CHAPTER VII
RELATIONSHIP AMONG SHARES AND
RELATIONSHIP AMONG STOCK EXCHANGES

7.1 INTRODUCTION:
This chapter examines whether certain notions widely-prevalent in the Indian stock market circles are true. The notions are:

i) There are 'leaders' and 'laggers' among shares; the 'leaders' lead the price changes for the 'laggers' 

ii) When a particular share is traded simultaneously in two different Stock Exchanges, the price changes in one Stock Exchange influence the price changes in the other Stock Exchange and 

iii) The Bombay Stock Exchange acts as the price-setter for the other stock exchanges.

Accordingly, this chapter is concerned with analysing the lead-lag relationship, if any,

a) among different shares 

b) between the price changes of a particular share traded simultaneously in two different stock exchanges and 

c) among different stock exchanges in India.

7.2 CROSS-CORRELATION TECHNIQUE:

Covariance is a measure of the joint variation between two variables, say X and Y. The covariance between X and Y is defined as follows:

\[ C_{XY} = E \{(X-\bar{X}) (Y-\bar{Y})\} \]
Cross-covariance is a measure of association between the present value of a given variable and past, present and future values of another time-series variable.¹

The estimated cross-covariances are defined according to the following formula:

\[ C_{XY}(k) = \frac{1}{n} \sum_{t=1}^{n-k} (X_t - \bar{X})(Y_{t+k} - \bar{Y}) \]

where \( \bar{X} \) and \( \bar{Y} \) are the means of the \( X \) and \( Y \) series and \( k = 0, 1, 2, 3, \ldots \)

\[ C_{YX}(k) = \frac{1}{n} \sum_{t=1}^{n-k} (Y_t - \bar{Y})(X_{t+k} - \bar{X}) \]

where \( k = 0, 1, 2, 3. \)

The cross-covariances can be converted to cross-correlations by dividing by two standard deviations, as below:

\[ r_{XY}(k) = P_{XY}(k) = \frac{C_{XY}(k)}{\sqrt{C_{XX}(0)C_{YY}(0)}} = \frac{C_{XY}(k)}{S_X S_Y} \]

where \( k = 0, +1, +2, +3, 0 \ldots \)
Cross-correlation is a standardised measure of association between one time-series and the past, present and future values of another time-series. The cross-correlation coefficients describe the degree of association between two variables for various time lags. The cross-correlations vary from -1 to +1. "The cross-correlation between X and Y defines the degree of association between values of X at time t and values of Y at t+k (where k=0, ±1, ±2, ±3, ...). If X is a leading indicator of Y, then X at time t will be positively related to Y at time t+k, where k = 1 or 2 or 3 and so on. If X is a concurrent indicator of Y, then X at time t and Y at time t are going to be related significantly. If X lags Y, then Y at time t will be positively associated with X at time t+k, for some k greater than zero."3

The standard errors have been computed by the following formula:

\[
\frac{1}{\sqrt{n-k}} \sim \sqrt{n} \quad \text{(for large n)}
\]

Cross-correlation tests are performed on the first differences of the data series.

7.3 LEAD-LAG RELATIONSHIP AMONG SHARES:

First, the relationship among the price movements of different-share price series is examined. Secondly, the relationship between the two price series of one share traded simultaneously in two different stock exchanges is tested.
7.3.1 Relationship Among Different Shares:

There is a widespread belief in the stock market circles that price changes in some shares called 'leaders' lead the price changes in other shares called 'laggers'. Hence the use of the terms 'market leaders', 'pivotal shares' etc. This part of the chapter tests this belief. The hypothesis framed for this purpose is that the price changes in some shares do not influence the price changes in other shares. The weekend prices of 11 shares from the Bombay Stock Exchange are used for analysis. The shares are ACC, Bombay Dyeing, GSFC, Hindustan Lever, Hindustan Motors, Mahindra & Mahindra, Premier Auto, Reliance, Tata Chemicals, TISCO and Larsen & Toubro. All these shares are very active. The data covers a period of five years from April 1982 to March 1987. There are 251 transactions common to all shares during this period.

7.3.1.1 Analysis and Interpretation of Results:

Cross-correlation coefficients are computed for -4 to +4 lags (in weeks). i.e. $k$ is allowed to range from -4 to +4. For every lag period, there are 55 coefficients for the eleven shares.

First, the zero order cross-correlation coefficients\(^4\) are analysed to see whether there is any concurrent relationship among share prices within the one week period. (i.e. $k = 0$). 48 of the 55 coefficients are significantly different from zero. More than half of the coefficients are negative. The coefficients are high in the case of ACC and Larsen & Toubro (0.62), followed by Premier Auto and TISCO (-0.60), Mahindra &
Mahindra and Tata Chemicals (-0.60), Hindustan Lever and Premier Auto (0.60) and Bombay Dyeing and Hindustan Motors (-0.60). Generally all the shares have significant relationship with almost all other shares. All the sample shares are either positively or negatively related with almost all other shares. The coefficients are the lowest in the case of Hindustan Motors and GSFC (0.00), Reliance and GSFC (0.00), TISCO and Hind.Motors (0.00) and ACC and ITC (0.00).

Next the cross-correlation coefficients for $k = +1, +2, +3, +4, -1, -2, -3$ and $-4$ are examined to see whether there exists any lead-lag relationship among different share price series. The coefficients for various $k = +1$ are presented in Table 7.1. The Table shows that 25 out of 55 coefficients exceed twice their standard error values suggesting dependence among price changes after a gap of one week. More than half of the coefficients (35 out of 55) are negative. Such a pattern of coefficients show that dependence is positive as well as negative. This indicates that shares lead as well as lag among themselves; no consistent leader influencing the prices of other shares is identified for $k = +1$. The same pattern is identified for other $k$ periods. Out of the 495 coefficients for $k = +1, +2, +3, +4, -1, -2, -3$ and $-4$, 357 coefficients (72 per cent of the total) exceed twice their standard error values. Almost half of the coefficients are negative. This kind of cross-correlations reinforce the earlier inference that though there exists a strong relationship among different shares for various $k$ periods, there are no shares which function as leaders consistently. Shares which act as leaders for some shares, lag some other shares. The sample shares lead as well as lag among themselves. They change their roles frequently. This may be because all the sample shares
TABLE 7.1
CROSS-CORRELATION COEFFICIENTS AMONG SHARES (k = +1)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<td>-15*</td>
<td>00</td>
<td>-13*</td>
<td>26**</td>
<td>-00</td>
<td>-28**</td>
<td>16*</td>
<td></td>
</tr>
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<td>-00</td>
<td>-19***</td>
<td>-00</td>
<td>-15*</td>
<td>28**</td>
<td>-00</td>
<td>-31**</td>
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<td>11</td>
<td>-11</td>
<td>-14*</td>
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<td>-12</td>
<td>26**</td>
<td>-00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>-00</td>
<td>17*</td>
<td>-00</td>
<td>-15*</td>
<td>00</td>
<td>-14*</td>
<td>29**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>00</td>
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<td>-00</td>
<td>-16*</td>
<td>-00</td>
<td>-16*</td>
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<td>-17*</td>
<td>-00</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>-00</td>
<td>17*</td>
<td>-00</td>
<td>-15*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8.</td>
<td>-00</td>
<td>11</td>
<td>-01</td>
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<td></td>
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<td></td>
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<tr>
<td>9.</td>
<td>-00</td>
<td>15*</td>
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<td></td>
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<tr>
<td>10.</td>
<td>-00</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Decimal points omitted.
Standard Error .063
*Coefficient more than twice its computed standard error.
** Coefficients more than thrice its computed standard error.
included in the study are very actively traded ones and almost all of them are treated as 'leaders' in the Bombay Stock Exchange. But it is clear from the analysis that there is no one definite leader among these actively traded shares. For $k = +1$ and $k = +2, 51$ and 54 of the 55 coefficients each exceed twice their standard error values indicating a more significant relationship than in the other $k$ periods. But the significance is positive as well as negative. 43 per cent of the coefficients (212 out of 495) exceed thrice their standard error values suggesting that the lead-lag relationship is comparatively low at the higher level of significance.

Based on the above evidence, it can be inferred that there are no clear leaders, who can influence the price changes for other shares consistently. Almost all the shares lead as well as lag among themselves. O.P. Gupta's study on lead-lag relationship among shares showed that majority of the observed cross-correlation coefficients are not significantly different from zero and hence he concluded that "... leads or lags are not discernible among different shares."5.

**7.3.2 Relationship Between the Two Price Quotations of One Particular Share Traded Simultaneously in Two Different Stock Exchanges:**

This part of the chapter tests whether the price changes in a particular share traded in one stock exchange influence the price movements of the same share traded simultaneously in some other stock exchange. The week-end quotations of Hindustan Motors traded simultaneously at Bombay and Calcutta are taken for this purpose. 251 weekly transactions covering a period of five years from April 1982 to March 1987 are analysed. The hypothesis framed for this purpose is that
the price changes in a particular share traded simultaneously in two different stock exchanges do not influence each other.

7.3.2.1 Analysis and Interpretation of Results:

The cross-correlation coefficients computed for -4 to +4 lags (in weeks) are presented in Table 7.2 (Table overleaf). The zero order cross-correlation coefficient show a negatively significant relationship between the two quotations of Hindustan Motors traded at Bombay and Calcutta. The coefficients for \( k = +1 \) and \( k = +2 \) exceed twice their standard error values suggesting that the price changes in Bombay influence the price changes in Calcutta after a gap of one and two weeks. The result for \( k = +3 \) shows that the price changes in Bombay do not influence the price changes in Calcutta after a period of three weeks.

The cross-correlation coefficient for \( k = +4 \) shows a negatively significant relationship. All the coefficients for \( k = -1 \) to \(-4\) are negatively significant exceeding thrice their standard error values. Thus the analysis show that after one week the price changes in Bombay leads the price changes in Calcutta to a significant extent. (Refer Graph 7.1) After two weeks, the influence is still significant, but to a lesser extent than the previous one. The influence is almost nil after three weeks. The influence reverses after four weeks showing a negative relationship. Thus it could be seen that there is no definite influence of the Bombay price over the Calcutta price consistently.

Hence it can be inferred that the price quotations of Hindustan Motors traded at the Bombay Stock Exchange do not suggest a positive influence over the price quotations of the same share traded simultaneously at the Calcutta Stock Exchange consistently.
TABLE 7.2

CORRELATION COEFFICIENTS FOR DIFFERENT LAGS BETWEEN WEEKLY PRICES OF HINDUSTAN MOTORS AT BOMBAY AND CALCUTTA

<table>
<thead>
<tr>
<th>Lags in weeks</th>
<th>Coefficients</th>
</tr>
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<td>-4</td>
<td>-22**</td>
</tr>
<tr>
<td>-3</td>
<td>-31**</td>
</tr>
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<td>-2</td>
<td>-60**</td>
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<tr>
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<tr>
<td>+3</td>
<td>-01</td>
</tr>
<tr>
<td>+4</td>
<td>-31**</td>
</tr>
</tbody>
</table>

Decimal points omitted
Standard Error = .063
** Coefficient more than thrice its computed Standard Error.

GRAPH 7.1

Relationship between two price series of Hindustan Motors traded simultaneously at Bombay and Calcutta.

Cross-correlation Graph.
7.4 RELATIONSHIP AMONG STOCK EXCHANGES:

The Sketch of the Stock Market in India brought out by the Bombay Stock Exchange notes that the "... activity on the Bombay Stock Exchange sets the pace for activity elsewhere in the country." In a particular day, 'The Economic Times' reported: "... it is a fact that the Bombay Stock Exchange is in effect a trend setter for the Indian market". This part of the Chapter tests whether the Bombay Stock Exchange is really the price-setter. A hypothesis that Bombay Stock Exchange is not a price-setter for the other stock exchanges is framed for this purpose.

The Financial Express week-end index numbers for five stock exchanges namely, Bombay, Calcutta, Delhi, Madras and Ahmedabad, during May 1982 to Dec. 1986 covering 221 weeks, have been taken for this study.

7.4.1 Analysis and Interpretation of Results:

The zero order cross-correlation coefficients suggest a simultaneous co-movement amongst all the stock exchanges except that of Bombay within the one week period (i.e. k = 0). The co-movement between the stock exchanges at Calcutta and Madras is the highest (0.70).

The cross-correlation coefficients for k = -4 to +4 are examined to see the lead lag relationships among stock exchanges. The number of significant correlation coefficients are given in Table 7.3.

Table overleaf...
**TABLE 7.3**

NUMBER OF SIGNIFICANT CROSS-CORRELATION COEFFICIENTS AMONG STOCK EXCHANGES FOR DIFFERENT LAGS:

<table>
<thead>
<tr>
<th>Lags in weeks</th>
<th>No. of coefficients</th>
<th>Coefficients exceeding 2 Standard Error Value</th>
<th>Coefficients exceeding 3 Standard Error Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-4</td>
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<td>6</td>
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</tr>
<tr>
<td>+2</td>
<td>10</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>+3</td>
<td>10</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>+4</td>
<td>10</td>
<td>10</td>
<td>10</td>
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</table>

Standard Error = .067
All the 10 cross correlation coefficients for $k = +1$ are significant exceeding twice their standard error values. All the coefficients for $k = +4$ are also significant. Nine coefficients for $k = +3$ and seven coefficients for $k = +2$ are significant exceeding twice their standard error values. All the coefficients for $k = +1$ to $+4$ are positive. 90 per cent of the coefficients (36 out of 40) exceed twice their standard error values. 80 per cent of the coefficients (32 out of 40) exceed thrice their standard error values. Such a high degree of cross-correlations indicate a strong positive relationship among the five stock exchanges in all the $k$ periods. The relationship is particularly high between the Stock Exchanges at Calcutta and at Madras. The relationship between the Stock Exchanges at Madras and Ahmedabad is also high, particularly after one week. Only the Delhi Stock Exchange does not suggest significant relationship with the Stock Exchanges at Bombay and Madras consistently.

Most of the cross-correlation coefficients for -1 to -4 lags are also significantly different from zero. Seven of the coefficients, all relating the Bombay Stock Exchange with the other stock exchanges, are negative. The above results show that whereas the Bombay Stock Exchange has positively significant relationship with all other stock exchanges for $k = +1$ to $+4$, it has negatively insignificant relationship for $k = -1$ to -4. Graph 7.2 clearly shows that the Bombay Stock Exchange influences all the other stock exchanges for $K = +1$ to $+4$, but the degree of influence on each stock exchange differs. Graph 7.3 shows that the influence of other stock exchanges over the Bombay Stock Exchange is not positively significant. Hence it seems that while the Bombay Stock Exchange affects the other Stock Exchanges, the other stock exchanges
Influence of Bombay Stock Exchanges over the other Stock Exchanges.

**Cross-correlation Graph.**

Co-efficients

<table>
<thead>
<tr>
<th>Lags in Weeks</th>
<th>-6</th>
<th>-4</th>
<th>-2</th>
<th>0</th>
<th>2</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bombay &amp; Calcutta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bombay &amp; Madras</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bombay &amp; Ahmedabad</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Bombay &amp; Delhi</td>
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</tr>
</tbody>
</table>
Influence of the other Stock Exchanges over the Bombay Stock Exchange.

Cross-correlation Graph.

Co-efficients

Lags in Weeks

Calcutta & Bombay  Madras & Bombay  Ahmedabad & Bombay  Delhi & Bombay
do not seem to affect the Bombay Stock Exchange. But the influence of Bombay Stock Exchange over the other stock exchanges is not very high; the highest cross-correlation coefficient is 0.42 only. The remaining four stock exchanges lead as well as lag among themselves. i.e., there is no one leader among the stock exchanges at Calcutta, Madras, Ahmedabad and Delhi. The relationship between Calcutta and Madras is always high for \( k = -4 \) to \(+4\) lags (in weeks).

Hence it can be inferred that the Bombay Stock Exchange is in a unique position in which while it affects the other stock exchanges, the other stock exchanges do not affect the Bombay Stock Exchange. On the basis of this argument, it can be said that the Bombay Stock Exchange influences the other stock exchanges to a certain extent in setting prices.

7.5 CONCLUSION:

The above analyses point out the following conclusions:

i) The analysis of different shares show a significant relationship. The significance is positive as well as negative. It seems that there are no clear 'leaders', who could lead the price changes for the remaining shares consistently.

ii) The price changes in Hindustan Motors traded at the Bombay Stock Exchange do not seem to influence the price changes of the same traded simultaneously in the Calcutta Stock Exchange consistently.

iii) While the Bombay Stock Exchange influences the other stock exchanges, the other stock exchanges do not seem to influence the Bombay Stock Exchange. But the degree of influence is less. Thus the Bombay Stock Exchange leads the other stock exchanges to a certain extent in setting prices.
Notes and References

1. Makridakis et al. op.cit., p.894.

2. ibid., p.894

3. ibid., p.493

4. The coefficients for \( k = -1, -2, -3, -4, 0, +2, +3 \) and +4 are given in Appendix E.

5. O.P. Gupta, op.cit., p.132.


7. The coefficients for \( k = -4 \) to +4 are given in Appendix F.