# PORTFOLIO CLASS 15

# HOME WORK SUPPORT

# COVERAGE

| Question | | | Answer | | | Lecture Time |
|---|---|---|---|---|---|---|
| Q. No | Page no. | Book | Q. No | Page no. | Book | |
| 24 | 39 | HW Q BOOK | 24 | 105 | HW ANS BOOK | 00:00:31 - 00:01:46 |
| 25 | 39 | HW Q BOOK | 25 | 106 | HW ANS BOOK | 00:01:47 - 00:03:59 |
| 26 | 40 | HW Q BOOK | 26 | 107 | HW ANS BOOK | 00:04:00 – 00:05:00 |
| 27 | 41 | HW Q BOOK | 27 | 108 | HW ANS BOOK | 00:05:01 – 00:06:38 |

# PART V: EFFICIENT MARKET HYPOTHESIS (EMH)

## Topic 19 AUTO CORRELATION TEST

**Question 24: SSEI HW Book Page No. 39**

Consider the following prices of a stock during January 2000 and January 2001:

| Trading Days | January 2000 | January 2001 |
|---|---|---|
| 1 | 130 | 500 |
| 2 | 133 | 492 |
| 3 | 133 | 472 |
| 4 | 139 | 460 |
| 5 | 139 | 416 |
| 6 | 141 | 392 |
| 7 | 142 | 430 |
| 8 | 141 | 392 |
| 9 | 144 | 416 |

Based on the above prices, test for the weak form of market efficiency using auto-correlation test and comment on the result.

***(Source: FOD)***

**ANSWER**

| Trading day | Change in prices | | | | |
|---|---|---|---|---|---|
| | Jan 2000 (x) | $x^2$ | Jan 2001 (y) | $y^2$ | xy |
| 2 | 3 | 9 | –8 | 64 | –24 |
| 3 | 0 | 0 | –20 | 400 | 0 |
| 4 | 6 | 36 | –12 | 144 | –72 |
| 5 | 0 | 0 | –44 | 1936 | 0 |
| 6 | 2 | 4 | –24 | 576 | –48 |
| 7 | 1 | 1 | 38 | 1444 | 38 |
| 8 | –1 | 1 | –38 | 1444 | 38 |
| 9 | 3 | 9 | 24 | 576 | 72 |
| | $\Sigma x = 14$<br>$\bar{x} = 1.75$ | $\Sigma x^2 = 60$ | $\Sigma y = -84$<br>$\bar{y} = -10.5$ | $\Sigma y^2 = 6584$ | $\Sigma xy = 4$ |

$$\text{Coefficient of determination } (r^2) = \frac{a\Sigma y + b\Sigma xy - n(\bar{y})^2}{(\Sigma y)^2 - n(\bar{y})^2}$$

Where,

$$b = \frac{n\Sigma xy - \Sigma x\,\Sigma y}{n\,\Sigma x^2 - (\Sigma x)^2} = \frac{8\times 4 - 14\times(-84)}{8\times 60 - (14)^2} = 4.254$$

$$a = \bar{y} - b\,\bar{x} = -10.5 - 4.254 \times 1.75 = -17.945$$

$$r^2 = \frac{a\Sigma y + b\Sigma xy - n(\bar{y})^2}{(\Sigma y)^2 - n(\bar{y})^2} = \frac{-17.945\times(-84) + 4.254\times 4 - 8\times(-10.5)^2}{(-84)^2 - 8\times(-10.5)^2} = 0.104$$

Hence, the correlation coefficient (r) between the above price changes is 0.32. Therefore, we can say that market is not efficient.

# PART V: EFFICIENT MARKET HYPOTHESIS (EMH)

## Topic 20 RUNS TEST

**Question 25: SSEI HW Book Page No. 39**

Mr. A. Rathi is testing the weak form efficient market hypothesis on the Indian stock market. For this he has collected the data on a leading market index for the last 15 trading days. This is given below:

| Trading day | Market Index |
|---|---|
| 1 | 4500 |
| 2 | 4550 |
| 3 | 4400 |
| 4 | 4350 |
| 5 | 4300 |
| 6 | 4330 |
| 7 | 4400 |
| 8 | 4445 |
| 9 | 4440 |
| 10 | 4370 |
| 11 | 4380 |
| 12 | 4365 |
| 13 | 4500 |
| 14 | 4560 |
| 15 | 4600 |

You are required to perform a runs test and determine the independence of data at 10% level of significance.

***(Source: FOD)***

**ANSWER:**

$$\text{Mean of the data } (\mu_r) = \frac{2n_1 n_2}{n_1 + n_2} + 1$$

$$\text{and Standard error } (\sigma_r) = \sqrt{\frac{2n_1 n_2 (2n_1 n_2 - n_1 - n_2)}{(n_1 + n_2)^2 (n_1 + n_2 - 1)}}$$

where

r = Total number of runs

$n_1$ = No. of positive price changes

$n_2$ = No. of negative price changes

| Trading Day | Market Index | Price Change |
|---|---|---|
| 1 | 4500 | |
| 2 | 4550 | + |
| 3 | 4400 | – |
| 4 | 4350 | – |
| 5 | 4300 | – |
| 6 | 4330 | + |
| 7 | 4400 | + |
| 8 | 4445 | + |
| 9 | 4440 | - |
| 10 | 4370 | – |
| 11 | 4380 | + |
| 12 | 4365 | – |
| 13 | 4500 | + |
| 14 | 4560 | + |
| 15 | 4600 | + |

r = 7

$$\mu_r = \frac{2n_1 n_2}{n_1 + n_2} + 1 = \frac{2 \times 8 \times 6}{14} + 1 = 7.857$$

$$\sigma_r = \sqrt{\frac{2n_1 n_2 (2n_1 n_2 - n_1 - n_2)}{(n_1 + n_2)^2 (n_1 + n_2 - 1)}}$$

$$= \sqrt{\frac{2 \times 8 \times 6 (2 \times 8 \times 6 - 8 - 6)}{(8 + 6)^2 (8 + 6 - 1)}} = \sqrt{\frac{96 (82)}{196 (13)}} = \sqrt{\frac{7872}{2548}} = \sqrt{3.089} = 1.758$$

At α = 0.10 , t= 1.771

The lower limit will be : 7.857 - (1.771 × 1.758) = 7.857 - 3.113 = 4.744

The upper limit: 7.857 + (1.771 × 1.758) = 7.857 + 3.113 = 10.970

Since the observed number of runs of 7 falls within the lower and upper limits it seems to indicate that the prices are independent at 10% level of significance.

# PART V: EFFICIENT MARKET HYPOTHESIS (EMH)

## Topic 21 RESIDUAL ANALYSIS

**Question 26: SSEI HW Book Page No. 40.**

To check the market efficiency in semi-strong form, an analyst collected the following information:

| Month | Closing price of HLL Rs. | Closing value of Sensex |
|---|---|---|
| November 01 | 210.10 | 3,287.56 |
| December 01 | 223.65 | 3,262.33 |
| January 02 | 220.70 | 3,311.03 |
| February 02 | 249.80 | 3,502.31 |
| March 02 | 225.35 | 3,469.35 |
| April 02 | 202.80 | 3,338.16 |
| May 02 | 184.85 | 3,125.73 |
| June 02 | 193.35 | 3,244.70 |
| July 02 | 171.00 | 2,987.65 |
| August 02 | 186.70 | 3,181.23 |
| September 02 | 172.65 | 2,991.36 |
| October 02 | 160.30 | 2,949.32 |

Using the data for last 2 years, the characteristic line arrived by the analyst is

$$r_{st} = 2.50 + 0.75\ r_{mt}$$

Where $r_{mt}$ is % monthly return on market in the month t.

$r_{st}$ is % monthly return on HLL stock in the month t.

You are required to conduct the residual analysis to test semi-strong form of market efficiency.

***(Source: FOD)***

## ANSWER:

**Monthly returns of HLL and Sensex are as follows:**

| Month | HLL (%) | Sensex (%) |
|---|---|---|
| November 01 | – | |
| December 01 | 6.45% | 0.77% |
| January 02 | –1.32% | 1.49% |
| February 02 | 13.19% | 5.78% |
| March 02 | –9.79% | –0.94% |
| April 02 | –10.01% | –3.78% |
| May 02 | –8.85% | –6.36% |
| June 02 | 4.87% | 3.81% |
| July 02 | –11.79% | –7.92% |
| August 02 | 9.18% | 6.48% |
| September 02 | –7.53% | –5.97% |
| October 02 | –7.15% | –1.41% |

Now, using the equation given in the question, we calculate expected return as per characteristic line.

| Month | Actual return (A) | Expected return (B) $2.50 + 0.75 \times r_{mt}$ | Abnormal return (A – B) |
|---|---|---|---|
| December 01 | 6.45% | 2.50 + 0.75 x 0.77 = 3.0775% | 3.3125% |
| January 02 | –1.32% | 2.50 + 0.75 x 1.49 = 3.6175% | –4.9375% |
| February 02 | 13.19% | 2.50 + 0.75 x 5.78 = 6.835% | 6.355% |
| March 02 | –9.79% | 2.50 + 0.75 x (–0.94) = 1.795% | –11.585% |
| April 02 | –10.01% | 2.50 + 0.75 x (–3.78) = –0.335% | –9.675% |
| May 02 | – 8.85% | 2.50 + 0.75 x –(6.36) = –2.27% | –6.58% |
| June 02 | 4.87% | 2.50 + 0.75 x 3.81 = 5.3575% | –0.4875% |
| July 02 | –11.79% | 2.50 + 0.75 x (–7.92) = –3.44% | –8.35% |
| August 02 | 9.18% | 2.50 + 0.75 x 6.48 = 7.36% | 1.82% |
| September 02 | – 7.53% | 2.50 + 0.75 x (–5.97) = – 1.9775% | –5.5525% |
| October 02 | –7.15% | 2.50 + 0.75 x (–1.41) = 1.4425% | –5.7095% |
| | | | –33.735% |

From the above computation, we observe that sum of abnormal return is not close to zero. Therefore, we conclude that market is not efficient in semi-strong form.

# PART V: EFFICIENT MARKET HYPOTHESIS (EMH)

## Topic 22 EVENT STUDIES

**Question 27: SSEI HW Book Page No. 41**

During the year 2003-04, three companies Polar Software Ltd., Sonata Airways and Time Auto Ltd. have announced higher dividends on December 31, 2003. A financial analyst working in a brokerage firm wanted to test the consistency of the semi-strong form of market efficiency. He estimated the characteristic lines for a period of 4 years on a monthly basis upto September 30, 2003. The relationship between the returns on these three companies and the market index are represented by following equations.

$r_{P,t} = 1.50\% + 0.75 r_{mt}$

$r_{S,t} = 1.26\% + 1.15\ r_{mt}$

$r_{t,t} = 1.98\% + 1.35\ r_{mt}$

Where $r_{P,t}$ $r_{S,t}$ and $r_{t,t}$ are the returns of Polar Software, Sonata Airways and Time Auto during period t and $r_{m,t}$ is return of the market index during the same period. The following data pertains to the returns of the companies and market for the period 3 months before and 3 months after the dividend was declared.

| Period (Months) | Actual return (%) | | | Market return (%) |
|---|---|---|---|---|
| | $r_{P,t}$ | $r_{S,t}$ | $r_{t,t}$ | $r_{m,t}$ |
| Sep 30, 2003 | 9.75 | 12.45 | 14.58 | 9.85 |
| Oct 31, 2003 | 9.85 | 12.35 | 14.85 | 9.95 |
| Nov 30, 2003 | 10.25 | 12.85 | 15.35 | 10.05 |
| Dec 31, 2003 | 10.45 | 13.45 | 15.78 | 10.25 |
| Jan 31, 2004 | 10.75 | 13.38 | 16.15 | 10.45 |
| Feb 29, 2004 | 11.25 | 14.25 | 17.35 | 11.25 |
| Mar 31, 2004 | 10.85 | 14.15 | 17.95 | 11.45 |

Using event studies approach you are **required** to verify the validity of semi-strong form of market efficiency in the Indian stock market.

***(Source: FOD)***

## ANSWER:

First we should find out abnormal return by deducting the actual return from the expected return

**Polar Software Limited**

| Period | Actual return | Market return | Expected return | Abnormal return |
|---|---|---|---|---|
| | (r Pt) | (rmt) | (%) (1.50 + 0.75 rmt) | |
| 3 | 9.75 | 9.85 | 8.8875 | 0.8625 |
| 2 | 9.85 | 9.95 | 8.9625 | 0.8875 |
| 1 | 10.25 | 10.05 | 9.0375 | 1.2125 |
| 0 | 10.45 | 10.25 | 9.1875 | 1.2625 |
| 1 | 10.75 | 10.45 | 9.3375 | 1.4125 |
| 2 | 11.25 | 11.25 | 9.9375 | 1.3125 |
| 3 | 10.85 | 11.45 | 10.088 | 0.7625 |

**Sonata Airways**

| Period | Actual return | Market return | Expected return | Abnormal return |
|---|---|---|---|---|
| | ($rS_t$) | ($r_{mt}$) | (%) (1.26 + 1.15 ($r_{mt}$) | |
| 3 | 12.45 | 9.85 | 12.5875 | -0.1375 |
| 2 | 12.35 | 9.95 | 12.7025 | -0.3525 |
| 1 | 12.85 | 10.05 | 12.8175 | 0.0325 |
| 0 | 13.45 | 10.25 | 13.0475 | 0.4025 |
| 1 | 13.38 | 10.45 | 13.2775 | 0.1025 |
| 2 | 14.25 | 11.25 | 14.1975 | 0.0525 |
| 3 | 14.15 | 11.45 | 14.4275 | -0.2775 |

**Time Auto**

| Period | Actual return | Market return | Expected return | Abnormal return |
|---|---|---|---|---|
| | ($r_{T,t}$) | ($r_{mt}$) | (1.98 + 1.35 $r_{mt}$) | |
| 3 | 14.58 | 9.85 | 15.2775 | 0.6975 |
| 2 | 14.85 | 9.95 | 15.4125 | 0.5625 |
| 1 | 15.35 | 10.05 | 15.5475 | 0.1975 |
| 0 | 15.78 | 10.25 | 15.8175 | 0.0375 |
| 1 | 16.15 | 10.45 | 16.0875 | -0.0625 |
| 2 | 17.35 | 11.25 | 17.1675 | -0.1825 |
| 3 | 17.95 | 11.45 | 17.4375 | -0.5125 |

We will now estimate the average abnormal return to each of the months before and after the dividend was announced

Third month before the announcement of dividend

$AAR_{(-3)}$ = (0.8625 – 0.1375+ 0.6975) = 1.4225

Second month before the announcement of dividend

$AAR_{(-2)}$ = (0.8875- 0.3525 +0.5625) = 1.0975

First month before the announcement of dividend

$AAR_{(-1)}$ = (1.2125 + 0.0325+0.1975) = 1.4425

Month during which the dividend was announced

$AAR_{(0)}$ = (1.2625+0.4025 + 0.0375) = 1.7025

First month after the announcement of dividend

$AAR_{(1)}$ = (1.4125 + 0.1025 – 0.0625) = 1.4525

Second month after the announcement of dividend

$AAR_{(2)}$ = (1.3125 + 0.0525-0.1825) = 1.1825

Third month after the announcement of dividend

$AAR_{(3)}$ = (0.7625 - 0.2775 –0.5125) = -0.0275

Now we will compute the cumulative Average Abnormal returns for the period of three months before and after the announcement of dividend.

CAAR = (1.4225 + 1.0975 + 1.4425 + 1.7025 + 1.4525+1.1825 + -0.0275) = 8.2725%.

As the value of CAAR is not close to zero, we conclude that market is not efficient in the semi-strong form.