CHAPTER 3

RESEARCH METHODOLOGY

3.1 Data

The data used in this study are:

i. Daily price data of securities listed on the Main Board of the KLSE from 1988 to 2000. These price data were obtained from Bloomberg.

ii. Dividend yield, total debt and book value which can be obtained or derived from information in the Investors Digest (a monthly publication of the KLSE) and the Annual Companies Handbook (an annual publication of the KLSE).

iii. The 3-month Treasury Bill rate, obtained from the Bank Negara Quarterly Bulletin.

iv. The one-month fixed deposit rates for commercial banks, obtained from the Monthly Statistical Bulletin.

3.2 Hypotheses

The efficacy of Graham's stock selection criteria as well as the efficacy of the selection criteria using different strategies are examined by testing the following hypotheses:

H_0 : A portfolio formed using Graham's stock selection criteria does not outperform the market.

H_1: A portfolio formed using Graham's stock selection criteria outperforms the market.

The hypotheses to compare the portfolio performances using different strategies are as follow:

H_0: There is no difference in the returns of portfolios using different strategies.

H_1: There is a difference in the returns of portfolios using different strategies.

In the case that the null hypothesis is rejected, the best strategy or the strategy generating the highest average portfolio return will be determined.

3.3 The Sample

As mentioned in section 1.4, Graham's selection criteria consist of 10 criteria. The first five measure 'reward' and the second five 'risk'. To be eligible for a portfolio, a security must meet at least one reward criterion and one risk criterion. The reward and risk criteria used in this study are criteria 3 and 6. The criteria used are restated below:

Criterion 3: A dividend yield of at least two-thirds of the AAA bond yield.

Criterion 6: Total debt less than the book value.

Due to the limitation of AAA bonds in Malaysia, the 3-month Treasury Bill rate is used instead of the AAA bond yield.

All the securities with financial year end later than June and listed in the KLSE are screened on the 31st December of each year between 1987 and 1997. Securities with financial year end earlier than June are not screened to avoid acting on outdated information. Table 3.1 lists the number of securities on the KLSE that qualified.

Table 3.1 Number of securities meeting criteria 3 and 6

Year	Number of securities
1987	47
1988	44
1989	34
1990	20
1991	15
1992	24
1993	7
1994	15
1995	13
1996	9
1997	84

A sample of 35 securities (where possible) is randomly selected from the eligible securities to form a portfolio. In cases where the number of eligible securities is less than 35 but more than eight, all eligible securities are used to form a portfolio. Equally weighted portfolios on the date of purchase of these securities are purchased on the last business day of March in the year following the screen.

This study employs 4 slightly different strategies:

Strategy 1: each security is held for either 2 years or until a 100% price appreciation is achieved, whichever comes first.

Strategy 2: each security is held for either 2 years or until a 75% price appreciation is achieved, whichever comes first.

Strategy 3: each security is held for either 2 years or until a 50% price appreciation is achieved, whichever comes first.

Strategy 4: each security is held for either 2 years or until a 25% price appreciation is achieved, whichever comes first.

3.4 Determining the portfolio returns

The return of security i in portfolio p is computed as:

$$R_i = \frac{P_{i,a} - P_{i,0} + d_i}{P_{i,0}} \qquad \text{----------(3.1)}$$

where

$P_{i,a}$ = transaction price per share of security i after a% price appreciation is achieved or at the end of the portfolio holding period

$P_{i,0}$ = transaction price per share of security i on the date of purchase

d_i = dividend per share of security i

In the case that security i is sold before the end of the two-year holding period, the return for the remaining period is the prevailing one month fixed deposit rate for commercial banks.

The return of portfolio p is then computed using the following:

$$R_{p,t} = \frac{\sum_{i=1}^{n_p} R_i}{n_t} \qquad \text{----------(3.2)}$$

where

n_p = number of securities in the sampled portfolio p

j = the year when the portfolio is formed

The return of security i in month t is computed from the following formula:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1} + d_{i,t}}{P_{i,t-1}} \qquad \text{----------(3.3)}$$

where

$P_{i,t}$ = the last transaction price per share of security i in month t

$d_{i,t}$ = dividends per share of security i in month t

In the case that security i is sold before the end of the 2 year holding period, the monthly return in subsequent months after selling is the prevailing one month fixed deposit rate for commercial banks.

The monthly portfolio returns are then computed from the monthly securities returns, i.e.

$$R_{p,t} = \frac{\sum_{i=1}^{n_p} R_{i,t}}{n_p} \qquad \text{----------(3.4)}$$

To determine the market returns, the values of the KLCI are used.

The return of the market portfolio formed in year j is

$$R_{m,j} = \frac{I_1 - I_0}{I_0} \qquad \text{----------(3.5)}$$

where

I_1 = the KLCI value at the end of the holding period

I_0 = the KLCI value at the beginning of the holding period

The monthly market return is computed using the following:

$$R_{m,t} = \frac{I_t - I_{t-1}}{I_{t-1}} \qquad \text{----------(3.6)}$$

where

I_t = the KLCI value at the last trading day of month t

3.5 *Testing the Efficacy of Graham's Stock Selection Criteria*

As mentioned in section 3.2, the first hypothesis is to test the efficacy of Graham's stock selection criteria. The hypothesis is tested using 2 approaches: the first, using the portfolio returns which applies the paired t-test and the second, using the risk-adjusted returns derived from the Capital Asset Pricing Model.

3.5.1 Using the Portfolio Returns

To test the efficacy of the selection criteria, the portfolio returns from different strategies are compared to the market returns of the market portfolio on a pair group basis; the returns are paired by the years of the portfolio formation. Thus the method of a matched pairs experiment is used.

For each strategy, the paired differences between the portfolio returns and market returns (i.e. $D_j = R_{p,j} - R_{m,j}$, $j = 1988, 1989, \ldots, 1998$) are computed. Altogether, 4 samples of paired differences are obtained, each with a size of 10. (There is no portfolio formed in 1994 due to insufficient number of eligible securities.) For each sample, the paired differences, $D_{1988}, D_{1989}, \ldots, D_{1998}$, are considered as random samples from a population with mean μ_D and standard deviation σ_D.

The hypotheses are reformulated as:

H_0 : $\mu_D = 0$

H_1 : $\mu_D > 0$

The test statistic used is as follow:

$$t = \frac{\bar{x}_D - \mu_D}{s_D / \sqrt{10}}$$

with 9 degrees of freedom and $\bar{x}_D$, s_D as the sample mean and sample standard deviation respectively.

Values of the t-statistic obtained are then compared to critical t values with certain levels of significance. If the null hypothesis is rejected, then there is sufficient evidence to conclude that portfolios formed using Graham's stock selection criteria outperform the market.

The use of the Student t distribution above requires the condition of normality, that is, the differences, D_j, must be normally distributed. In order to check this requirement, the Kolmogorov-Smirnov test is used to test the samples of paired differences.

Checking the normality requirement

The Kolmogorov-Smirnov test is a test that considers the goodness of fit between a hypothesized distribution function $F(x)$ (in this case, the normal distribution) and a sample distribution function $S(x)$. The null and alternative hypotheses are:

H_0 : Data from the sample of paired differences were from a normal distribution.

H_1 : Data from the sample of paired differences were not from a normal distribution.

The test statistic is as follow:

$$D = \sup_{-\infty < x < \infty} \left| S(x) - F(x) \right|$$

For each sample, values of the test statistic are compared to critical values with certain levels of significance. If the null hypothesis is rejected, then there is enough evidence to conclude that the data are not normally distributed.

3.5.2 Using the Risk-Adjusted Returns

The performances of the portfolios are evaluated using the following model:

$$\overline{R}_{p,t} - R_{ft} = \alpha_p + \beta_p\left(\overline{R}_{m,t} - R_{ft}\right) + \widetilde{e}_{pt}$$

where

$\overline{R}_{p,t}$	=	the month t (t = *1, 2, ..., 24*) mean return earned by a portfolio p of securities meeting the selection criteria and purchased in month 0
R_{ft}	=	the 'risk-free' or 3-month Treasury Bill rate of return in month t
$\overline{R}_{m,t}$	=	the mean rate of market return of the KLCI
$\widetilde{e}_{pt}$	=	an error term assumed to have expected value of zero and be serially uncorrelated
β_p	=	risk of portfolio p relative to the market
α_p	=	the measure of monthly abnormal performance for the portfolio evaluated

The above equation indicates that realized portfolio return in excess of the risk-free rate is a linear function of 3 terms:

i. a premium for accepting risk, that is, $\beta_p\left(\overline{R}_{m,t} - R_{ft}\right)$.

ii. a random error term with expected return of zero, that is, $\tilde{e}_{pt}$.

iii. an estimate of security performance not accounted for by either portfolio risk or market return, that is, α_p.

The last term, α_p, provides a direct estimate of the selectivity of the specified criteria. If α_p is statistically significant, then a portfolio formed using Graham's stock selection criteria 3 and 6 outperforms the market.

α_p is obtained from the Ordinary Least Squares (OLS) regression of the observed excess returns of the sampled portfolio on the corresponding observed excess returns of the market index. The hypotheses are reformulated as

H_0 : $\alpha_p = 0$

H_1 : $\alpha_p > 0$

The test statistic obtained is tested for its statistical significance. Rejection of the null hypothesis will indicate that the selection criteria have selective ability.

In order for the OLS method to be valid, requirements involving the probability distribution of the error variable must be satisfied.

These requirements are:

i. The probability distribution of the error term is normal with a mean of zero.

ii. The variance of the error terms is a constant for each value of the explanatory variable, that is, variance is homoscedastic.

iii. There is no autocorrelation between the error terms.

Testing the normality of the error terms

The Jarque-Bera test is used to test the normality of the error terms. This is an asymptotic test that is based on the ordinary least squares residuals. The null and alternative hypotheses are

H_0 : The error terms are normally distributed.

H_1 : The error terms are not normally distributed.

The test statistic used is

$$JB = N\left[\frac{s^2}{6} + \frac{(k-3)^2}{24}\right]$$

where

N = sample size

s = skewness of the error terms

k = kurtosis of the error terms

Under the null hypothesis of normality, the Jarque-Bera test statistic follows the chi-square distribution with 2 degrees of freedom. If the p-value of the computed test statistic sufficiently low, then the null hypothesis of normally distributed error terms can be ected.

sting for homoscedasticity of error terms

e null hypothesis of homoscedasticity is tested using White's test. The following gression is run:

$$\hat{\varepsilon}_i^2 = \alpha_1 + \alpha_2\left(\overline{R}_{mi} - R_{fi}\right) + \alpha_3\left(\overline{R}_{mi} - R_{fi}\right)^2 + v_i$$

it is, the squared errors from the original regression are regressed on the original gressor and its squared values. The null and alternative hypotheses are

) : $\alpha_2 = \alpha_3 = 0$

1 : at least one $\alpha_i \neq 0$, $i = 2, 3$

ie test statistic is given by nR^2 where n is the sample size and R^2 is obtained from the ove regression; R^2 describes the model fit. Under the null hypothesis of omoscedastice error terms, the test statistic follows the chi-square distribution with 2 egrees of freedom. The null hypothesis is rejected if the value of the test statistic cceeds the critical chi-square value at the chosen level of significance.

esting for autocorrelation among error terms

erial correlation among error terms can be detected by the Durbin-Watson d test. The ull and alternative hypotheses are

H_0 : First order autocorrelation is not present

H_1 : First order autocorrelation is present

The test statistic, also known as the *d* statistic, is defined as

$$d = \frac{\sum_{t=2}^{24} (\hat{\varepsilon}_t - \hat{\varepsilon}_{t-1})^2}{\sum_{t=1}^{24} \hat{\varepsilon}_t^2}$$

The probability distribution of the *d* statistic is difficult to derive and, therefore, there is no unique critical value that will lead to the rejection of the null hypothesis. However, a decision can be made by considering the lower bound d_L and upper bound d_U from the Durbin-Watson table.

The decision rules are as follow:

Value of *d*	Decision
$0 < d < d_L$	Reject the null hypothesis of no positive autocorrelation.
$d_L \leq d \leq d_U$	Test is inconclusive
$4 - d_L < d < 4$	Reject the null hypothesis of no negative autocorrelation
$4 - d_U \leq d \leq 4 - d_L$	Test is inconclusive
$d_U < d < 4 - d_U$	Retain the null hypothesis of no autocorrelation

3.6 *Comparing the portfolios' performances using different strategies*

As mentioned in section 3.2, portfolios' performances using different strategies are compared by testing the null hypothesis that there is no difference in the returns of portfolios using different strategies. This null hypothesis is tested by using a randomized block design with 10 blocks, each containing 4 experimental units. Treatments are the 4 different strategies and blocks are the years of portfolio formation. Observations are the return of portfolios. The statistical model for this design is

$$R_{ij} = \mu + \tau_i + \beta_j + \varepsilon_{ij}, \quad i = 1,2,3,4 \qquad j = 1,\ldots,10$$

where

R_{ij}	=	return of a portfolio formed in year j using strategy i
μ	=	overall mean
τ_i	=	effect of the i^{th} treatment or strategy
β_j	=	effect of the j^{th} block
ε_{ij}	=	NID $(0, \sigma^2)$ random error term

The null and alternative hypotheses are restated as

H_0 : $\tau_1 = \tau_2 = \tau_3 = \tau_4 = 0$

H_1 : $\tau_i \neq 0$ for at least one i

The test statistic to test the equality of treatment means is

$$F = \frac{MS_{treatment}}{MS_E}$$

where

$$MS_{treatment} = \frac{1}{3}\left[\sum_{i=1}^{4}\left(\frac{R_{i.}^2}{10}\right) - \frac{R_{..}^2}{40}\right]$$

$$MS_E = \frac{1}{27}\left[\sum_{i=1}^{4}\sum_{j=1}^{10}\left(R_{ij}^2 - \frac{R_{..}^2}{40}\right) - \sum_{i=1}^{4}\left(\frac{R_{i.}^2}{10} - \frac{R_{..}^2}{40}\right) - \sum_{j=1}^{10}\left(\frac{R_{.j}^2}{4} - \frac{R_{..}^2}{40}\right)\right]$$

$$R_{i.} = \sum_{j=1}^{10} R_{ij}\ ,\quad R_{.j} = \sum_{i=1}^{4} R_{ij}\ ,\quad R_{..} = \sum_{i=1}^{4}\sum_{j=1}^{10} R_{ij}$$

If the null hypothesis is true, the test statistic F is distributed as $F_{3,27}$. The null hypothesis is rejected if the value of the test statistic exceeds the critical F value at the chosen level of significance and therefore conclusion can be made that there is a difference in the returns of portfolios using different strategies.

Model Adequacy Checking

The use of a randomized block design requires conditions of normality, equal error variance by treatment or block and no block-treatment interaction. Residual analysis is used to check these requirements. The residuals for a randomized block design are

$$e_{ij} = R_{ij} - \hat{R}_{ij}$$

$$= R_{ij} - \overline{R}_{i.} - \overline{R}_{.j} + \overline{R}_{..}$$

The Kolmogorov-Smirnov test is used to check the normality requirement. Rejection of the null hypothesis that residuals are normally distributed would indicate model inadequacy.

The equality of error variance by treatment or block could be checked by plotting scatter diagrams of the residuals versus treatment and residuals versus block. If there is more scatter in the residuals for a particular block or treatment, then it can be concluded that the error variances are heterogeneous.

The residuals are plotted against $\hat{R}_{ij}$ to check for block-treatment interaction. A curvilinear pattern in the plot will indicate interaction between blocks and treatments.

Violation of the required conditions will indicate that the result of the test using a randomized block design is not reliable. An equivalent non-parametric test, namely Friedman test, for the randomized block design shall be employed.

Friedman Test for the Randomized Block Design

The null and alternative hypotheses remained the same as those in the equivalent parametric test. To find the value of the test statistic, rank all the observations from 1 to 4 within each block, with average ranks assigned when there are ties. The rank sum of each treatment, Q_i, is then calculated.

The test statistic is

$$T = \frac{12}{bk(k+1)} \sum_{i=1}^{k} Q_i^2 - 3b(k+1)$$

where

k = number of treatments or strategies ($k = 4$)

b = number of blocks or years of portfolio formation ($b = 10$)

If the null hypothesis that the performances of all the strategies are the same is true, then the test statistic follows a chi-square distribution with 3 degrees of freedom. The null hypothesis is rejected if the value of the test statistic exceeds the critical chi-square value at a chosen level of significance.

In the case that there is a difference in the returns of the portfolios using different strategies, multiple comparison tests are performed to determine the best strategy.

Multiple Comparison Tests

The parametric version of the multiple comparison test used is the Scheffe's test. The null hypothesis that portfolio performance of strategy i is not different from the portfolio performance of strategy j is tested against the alternative that portfolio performances of strategies i and j are different.

Restated, the null and alternative hypotheses are

H_0 : $\mu_i = \mu_j$ for all $i \neq j$, $i, j = 1, 2, 3, 4$

H_1 : $\mu_i \neq \mu_j$ for any $i \neq j$

The null hypothesis is rejected if

$$\left|\overline{R}_i - \overline{R}_j\right| > \sqrt{3 F_{\alpha, 3, 27}} \sqrt{\frac{2}{10} MS_E}$$

where MS_E is obtained from the randomized block design test and α is the level of significance.

For the non-parametric version of the multiple comparison test, the null and alternative hypotheses are the same as the Scheffe's test. Strategies i and j are considered different if the following inequality is satisfied:

$$\left|Q_i - Q_j\right| > t_{1-\frac{\alpha}{2}} \left[\frac{2b(A_2 - B_2)}{(b-1)(k-1)}\right]^{1/2}$$

with 27 degrees of freedom for the t-distribution and

A_2 = sum of the squared ranks

B_2 = $\frac{1}{10}\sum_{i=1}^{4} Q_i^2$

k = number of treatments or strategies ($k = 4$)

b = number of blocks or years of portfolio formation ($b = 10$)