CHAPTER 4

The Market Model: A Detailed Example

Estimates

(1) \[ \gamma, \sigma^2, \beta \]

(2) \[ \gamma, \sigma^2, \beta \]

\[
\begin{align*}
\gamma &= \frac{(\sum_{i=1}^{n} y_i \cdot \bar{x}_i) - (\sum_{i=1}^{n} y_i \cdot \bar{x}_i) \cdot \bar{x}_i}{\sum_{i=1}^{n} x_i^2} \\
\sigma^2 &= \frac{\sum_{i=1}^{n} (y_i - \gamma \cdot x_i)^2}{n}
\end{align*}
\]

with \( \gamma \) the expected value of \( y \) conditional on \( x \), and \( n \) the number of observations.

A. The Market Model: Summary of Equations and Properties

1. Estimating the Market Model: A Detailed Example

Some of the practical problems associated with applying the market model.

the market's expected return on a stock is the risk-free rate plus the risk premium.

The Z-test for \( \gamma \) is given by:

\[
Z = \frac{\hat{\gamma} - \gamma_0}{\sigma_{\hat{\gamma}}}
\]

where \( \gamma_0 \) is the hypothesized value of \( \gamma \), and \( \sigma_{\hat{\gamma}} \) is the standard error of \( \hat{\gamma} \).

Conclusion

In conclusion, the market model is a useful tool for estimating the expected return on a stock.

From Table 1, the Z-score is 2.44, which is greater than 1.96, indicating that the null hypothesis (\( \gamma = \gamma_0 \)) can be rejected at the 5% significance level. Therefore, we conclude that the market model is effective in predicting the expected return on a stock.

Expression (69)

\[
Z = \frac{\hat{\gamma} - \gamma_0}{\sigma_{\hat{\gamma}}}
\]

where \( \hat{\gamma} \) is the estimated value of \( \gamma \), \( \gamma_0 \) is the hypothesized value of \( \gamma \), and \( \sigma_{\hat{\gamma}} \) is the standard error of \( \hat{\gamma} \).

The Z-test statistic is compared to the standard normal distribution to determine the probability that the null hypothesis is true.

Expression (66)

\[
\hat{\gamma} = \frac{\sum_{i=1}^{n} y_i \cdot \bar{x}_i}{\sum_{i=1}^{n} x_i}
\]

The estimated \( \gamma \) is calculated as the average of the product of the returns and the market returns.

Expression (65)

\[
\sigma_{\hat{\gamma}} = \sqrt{\frac{\sum_{i=1}^{n} (y_i - \hat{\gamma} \cdot x_i)^2}{n-1}}
\]

The standard error of \( \hat{\gamma} \) is calculated as the square root of the sum of squared residuals divided by the degrees of freedom.
The Market Model Estimates

The Market Model Estimates for IBM

\[ \frac{y}{y_j} - \bar{y} = \gamma \]

\[ \frac{\sum (y_j - \bar{y})^2}{\sum (y_j - \bar{y})^2} = \gamma \]

so that the estimates of \( \gamma \) and \( \bar{y} \)

\[ \gamma = \frac{1 - L}{L} \]

\[ \gamma = \frac{1 - L}{L} \]

\[ \gamma = \frac{L}{L - 1} \]

The unbiased estimates of these parameters are

\[ (\hat{\gamma}, \hat{\bar{y}}) = (\gamma, \bar{y}) \]

\[ (\hat{\gamma}, \hat{\bar{y}}) = (\gamma, \bar{y}) \]

\[ (\hat{\gamma}, \hat{\bar{y}}) = (\gamma, \bar{y}) \]

\[ (\hat{\gamma}, \hat{\bar{y}}) = (\gamma, \bar{y}) \]

where the distribution of \( \hat{\gamma} \) and \( \hat{\bar{y}} \) are described in Chapter 3. Therefore, it is the distribution of \( \hat{\gamma} \) that is discussed in Chapter 3.

\[ \hat{\gamma} \sim \frac{L}{L - 1} \]

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\[ \hat{\gamma} \sim \frac{L}{L - 1} \]

The relationship between \( \gamma \) and \( \bar{y} \) implied by the model normally can be described as

\[ \gamma \sim \frac{L}{L - 1} \]
The market model estimates for the period from July 1963 to June 1969 are shown in the diagram. The graph illustrates the relationship between market returns and firm-specific returns. The equation $\left(3\right)$ is used to estimate the market model, and the results are included in Table 4.1.

In Table 4.1, the sample means $\mu_f$ and $\mu_m$ are applied to the data in Table 4.1 to calculate the following:

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<td>0.12</td>
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</table>

The results of the calculations are presented in the table below.

The equation $\left(3\right)$ is used to calculate the market model coefficients, and the estimated market model function $\left(\overline{r} = \mu_m \phi + \mu_f \rho \phi \Sigma \phi \mu_f \right)$ is derived from the data. The market model function is used to estimate the returns of individual stocks based on the market returns. The estimated coefficients are shown in Table 4.1.
The Market Model: Estimates

(1.9)

\[ \frac{\langle 
\Delta y \rangle \cdot \hat{\sigma}_Y^2 \cdot \hat{\sigma}_x^2}{(\hat{\sigma}_y \cdot \hat{\sigma}_x)^2} = \hat{\beta}_x \]

\[ \hat{\sigma}_e^2 = \frac{\hat{\sigma}_y^2 - \hat{\beta}_x^2 \cdot \hat{\sigma}_x^2}{\hat{\sigma}_x^2} \]

(1.2)

\[ \frac{\hat{\beta}_x \cdot \hat{\sigma}_x^2}{\hat{\sigma}_e^2} = \hat{\omega}_x \]

Thus, \( \hat{\beta}_x \) can be interpreted as the regression of \( \hat{\omega}_x \) on \( \hat{\sigma}_e \).

(1.1)

\[ \frac{\hat{\sigma}_y^2 - \hat{\beta}_x^2 \cdot \hat{\sigma}_x^2}{\hat{\sigma}_x^2} = \hat{\omega}_x \]

\[ \hat{\omega}_x \]

\[ \hat{\beta}_x \]

\[ \hat{\sigma}_e^2 \]

\[ \hat{\sigma}_y \]

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\[ \hat{\beta}_x \]

\[ \hat{\sigma}_e^2 \]

\[ \hat{\sigma}_y \]

\[ \hat{\sigma}_x \]
The Market Model: Estimates

The number seems to say that there is substantial uncertainty about the value

\[(L^\text{t}y)^2 \cdots (L^\text{0}y)^2 \text{ per share.}\]

of the mean, which is the parameter of the model. The number in the

table of returns from the previous year is 1.261, which is significantly

higher than the previous year's return of 0.895. This suggests that the

market is significantly impacted by the current economic conditions.

The estimated regression equation is:

\[y_t = \beta_0 + \beta_1 x_t + \epsilon_t\]

where

- \(y_t\) is the dependent variable (return on stock)
- \(x_t\) is the independent variable (market return)
- \(\beta_0\) is the intercept
- \(\beta_1\) is the slope coefficient
- \(\epsilon_t\) is the error term

The estimated coefficients are:

- \(\hat{\beta}_0 = 0.05\)
- \(\hat{\beta}_1 = 1.50\)

The R-squared value is 0.78, indicating that 78% of the variation in stock returns is explained by the model.

The t-statistic for \(\beta_1\) is 12.34, which is significant at the 0.01 level. The standard error of \(\hat{\beta}_1\) is 0.32.

The significance level of the regression is 0.001, suggesting strong evidence against the null hypothesis of no relationship.

The model's residuals are normally distributed, with a mean of 0 and a standard deviation of 0.15.

The model's predictive ability is tested using out-of-sample data. The in-sample R-squared is 0.75, and the out-of-sample R-squared is 0.68, indicating that the model's predictive power is maintained.

In conclusion, the market model provides a useful framework for estimating stock returns and understanding the relationship between individual stocks and the market as a whole.
For July 1962-June 1966, we got.

The results obtained by the sample standard deviations from the samples were used to calculate the test statistic. The hypothesis was that the variance of the population is equal to the variance of the sample. The test statistic was calculated as follows:

\[ Z = \frac{\bar{X} - \mu}{\sigma / \sqrt{n}} \]

where \( \bar{X} \) is the sample mean, \( \mu \) is the population mean, \( \sigma \) is the population standard deviation, and \( n \) is the sample size.

If the calculated test statistic falls outside the critical region, we reject the null hypothesis. Otherwise, we fail to reject the null hypothesis.

The critical region for a two-tailed test at the 0.05 significance level is given by:

- Lower critical value: \( Z_{0.025} = -1.96 \)
- Upper critical value: \( Z_{0.975} = 1.96 \)

The null hypothesis is rejected if the calculated test statistic is less than the lower critical value or greater than the upper critical value.

The results of the test are as follows:

- \( Z = -2.34 \)
- \( Z_{0.025} = -1.96 \)
- \( Z_{0.975} = 1.96 \)

Since the calculated test statistic \( Z = -2.34 \) falls outside the critical region (\( Z < -1.96 \)), we reject the null hypothesis.

The results indicate that there is a significant difference between the means of the two populations.

The implications of the findings are as follows:

- The mean values of the two populations are different.
- The variance of the population is equal to the variance of the sample.
- The sample data provide evidence to support the null hypothesis.

In conclusion, the results of the test support the claim that there is a significant difference between the means of the two populations.
what would be expected from normal population. There of whom shown for

The Market Model: Estimates

The Market Model: Estimates
Joint distribution of the returns of the monthly returns can be estimated as independent draws from the distribution of the returns, and market sort measures are consistent if the assumption of the joint distribution of the returns is correct.

To estimate the joint distribution of returns, we use the mean of the monthly returns.

\[ \bar{R}_t = \frac{1}{L} \sum_{i=1}^{L} R_{t,i} \]

where \( R_{t,i} \) is the return of asset \( i \) at time \( t \), and \( L \) is the number of assets.

The sample covariance between \( R_{t,i} \) and \( R_{t,j} \) cannot be used to test the hypothesis of no correlation between the returns of two assets.

\[ \hat{\rho}_{ij} = \frac{\sum_{t=1}^{T} (R_{t,i} - \bar{R}_i)(R_{t,j} - \bar{R}_j)}{\sqrt{\sum_{t=1}^{T} (R_{t,i} - \bar{R}_i)^2 \sum_{t=1}^{T} (R_{t,j} - \bar{R}_j)^2}} \]

where \( \rho_{ij} \) is the true correlation coefficient between the returns of assets \( i \) and \( j \), and \( T \) is the number of observations.

Moreover, it is also always true that in any sample, the sample correlation coefficient will be unbiased.

\[ \hat{\rho}_{ij} \approx \rho_{ij} \]

Hence, estimates of \( \rho_{ij} \) are obtained in a way that in any sample, the sample correlation coefficient will be approximately equal to the true correlation coefficient.

The mean of the return is used to estimate the mean of the returns.

\[ \bar{R} = \frac{1}{L} \sum_{i=1}^{L} \bar{R}_i \]

where \( \bar{R}_i \) is the mean return of asset \( i \), and \( L \) is the number of assets.

The sample mean of returns is consistent if the assumption of the joint distribution of returns is correct.

\[ \bar{R}_t = \frac{1}{L} \sum_{i=1}^{L} R_{t,i} \]

where \( R_{t,i} \) is the return of asset \( i \) at time \( t \), and \( L \) is the number of assets.

The sample mean of returns is unbiased if the assumption of the joint distribution of returns is correct.

\[ \bar{R}_t \approx \bar{R} \]
The statistical properties of the market model coefficients estimates discussed in Section 3.2.3 are known and therefore the estimates are statistically independent and have variance $\sigma^2$. Thus, the F-test to determine the significance of the coefficients can be applied.

The F-test statistic is given by:

$$(F) = \frac{(n-k)s^2}{\sigma^2}$$

where $n$ is the number of observations, $k$ is the number of coefficients, $s^2$ is the mean squared error, and $\sigma^2$ is the variance of the estimates.

If the F-test statistic is greater than the critical value from the F-distribution, the null hypothesis that all coefficients are zero is rejected.

Example:

Consider a portfolio with two assets, $X$ and $Y$. The returns for the portfolio are given by:

$$R_p = \alpha_p + \beta_p X + \epsilon_p$$

where $R_p$ is the return of the portfolio, $\alpha_p$ is the intercept, $\beta_p$ is the slope coefficient, and $\epsilon_p$ is the error term.

The F-test statistic for testing the null hypothesis that $\beta_p = 0$ is:

$$(F) = \frac{\text{MSR}}{\text{MSE}} = \frac{\sigma^2}{\sigma^2} = 1$$

Since $F(1, n-k) = 1$, the null hypothesis cannot be rejected at the 5% significance level.

In summary, the F-test is a useful tool for determining the significance of the coefficients in the market model. It allows us to test whether the coefficients are statistically different from zero, which is crucial for understanding the relationship between the portfolio's returns and the market returns.
The Market Model Estimation

The standard deviation of return

\( \sigma_r \) is the standard deviation of return on the market index (e.g., the S&P 500).

The market model is used to estimate the rate of return on a stock that is determined by the market. The equation is:

\[ r_t = \alpha + \beta r_m + \epsilon_t \]

where:
- \( r_t \) is the rate of return on the stock at time \( t \)
- \( \alpha \) is the alpha (intercept)
- \( \beta \) is the beta (sensitivity to the market)
- \( r_m \) is the rate of return on the market at time \( t \)
- \( \epsilon_t \) is the error term

The beta coefficient, \( \beta \), measures the sensitivity of the stock's return to the market's return. It is calculated as:

\[ \beta = \frac{\text{Cov}(r_t, r_m)}{\sigma_r^2} \]

where:
- \( \text{Cov}(r_t, r_m) \) is the covariance between the stock's return and the market's return
- \( \sigma_r^2 \) is the variance of the market's return

The alpha coefficient, \( \alpha \), represents the expected return on the stock when the market's return is zero. It is calculated as:

\[ \alpha = \mu - \beta \mu_m \]

where:
- \( \mu \) is the expected return on the stock
- \( \mu_m \) is the expected return on the market

The market model can be used to evaluate the performance of a stock by comparing its actual return with the predicted return based on the market's return. This comparison can help investors make informed decisions about buying and selling stocks.
In practice, moments are determined by measuring the sample moments of the data set, which is a measure of the data's skewness. A moment is determined by finding the location of the moment function that is closest to the mean of the data set. However, we do not know the true moments of the data set, so we use the sample moments of the data set as our estimate of the true moments.

In the context of the problem, we have the moment function defined as:

\[ m_k = \frac{1}{n} \sum_{i=1}^{n} (x_i - \mu)^k \]

where \( x_i \) are the data points, \( n \) is the number of data points, and \( \mu \) is the mean of the data set.

We are interested in finding an approximation of the true moments of the data set, which can be done by using the sample moments of the data set. To do this, we can use the following approximation:

\[ m_k \approx m_k^* = \frac{1}{n} \sum_{i=1}^{n} (x_i^* - \mu)^k \]

where \( x_i^* \) are the sample data points. This approximation is known as the sample moments approximation.

The approximation is useful because it allows us to estimate the moments of the data set without knowing the true moments. However, it is important to note that the approximation may not be accurate for small sample sizes.

The approximation is also useful in the context of statistical inference, where we use the sample moments to estimate the true moments of the data set. This is particularly useful in hypothesis testing and confidence interval estimation.

In the context of the problem, we have the following moments:

\[ m_1 = \frac{1}{n} \sum_{i=1}^{n} (x_i - \mu) \]

and

\[ m_2 = \frac{1}{n} \sum_{i=1}^{n} (x_i - \mu)^2 \]

where \( n \) is the number of data points.

Using the sample moments approximation, we can estimate the true moments of the data set as follows:

\[ m_1^* = \frac{1}{n} \sum_{i=1}^{n} (x_i^* - \mu)^1 \]

and

\[ m_2^* = \frac{1}{n} \sum_{i=1}^{n} (x_i^* - \mu)^2 \]

where \( x_i^* \) are the sample data points.

These estimates can be used in hypothesis testing and confidence interval estimation to make inferences about the true moments of the data set.
A. Commitees on Market Model Estimates for Large and Small Firms

B. Evidence on the Risk of Market Sensitivities

C. The Market Model Estimates

D. Foundations of Finance
<table>
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<tr>
<th>NAME</th>
<th>1922</th>
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<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Mobil Oil</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Standard Oil (California)</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>American Home Products</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
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<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>J. P. Morgan</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
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<td>Wheeling Electric</td>
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<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Du Pont, S. S.</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Kellogg, S.</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Atlantic Richfield</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
<tr>
<td>Averages</td>
<td>1.20</td>
<td>0.24</td>
<td>0.28</td>
<td>0.30</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
<td>0.37</td>
</tr>
</tbody>
</table>
### Table 4.5

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>SRR(n)</th>
<th>SRR(n-1)</th>
<th>(SRR(n) - SRR(n-1))</th>
<th>(SRR(n) - SRR(n-1)) / SRR(n-1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Telephone &amp; Telegraph</td>
<td>0.62</td>
<td>0.60</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>General Motors</td>
<td>0.97</td>
<td>0.96</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Exxon</td>
<td>0.75</td>
<td>0.74</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Eastman Kodak</td>
<td>0.94</td>
<td>0.93</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>General Electric</td>
<td>0.71</td>
<td>0.70</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Xerox</td>
<td>0.75</td>
<td>0.74</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Ford</td>
<td>0.71</td>
<td>0.70</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Coca-Cola</td>
<td>0.79</td>
<td>0.78</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Du Pont</td>
<td>0.76</td>
<td>0.75</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Gulf Oil &amp; Gas</td>
<td>0.74</td>
<td>0.73</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Mobil Oil</td>
<td>0.76</td>
<td>0.75</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Standard Oil (Continental)</td>
<td>0.74</td>
<td>0.73</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Royal Dutch Petroleum</td>
<td>0.71</td>
<td>0.70</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>American Home Products</td>
<td>0.72</td>
<td>0.71</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>General Mills</td>
<td>0.74</td>
<td>0.73</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Weyerhaeuser Electric</td>
<td>0.71</td>
<td>0.70</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Dow Chemical</td>
<td>0.60</td>
<td>0.59</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>J. C. Penney</td>
<td>0.52</td>
<td>0.51</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>General Foods</td>
<td>0.74</td>
<td>0.73</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Atlantic Richfield</td>
<td>0.62</td>
<td>0.60</td>
<td>0.02</td>
<td>0.03</td>
</tr>
</tbody>
</table>

*The sample studentized range values are 0.02 to 0.02. The mean range of the distribution of the studentized range values is 0.03.*

The table shows the studentized range values for the top 25 large firms as of June 1952, as determined by the Anderson-Darling test. The values are based on the assumption of normal distribution for the studentized range. The table includes the studentized range for each firm, the difference between the studentized range and the previous year's value, and the percentage change from the previous year. The data is sorted in descending order of the studentized range values.

### B. Evidence on the Assumptions Underlying the Market Model Estimates

The studentized range values for the top 25 large firms indicate that the assumptions of normal distribution and independence of errors are reasonable. The mean range of the studentized range values is 0.03, which is consistent with the expected range for a normal distribution.

Although the assumptions of normality and independence of errors are not strictly satisfied, the results are still valid for practical purposes. The studentized range values provide a useful measure of the variability in the data, and the results can be interpreted in a similar manner to the t-test.

The table also shows that the percentage change in the studentized range values is generally small, indicating that the assumptions are reasonably well satisfied. However, further analysis may be required in specific cases to ensure the validity of the assumptions.

### Foundations of Finance

The study of the studentized range values for the top 25 large firms provides evidence that the assumptions underlying the market model estimates are reasonable. The results are consistent with the expected range for a normal distribution, and the assumptions of normality and independence of errors are reasonably well satisfied.

The studentized range values provide a useful measure of the variability in the data, and the results can be interpreted in a similar manner to the t-test. Further analysis may be required in specific cases to ensure the validity of the assumptions.
tion of variance, normally distributed, and that the sample size is large enough to guarantee the validity of the statistical tests. However, if the data deviate significantly from normality, different methods may be required to analyze the data.

Summary:

The Studentized Range (SRT) is a statistical test used to compare the means of different groups. It is particularly useful in multiple comparison tests. The SRT is calculated based on the differences between the group means and the error variance. The SRT test statistic is given by:

\[ SRT = \frac{\text{Large Mean} - \text{Small Mean}}{\text{Error Standard Deviation}} \]

where the Large Mean is the largest mean of the groups being compared, the Small Mean is the smallest mean of the groups being compared, and the Error Standard Deviation is the standard deviation of the error term from an analysis of variance (ANOVA) test.

The SRT test is used to determine if there is a significant difference between the means of at least one pair of groups. The null hypothesis is that all group means are equal, and the alternative hypothesis is that at least one pair of group means is different. The SRT test is based on the Studentized range distribution, which is a distribution of the maximum of a set of correlated normal random variables.

The SRT test is often used in conjunction with other multiple comparison tests, such as Tukey's Honestly Significant Difference (HSD) test, to identify which pairs of groups are significantly different.

In conclusion, the SRT test is a powerful tool for comparing group means in the presence of multiple groups. It is a robust method that can be used with a variety of data types and is particularly useful in situations where the sample sizes are unequal or the variances are heterogeneous.

### Example

Consider a study comparing the effectiveness of four different treatments for a disease. The data are analyzed using ANOVA, and the SRT test is used to compare the means of the four treatments. The SRT test statistic is calculated, and it is found to be significant. This suggests that at least one pair of treatments is significantly different in terms of their effectiveness.

### Further Reading


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The Studentized Range and Multiple Comparison Tests, 1962-1966 Sample.
the parameter estimates of the market model are statistically significant. These results provide evidence that the market model is a useful tool for decomposing the returns on individual stocks into a market component and a company-specific component. The market component reflects the general market conditions and the company-specific component reflects the idiosyncratic factors that affect the returns on individual stocks.

Table 4.1 presents the parameter estimates for the half-year returns on the S&P 500 index and the individual stocks for the period from January 1934 to December 1938. The table shows that the market model is able to explain a significant portion of the variance in the returns on the individual stocks. The R^2 values range from 0.14 to 0.77, indicating that the market model is a good fit for the data.

Table 4.1: Parameter Estimates for the Market Model

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>( b_1 )</th>
<th>( \beta_1 )</th>
<th>( t )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Business Machines</td>
<td>0.058</td>
<td>0.036</td>
<td>42</td>
<td>0.172</td>
</tr>
<tr>
<td>Exxon</td>
<td>0.067</td>
<td>0.034</td>
<td>46</td>
<td>0.154</td>
</tr>
<tr>
<td>IBM</td>
<td>0.064</td>
<td>0.038</td>
<td>41</td>
<td>0.177</td>
</tr>
<tr>
<td>General Electric</td>
<td>0.059</td>
<td>0.036</td>
<td>45</td>
<td>0.203</td>
</tr>
<tr>
<td>Du Pont</td>
<td>0.066</td>
<td>0.037</td>
<td>44</td>
<td>0.209</td>
</tr>
<tr>
<td>Pepsico</td>
<td>0.063</td>
<td>0.037</td>
<td>43</td>
<td>0.209</td>
</tr>
<tr>
<td>Modine</td>
<td>0.065</td>
<td>0.038</td>
<td>45</td>
<td>0.196</td>
</tr>
<tr>
<td>American Telephone &amp; Telegraph</td>
<td>0.067</td>
<td>0.039</td>
<td>46</td>
<td>0.216</td>
</tr>
<tr>
<td>Standard Oil (California)</td>
<td>0.069</td>
<td>0.040</td>
<td>46</td>
<td>0.223</td>
</tr>
<tr>
<td>Krupp, S.S.</td>
<td>0.066</td>
<td>0.039</td>
<td>45</td>
<td>0.212</td>
</tr>
<tr>
<td>Average</td>
<td>0.069</td>
<td>0.039</td>
<td>45</td>
<td>0.212</td>
</tr>
</tbody>
</table>

In Chapter 5, we will explore the implications of these results for understanding the determination of stock prices and the behavior of the market.
D. The Reliability of the Risk Estimates

The reliability of the risk estimates is often questioned, particularly when the risk of overestimation is greater than the risk of underestimation. However, the risk associated with the estimates of the parameters of the Black-Scholes model is not as straightforward as it may seem. The parameters of the model, such as volatility and correlation, are estimated from historical data, and there is always uncertainty about their true values. This uncertainty can lead to overestimation or underestimation of the risk.

Table 4.8: Market Model Parameter Estimates for Random-Rated Firms for January 1963-December 1966

<table>
<thead>
<tr>
<th>COMPANY</th>
<th>b1</th>
<th>b2</th>
<th>s1</th>
<th>s2</th>
<th>t1</th>
<th>t2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Union Pacific Railroad</td>
<td>0.121</td>
<td>0.132</td>
<td>0.034</td>
<td>0.029</td>
<td>-0.101</td>
<td>-0.116</td>
</tr>
<tr>
<td>Delaware and Hudson</td>
<td>0.134</td>
<td>0.145</td>
<td>0.041</td>
<td>0.036</td>
<td>-0.098</td>
<td>-0.113</td>
</tr>
<tr>
<td>New York Central</td>
<td>0.146</td>
<td>0.157</td>
<td>0.047</td>
<td>0.042</td>
<td>-0.095</td>
<td>-0.110</td>
</tr>
<tr>
<td>New Haven Railroad</td>
<td>0.158</td>
<td>0.169</td>
<td>0.053</td>
<td>0.047</td>
<td>-0.092</td>
<td>-0.107</td>
</tr>
<tr>
<td>Average</td>
<td>0.141</td>
<td>0.152</td>
<td>0.046</td>
<td>0.042</td>
<td>-0.094</td>
<td>-0.108</td>
</tr>
</tbody>
</table>

The results in Table 4.8 show that the parameter estimates vary widely across different companies. This variation highlights the importance of using sample weights in the estimation process to account for differences in the underlying risk profiles. The table also suggests that the model may not be fully capturing the risk associated with these firms, as indicated by the high standard deviations and the presence of negative coefficients in some cases.

In conclusion, the reliability of the risk estimates is an ongoing concern, and further research is needed to develop more robust methods for estimating risk in financial markets.