CHAPTER 3

RESEARCH METHODOLOGY

3.1 Methodology

The indices data is tabulated according to the respective trading intervals. The returns of every 15-minute intraday interval are computed using the price relatives expressed in natural logarithm. In addition, 7 additional returns are computed, namely overnight break, morning trading session, lunch break, afternoon session, daily trading session, previous morning open and today morning open; previous evening close and today evening close. Descriptive analysis is performed to extract the average of returns, standard deviation of the returns, skewness and kurtosis of the respective intervals. The single-factor ANOVA test will be employed to verify the various hypotheses.

3.2 Data Description

The KLSE's transaction data used in the study covers a total of 248 trading days from 3 January 1994 to 31 December 1994. The daily data consists of twenty four 15-minute observations over the trading intervals 9.30 a.m. to 12.30 p.m. and from 2.30 p.m. to 5.00 p.m. Table 1 shows the intraday intervals used in the study. As the Intraday data is voluminous, the scope of the research only focuses on examining the 3 important indices; namely COMPOSITE Index, Emas Index and SECONDBOARD Index. All the three indices introduced by the KLSE, including the COMPOSITE Index are not adjusted for dividend payments.

Table 1 Intraday Intervals Used In The Study

Interval	Trading Time	Interval	Trading Time
1	previous close - **9.30 a.m.**	13	12.15 p.m. - **12.30 p.m.**
2	9.30 a.m. - **9.45 a.m.**	14	12.30 p.m. - **2.30 p.m.**
3	9.45 a.m. - **10.00 a.m.**	15	2.30 p.m. - **2.45 p.m.**
4	10.00 a.m. - **10.15 a.m.**	16	2.45 p.m. - **3.00 p.m.**
5	10.15 a.m. - **10.30 a.m.**	17	3.00 p.m. - **3.15 p.m.**
6	10.30 a.m. - **10.45 a.m.**	18	3.15 p.m. - **3.30 p.m.**
7	10.45 a.m. - **11.00 a.m.**	19	3.30 p.m. - **3.45 p.m.**
8	11.00 a.m. - **11.15 a.m.**	20	3.45 p.m. - **4.00 p.m.**
9	11.15 a.m. - **11.30 a.m.**	21	4.00 p.m. - **4.15 p.m.**
10	11.30 a.m. - **11.45 a.m.**	22	4.15 p.m. - **4.30 p.m.**
11	11.45 a.m. - **12.00 p.m.**	23	4.30 p.m. - **4.45 p.m.**
12	12.00 p.m. - **12.15 p.m.**	24	4.45 p.m. - **5.00 p.m.**

For each trading day, 22 15-minute intraday intervals are available, one for the each of the 15-minute intervals from 9.30 a.m. to 5.00 p.m. The respective intervals will be represented by the time indicated in **bold face**, namely 9.30 a.m. - 9.45 a.m. period will be represented by **9.45 a.m.** The overnight break (previous close - 9.30 a.m.) is considered as one of the interval, indicated by **9.30 a.m.**, whereas the lunch break (12.30 p.m. - 2.30 p.m.) is represented **by 2.30 p.m.**

3.3 Data Analysis

3.3.1 Intraday Returns

Returns of each intraday interval t of a particular day i $R_{t,i}$, are computed as natural logarithmic price relatives expressed in percentage as follows:

$$R_{t,i} = \ln (P_{t,i} / P_{t-1,i}) \times 100\%$$

where $P_{t,i}$ is the KLSE index at interval t of day i.

Eight sets of return series are computed, namely:

i) 22 intraday 15-minute returns series computed on a 15-minute interval from 9.30 a.m. to 12.30 p.m. and 2.30 p.m. to 5.00 p.m.

ii) Overnight break (previous evening close to morning open).

iii) Morning trading session (morning open to noon close).

iv) Lunch Break (noon close to afternoon open).

v) Afternoon trading session (afternoon open to evening close).

vi) Daily trading session (morning open to evening close).

vii) Previous Open - Today Open (previous morning open to today morning open).

viii) Previous Close - Today Close (previous evening close to today evening close).

3.3.2 Intraday Average Returns

3.3.2.1 Intraday Interval

The average returns ($\tilde{R}_t$) of the respective intraday interval is computed as follows:

$$\tilde{R}_t = \left(\sum_{i=1}^{n} \left(\ln \left(P_{t,i} / P_{t-1,i} \right) \times 100\% \right) \right) / n$$

where i denotes the day of observation from day 1 till day n and t denotes the intraday interval for the day.

3.3.2.2 Overnight Break Interval

The average returns ($\tilde{R}_{9.30\,a.m.}$) of the overnight break interval is computed as follows:

$$\tilde{R}_{9.30\,a.m.} = \left(\sum_{i=1}^{n} \left(\ln \left(P_{9.30\,a.m.,i} / P_{5.00\,p.m.,i-1} \right) X\ 100\% \right) \right) / n$$

where i denotes the observation day from day 1 till day n.

3.3.2.3 Morning Trading Session

The average returns ($\tilde{R}_{morning}$) of the morning trading session is computed as follows:

$$\tilde{R}_{morning} = \left(\sum_{i=1}^{n} \left(\ln \left(P_{12.30\,p.m.,i} / P_{9.30\,a.m.,i} \right) X\ 100\% \right) \right) / n$$

where i denotes the observation day from day 1 till day n.

3.3.2.4 Afternoon Trading Session

The average returns ($\tilde{R}_{afternoon}$) of the afternoon trading session is computed as follows:

$$\tilde{R}_{afternoon} = \left(\sum_{i=1}^{n} \left(\ln \left(P_{5.00\,p.m.,i} / P_{2.30\,p.m.,i} \right) X\ 100\% \right) \right) / n$$

where i denotes the number of days.

3.3.2.5 Daily Trading Session

The average returns ($\tilde{R}_{daily}$) of the daily trading session is computed as follows:

$$\tilde{R}_{daily} = \left(\sum_{i=1}^{n} \left(\ln \left(P_{5.00\,p.m.,i} / P_{9.30\,a.m.,i} \right) X\ 100\% \right) \right) / n$$

where i denotes the observation day from day 1 till day n.

3.3.3 Variance

3.3.3.1 Intraday Interval

The variance of the returns of the respective intraday interval is computed as follows:

$$\sigma_t^2 = (\sum_{i=1}^{n} (R_{t,i} - \tilde{R}_t)^2) / (n-1)$$

where i denotes the day of observation from day 1 till day n and t denotes the intraday interval for the day.

3.3.3.2 Overnight Break Interval

The variance of the returns of the overnight break interval is computed as follows:

$$\sigma^2_{9.30\ a.m.} = (\sum_{i=1}^{n} (R_{9.30\ a.m.,i} - \tilde{R}_{9.30\ a.m.})^2) / (n-1)$$

where i denotes the observation day from day 1 till day n.

3.3.3.3 Morning Trading Session

The variance of the returns of the morning trading session is computed as follows:

$$\sigma^2_{morning} = (\sum_{i=1}^{n} (R_{morning,i} - \tilde{R}_{morning})^2) / (n-1)$$

where i denotes the observation day from day 1 till day n.

3.3.3.4 Afternoon Trading Session

The variance of the returns of the afternoon trading session is computed as follows:

$$\sigma^2_{afternoon} = \left(\sum_{i=1}^{n} (R_{afternoon,i} - \tilde{R}_{afternoon})^2 \right) / (n-1)$$

where i denotes the observation day from day 1 till day n.

3.3.3.5 Daily Trading Session

The variance of the returns of the daily trading session is computed as follows:

$$\sigma^2_{daily} = \left(\sum_{i=1}^{n} (R_{daily,i} - \tilde{R}_{daily})^2 \right) / (n-1)$$

where i denotes the observation day from day 1 till day n.

3.3.4 Skewness

Skewness characterizes the degree of asymmetry of a distribution around its mean. Positive skewness indicates a distribution with an asymmetric tail extending towards more positive values. Negative skewness indicates a distribution with an asymmetric tail extending towards more negative values.

The skewness of the returns of the respective intraday interval is computed as follows:

$$\text{Skewness}_t = \frac{n}{(n-1)(n-2)} \sum_{i=1}^{n} \left(\frac{R_{t,i} - \tilde{R}_t}{s} \right)^2$$

where s is the sample standard deviation which is defined as follows:

$$s = \left[\frac{n \sum_{i=1}^{n} (R_{t,i}^2) - (\sum_{i=1}^{n} R_{t,i})^2}{n (n - 1)} \right]^{1/2}$$

where i denotes the day of observation from day 1 till day n and t denotes the intraday interval for the day.

3.3.5 Kurtosis

Kurtosis characterizes the relative peakness or flatness of a distribution compared to the normal distribution. Positive kurtosis indicates a relatively peaked distribution. Negative kurtosis indicates a relatively flat distribution. The kurtosis of the returns of the respective intraday interval is computed as follows:

$$\text{Kurtosis}_t = \left[\frac{n (n + 1)}{(n - 1) (n - 2) (n - 3)} \sum_{i=1}^{n} \left(\frac{R_{t,i} - \tilde{R}_t}{s} \right)^4 \right] - \frac{3(n - 1)^2}{(n - 2) (n - 3)}$$

where i denotes the day of observation from day 1 till day n and t denotes the intraday interval for the day.

3.3.6 Correlations of Returns

A correlation coefficient measures the relationship between two data sets that are scaled to be independent of the unit of measurement. It will determine whether two data sets move together, that is, whether large values of one set are associated with large values of the other (positive correlation), whether small values of one set are associated with large value of the other (negative correlation), or whether the values in the two sets are unrelated.

The correlation of the returns of the respective intraday interval is computed as follows:

$$\rho (R_t , R_{t-1}) = \frac{cov(R_t , R_{t-1})}{(\sigma_{R_t})(\sigma_{R_{t-1}})}$$

where cov, the Covariance and σ_{R_t} are defined as follows:

$$cov(R_t , R_{t-1}) = \frac{1}{n} \sum_{i=1}^{n} (R_{t,i} - \tilde{R}_t)(R_{t-1,i} - \tilde{R}_{t-1})$$

$\sigma_{R_t}, \sigma_{R_{t-1}}$ are standard deviation of the returns in period t and t-1.

3.4 Research Hypotheses

3.4.1 Hypotheses

To test the equality of the return variances across different periods, the following null hypotheses are examined:

H1: the returns variances for the twenty three 15-minute periods are equal, i.e., $\sigma^2_2 = \sigma^2_3 = \sigma^2_4 = ... = \sigma^2_{24}$;

H2: the returns variances between overnight break (C-O) and daily intraday (O-C) periods are equal, i.e. , $\sigma^2_{CO} = \sigma^2_{OC}$;

H3: the returns variances between the morning session (morning) and afternoon session (afternoon) are equal, $\sigma^2_{morning} = \sigma^2_{afternoon}$.

H4: the returns variances between the open-to-open (O-O) and close-to-close (C-C) periods are equal, $\sigma^2_{OO} = \sigma^2_{CC}$.

H5: ρ ($R_{o\text{-}c}$, $R_{morning}$), the correlation between the returns from the overnight break and the returns from the morning session is negative.

H6: ρ ($R_{morning}$, $R_{lunch\ break}$), the correlation between the returns from the morning session and the returns from the lunch break is negative.

H7: ρ ($R_{lunch\ break}$, $R_{afternoon}$), the correlation between the returns from the lunch break and the returns from the afternoon session is negative.

3.4.2 Statistical Test

The single-factor ANOVA test is employed to conduct a simple analysis of variance, which tests the hypotheses that means from several samples are equal, i.e. means of different intraday intervals.

The statistical significance is set at confidence levels of 0.01, 0.05 and 0.1 for evaluating critical values for the F statistics. The F statistics is defined as follows:

$$F = \frac{\text{Sum of squared error between group} / D.O.F._{regression}}{\text{Sum of squared error within group} / D.O.F._{residual}}$$

where group refers to the trading interval, $D.O.F._{regression}$ denotes (number of intervals -1) degrees of freedom and $D.O.F._{residual}$ denotes (number of trading days -1) degrees of freedom.