0.009608	-1.069715	1.652586
CDLSHORTLINE	101	0.047990	100	0.128504	0.012787	-0.157169	1.660234
CDLSPINNINGTOP	194	0.024185	193	0.124453	0.008935	-2.889095	1.652787
CDLTAKURI	25	0.004740	24	0.137298	0.027460	-1.648222	1.710882

***Figure III.3.4.1*** — *5-day bullish return statistics for KOSPI 50*

Figure III.3.4.2 — *250-day bullish return statistics for KOSPI 50*

III.4. Exploration of Findings

As an investor or trader, statistics and testing would not be their main interests. Introduction to some of the significant bullish/bearish patterns, and their corresponding trading rules will be discussed by the markets (Hong Kong & Korea), and by the periods of time (Short-term & Long-term).

III.4.1 Hang Seng Index
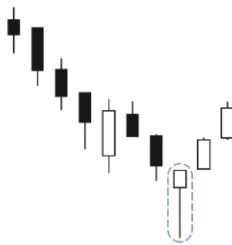
A **Hammer**(Bullish) is a bullish reversal pattern, which signals that a stock is nearing bottom in a downtrend. The body of the candle is short with a longer lower shadow. For the recommended training rule, since the stock is bearish and it is believed the price will go up for a period of time. Therefore, traders should long the asset in a short-term right after a bullish hammer is observed. Appling buy-low-sell-high strategies, traders will be able to earn a profit.

Figure III.4.1.1 Hammer (Bullish)
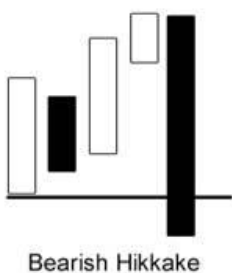
A **Hikkake**(Bearish) is a complex bar or candle pattern that begins to move in one direction but reverses quickly and is said to establish a forecast for a move in the opposite direction. For the recommended training rule, since the stock is bullish and it is believed the price will go down for a lot. Therefore, traders should short sell the asset in a short-term/long-term right after a bearish Hikkake is observed. Appling buy-low-sell-high strategies, short-sellers can earn a profit by purchasing the asset at a lower price afterward.

Figure III.4.1.2 Hikkake (Bearish)
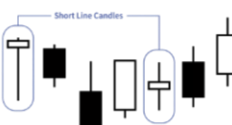
A **Short Line**(Bearish) is a short body, and this one-bar occurs when there is only a small difference between the opening and the closing price. For the recommended training rule, it does not provide a straightforward strategy, it indicates a period of consolidation in a stock, but the interpretation will vary based on what other price action has preceded and follows it.

Figure III.4.1.3 Short Line (Bearish)

III.4.2. KOSPI 50

An **Inverted Hammer**(Bullish) also forms in a downtrend and represents a likely trend reversal or support. It's identical to the Hammer except for the longer upper shadow. For the recommended training rule, since the stock is bearish and it is believed the price will go up for a period of time. Therefore, traders should long the asset in a short-term right after a bullish inverted hammer is observed. Appling buy-low-sell-high strategies, traders will be able to earn a profit.

Figure III.4.2.1 Inverted Hammer (Bullish)

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