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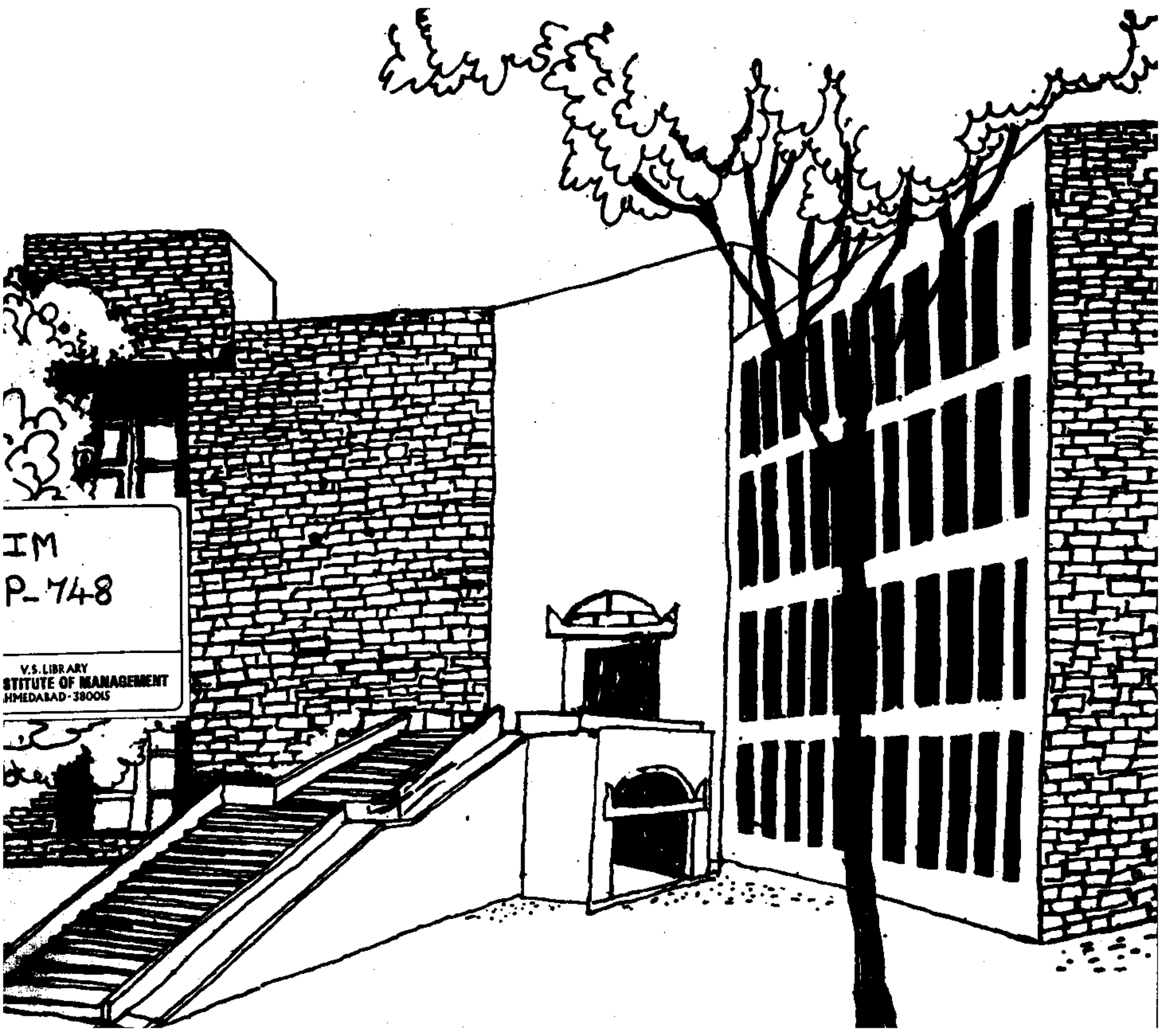

AN EMPIRICAL STUDY OF THE INTERTEMPORAL RELATIONS AMONG THE REGIONAL SHARE PRICE INDICATORS

By

Ramesh Bhat

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INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA

ABSTRACT

The purpose of the present research effort is to examine the intertemporal relationships among the share price indicators of five regional stock exchanges at Bombay, Calcutta, Madras, Ahmedabad and Delhi. For each regional share price index the monthly changes, both absolute and percentage, are compiled and correlated with each other and all-India index over the time period March 1971 to June 1985. The lag of each regional price relative has been regressed against the lag of all India price relative with its lead and lag variables. Finally, an attempt has been made to examine the inter-regional relationships among the five indicators by using the recursive regression method.

AN EMPIRICAL STUDY OF THE INTERTEMPORAL RELATIONS AMONG THE REGIONAL SHARE PRICE INDICATORS

Introduction and Objective

The stock exchange is a powerful institutional mechanism which facilitates the trading (viz. buying and selling) of securities. Its function is to provide active secondary market that ensure liquidity, transferability, and price stability to the trading of securities. At present, in India, there are 15 organised stock exchanges established as associated companies or limited liability companies in different regions of the country. Each stock exchange is self-governed and has its own rules, bye-laws, and trading practices under the overall provisions of the Securities Contracts Regulation Act and duly approved by the Government of India. It is in the interest of investors as well as the companies which raise funds through stock markets that these exchanges function in an orderly fashion. The sudden change in market sentiments in 1986-87 when the two year upward trend in stock prices reversed has resulted in the realisation that all is not well with the functioning of stock markets. On surveying the Indian scene, number of inadequacies of stock exchanges were highlighted by the comprehensive report of the High Powered Committee on Stock Exchanges Reforms. Inter-alia, weak organizational structure, non-professional limited membership, domination of large member brokers were identified as major weaknesses [see Patil (1986, 1987)]. For an orderly functioning of the stock markets, it is important that these shortcomings are remedied. It is in this direction, recently the Government of India has constituted National Securities Board.

For an orderly functioning of the securities market, it is also important that financial assets do not differ significantly in terms of their return on the various stock exchanges. Thus, the analysis of the share price behaviour and their temporal relationship assumes significance. This area has hardly received much attention by the researchers in India. With regard to the behaviour and temporal relationships of share price indicators of stock exchanges, there are two alternative hypotheses:

1. stock exchanges exhibit consistency in the behaviour of share price indicators over a period of time, (or alternatively)

2. the geographically separated stock exchanges in fact have fundamental economic and organisational characteristics that distinguish them, as a result the financial assets differ in terms of their return on different stock exchanges.

The main focus of this paper is to study the consistency in the share price behaviour by analysing the intertemporal relations among the share price indices of five most important regional stock exchanges. These five stock exchanges are Bombay, Calcutta, Madras, Ahmedabad and Delhi. The selection is confined to these five regional SEs for three reasons. First, they are top five exchanges in terms of their structural importance and market-wise pattern of listed stocks (see Table I).

Second, shareholding in India is still an urban phenomenon, and these five exchanges together comprise two-thirds of the shareholding population (see Table 2). Finally, the share price indices for these stock exchanges is easily available from the Reserve Bank of India Bulletins.

A recently completed study [see Gupta (1987)] brings out the 'regional pull' effect. This implies that the location of a company's registered office exercises a definite and fairly strong effect on the geographic distribution pattern of its shareholding. As a result, the regional stock exchange indicator of share prices may reflect the sentiments of the investors from that region. The present study would therefore provide some insights into the degree of relationships among local preferences and attitudes towards risk and return of various regional investors. The present study is also directed towards presenting the evidence about the movement of other regional share price indicators in conjunction with prices on the Bombay Stock Exchange. As the results of Gupta's study (1987) clearly indicate that regional stock exchanges cater to the requirements of regional investors, the evidence would determine whether the five most well known stock exchanges are unique only in terms of location, or whether they also differ with regard to short-term price movements. The scope of the study is limited to the analysis of co-movements in share price indices of various regions. No attempt has been made to test the efficiency of the stock exchange price indicators or of the stock market.

For the purpose of analysis, the study uses the share price indices of five regions as published by the Reserve Bank of India. The co-movements in regional indices have been examined over the time period March 1971 to June 1985 by using the monthly figures. The discussion in the paper has been divided into four sections. First section explains the index system of the Reserve Bank of India as this is the basis of the present study. Second section reports the results based on correlation and regression analysis. Third section deals with the results from recursive regression method. And finally, the last part concludes the paper.

The Reserve Bank of India Index System

The sample for the computation of regional share price indices include all the scrips quoted as on March 31, 1971 at Bombay, Calcutta, Madras, Ahmedabad and Delhi stock exchanges. The sample excludes the general insurance companies, natinalised banking companies, coal companies, companies having their major assets in Pakistan, defunct companies and companies delisted between April 1, 1971 and January 31, 1973. The financial year 1970-71 is a base period for its relative stability in share prices, comparative all round economic stability and closeness to the current period. The grouping of scrips is broadly on the lines of the classification adopted for the studies on company finances undertaken regularly by the RBI and is based on the Standard Industrial Classification followed by the Government of India. The main broad groups are (i) agriculture and allied activities consisting of 2 sub groups; (ii) foodstuffs; (iii) textile etc., (iv) metals and products thereof; (v) chemicals and products thereof; (vi) other processing and manufacturing, and (vii) other industries. Together (ii) to (vi) consists of 25 sub-groups and (vii) consists of 5 sub-groups. In total there are 32 sub-groups.

The scrips included in the sample is based on (i) the size of market value of the share capital of the company, and (ii) the activity of the scrip as indicated by the number of price changes during the base year. The sample includes both profit and non-profit making companies and is duly represented by different size groups of market value of scrips. The sample scrips ensure that any industrial sub-group covers at least 50 per cent of the market value of the corresponding sub-group in the population. The number of scripts for each region included in the sample is given in Table 3.

To describe the methodology of compilation of the index numbers, the following symbols have been defined:

$P_t^{(i)}$: Weekly average price of scrip i obtained as the average of daily closing quotations in the week.

$PR_t^{(i)}$: Price relative of scrip i worked out as the ratio of $P_t^{(i)} / P_1^{(i)}$, where $P_1^{(i)}$ is the average price in the conveniently chosen link week. (The link week is continuously revised to bring it close to the current week).

ng : Number of groups used for grouping the scrips. (There are seven groups viz. agriculture and allied activities;

foodstuffs; textiles etc., metals; chemicals and products thereof; other processing and manufacturing; other Indusdtries).

nsg : Number of sub-groups (in total there are 32 sub groups)

W_g, W_{sg} : Weights for group and sub-group. (These weights are proportional to the total agverage market value of share capital of all the scrips belonging to the group/sub-group and quoted on the respective stock exchanges as on March 31, 1971. The average market value is worked out for each scrip by multiplying the number of shares as on March 31, 1971, by the average of 12 mid-month price quotations during the base year).

G, SG: The super-scripts G and SG indicate group and sub-group.

W_r : Regional weights proportional to the total market value of all the scrips belonging to the corresponding sub group at each region.

RPI_t : Regional Price Index for period t. The super-script attached to RPI would indicate whether it belongs to group or sub group.

t, l : the subscripts t and l indicate the current and link weeks respectively.

API_t : All India Price index for period t.

nr : Number of regions (In total the indices for five regions viz. Bombay, Calcutta, Madras, Ahmedabad and Delhi are computed).

Wps, Wpg : Pooled weights for the all-India sub-group/group quoted at the respective stock exchange, the average market value of scrips quoted at more than one centre being counted only once to avoid duplication.

For each region, the price indices of groups and sub-groups are obtained as follows:

$$PR_t^{(SG)} = \left[\prod_{i=1}^{nsg} PR_t^{(i)} \right]^{1/nsg}$$

$$PI_t^{(SG)} = \begin{cases} PR_t^{(SG)} \times 100 & \forall \; t=1 \\ PR_t^{(SG)} \times PR_1^{(SG)} & \forall \; t \neq 1 \end{cases}$$

$$RPI_t^{(SG)} = \left[\sum_{sg=1}^{nsg} Wsg \;\; PI_t^{(SG)} \right] \div \left[\sum_{sg=1}^{nsg} Wsg \right]$$

$$RPI_t^{(G)} = \left[\sum_{g=1}^{ng} Sg \;\; RPI_t^{(G)} \right] \div \left[\sum_{g=1}^{ng} Wg \right].$$

The regional price indices of sub-groups ($RPI_t^{(G)}$) are used to derive the all-India sub-group price index numbers as follows:

$$API_t^{(SG)} = \sum_{r=1}^{nr} W_r \, RPI_t^{(SG)} \Big/ \sum_{r=1}^{nr} W_r$$

$$API_t^{(G)} = \sum_{ps=1}^{nsg} W_{ps}\, API_t^{(SG)} \Big/ \sum_{ps=1}^{nsg} W_{ps}$$

$$API_t = \sum_{pg=1}^{ng} W_{pg}\, API_t^{(G)} \Big/ \sum_{pg=1}^{ng} W_{pg}$$

Whenever the prices of scrips change abruptly on account of increase in the paid-up capital of companies either by calling up the balance in respect of partly paid up shares or by issue of right/bonus shares to existing shareholders, suitable adjustments are made in the link week average prices in the following manner so as to facilitate comparison.

(a) In case of bonus issues, the previous cum-bonus prices are adjusted and made comparable with the ex-bonus quotations by the factor (1 + f) where 'f' is the number of new shares or fraction of share issued as bonus against every old share.

(b) In case of right issues, necessary adjustments are carried out in 'f' for the cash payment involved.

(c) When the price of a scrip increases due to payment of call money, the previous quotation of the partly paid up share is raised to the level of the quotation after the call money has been paid by taking the ratio between the two quotations as the adjustment factor. However, the methodology of compiling the index numbers does not make any adjustments for the price changes arising on account of scrips being quoted ex-dividend after the declaration of dividends.

Relations Between Price Indicator Series

The relationship between the five regional indicator series and all-India index is examined by employing the correlation and regression analysis techniques to monthly changes, absolute and percentage both, in the index series. The relationship in level series of indicators was not considered for two reasons. Firstly, because of high serial correlation in residuals and secondly, the study of changes in price levels is of importance primarily because of its contribution in explaining the short-run price movements.

The correlation results are given in Tables 4 and 5. These results indicate that the movements in indicator series of five stock exchanges experienced significant relationship with all-India index. Only in two cases Bombay and Calcutta the relationship is strong. The percentage of variation explained in case of Delhi is less than 50 per cent. In order to test the hypothesis whether the price indicators exhibit consistency over a period of time, the market model has been estimated. The use of market model is an efficient way to investigate the comovements in price indicators. Given the assumption that the fluctuations of returns are affected by one common 'market factor' represented by all-India price index, the returns of one exchange has been regressed against this index. For this purpose, following models have been estimated:

$$\log (B_t/B_{t-1}) = \alpha_1 + \beta_1 \log (AI_t/AI_{t-1}) + e_{t1}$$

$$\log (C_t/C_{t-1}) = \alpha_2 + \beta_2 \log (AI_t/AI_{t-1}) + e_{t2}$$

$$\log (M_t/M_{t-1}) = \alpha_3 + \beta_3 \log (AI_t/AI_{t-1}) + e_{t3}$$

$$\log (A_t/A_{t-1}) = \alpha_4 + \beta_4 \log (AI_t/AI_{t-1}) + e_{t4}$$

$$\log (D_t/D_{t-1}) = \alpha_5 + \beta_5 \log (AI_t/AI_{t-1}) + e_{t5}$$

The relations between each one of the log of the price relatives of the indices and the log of all-India price relative have been estimated using the OLS method. The estimated results are given in Table 6. The results indicate that Bombay and Calcutta are closely related to the market index. The $\bar{R}^2$ in these two cases is more than 85 per cent. The relationships between other three exchanges and all-India index are not that strong. However, the the estimated coefficients are significant in all cases. In order to examine the relationships between the price movement on the Bombay stock exchange and rest of the exchanges, the log of price relatives of each exchange has been regressed against the log of price relatives series of Bombay. The results obtained by using the OLS method has been given in Table 7.

The price movements on the Calcutta and Ahmedabad exhibit stronger relationship with Bombay whereas for Delhi and Madras the $\bar{R}^2$ is only 31 per cent and 58 per cent respectively.

In order to examine whether the participants in the trading process on the various stock exchanges take some time to adjust or to respond to changes in the relative rate of return of the market, a lead-lag analysis has been done. The results for the lead-lag analysis have been obtained by estimating the following regressions for each stock exchange:

$$\log (X_t/X_{t-1}) = \beta_0 + \sum_{i=-3}^{3} \beta_{t+i} \log (AI_{t+i}/AI_{t+i-1}) + e_t$$

The dependent variable $\log (X_t / X_{t-1})$ represent the log of price relative on each stock-exchange. Five such regressions have been estimated using the OLS method. The results of lead-lag analysis are given in Table 8. The results indicate that, on a monthly basis, there is no significant lagging, and the responses are mostly immediate. The explanatory power of the regressions have not changed significantly compared to those presented in Table 6.

Similar kind of exercise has been done in relating the log of price relatives of four stock exchanges with the lead-lag variables of Bombay stock exchange. The results are presented in Table 9. Except in case of Calcutta and Madras where the prices seem responding to Bombay prices in immediate month and one month after. The influence of immediate month is much stronger. All other lead-lag coefficients are not significant except the coefficient of the immediate month which is significant in all cases.

Relations Expressed as Recursive System

The correlation and regression analysis presented in the previous section provide some insights into the relationship between the share price indicators of various stock exchanges. The lead-lag analysis made an attempt to determine and understand the simultaneity of price-determination. However, this analysis has number of limitations to study the simultaneity.

For example, the methodology applied in the preceeding section treats regression equation of each stock exchange in isolation, ignoring the simultaneous effect from other exchanges. The problem of simultaneity arises because of the domination of Bombay stock exchange in Indian stock market and thus influencing the operations of other exchanges. The influence of one regional stock exchange on others would be in addition to the macro influences on the market as a whole for which an all-India index usually may serve as a surrogate. Therefore, the model as estimated should incorporate these interrelationships as well as the relationship of each regional stock exchange with a market represented by all-India index. The single equation model would fail as the residuals of each estimated model would be highly correlated. The answer to this problem may lie in structural simultaneous equation model. Yet it is probably unnecessary to use a full structural simultaneous equation since many of the endogenous coefficients may not be significant. The endogeneous coefficients for the most passive stock exchange would most likely be insignificant. It is possible to restrict the full structural simultaneous equation model by formulating the equations model as recursive system. The present section uses this methodology of recursive regression system as developed by Wold (1954) to estimate the simultaneity of share price determination among five stock exchanges. This methodology finds reference in empirical financial research particularly by Simkowitz and Logue (1973) who use this to take care of simultaneity of security price determination while estimating the capital asset pricing model. The development of the model and its methodological aspects have been discussed in detail in Lee and Lloyd (1976) paper. Only some key aspects of the model has been presented here.

In recursive system, the structural equations are odered such that the first equation has only one endogeneous variable, the second equation has two endogeneous variables and so on. The system can be represented as:

$$
\begin{aligned}
Y_1 &= \beta_{11} X_{11} + \beta_{12} X_{12} + \cdots\cdots + \beta_{1K} X_{1K} + \varepsilon_1 \\
\phi_{21} Y_1 + Y_2 &= \beta_{21} X_{21} + \beta_{22} X_{22} + \cdots\cdots + \beta_{2K} X_{2K} + \varepsilon_2 \\
&\vdots \\
\phi_{L1} Y_1 + \phi_{L2} Y_2 + \cdots + Y_L &= \beta_{L1} X_{L1} + \beta_{L2} X_{L2} + \cdots\cdots + \beta_{LK} X_{LK} + \varepsilon_L
\end{aligned}
$$

where γ represents the coefficients on the L endogeneous variable, β represents the coefficients on the K exogeneous variables and ε represents the disturbance term for the equations. The endogeneous variables entering into the system Second equation onwards may be regarded as pre-determined for that particular equation. Under these conditions the ordinary least squares estimators gives unbiased estimates. As a result of this, the OLS method can be used in estimating the system without any bias. This has empirical support from previous studies [see, Lee and Lloyd]. The use of any other estimation procedure particularly, two-staged least squares method is ruled out because of the difficulties of multicollinearity and other problems associated with them. The problems associated with 2SLS estimator in financial models are discussed in Lloyd (1975) and Smith (1976).

The estimation of the recursive system requires the ordering of the dependent variable. As suggested in Lee and Lloyd (1976), the ordering has been obtained on the basis of each stock exchange's degree of correlation with other exchanges. The measure of the correlation used here is the coefficient of determination ($\bar{R}^2$) for each stock exchange's individual regression on all of the other stock exchanges. The $\bar{R}^2$ for price relative series, (X_t / X_{t-1}) designated as <u>linear form</u> and rate of return series, $\log (X_t/X_{t-1})$, designated as <u>log form</u> for each stock exchange appear in Tables 10 and 11. $\bar{R}^2$ results from both the forms provide the identical ordering for the recursive system. The Delhi stock exchange share price indicator both in log and linear form exhibit lowest correlation. The result of highest $\bar{R}^2$ for Bombay stock exchange has a great deal of intuitive appeal. On the basis of R values, the following recursive system has been estimated in both linear and log form:

$$D = f_1 (AI)$$
$$M = f_2 (D, AI)$$
$$A = f_3 (M, D, AI)$$
$$C = f_4 (A, M, D, AI)$$
$$B = f_5 (C, A, M, D, AI)$$

Each equation in the above system has been estimated using the OLS method. The results pertaining to linear form i.e. X_t / X_{t-1} and log form i.e., $\log (X_t / X_{t-1})$ appear in Tables 12 and 13. The results indicate significant interrelationships between Bombay-Ahmedabad, Ahmedabad-Calcutta and Madras-Ahmedabad share price indicators in both forms. These relationships indicate the interregional stock exchange influences which are significant. These variables are significant in addition to the all-India share price indicator used as a proxy for macro influences. Except the Bombay-Ahmedabad relationship, the other two relationships as exhibited by their respective coefficients in the system are in negative direction. In terms of their signs these relationships are disturbing. High multicolinearity in the variables used in the system is suspected as the reason of such disturbing relationships. As can be seen from the Table 4 and 5 the simple correlation coefficients between the all-India index and stock exchange indices are quite high. If we look at the t-ratios of estimated coefficients in recursive system, we find them 'significant'. Using t-ratio as criteria to judge the intensity of multicolinearity problem, we might conclude it is not serious. However, the problem may exist even with 'highly significant' t-ratios [see Maddala (1986)].

The recursive system as estimated contains all-India index iun each equation. This index is highly correlated with all stock exchange price indices. Because of this common influence, the stock exchange indices further get correlated. In order to separate the influence of the all-India index from that of stock exchange indices, we created 'orthogonal' index for each stock exchange in the following way:

$$R^*_{E,t} = R_{E,t} - \left[Cov\ (R_{E,t},\ R_{AI,t}) \ /\ Var\ (R_{AI,t}) \right] R_{AI,t}$$

such that $Cov\ (R^*_{E,t}, R_{AI,t}) = 0$, where $R^*_{E,t}$ is the orthogonal factor, $R_{E,t}$ and $R_{AI,t}$ are the return series of E'th stock exchange and all-India respectively. In effect, R^*_{Et} is equivalent to the residual errors from a linear regression of $R_{E,t}$ against $R_{AI,t}$ with the intercept constrained to zero. This alternative testing has been done for the rate of return series only. $R_{E,t}$ and $R_{AI,t}$ denotes the rate of return series for a particular stock exchange and all-India respectively. In estimating the recursive system the orthogonal factors has been used, replacing the rate of return series for each exchange. The use of orthogonalized factor variables allows to establish the additional gain from the inclusion of the new variable. The coefficient of the orthogonalized index will measure the sensitivity of a exchange's return beyond that already reflected by the all-India index. Also, the t-statistic will indicate whether the variable has a statistically significant influence. It should be noted, however, that the orthogonalising process changes the original character of return index.

The results of recursive system estimates using orthogonalized factors for the regional indicators are given in Table 15. The Table 16 reports the correlation values between orthogonalized factors. The resulted correlation values are significantly low in comparison with the values associated with non-orthogonalized factors. Now this should not pose any multicollinearity problem as suspected in the recursive system estimated previously. However, the results obtained for the recursive system after using orthogonalized factors are not markedly different from the results obtained earlier. This exercise suggests that the multicollinearity was not the problem in the results presented earlier. The results have been obtained for the recursive system using orthogonalised variables in both log and linear forms and they confirm the significant negative inter-relationships between Bombay-Ahmedabad, Ahmedabad-Calcutta and Madras-Ahmedabad. These interrelationships are significant in addition to the macro influences.

Conclusions

The results relating to the analysis of the behaviour of the regional share price indicators suggest that there exists a substantial amount of relationship among the five regional stock indicators in our sample. The initial results indicate that changes in price index of stock exchanges respond immediately (i.e. one month period) to price changes in the all-India index. The immediate responses however do not suggest that we have reasonably one integrated national market. In fact, it was beyond the scope of this paper to test the integrated one-market hypothesis. More data and better tests are needed to test this hypothesis. Regarding the temporal inter-relationships among regional price indicators, recursive regression system provides a different set of results. Though among regional indicators there appears to be significant inter-relationships but some of the movements after accounting for the macro influences are in opposite direction. The results indicate that regional exchanges do not move together in confirmity in the short run as the price indicator changes or their logarithms between regions do not exhibit directional consistency.

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Table 1: <u>Structural and Market-wise Pattern of Listed Stocks on Selected Stock Exchanges (as on Dec.31, 1985)</u>

Stock exchange	No.of stock issues listed	Capital listed (Rs.crores)	Market value of capital listed (Rs.in crores)
Bombay	1794	3764	17475
Calcutta	1980	1888	6544
Madras	490	1204	6213
Ahmedabad	329	1115	7263
Delhi	1335	2068	9849
Total All SE	4344	5709	20783

<u>Source</u>: Official Directory of the Bombay Stock Exchange. Note the overlap in the number of stock issues listed on the five stock exchanges is because of listing on more than one stock exchange.

Table 2 : <u>Shareholding Population</u>

Region	Percentage
Bombay	35.3
Calcutta	10.0
Madras	3.9
Ahmedabad	7.4
Delhi	9.5
	66.1

<u>Source</u>: Gupta (1987)

Table 3 : Region-wise Number of Securities Selected

Region	Number of Scrips*
Bombay	136
Calcutta	126
Madras	84
Ahmedabad	29
Delhi	39
Total	356

Note*: The overlapping scrips have been counted only once to avoid the duplication.

Table 4 : Coefficient of Determination Between Regional Stock Exchange Indicators and All India (Monthly figures first differences)

	All India	Bombay	Calcutta	Madras	Ahmedabad	Delhi
Bombay	0.949	1.000				
Calcutta	0.875	0.765	1.000			
Madras	0.670	0.566	0.650	1.000		
Ahmedabad	0.682	0.733	0.455	0.346	1.000	
Delhi	0.465	0.410	0.429	0.330	0.267	1.000

Table 5 : Coefficient of Determination Between Regional Stock Exchange Indicators and All India (Monthly Figures Percentage Changes)

	All India	Bombay	Calcutta	Madras	Ahmedabad	Delhi
Bombay	0.927	1.000				
Calcutta	0.877	0.774				
Madras	0.689	0.584	0.636	1.000		
Ahmedabad	0.672	0.720	0.482	0.373	1.000	
Delhi	0.353	0.318	0.325	0.258	0.239	1.000

Table 6 : Results of the Regression Parameters from the Model

$$\text{Log (Dependent Variable)} = \hat{\alpha} + \hat{\beta} \log (AI_t/AI_{t-1})$$

Dependant Variable	Regression Parameters $\hat{\alpha}$	$\hat{\beta}$	$\bar{R}^2$	DW Ratio
B_t/B_{t-1}	0.0003 (0.29)	1.0693 (44.83)	0.9249	2.14
C_t/C_{t-1}	-0.0014 (-1.35)	1.0790 (34.03)	0.8765	1.90
M_t/M_{t-1}	0.0020 (1.74)	0.6365 (18.91)	0.6864	1.69
A_t/A_{t-1}	0.0011	0.9429	0.6623	1.62
D_t/D_{t-1}	0.0014 (0.55)	0.7137 (9.37)	0.3472	2.45

Note: t - values appear in parentheses beneath coefficients.

Table 7 : Results of the Regression Parameters from the Model

$$\text{Log (Dependent Variable)} = \hat{\alpha} + \hat{\beta} \log (B_t/B_{t-1})$$

Dependent Variable	Regression Paremeters $\hat{\alpha}$	$\hat{\beta}$	$\bar{R}^2$	DW Ratio
C_t/C_{t-1}	-.0008 -0.59	0.9127 23.67	0.7743	1.76
M_t/M_{t-1}	0.0024 1.84	0.5284 15.15	0.5837	1.66
A_t/A_{t-1}	0.0009 0.55	0.8806 20.20	0.7141	1.72
D_t/D_{t-1}	0.0017 0.66	0.6093 8.66	0.3121	2.41

Note: t - values appear in parentheses beneath coefficients.

Table 8 : Results of the Lead-lag Analysis Using the Regression Model

$$\log(\text{Dependent Variable}) = \beta_0 + \sum_{t=-3}^{3} \beta_{t+i} \log(AI_{t+i}/AI_{t+i-1})$$

Dependent Variable	$\hat\beta_0$	$\hat\beta_{t-2}$	$\hat\beta_{t-2}$	$\hat\beta_{t-1}$	$\hat\beta_t$	$\hat\beta_{t+1}$	$\hat\beta_{t+2}$	$\hat\beta_{t+3}$	$\bar R^2$	DW	ρ_1
B_t/B_{t-1}	0.0004 (0.55)	-0.0125 (-0.49)	0.0484 (1.74)	-0.1096 (-3.86)	1.0664 (37.41)	0.1025 (3.63)	-0.0561 (-2.01)	-0.0064 (0.26)	0.9304	2.09	-0.0475
C_t/C_{t-1}	-0.0009 (-0.82)	0.0058 (0.16)	-0.0547 (-1.35)	0.0478 (1.16)	1.0524 (25.41)	0.0502 (1.22)	-0.0075 (-0.19)	-0.0527 (-1.49)	0.8682	1.91	0.0476
M_t/M_{t-1}	0.0005 (0.47)	0.0499 (1.37)	0.0308 (0.78)	0.0867 (2.14)	0.6319 (15.57)	-0.0047 (-0.12)	0.0828 (2.09)	0.0075 (0.22)	0.7153	1.83	0.0540
A_t/A_{t-1}	0.0007 (0.38)	0.0055 (0.09)	0.0834 (1.23)	-0.1186 (-1.72)	0.9686 (13.99)	-0.0061 (-0.08)	-0.0644 (0.89)	-0.0273 (-0.46)	0.6223	1.59	0.2029
D_t/D_{t-1}	0.0002 (0.08)	-0.0083 (-0.09)	0.1371 (1.14)	0.0839 (3.98)	0.6129 (6.15)	0.2201 (2.23)	-0.0336 (-0.35)	-0.0586 (-0.69)	0.3225	2.46	-0.230

Note: t-values appear in parentheses beneath coefficients. The subscripts for the coefficients denote the lead or lag associated with its independent variable.

Table 9 : Results of the Lead-lag Analysis Using the Regression Model

$$\log(\text{Dependent Variable}) = \hat\beta_0 + \sum_{t=-3}^{3} \hat\beta_{t+i} (B_{t+i} / B_{t+i-1})$$

Dependent Variable	$\hat\beta_0$	$\hat\beta_{t-3}$	$\hat\beta_{t-2}$	$\hat\beta_{t-1}$	$\hat\beta_t$	$\hat\beta_{t+1}$	$\hat\beta_{t+2}$	$\hat\beta_{t+3}$	$\bar R^2$	DW	ρ_1
C_t/C_{t-1}	-0.0008 (-0.55)	-0.0187 (-0.44)	-0.0660 (-1.43)	0.1681 (3.58)	0.8591 (18.24)	-0.0074 (-0.16)	-0.0247 (-0.56)	-0.0365 (-0.89)	0.7734 (80.47)	1.69	0.1564
M_t/M_{t-1}	0.0007 (0.54)	0.0257 (0.71)	0.0115 (0.29)	0.1632 (4.15)	[illegible] (12.78)	[illegible] (-0.40)	0.0696 (1.80)	0.0169 (0.49)	0.6440	1.77	0.1113
A_t/A_{t-1}	0.0000 (0.00)	0.0522 (1.04)	-0.0078 (-0.15)	0.0329 (0.60)	0.8745 (15.89)	-0.0354 (-0.65)	0.0636 (1.17)	0.0033 (0.07)	0.6827 (51.07)	1.72	0.1378
D_t/D_{t-1}	0.0002 (0.07)	0.0162 (0.20)	0.0674 (0.78)	0.1029 (1.16)	0.4996 (5.62)	0.1791 (2.02)	-0.0198 (-0.22)	-0.0497 (-0.64)	0.2827 (10.176)	2.42	-0.2098

Note: t - values appear in parentheses beneath coefficients. The subscripts for the coefficient denote the lead or lag associated with its independent variable.

Table 10 : Results of the Regression of Each Regional Indicator Against the Rest

(Linear Form)

Dependent Variable	Independent Regional Indicator: Bombay	Calcutta	Madras	Ahmedabad	Delhi	$\bar{R}^2$	Constant Term
Bombay	...	0.4665	0.1433	0.4355	0.0208	0.8847	-0.0557
		(9.71)	(2.26)	(12.00)	(0.71)		(-1.39)
Calcutta	0.7791	...	0.4040	-0.1519	0.0750	0.8179	-0.1076
	(9.71)		(5.24)	(-2.47)	(1.99)		(-2.09)
Madras	0.2093	0.3535	...	-0.0256	0.0356	0.6476	0.4296
	(2.26)	(5.24)		(-0.44)	(1.00)		(12.12)
Ahmedabad	1.0952	-0.2340	-0.0451	...	0.0418	0.7275	0.1420
	(12.00)	(-2.47)	(-0.44)				(2.24)
Delhi	0.1456	0.3138	0.1703	0.1135	...	0.3333	0.2582
	(0.71)	(1.99)	(1.00)	(0.89)			(2.47)

Note: t - values appear in the parentheses beneath each regression coefficient.

Table 11 : Results of the Regression of Each Regional Indicator Against the Rest

(Log Form)

Dependent Variable	Independent Regional Indicator: Bombay	Calcutta	Madras	Ahmedabad	Delhi	$\bar{R}^2$	Constant Term
Bombay		0.4639	0.1541	0.4268	0.0197	0.8893	0.0004
		(9.74)	(2.44)	(12.21)	(0.66)		(0.41)
Calcutta	0.7865		0.4005	-0.1576	0.0782	0.8223	-0.0015
	(9.74)		(5.15)	(-2.56)	(2.04)		(-1.24)
Madras	0.2252	0.3452		-0.0353	0.0378	0.6571	0.0025
	(2.44)	(5.15)		(-0.61)	(1.05)		(2.16)
Ahmedabad	1.1124	-0.2423	-0.0529		0.04078	0.7328	0.0006
	(12.21)	(-2.56)	(-0.61)		(0.85)		(0.40)
Delhi	0.1351	0.3158	0.1768	0.1071		0.3405	0.0012
	(0.66)	(2.04)	(1.05)	(0.85)			(0.48)

Note: t-values appear in the parentheses beneath each regression coefficient.

Table 12 : Recursive System Estimates for the Regional Stock Exchanges Indicators

(Linear Form)

Independent Variables	Dependent Variable				
	Bombay	Calcutta	Ahmedabad	Madras	Delhi
Calcutta	-0.0639 (-1.11)				
Ahmedabad	0.1471* (4.15)	-0.2171* (-4.85)			
Madras	-0.1012* (-1.97)	0.0239 (0.34)	-0.3364* (-2.87)		
Delhi	-0.0082 (-0.37)	0.0208 (0.70)	0.0086 (0.17)	0.0149 (0.44)	
All India	1.0693* (11.71)	1.2470* (16.36)	1.1600* (12.00)	0.6273* (15.21)	0.7263* (9.57)
Constant	-0.0428 (-1.44)	-0.0754 (-1.90)	0.1695* (2.51)	0.3597* (10.36)	0.2752* (3.60)
$\bar{R}^2$	0.9368	0.8989	0.6819	0.6852	0.3488
DW	2.26	2.01	1.64	1.67	2.46

Note: t-values appear in the parentheses beneath each regression. *Denotes significance at 0.05 level for two-tailed test.

Table 13 : Recursive System Estimates for the Regional Stock Exchanges Indicators

(Log Form)

Independent Variables	Dependent Variable				
	Bombay	Calcutta	Ahmedabad	Madras	Delhi
Calcutta	-0.0582				
	(-1.01)				
Ahmedabad	0.1521*	-0.2186*			
	(4.31)	(-4.90)			
Madras	-0.0913	0.0223	-0.3517*		
	(-1.77)	(0.32)	(-2.97)		
Delhi	-0.0090	0.0222	0.0053	0.0173	
	(-0.40)	(0.74)	(0.10)	(0.51)	
All India	1.0557*	1.2512*	1.1710*	0.6261*	0.7158*
	(11.55)	(16.36)	(12.06)	(15.36)	(9.71)
Constant	0.0001	-0.011	0.0014	0.0019	0.0012
	(0.15)	(-1.11)	(0.86)	(1.73)	(0.47)
$\bar{R}^2$	0.9366	0.8933	0.6843	0.6927	0.3555
DW	2.27	2.02	1.65	1.69	2.45

Note:t-values appear in the parentheses beneath each regression coefficient. * denotes a significance at 0.05 level of two-tailed test.

Table 14 : Correlation Matrix of Orthogonalised Factors

(Rate of Return Series)

	$R_{AT,t}$	$R^*_{B,t}$	$R^*_{C,t}$	$R^*_{M,t}$	$R^*_{A,t}$	$R^*_{D,t}$
$R^*_{B,t}$	0.012	1.000				
$R^*_{C,t}$	-0.014	-0.216	1.000			
$R^*_{M,t}$	0.005	-0.213	0.107	1.000		
$R^*_{A,t}$	0.011	0.393	-0.369	-0.224	1.000	
$R^*_{D,t}$	0.002	-0.038	0.055	0.039	-0.001	1.000

Table 15 : Recursive System Estimates using Orthogonalised Factors for the Regional Stock Exchange Indicators

(Rate of Return Form)

Independent Variable	Dependent Variable $R_{B,t}$	$R_{C,t}$	$R_{A,t}$	$R_{M,t}$	$R_{D,t}$
$R^*_{C,t}$	-0.0582 (-1.01)				
$R^*_{A,t}$	0.1521* (4.31)	-0.2186* (-4.90)			
$R^*_{M,t}$	-0.0913 (1.77)	0.0223 (0.32)	-0.3517* (-2.97)		
$R^*_{D,t}$	-0.0090 (-0.40)	0.0222 (0.74)	0.0053 (0.10)	0.0173 (0.51)	
$R^*_{AI,t}$	1.0718* (50.45)	1.0751* (37.37)	0.9509* (19.00)	0.6395* (19.56)	0.7158* (9.77)
Constant	0.0002 (0.24)	-0.0013 (-1.30)	0.0008 (0.45)	0.0009 (1.75)	0.0012 (0.47)
$\bar{R}^2$	0.9386	0.8933	0.6843	0.6927	0.3555
DW	2.27	2.02	1.65	1.69	2.45

Note: t-values appear in the parentheses beneath each regression coefficients. * denotes a significance at 0.05 level of two-tailed test.