CHAPTER 3

This chapter describes the data, computation and statistical tests. The first section describes the data, how capital changes are dealt with, how excess returns are computed and how firm-size portfolios are formed. The second section explains the statistical tests on firm size effect and seasonality in stock returns.

3.1 DATA DESCRIPTION

This empirical research focuses on common stocks listed with the Kuala Lumpur Stock Exchange (KLSE). The end-of-month closing prices of companies listed on the KLSE were used to analyse the monthly return seasonality during the period from January 1987 to December 2001.

Monthly stock returns are calculated using data obtained from *Datastream*, the KLSE Daily Dairy and the Investors Digest, published monthly by the KLSE. This on-line database gives the monthly closing prices of KLSE listed firms, adjusted for capital changes due to stock splits, rights issue and bonus issue. The computation methods for capital changes are showed in Appendix II. The sample companies in existence for at least ten years or above during the period from 1987 to 2001 are included in the analysis. There are 150 companies identified for this purpose.

To avoid any potential bias in the monthly return computations, only companies that are listed for the full twelve calendar months starting from January to December in a respective year will be included in the sample, whereas companies that are listed for less than twelve months will be excluded. However, such companies will be included in the following year once all of its monthly observations are available. Therefore, the number of companies included in the sample for respective year will be different and giving a total of 24,720 monthly companies observations during the period from 1987 to 2001. In addition, the monthly closing values of the KLCI were used to investigate the monthly seasonal return on the KLSE's main index throughout the 1987 to 2001 period, giving a total of 180 monthly observations.

To investigate the relationship between the firm size and the monthly seasonal return in the Malaysian equity market, all companies that meet the criteria of having all twelve monthly observations in a particular year are divided into five equally weighted portfolios formed based on the size of their December-end market capitalization values. On the last trading day of each year, the portfolios were constructed by initially sorting all the available companies' market values in an ascending order. Then, dividing them into five groups with the lowest market value assigned to Portfolio 1 (smallest), followed by the second group comprising of companies with the second lowest market value assigned to Portfolio 2, and continuing until Portfolio 5 (largest) is completed. The average size of the market value of each company in the portfolios is RM135.7 million for Portfolio 1, RM261.8 million for Portfolio 2, RM474.7 million for Portfolio 3, RM900.3 million for Portfolio 4, and RM3,865 million for Portfolio 5.

The portfolios were held for one year so that on the December-end of each year, the monthly returns for each portfolio are computed. Following the method employed by Keim (1983), Brown *et al.* (1983) and Berges *et al.* (1984), the monthly returns for each portfolio are based on an equally weighted portfolio. Portfolios are rebalanced on a annually basis. This procedure was repeated for every year from 1987 to 2001.

The time period is divided into two sub-periods. For the stock portfolios, two sub-periods were created namely: (1) Full period (1987-2001); (2) Sub-period 1 (1987-1993); and (3) Sub-period 2 (1995-2001). Year 1994 was excluded in this section because the price of stocks decreased rapidly during this year and the other purpose is to let both sub-periods have the same number of years. For the analysis on the KLCI, two sub-periods were also created likely above. The periodical classifications are needed for several purposes. The full period will enable the analysis of return seasonality in a longer time horizon. On the other hand, the sub-periods will enable a closer examination of the return seasonality during the respective sub-periods.

To maintain the consistencies of the data and the observations, the 15-year period from 1987 to 2001 were divided into two sub-periods. The Sub-period 1 covers the time period from 1987 to 1993. During this period, the Malaysian stock market was still relatively small. The Sub-period 2 covers the time period from 1995 to 2001, during which the Malaysian stock market experienced high volatility featured by sharp rebounds and corrections, as well as prolonged consolidation following the 1997 Asian financial crisis.

3.2 METHODOLOGY

The monthly return for each stock in this study is computed using the capital price change measure as below:

$$R_{it} = [(P_t - P_{t-1}) / P_{t-1}] * 100$$

where

R_{it} = The monthly return of stock index i on month t

P_t = The monthly closing price for month t

P_{t-1} = The monthly closing price for previous month $t-1$.

Adjustments for capital changes are made and the computation for such changes are presented in Appendix II.

3.2.1 MODEL OF STOCK RETURNS

Stock returns are assumed to follow a linear model. In the regression model, the dependant variable is regressed against twelve monthly dummies as follows:

$$R_{it} = \alpha_1 D_1 + \alpha_2 D_2 + \ldots + \alpha_{12} D_{12} + e_t \qquad (1)$$

where R_{it} is the return of security i in month t; the dummy variables D_1, D_2 until D_{12} take the value of one for the month (January = 1, February = 2, March = 3, ..., December = 12) for which the return is observed and zero otherwise. The coefficients for the twelve dummy variables (α_1, α_2, ..., α_{12}) indicate the monthly mean returns of the twelve months. The error term, e_t, is assumed to be normally distributed.

The objective of this regression is to examine the significance of the mean return of each of the twelve months of the year. Therefore, the null hypothesis states that each of the individual coefficients is equal to zero. Consequently, if there is no monthly seasonality in the return of the Malaysian stocks, the coefficients for each of the twelve dummy variables (α_1, α_2, ..., α_{12}) will be close to zero and their t-statistics not significant. Rejection of this null hypothesis would indicate the month-of-the-year effect.

3.2.2 STATISTICAL TESTS

There are two major types of statistical tests used in this study, the parametric test and the non-parametric test. The parametric tests assume that the populations are normally distributed. The non-parametric tests do not require the presence of normality of the distribution. They require fewer and less stringent conditions for their use and are more flexible. The non-parametric test is also known as a distribution-free test.

To test for the presence of the seasonal return and differences in month-to-month mean returns (μ_i), the parametric One-way Analysis of Variance (ANOVA) *F* test and the non-parametric Kruskal-Wallis test are used to test the hypotheses:

$$H_0 : \mu_1 = \mu_2 = \mu_3 = ... = \mu_{12}$$

against

$$H_1 : \text{at least two } \mu \text{ are not equal}$$

where

μ_i = The effect specific to month i of the year

Rejection of the null hypothesis will infer that the stock returns R_{it} exhibit seasonality according to the month-of-the-year. If the *F* test rejects the null hypothesis, the Tukey test is then used for pairwise comparison of monthly returns for significance.

To test whether the monthly return for each size portfolio is different from zero, the one-sample t-test is used. The hypotheses to be tested are:

$H_0 : \mu_{i,t} = 0$

against

$H_1 : \mu_{i,t} \neq 0$

where

i = The calendar month (January, February, ..., December)

t = The size portfolio (Portfolio 1, Portfolio 2, ..., Portfolio 5)

Rejection of the null hypothesis will indicate that the monthly mean return is different from zero.

3.2.2(A) PARAMETRIC TESTS

ONE-WAY ANOVA

One-way ANOVA is a procedure used for comparing sample monthly mean returns of a particular stock to see if there is sufficient evidence to infer that the means of the corresponding population distribution of the monthly returns of the same share also differ. The hypotheses for the test are:

$H_0 : \mu_1 = \mu_2 = \mu_3 = ... = \mu_{12}$

H_1 : at least two μ are not equal

The one-way ANOVA assumes normal populations and homogeneity of population variances.

In the One-way ANOVA test, comparison of the Mean $\text{Squares}_{(\text{between groups})}$ to the Mean $\text{Squares}_{(\text{within groups})}$ is carried out to derive the F ratio. The test statistic is:

$$F = MS_{bg} / MS_{wg}$$

where

F = Ratio of the mean squares between groups to the mean squares within groups

MS_{bg} = Mean squares between groups

MS_{wg} = Mean squares within groups

If the p-value less than 0.05 we reject the null hypothesis.

TUKEY TEST

Although the univariable tests of ANOVA allow one to reject the null hypothesis that group means are equal, it does not pinpoint where the significant difference lies. For further investigation of specific group mean difference of interest, a post hoc method will be used, for instance, Tukey test. Tukey test is used to test the significance of difference between the means of any paired groups as part of the unplanned comparison means technique. A pair of means is considered to be significantly different at $\alpha = 0.05$ if their difference is equal or greater than the critical difference MSD_{ij}, that is, if $| \bar{Y}_j = \bar{Y}_i | \geq MSD_{ij}$ (Sokal and Rohlf, 1969).

$$MSD_{ij} = Q_{\alpha(k,v)}\sqrt{\frac{MS_{withingroups}\left(\frac{1}{n_i}+\frac{1}{n_j}\right)}{2}}$$

where

$Q_{\alpha(k,\ v)}$ = Critical value of studentized range

n_i = Sample size of group i

n_j = Sample size of group j

α = 0.05, significancce level

k = Number of groups (in this case, $k = 12$)

v = Degree of freedom, $\Sigma(n_i - 1)$

ONE-SAMPLE T-TEST

The one-sample t-test on each size stock portfolio is used to test the statistical significance of month-of-the-year effect. It is assumed that monthly stock returns are normally distributed and are independent from year-to-year[1]. The hypotheses to be tested are:

$H_0 : \mu_{i,t} = 0$

against

$H_1 : \mu_{i,t} \neq 0$

[1] Time series analysis revealed that most autocorrelations of monthly stock returns are not significantly different from zero.

where

i = The calendar month (January, February, ..., December)

t = The size portfolio (Smallest, Portfolio 2, ..., Largest)

In the one-sample t-test, the test statistic is:

$$t = \frac{\bar{X} - \mu_0}{S / \sqrt{n}}$$

where

$\bar{X}$ = The sample mean

μ_0 = The population mean

S = The sample standard deviation

n = The number of observations

The null hypothesis states that the average monthly return for each firm size portfolio does not differ from zero. The alternative hypothesis states that the average monthly return for each firm size portfolio is different from zero. If the p-value is less than 0.05, we reject the null hypothesis.

3.2.2(B) NON-PARAMETRIC TEST

KRUSKAL-WALLIS TEST

The Kruskal-Wallis test is the non-parametric test used for testing the existence of the month-of-the-year effect. This test is the non-parametric equivalent to the one-way ANOVA F statistical test. It is a very useful test in determining k independent samples are from the same population or from different populations. Unlike the one-way ANOVA test, the Kruskal-Wallis test is not as stringent in its assumptions. This test is essentially a distribution free test. The hypotheses to be tested are:

H_0 : all k populations are identical

against

H_1 : at least two populations are different

In this study, the Kruskal-Wallis test is used to test the null hypothesis that the populations of monthly returns of the twelve trading months of the year are identical. Rejection of the null hypothesis will indicate that the month-of-the-year effect exists in the monthly returns.

In the computation, each of the N observations (N = the total number of independent observations in the k samples) is replaced by rank. All the stock returns are ranked from the smallest to the largest. The statistic H used in the Kruskal-Wallis test is defined as below:

$$H = \frac{12}{N(N+1)} \sum_{d=1}^{k} \frac{R_d^2}{n_d} - 3(N+1)$$

where

k = 12, number of trading months in a year

n_d = Number of cases in month d of the year

N = Σn_d, the number of cases in all months combined

R_d = Sum of ranks in the month d of the year

If H_0 is true, and the sample sizes of the k samples are not too small, then the H statistic has approximately a chi-square, χ^2, distribution with degree of freedom of k-1. Therefore, the decision rule is as follows:

Reject H_0 if $H > \chi^2(11, \alpha)$

where $\chi^2(11, \alpha)$ is the upper percentile point of a chi-square distribution with 11 degrees of freedom. In this study, H_0 is tested at 5 percent significance level.

When two or more scores in the combined sample have the same value, ties occur. In this case, each score is given the mean of the ranks for which it is tied. Hence, corrections must be made for tied observations in computing H. The H statistic corrected for tied observations is:

$$H = \frac{\frac{12}{N(N+1)} \sum_{d=1}^{k} \frac{R_d^2}{n_d} - 3(N+1)}{1 - \frac{\sum T}{N^3 - N}}$$

where

T $= t^3 - t$ (when t is the number of tied observations in a tied group of scores)

ΣT = Summation of all groups of ties

3.3 USE OF COMPUTER SOFTWARE

The summary sample statistics for every month and for every index are obtained with the use of the statistical software package SPSS (Version 10.0).