CHAPTER TWO

DATA & METHODOLOGIES

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DATA AND METHODOLOGIES

This chapter explains the sources of data, method of sample selection and methodologies that will be used in this study. The adjustment factors for capital changes are given in Appendix II. The methodologies of technical indicators will be explained in detail. In addition, this chapter also explains the methodologies of statistical methods that will be used in this study. They are ANOVA, chi-square test, Tukey test and Kolmogorov-Smirnov test.

2.1 DATA

The study period is from 1 July 1995 to 30 June 2000, a 5-year period. Fifty counters, as shown in Appendix I, have been selected randomly as sample of study. Only the counters that were listed on the KLSE (either Main Board or Second Board) during the period of study have been considered in the sample selection. Daily opening, closing, high and low prices of the sample are used in the study. All the prices are adjusted for capital changes, that is bonus issue, rights issue and stock split.

Other than the price series of fifty selected counters and the transaction cost, dividend and interest rate will be considered in this study to obtain precise returns by assuming that trade is done under the actual trading environment.

2.1.1 HISTORICAL PRICE SERIES

The price series are widely available information. It can be obtained from newspapers, as well as the daily dairy available in the KLSE Information Centre. Other than the closing prices, the opening prices, daily highest prices and daily lowest prices are collected as well, for the use of some technical indicators.

The price of a share is related to the market capitalisation of the company and the number of shares that have been issued. The company can take action to increase the number of shares on issue. This can be done through:

1. Rights Issues,
2. Bonus Issues,
3. Share Splits.

The capital changes have direct effect on the market price of the shares. Therefore, price adjustment is needed for the above-mentioned capital changes. For the purpose of this study, the historical price series before the *ex-date* will be adjusted. The details of adjustment factors and capital changes of the sample stocks are given in Appendix II.

2.1.2 INTEREST RATES

One of the key assumptions under this study is that the capital or fund will be saved in banks to earn interest when there is no position to hold. As such, the total interest earned will be included as a part of total returns. In this study, the interests earned will be compounded on a daily basis.

There are various interest rates available in the market, such as interest rate for fixed deposits and saving deposits as well as base lending rate, interbank offer rate and discount rate on Bank Negara bills.

The commercial banks savings deposit interest rate has been chosen as the interest rate that will be used in this study. The logic is that investors may need to withdraw the fund from the bank account to purchase share when there is a buying signal generated by technical indicators. On the other hand, the investors will immediately save the money in the bank account after the shares have been sold. Therefore, interbank offer rate, base lending rate and other discount rates are inappropriate.

Table 2.1 shows the average commercial banks saving deposit interest rates during the period of study, as stated in the Bank Negara's Monthly Bulletin. These are the interest rates that will be used in the study.

Table 2.1: Commercial Banks Saving Deposit Interest Rate, 1995 – 2000

Year	1995	1996	1997	1998	1999	2000
Interest Rate (%)	3.70	4.10	4.23	3.87	2.76	2.70

Source: Bank Negara's Monthly Bulletin

2.2 METHODOLOGIES

The methodologies will cover both technical indicators as well as statistical methods that will be used in this study. The four technical indicators are Simple Moving Average (SMA), Moving Average Convergence/Divergence (MACD), Relative Strength Index (RSI) and Stochastics Oscillator (STOC), while the methodologies of statistical methods include ANOVA, chi-Square test, Tukey test and Kolmogorov-Smirnov test.

The return for each counter will be based on the following equation:

$$R_i = \frac{V_{e,i} - V_{o,i}}{V_{o,i}} \qquad (2.1)$$

where

R_i = Return for the counter i

$V_{e,i}$ = Value of the investment at the end of study period

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2.2.1 TECHNICAL INDICATORS

This section will explain the details of technical indicators that will be used in this study. In addition, the trading rules are also explained in detail.

2.2.1.1 SIMPLE MOVING AVERAGE (SMA)

A moving average is a method of calculating the average value of a stock's price, over a period of time. When calculating a moving average, a mathematical analysis of the stock's average value over a predetermined time period is made. As the stock's price changes over time, its average price moves up or down. The value of SMA is described as below:

$$n-\mathrm{SMA}=\frac{\sum_{i=1}^{n} C_i}{n} \tag{2.2}$$

where

n-SMA is the value of n-day Simple Moving Average

C_i is the closing price at time i

n is the predetermined time period used

Example 2.1 shows sample closing price data for 10 days, as well as how to calculate a 5-SMA (five-day Simple Moving Average). The second column in

Example 2.1 shows the closing price. The Moving Total (third column) is the total of the latest five days' closing prices. The last column shows the value of SMA, i.e., the Moving Total from third column divided by five.

Example 2.1: Simple Moving Average

Day	Closing Price	Moving Total	SMA
1	4.50	-	-
2	4.75	-	-
3	4.25	-	-
4	4.00	-	-
5	4.20	21.70	4.34
6	4.40	21.60	4.32
7	4.35	21.20	4.24
8	4.25	21.20	4.24
9	4.60	21.80	4.36
10	4.40	22.00	4.40

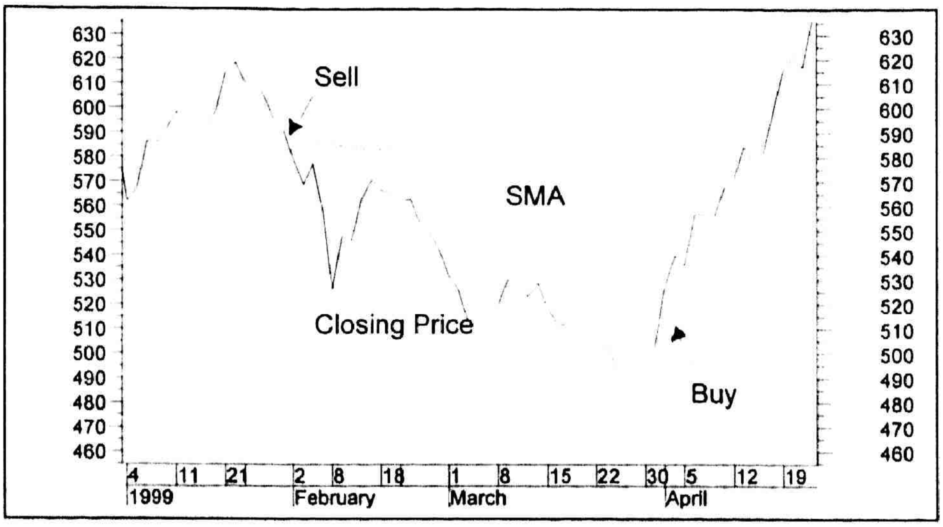
Four SMAs will be tested in this study. They are 9-SMA (approximately 2 weeks or half month), 21-SMA (approximately one month), 60-SMA (approximately one quarter) and 200-SMA (approximately one year) moving average. The trading rules for the SMA are given below:

Buy when daily closing price crosses above the n-SMA

Sell when daily closing price crosses below the n-SMA

Figure 2.1 illustrates an example of SMA and the trading signal. A buying signal appears when the daily closing price crosses above the SMA and a selling signal appears when the daily closing price crosses below the SMA.

Figure 2.1: Simple Moving Average Trading Signal



2.2.1.2 MOVING AVERAGE CONVERGENCE/DIVERGENCE (MACD)

Moving Average Convergence/Divergence (MACD) is a trend following indicator developed by Appel (1979). The underlying theory suggests that when a stock's price is trending, speculative forces will test the trend from time to time. To locate turning points in the stock's trend, MACD calculates two price averages, using Exponential Moving Average (EMA) periods of 12 and 26. The difference between these two EMAs is then called MACD.

After obtaining the value of MACD, a Signal Line is calculated by smoothing the value of MACD. A change in trend occurs when the MACD crosses the Signal Line. If the MACD crosses the Signal Line from below, it indicates a positive change in trend (buying signal). If the MACD crosses the indicator from above, it indicates a negative change in trend (selling signal). The value of MACD and Signal Line is described as below:

$$\text{MACD} = \text{12-EMA} - \text{26-EMA} \tag{2.3}$$

$$\text{Signal Line} = \text{n-EMA}_{\text{MACD}} \tag{2.4}$$

where

12-EMA is the value of 12-period Exponential Moving Average

26-EMA is the value of 26-period Exponential Moving Average

The most important part of MACD analysis is the EMA. The calculation of EMA is slightly different from SMA. An Exponential Moving Average gives more weight to recent prices and ever-decreasing weight to older data. The value of EMA is described as below:

$$n - \text{EMA} = [n - \text{EMA}_{-1}] + \frac{2}{n+1}[V - (n - \text{EMA}_{-1})] \tag{2.5}$$

where

V is the latest closing price

n-EMA_{-1} is the value of n-EMA at one period ago

n is the number of period used in calculating the first value of EMA

Example 2.2 illustrates the calculation of a five-day Exponential Moving Average (5-EMA) of closing prices. The value of EMA takes into account previous day's EMA. To start, use a five-day (or any other period, which is consistent with the period used for calculating EMA) SMA to substitute the first previous day's EMA.

The third column in Example 2.2 shows the value of EMA at one period ago. On the 5^{th} day, when the first EMA is calculated, the previous day's EMA is not available. Therefore, the value is substituted with a five-day SMA. The fourth column is the difference between the latest closing price and previous day's EMA. In the fifth column, the value in fourth column is multiplied by a smoothing factor, which is 2/(n+1). In this example, the smoothing factor is 1/3.

For calculating the Signal Line, just simply replace the second column (closing price) with the value of MACD obtained by using Equation 2.3.

Example 2.2: Exponential Moving Average

Day	Closing Price (A)	Previous day's EMA (B)	(C)=(A)-(B)	(D)=(C)X1/3	5-EMA=(B)+(D)
1	4.5	-	-	-	-
2	4.75	-	-	-	-
3	4.25	-	-	-	-
4	4.00	-	-	-	-
5	4.20	4.34*	-0.14	-0.05	4.29
6	4.40	4.29	0.11	0.04	4.33
7	4.35	4.33	0.02	0.01	4.34
8	4.25	4.34	-0.09	-0.03	4.31
9	4.60	4.31	0.29	0.10	4.40
10	4.40	4.40	0.00	0.00	4.40

Note:
* Five-day SMA

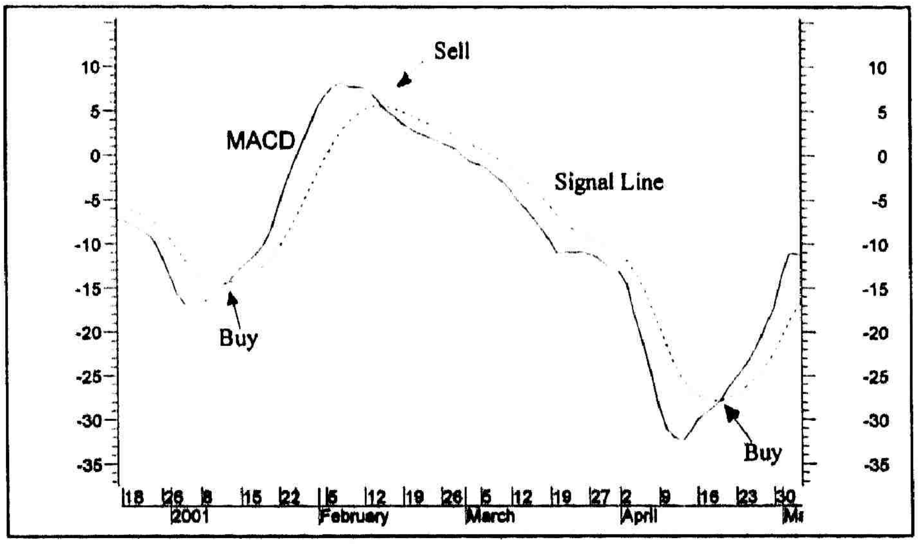
The most commonly used MACD Signal Lines are based on 9, 12 and 26 period EMA. Therefore, the MACD test where the Signal Line is based on 9-EMA is represented by 9-MACD, while 12-MACD and 26-MACD will be used to represent the MACD tests where the Signal Lines are based on 12-EMA and 26-EMA respectively. The trading rules for MACD are as below:

Buy when MACD crosses above the Signal Line

Sell when MACD crosses below the Signal Line

Figure 2.2 illustrates an example of MACD and the trading signal. A buying signal appears when MACD crosses above the Signal Line and selling signal appears when MACD crosses below the Signal Line.

Figure 2.2: Moving Average Convergence/Divergence Trading Signal



2.2.1.3 RELATIVE STRENGTH INDEX (RSI)

The term "relative strength" is a bit of a misnomer and often causes confusion among those more familiar with that term as it is used in stock market analysis. Relative strength generally means a ratio comparing two different entities. A ratio of a stock or industry group to the Composite Index is one way of gauging the relative strength of different stocks or industry groups against one objective benchmark. The Relative Strength Index in this study, however, compares the internal strength of a single stock. A more appropriate name might be "Internal Strength Index".

A stock's price move reflect changing consensus about its worth among buyers and sellers in the market. Those collective positions determine the price of a stock and in this turn becomes valuable information for technical analyst. Relative Strength Index, developed by Wilder (1978), measures the velocity of price movement, identifying potential turning points in the stock price.

The underlying theory suggests that prices tend to be mean reverting and can only move so far from a trend before retreating or advancing. So a rapid price increase (decrease) results in an overbought (oversold) condition, setting the stage for next price move, which is typically sideway, then drop (rise). In general, RSI levels in excess of 70/80 are thought to indicate overbought conditions. Conversely, RSI levels below

20/30 are thought to indicate oversold conditions. The value of RSI is described below:

$$\mathrm{RSI} = 100 - \frac{100}{1 + \mathrm{RS}} \tag{2.6}$$

where:

RSI is the value of 14-day RSI

RS is the value of Relative Strength

The RSI is a fairly simple formula, but is difficult to explain without further illustration. Example 2.3 illustrates the calculation of a 3-day RSI. The third column shows the value of daily price changes. The fourth column only considers the positive price changes while fifth column considers the negative price changes (ignoring the negative sign). If the price traded remain unchanged for a particular day, the change is neither classified under positive price changes nor negative price changes. The sixth column calculates the average advancing value, which is equal to the total positive price changes divided by the number of days with positive price changes. On the other hand, the average declining value is shown in seventh column. Since this is a 3-day RSI, the average advancing or declining value only considers the latest three days' price changes. Finally, the eighth column, Relative Strength (RS), equals the average advancing value divided by average declining value.

Example 2.3: Relative Strength Index

Day	Closing Price	Price Change	Positive Price Change	Negative Price Change	Average Advancing Value	Average Declining Value	Relative Strength (RS)
1	4.50	-	-	-	-	-	-
2	4.75	0.25	0.25	-	-	-	-
3	4.25	-0.50	-	0.50	-	-	-
4	4.00	-0.25	-	0.25	0.25	0.38	0.67
5	4.20	0.20	0.20	-	0.20	0.38	0.53
6	4.40	0.20	0.20	-	0.20	0.25	0.80
7	4.35	-0.05	-	0.05	0.20	0.05	4.00
8	4.25	-0.10	-	0.10	0.20	0.08	2.67
9	4.60	0.35	0.35	-	0.35	0.08	4.67
10	4.40	-0.20	-	0.20	0.35	0.15	2.33

The RSI ranges in value from 0 to 100. A value of 70/80 and above indicates a potential overbought condition; a value of 20/30 and below points to an oversold condition. The trading rules for RSI are as below:

Buy when RSI crosses above the oversold region line

Sell when RSI crosses below the overbought region line

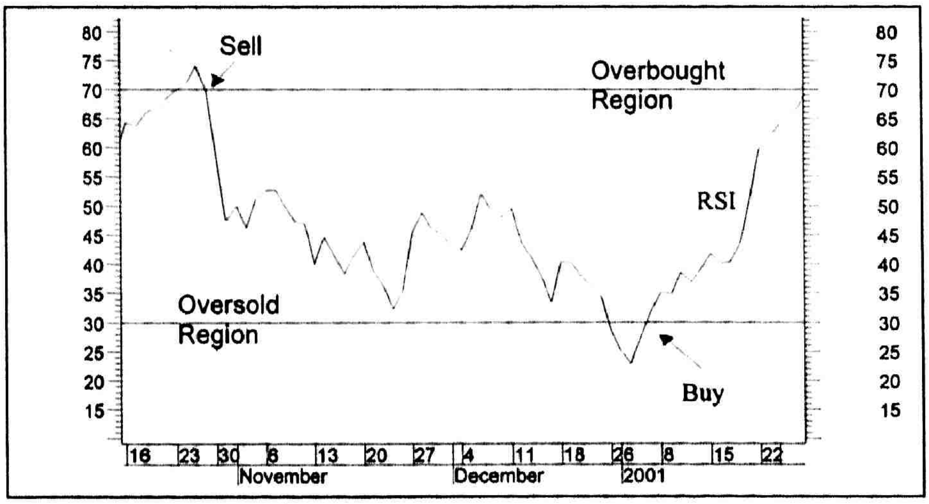
Since there are two overbought and oversold regions to be tested, there will be four combinations of overbought-oversold regions, as follow:

Overbought	*Oversold*
80	20
80	30
70	20
70	30

The RSI-20/80 represents the RSI based on the combination of 20 and 80 oversold/overbought regions. While RSI-20/70 represents the RSI based on 20 and 70 oversold/overbought combination. RSI-30/70 and RSI-30/80 will be used to represent the RSI based on 70 and 80 overbought regions with oversold region at 30.

Figure 2.3 illustrates an example of RSI and the trading signal. A buying signal is generated when the RSI crosses above the oversold region and a selling signal is generated when the RSI crosses below the overbought region.

Figure 2.3: Relative Strength Index Trading Signal



2.2.1.4 STOCHASTICS OSCILLATOR (STOC)

Stochastics Oscillator developed by Lane (1984) is based on the observation that as prices increase, closing prices tend to be closer to the upper end of the price range. Conversely, in downtrends, the closing price tends to be near the lower end of the range. In both cases, as price approaches extreme points, it will most likely turn in the opposite direction. Stochastics Oscillator expands upon the concept of RSI which measures momentum based on changes in daily closing prices.

The intent is to determine where the most recent closing price is in relation to the price range for a chosen time period. Five days is the most common period used for this indicator and this will be used in the study. There are two lines that are available in STOC. They are %K and %D. To determine the %K line, which is the more sensitive of the two, the formula is:

$$\%K = \left(\frac{C - L_5}{H_5 - L_5} \right) \times 100 \tag{2.7}$$

where

C is the latest closing price.

L_5 is the lowest price for the period of 5-day

H_5 is the highest price for the period of 5-day

The second line, %D, is simply the 3-day simple moving average of %K. The major signal to watch is the %D line when the %D line crosses overbought or oversold region.

Example 2.4 illustrates the calculation of %K and %D. The third and fourth columns show the highest and lowest prices for each trading day. The fifth column shows the highest price for the period of five-day. On the other hand, the sixth column shows the lowest price for the same period. The seventh column is the value of %K, calculated by using Equation 2.7. The last column shows the value of %D, which is the 3-day average value of %K.

Example 2.4: Stochastics Oscillator

Day	Close	High	Low	H_5	L_5	%K	%D
1	4.50	4.75	4.30	-	-	-	-
2	4.75	4.90	4.65	-	-	-	-
3	4.25	4.25	4.05	-	-	-	-
4	4.00	4.35	4.00	-	-	-	-
5	4.20	4.35	4.05	4.90	4.00	22.22	-
6	4.40	4.55	4.20	4.90	4.00	44.44	-
7	4.35	4.35	4.10	4.55	4.00	63.64	43.43
8	4.25	4.45	4.20	4.55	4.00	45.45	51.18
9	4.60	4.65	4.35	4.65	4.05	91.67	66.92
10	4.40	4.55	4.30	4.65	4.10	54.55	63.89

The %K and %D ranges in value from 0 to 100. A value of 70/80 and above indicates a potential overbought condition; a value of 20/30 and below points to oversold. The trading rules for STOC are as below:

Buy when %D crosses above the oversold region line

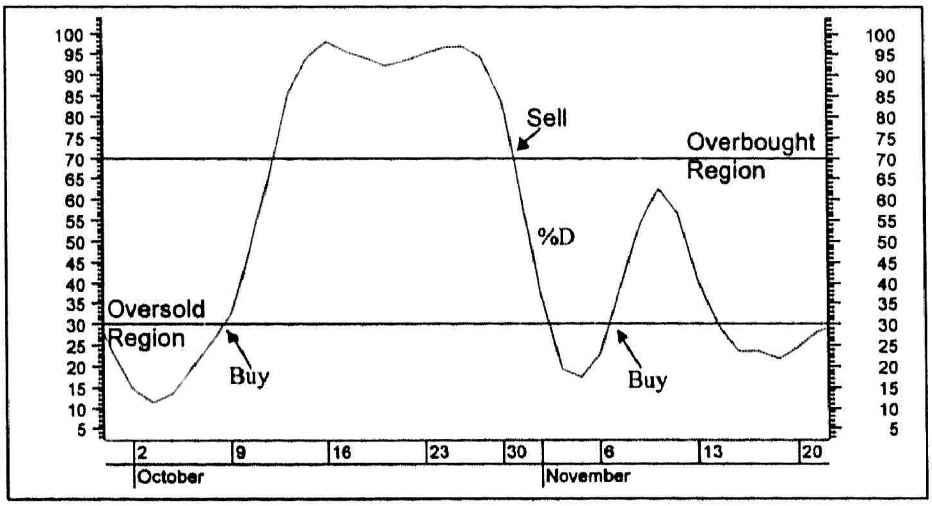
Sell when % D crosses below the overbought region line

The STOC-20/80 represents the STOC based on the combination of 20 and 80 oversold/overbought regions. While STOC-20/70 represents the RSI based on 20 and

70 oversold/overbought combination, STOC-30/70 and STOC-30/80 will be used to represent the STOC based on 70 and 80 overbought regions with oversold region at 30.

Figure 2.4 illustrates an example of STOC and the trading signal. A buy signal is generated when the %D crosses above the oversold region and a sell signal is generated when the %D crosses below the overbought region.

Figure 2.4: Stochastics Oscillator Trading Signal



2.2.2 STATISTICAL TEST

After obtaining returns by using the technical indicators mentioned above, statistical tests will be carried out to analyse the differences obtained by applying different trading signals under each method and also the returns between different trading methods.

2.2.2.1 ANALYSIS OF VARIANCE

In this study, there are two hypotheses being tested by using two-way ANOVA. The first hypothesis evaluates the difference in portfolio returns for Main Board and Second Board counters when different trading signals are being applied. The second hypothesis tests the difference in portfolio returns of the trading signals for the different sectors. The model of two-way ANOVA is given below:

$$y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk} \qquad (2.8)$$

with $i = 1,2,3,\ldots,a$

$j = 1,2,3,\ldots,b$

$k = 1,2,3,\ldots,r_i$

where

μ is the overall mean effect,

α_i is the effect of the *i*th level of Factor A,

β_j is the effect of the *j*th level of Factor B,

$(\alpha\beta)_{ij}$ is the effect of the interaction between α_i and β_j

ε_{ijk} is a random error component

Under fixed effect model,

$$\sum_{i=1}^{a} \alpha_i = 0, \sum_{j=1}^{b} \beta_j = 0 \text{ and } \sum_{i=1}^{a} (\alpha\beta)_{ij} = \sum_{j=1}^{b} (\alpha\beta)_{ij} = 0$$

The null and alternative hypotheses for testing the Factor A, which is the effect of trading signals are as below:

H_o: $\alpha_i = 0$, for all i

H_a: at least one $\alpha_i \neq 0$

On the other hand, the null and alternative hypotheses for testing the Factor B, which is the effect of the listing board (first hypothesis) or sectoral effect (second hypothesis) are described as below:

H_o: $\beta_j = 0$ for all j

H_a: at least one $\beta_i \neq 0$

In addition, interaction effect between two factors is also tested. The hypotheses for the interaction are:

H_o: $(\alpha\beta)_{ij} = 0$ for all i,j

H_a: at least one $(\alpha\beta)_{ij} \neq 0$

The value of the test statistic, F is described by:

$$F = \frac{MST}{MSE} \qquad (2.9)$$

where

MST = Mean square for factor (Factor A or Factor B)

MSE = Mean square for error

The computed F can be referred to a table of the F distribution to determine the significance level at which the null hypothesis can be rejected.

2.2.2.2 TUKEY TEST

If the null hypothesis is rejected in the analysis of variance, this means that there are differences between the portfolio returns obtained by using different trading signals. In this situation, comparison among the portfolio returns may be useful. Tukey (1953) proposed a multiple comparison test that is based on the studentized range statistic.

Under Tukey's test, two portfolio returns are significantly different if the absolute value of the sample difference is greater than the critical value, which is described by:

$$T_\alpha = q_\alpha(a, f)\sqrt{\frac{MS_E}{n}} \qquad (2.10)$$

where

q is the studentized range statistic from Table Q

α is the level of significance

a is the number of trading signals

f is the degrees of freedom for error

n is the sample size for each trading signal

MS_E is the mean squares for error

2.2.2.3 CHI-SQUARE TEST

The purpose of the chi-square test is to determine how well observed number of counters that achieved the highest return under each trading signal fits the expected number of counters that achieved the highest return under each trading signal. The value of χ^2 is described by:

$$\chi^2 = \sum_{j=1}^{k} \frac{(f_{o,j} - f_{e,j})^2}{f_{e,j}} \qquad (2.11)$$

with k-1 degrees of freedom,

where

k is the number of trading signals

f_{oj} is the observed number of counters that achieved the highest return under each trading signal

f_{ej} is the expected number of counters that achieved the highest return under each trading signal.

2.2.2.4 KOLMOGOROV-SMIRNOV TEST

The Kolmogorov-Smirnov test is based on the difference between the empirical distribution function S(x) with the hypothesized distribution function F'(x). In this study, the empirical distribution would be the return of individual stock under each trading method. If the largest vertical distance between S(x) and F'(x) exceeds the critical value, the null hypothesis is rejected and the population is said to be non-normally distributed. The Kolmogorov-Smirnov test can be described as below:

$$T_1 = \sup_x | F'(x) - S(x) | \quad (2.12)$$

where

T_1 equals the supremum, over all x, of the absolute value of the difference of F'(x) and S(x).