CHAPTER 3: DATA AND METHODOLOGY

3.1 Data

This study uses the data extracted from the Daily Dairy, published by the Kuala Lumpur Stock Exchange (KLSE). The KLSE operates five trading days weekly, from Monday to Friday. The data for the morning open (9.00 am or 9.30 am), morning close (12.30 noon) and afternoon close (5.00 pm) for seven KLSE indices are obtained for this study. The seven indices are the Composite Index, Emas Index, Industrial Index, Finance Index, Property Index, Mining Index and Plantation Index. Due to the unavailability of data of the afternoon opening (2.30 p.m.), the morning close (12.30 p.m.) will be used instead to replace the afternoon opening. The intradaily trading is classified into two trading sessions: the morning trading session from 9.00 to 12.30 pm and the afternoon trading session from 12.30 noon to 5.00 pm. This study covers a period of about 6 years from 3 January 1994 to 26 November 1999.

3.2 Methodology

3.2.1 Mean return

All stock returns are computed as logarithmic price relatives as follows:

$R_t = \ln (P_t / P_{t-1}) \times 100$

where P_t = price of the stock at time t

P_{t-1} = price of the stock at time t -1

For instance, the intraday stock return from morning open to morning close is computed as $R_t = \ln (P_{mc} / P_{mo}) \times 100$. The stock returns are expressed in percentages. The mean return of the morning open to morning close for all trading days in a period, $\bar{R}$ is then obtained as follows:

$$\bar{R} = \frac{\sum \ln(P_t / P_{t-1})}{n} \times 100 \quad \text{where n = number of trading days in a period}$$

To make computation easy, computer software such as the Excel program is used to compute the mean returns for the seven KLSE indices. Six mean return series will be computed and they are as follows:

(a) the close to open series from 5.00 p.m. of the previous day to 9.00 a.m. of the current day (overnight non- trading period)

(b) the open to close series from 9.00 a.m. to 5.00 p.m. of the trading day (daily trading period)

(c) the morning session series from 9.00 to 12.30 noon (or 9.30 a.m. to 12.30 noon)

(d) the afternoon session series from 12.30 noon to 5.00 p.m.

(e) the close to close series from 5.00 p.m. of the previous day to 5.00 p.m. of the current day.

(f) the open to open series from 9.00 a.m. of the previous day to 9.00 a.m. of the current day

The entire sample period consists of 1400 trading days of returns. The mean returns immediately after public holidays are omitted. The six series of mean returns are computed for each of the seven KLSE indices namely the Composite Index (CI), Emas Index, Industrial Index, Finance Index, Property Index, Mining Index and Plantation Index.

The entire sample period is further classified into 3 sub-periods to detect if there is a change in the mean return over time. For each sub-period, six series of mean returns are again computed for seven KLSE indices. The 3 sub-periods are classified based on the economic situations in Malaysia. They are as follows:

(a) sub period 1 - before financial crisis from January 3, 1994 to December 31,1996, for a total of 709 trading days.

(b) sub period 2 - during financial crisis from January 3, 1997 to August 28, 1998 for a total of 392 trading days

(c) sub period 3 - after capital control is implemented and after financial crisis from September 2, 1998 to November 26, 1999 for a total of 299 trading days.

The mean returns of all 3 sub-periods are also compared between each other.

3.2.2 Standard deviation of return or volatility

Standard deviation of return shows the risk of a particular stock. A high(low) volatility indicates a high (low) variation in the stock prices. Standard deviation is the square root of the variance. The variance is computed by the following formula:

$$s^2 = \frac{\sum\left(R_t - \bar{R}\right)^2}{n-1}$$

3.2.3 Skewness

Skewness measures the degree of asymmetry of a distribution around the mean return. The mean return will have either positive skewness or negative skewness. If the mean return is more than the median return, the stock market will have positive skewness. Conversely, if the mean return is less than the median return, it will have negative skewness. A positive skewness indicates that a large proportion of stocks has low returns. In contrast, a negative skewness indicates that a large proportion of stocks has high returns. If the skewness changes frequently from positive to negative or vice versa, this indicates that there is instabilty in the stock market. The skewness is computed by the following formula:

$$Sk = \frac{\left(\frac{1}{n}\right)\Sigma\left(R_t - \bar{R}\right)^3}{s^3}$$

3.2.4 Kurtosis

Kurtosis measures the relative peakedness or flatness of a distribution compared to normal distribution. Positive kurtosis indicates a relatively peaked distribution while negative kurtosis shows a relatively flat distribution. It is computed by the following formula:

$$K = \frac{\left(\frac{1}{n}\right)\Sigma\left(R_t - \bar{R}\right)^4}{s^4}$$

3.2.5 Statistical tests

(a) Testing the existence of weekday, overnight, weekend and daily effects – using one sample t-test approach

t-test is conducted to test the significance of each mean return series for seven indices. This test is performed throughout the entire sample period and each sub-period respectively. The objective is to determine if there exists a weekday, overnight, weekend and daily effects.

For sub period 1 and the entire sample period, a two-tailed t-test is performed to determine if each mean return is significantly different from zero. The hypothesis used is as follows:

Ho: $\mu = 0$

Ha: $\mu \neq 0$

Test Statistic: $t = \dfrac{\bar{R} - \mu}{s/\sqrt{n}}$

Rejection Region:

Ho is rejected at 1% significance level if $t > 2.58$ or $t < -2.58$

Ho is rejected at 5% significance level if $t > 1.96$ or $t < -1.96$

Ho is rejected at 10% significance level if $t > 1.65$ or $t < -1.65$

When Ho is rejected, it indicates there is sufficient evidence that the mean return is significantly different from zero.

However, to test whether each mean return is less than zero, a one tailed t-test is used instead. The mean return (for each series) of less than zero is tested throughout sub period 2 to determine if each return is negative. The alternative hypothesis will be changed to as follows:

Ho: $\mu = 0$

Ha: $\mu < 0$

Test Statistic: $t = \dfrac{\bar{R} - \mu}{s/\sqrt{n}}$

Rejection Region:

Ho is rejected at 10% significance level if t < - 2.33

Ho is rejected at 5% significance level if t < -1.65

Ho is rejected at 1% significance level if t < -1.28

When Ho is rejected, there is sufficient evidence that the mean return is significantly or less than zero (negative returns).

As for sub period 3, each mean return of greater than zero is tested to determine if each mean return is positive. The hypothesis is as follows:

Ho: $\mu = 0$

Ha: $\mu > 0$

Test Statistic: $t = \dfrac{\bar{R} - \mu}{s/\sqrt{n}}$

Rejection Region:

Ho is rejected at 10% significance level if t > 2.33

Ho is rejected at 5% significance level if $t > 1.65$

Ho is rejected at 1% significance level if $t > 1.28$

When Ho is rejected, there is sufficient evidence that the mean return is significantly greater than zero (positive returns).

(b) Testing equality of mean return across trading and non-trading returns – using two sample t-test approach

Two mean t-test is performed to test whether there is a difference between two mean return series. It is used to test the difference in the mean return between close to open and open to close series, morning and afternoon series, and the close to close and open-open series respectively. Two tailed t-test is similarly performed for each return series between sub-periods 1 and 2, sub-periods 2 and 3 as well as sub-periods 1 and 3 respectively.

Before two-tailed t-test is performed, the variance of each series of returns has to be assumed equal. The following hypothesis will be performed:

Ho: $\mu_i = \mu_j$

Ho: $\mu_i \neq \mu_j$

where i = close to open or morning or close to close series

j = open to close or afternoon or open to open series

Test Statistic: $t = \dfrac{\left(\bar{R}_i - \bar{R}_j\right) - \left(\mu_i - \mu_j\right)}{\sqrt{s_p^2\left(\frac{1}{n_i} + \frac{1}{n_j}\right)}}$

where $s_p^2 = \dfrac{(n_i - 1)s_i^2 + (n_j - 1)s_j^2}{n_i + n_j - 2}$

n_i = sample size of i series

n_j = sample size of j series

$\bar{R}_i$= mean return of i series

$\bar{R}_j$ = mean return of j series

Rejection region:

Ho is rejected at 1% significance level if t > 2.58 or t < -2.58

Ho is rejected at 5% significance level if t > 1.96 or t < -1.96

Ho is rejected at 10% significance level if t > 1.65 or t < -1.65

When Ho is rejected, there is sufficient evidence of a difference in the mean return between close to open and open to close series, morning and afternoon series, close to close and open to open series respectively. It also indicates there are significant differences in the mean return of each series between sub-periods 1 and 2, sub-periods 2 and 3 as well as sub-periods 1 and 3 respectively.

(c) Testing equality of variances between two series – using F-test

F- test is used to test the equality of variances between close to open and open to close series, morning and afternoon series, close to close and open to open series respectively for each indices and across all weekdays. Equality of variance for each return series is similarly tested between sub-periods 1 and 2, 2 and 3 as well as 1 and 3 respectively. The following steps are involved:

Ho: $\sigma^2_i = \sigma^2_j$

Ha: $\sigma^2_i \neq \sigma^2_j$

Test Statistic: $F = \frac{S_i^2}{S_j^2}$

where s_i^2 = sample variance of i series

s_j^2 = sample variance of j series

Rejection Region:

Ho is rejected at 10% significance level if $F > F_{.1;(ni-1);(nj-1)}$

Ho is rejected at 5% significance level if $F > F_{.05;(ni-1);(nj-1)}$

Ho is rejected at 1% significance level if $F > F_{.01;(ni-1);(nj-1)}$

where $n_i - 1$= degrees of freedom of i series

$n_j - 1$= degrees of freedom of j series

When Ho is rejected, there is sufficient evidence of a difference in the variance return between close to open and open to close series, morning and afternoon series as well as close to close and open to open series respectively. It also shows a significant difference in the return variance for each return series between sub-periods 1 and 2, sub-periods 2 and 3 and sub-periods 1 and 3 respectively.

(d) (i)Testing homogeneity of each return across all weekdays – using one-way Anova F test approach

This test is performed to determine if there is a difference in each mean return series from Monday to Friday.

Ho: $\mu_1 = \mu_2 = \ldots\ldots\ldots = \mu_5$

Ha: at least two days of mean returns are not equal

where 1 to 5 = Monday to Friday

μ= mean return of each series

Test Statistic: $F = \dfrac{SSB/(k-1)}{SSW/(n-k)}$

where SSB = sum of squares between groups

SSW = sum of squares within groups

k – 1 = degrees of freedom between groups

n – k = degrees of freedom within groups

k = 5 days of each mean return series

n = size of samples

Rejection Region:

Ho is rejected at 10% significance level if $F > F_{.1;k-1;n-k}$

Ho is rejected at 5% significance level if $F > F_{.05;k-1;n-k}$

Ho is rejected at 1% significance level if $F > F_{.01;k-1;n-k}$

When Ho is rejected, there is sufficient evidence of at least two mean returns are different from Monday to Friday.

On the other hand, to determine if there is any difference in each mean return series from Tuesday to Friday, the hypothesis will be as follows:

Ho: $\mu_2 = \mu_3 = \mu_4 = \mu_5$

Ha: at least two days of mean returns are not equal

where 2 to 5 = Tuesday to Friday

μ = mean return of each series

Test Statistic: $F = \dfrac{SSB/(k-1)}{SSW/(n-k)}$

where SSB = sum of squares between groups

SSW = sum of squares within groups

$k - 1$ = degrees of freedom between groups

$n - k$ = degrees of freedom within groups

$k = 4$ days of each mean return series

n = size of samples

Rejection Region:

Ho is rejected at 10% significance level if $F > F_{.1;k-1;n-k}$

Ho is rejected at 5% significance level if $F > F_{.05;k-1;n-k}$

Ho is rejected at 1% significance level if $F > F_{.01;k-1;n-k}$

When Ho is rejected, there is sufficient evidence of at least two returns are not equal from Tuesday to Friday.

(d) (ii)Testing homogeneity of all returns for each day – using Anova F-test approach

One-way Anova F-test is also used in determining if there is a significant difference of all mean return series for each day and indices. It is done as follows:

Ho: $\mu_{dc} = \mu_{do} = \mu_{dm} = \mu_{da} = \mu_{dcc} = \mu_{doo}$

Ha: at least two mean returns are not equal

where d = Monday to Friday respectively

c = close to open series

o = open to close series

m = morning series

a = afternoon series

cc = daily close to close series

oo = daily open to open series

Test Statistic: $F = \dfrac{SSB/(k-1)}{SSW/(n-k)}$

where SSB = sum of squares between groups

SSW = sum of squares within groups

k – 1 = degrees of freedom between groups

n – k = degrees of freedom within groups

k = 6 mean return for each day

n = size of samples

Rejection Region:

Ho is rejected at 10% significance level if $F > F_{.1;k-1;n-k}$

Ho is rejected at 5% significance level if $F > F_{.05;k-1;n-k}$

Ho is rejected at 1% significance level if $F > F_{.01;k-1;n-k}$

When Ho is rejected, there is sufficient evidence of a difference in at least two mean return series for each day.

(e) (i) Testing equality of variance for each return across all weekdays

– using Bartlett's test approach

It is used to test the homogeneity of variance for each return from Monday to Friday.

Ho: $\sigma^2_1 = \sigma^2_2 = \sigma^2_3 = \sigma^2_4 = \sigma^2_5$

Ho: at least two variances are different

where 1 to 5 = Monday to Friday

and σ^2 = variance of each series

Test Statistic: $$M = \frac{2.3026}{C}\left[(n-t)\log s_p^2 - \Sigma(r_i - 1)\log_{10} s_i^2\right]$$

where $$s_p^2 = \frac{\Sigma(r_i - 1)s_i^2}{n-t}$$

and $$C = 1 + \frac{1}{3(t-1)}\left[\Sigma\left(\frac{1}{r_i - 1}\right) - \frac{1}{n-t}\right]$$

$t = 5$, for Monday to Friday

r_i = number of trading days for day i

Rejection region: Ho is rejected at 10% if $M > \chi^2_{(t-1)} = \chi^2_{(4)}$

Ho is rejected at 5% if $M > \chi^2_{(t-1)} = \chi^2_{(4)}$

Ho is rejected at 1% if $M > \chi^2_{(t-1)} = \chi^2_{(4)}$

If Ho is rejected, there is sufficient evidence that at least two variances are different from Monday to Friday.

This test is similarly performed to determine whether there is a difference in the variance throughout Tuesday to Friday. The steps are as follows:

Ho: $\sigma^2_2 = \sigma^2_3 = \sigma^2_4 = \sigma^2_5$

Ho: at least two variances are different

where 2 to 5 = Tuesday to Friday

and σ^2 = variance of each series

Test Statistic: $M = \frac{2.3026}{C}\left[(n-t)\log s_p^2 - \Sigma(r_i - 1)\log_{10} s_i^2\right]$

where $s_p^2 = \frac{\Sigma(r_i - 1)s_i^2}{n-t}$

and $C = 1 + \frac{1}{3(t-1)}\left[\Sigma\left(\frac{1}{r_i - 1}\right) - \frac{1}{n-t}\right]$

$t = 4$, for Tuesday to Friday

r_i = number of trading days for day i

Rejection region: Ho is rejected at 10% if $M > \chi^2_{(t-1)} = \chi^2_{(3)}$

Ho is rejected at 5% if $M > \chi^2_{(t-1)} = \chi^2_{(3)}$

Ho is rejected at 1% if $M > \chi^2_{(t-1)} = \chi^2_{(3)}$

If Ho is rejected, there is sufficient evidence that at least two variances are different throughout Tuesday to Friday.

(ii) Testing equality in variances among all return series for each day

– using Bartlett's test approach

Equality of variance among all return series for each day is also tested using Bartlett's test. The hypothesis will be as follows:

Ho: $\sigma^2_{dc} = \sigma^2_{do} = \sigma^2_{dm} = \sigma^2_{da} = \sigma^2_{dcc} = \sigma^2_{doo}$

Ho: at least two variances are different

where d = each day

and c = close to open series

o = open to close series

m = morning series

a = afternoon series

cc = daily close to close series

oo = daily open to open series

Test Statistic: $$M = \frac{2.3026}{C}\left[(n-t)\log s_p^2 - \Sigma(r_i - 1)\log_{10} s_i^2\right]$$

where $$s_p^2 = \frac{\Sigma(r_i - 1)s_i^2}{n-t}$$

and $$C = 1 + \frac{1}{3(t-1)}\left[\Sigma\left(\frac{1}{r_i - 1}\right) - \frac{1}{n-t}\right]$$

$t = 6$

r_i = number of trading days for day i

Rejection region: Ho is rejected at 10% if $M > \chi^2_{(t-1)} = \chi^2_{(5)}$

Ho is rejected at 5% if $M > \chi^2_{(t-1)} = \chi^2_{(5)}$

Ho is rejected at 1% if $M > \chi^2_{(t-1)} = \chi^2_{(5)}$

If Ho is rejected, there is sufficient evidence that at least two variances (of all return series) are different for each day.