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The Efficiency of Emerging Stock Markets: Empirical Evidence from the South Asian Region

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Abstract

This paper examines weak form efficiency in the stock markets of India, Sri Lanka, Pakistan and Bangladesh; and the linkages between these four markets. The Augmented Dicky Fuller (ADF-1979), the Phillip-Perron (PP-1988), the Dicky-Fuller Generalized Least Square (DF-GLS 1996) and Elliot-Rothenber-Stock (ERS – 1996) tests are used to examine stock market efficiency. Weak form efficiency is supported by the classical unit root tests, however, it is not strongly supported for Bangladesh under the DF-GLS and ERS tests. The cointegration and Granger causality tests indicate a high degree of interdependence between the South Asian stock markets.

Keywords:

South Asia, India, Sri Lanka, Pakistan, Bangladesh,
unit root tests, stock markets, market efficiency

1. Introduction

The purpose of this study is to examine the degree of efficiency and linkage between the post-deregulation stock markets of South Asia[i]. Stock market efficiency has important implications for investors and regulatory authorities. In such a market, the role of the regulatory authorities is limited as stocks are accurately priced. The efficient dissemination of information ensures that capital is allocated to projects that yield the highest expected return with necessary adjustment for risk. With an efficient pricing mechanism an economy's savings and investment are allocated efficiently. Hence, an efficient stock market provides no opportunities to engage in profitable trading activities on a continuous basis. If on the other hand, a market is not efficient, the regulatory authorities can take necessary steps to ensure that stocks are correctly priced leading to stock market efficiency.

Studies of stock price behaviour for the developing economies can be found in Magnusson and Wydick (2002), Chiang, Yang and Wang (2000) and Alam, Hasan and Kadapakkam (1999). The results of these studies have been mixed. Magnusson and Wydick (2000) test the random walk hypothesis for a group of African countries and find that there is greater support for the African stock markets than for other emerging stock markets. Chian, Yan and Wang (2000) analysing stock returns for a group of Asian economies find that most markets exhibit an autoregressive process rejecting the weak form efficiency. Alam, Hasan and Kadapakkam (1999) test the random walk hypothesis for Bangladesh, Hong Kong, Sri Lanka and Taiwan. They find that all the stock indices except the Sri Lankan stock index follow a random walk.

The South Asian economies introduced a series of reforms starting in the 1980s and 1990s - Sri Lanka in 1977. Therefore this study attempts to see if the removal of restrictions on foreign investment has improved the pricing efficiency of stock markets in the South Asian region. The study makes use of four unit root tests to investigate weak form efficiency.

The classical ADF (1979) and PP (1988) tests; and the newer DF-GLS (1996) and the ERS (1996) tests developed by Elliot, Rothenberg and Stock. Weak form efficiency is supported for all four countries by the classical unit root tests, however, it is not strongly supported for Bangladesh under the DF-GLS and ERS tests. The multivariate cointegration test of Johansen (1988) indicates three long run stochastic trends among the South Asian stock markets suggesting a high degree of interdependence between the South Asian stock markets. These results are corroborated by the Granger causality tests. The generalized impulse response analysis used to examine the effects of a price shock of the Indian stock market on the stock prices of Sri Lanka, Pakistan and Bangladesh suggests that Pakistan and Sri Lanka are more responsive to price shocks in India than Bangladesh.

This paper is structured as follows. Section 2 describes the data and presents the results of preliminary analysis. Section 3 outlines the methodology. The empirical results are analysed in Section 4 and Section 5 concludes the paper.

2. Data and Preliminary Analysis

The data set consists of stock market indices for India, Sri Lanka, Pakistan and Bangladesh. The stock indices used are the FTSE for India and Pakistan, the All Share Index for Sri Lanka and the S&P for Bangladesh. The data used are monthly and cover the period January 1996 to October 2003. All data are obtained from DATASTREAM. In order to obtain a better understanding of the behaviour of stock prices, a preliminary analysis of the data are carried out in this section. Table 1 presents summary statistics for the logarithms of the first differences of the stock price indices or continuously compounding returns.

Table 1: Descriptive statistics for the stock returns				
	Country			
	India	Pakistan	Sri Lanka	Bangladesh
Maximum	0.17205	0.29203	0.19330	0.64531
Minimum	-0.21175	-0.47011	-0.19112	-0.35881
Mean	0.00472	0.00331	0.00789	-0.00470
Std Deviation	0.08684	0.12928	0.06699	0.12136
Skewness	-0.49100	-0.71437	0.10562	1.60910
Kurtosis-3	0.02459	1.51680	0.29781	8.91160
Coef of Variation	18.40300	39.07400	8.09460	25.64700

Table 1 shows that the means of the stock returns for India, Pakistan, and Sri Lanka are not far apart. For Bangladesh the mean is negative. The standard deviations of all stock returns appear to be similar. The stock returns for India and Pakistan are skewed to the left while those for Sri Lanka and Bangladesh are skewed to the right. All the series exhibit kurtosis. The coefficient of variation indicates that stock returns for Pakistan and Bangladesh are more variable than those for India and Sri Lanka.

Table 2 presents the pair-wise correlation coefficients for the stock returns. The correlation coefficients are in the range of -0.11 to 0.44. The correlation coefficients between the stock returns of India and Pakistan, India and Sri Lanka and Pakistan and Sri Lanka are positive. However, those between the stock returns of India and Bangladesh, Pakistan and Bangladesh and Bangladesh and Sri Lanka are negative. The highest correlation (+0.44) is found between the stock returns of India and Pakistan. The positive correlation indicates that the stock returns of these two countries move in the same direction.

Table 2: Correlation Matrix of Stock Returns Between Countries				
	India FTSE	Pakistan FTSE	Bangladesh S&P	Sri Lanka
India FTSE	1.0000	.44245	-.11289	.30887
Pakistan FTSE	.44245	1.0000	-.03387	.25320
Bangladesh S&P	-.11289	-.03387	1.0000	-.06294
Sri Lanka	.30887	.25320	-.06294	1.0000

Autocorrelation test results

The autocorrelation coefficients and Ljung Box statistics for the first differences of the stock returns are reported in Table 3. The null hypothesis is that the autocorrelation coefficients are equal to zero and the alternative is that they deviate from zero. If the t statistics for the autocorrelation coefficients fall within ± 1.96 the null hypothesis that $\rho = 0$ is not rejected. The correlation coefficients for 1, 2, 4, 8 and 16 are reported.

Table 3: Autocorrelation coefficients and LJung-Box Q Statistics for Stock Returns			
Country	Lag	Autocorrelation coefficient ones	Ljung-Box Q statistic
India	1	-0.10103	0.98028
	2	0.12123	2.4071
	4	-0.11432	4.4405
	8	-0.05201	6.4631
	16	0.04661	21.5050
Pakistan	1	-0.02973	.084868
	2	-0.06565	.50324
	4	0.12496	2.0631
	8	0.04986	4.3842
	16	-0.09156	10.3641
Bangladesh	1	0.30896	9.1669
	2	-0.77000	9.7425
	4	0.11719	11.1819
	8	0.02092	20.6825

Table 3: Continued			
Country	Lag	Autocorrelation coefficient ones	Ljung-Box Q statistic
	16	-0.03802	26.5097
Sri Lanka	1	0.16615	2.6510
	2	0.09853	3.5936
	4	-.019389	5.0967
	8	0.01468	7.2020
	16	0.08438	11.6351

The autocorrelation coefficients reported in column three indicate that except for the first autocorrelation coefficient for Bangladesh, the rest of the autocorrelation coefficients are not statistically significant. The t-ratios for the autocorrelation coefficients for the other countries are within the critical values of the standard normal distribution at the five per cent level. Therefore the results support weak form efficiency.

3. Methodology

Weak form efficiency is tested using four unit root tests: the Augmented Dicky Fuller (ADF–1979), Phillips-Perron (1987, 1988), the Dickey-Fuller Generalised Least Squares (DF-GLS 1996) and the Elliott, Rothenberg and Stock (ERS) (1996) tests. These tests are explained below.

The ADF unit root test is based on the estimation of the following equation:

$$\Delta X_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 T + \sum_{i=1}^{n} \beta_i \Delta X_{t-i} + \varepsilon_t \quad (1)$$

where X_t = the time series; T = linear time trend; ε_t = the error term with zero mean and constant variance. Using equation (1), the null hypothesis of a unit root is $\beta_1 = 0$ which is tested against the alternative hypothesis that $\beta_1 < 0$. The Z_t statistic of Phillips and Perron (1987, 1988) is a modification of the Dickey-Fuller t statistic which allows for autocorrelation and conditional heteroscedasticity in the error term of the Dicky-Fuller regression. This is based on the estimation of equation (2).

$$\Delta X_t = \alpha_0 + \alpha_1 T + \alpha_2 X_{t-1} + \omega_t \qquad (2)$$

Dickey-Fuller Generalised Least Squares (DF-GLS)

The DF-GLS is a more powerful test than the Dickey-Fuller test. In the Augmented Dickey-Fuller (ADF) (1979,1981) test regression, either a constant or a constant and a linear time trend is included to take account of the deterministic components of data. Elliot, Rothenberg and Stock (ERS), propose a modification to the ADF regression in which data are detrended before the unit root test is conducted. This de-trending is done by taking the explanatory variables out of the data (see, Elliott, Rothenberg and Stock, 1996). The following equation is then estimated to test for a unit root in the variable:

$$\Delta y_t^d = \alpha y_{t-1}^d + \beta_t \Delta y_{t-1}^d + \ldots + \beta_p \Delta y_{t-p}^d + v_t \qquad (3)$$

where Δ is the difference operator, y_t^d is the generalised least squares de-trended value of the variable, α, β_t and β_p are coefficients to be estimated and v_t is the independently and identically distributed error term. As in the case of the ADF test, a test for a unit root of the variable y involves examination of whether the coefficient of the AR(1) term, in this case α , in equation (3) is zero against the alternative of a ≠ 0. In making inferences, the critical values tabulated in Elliott, Rothenberg and Stock (1996) are used.

Elliott, Rothenberg and Stock (ERS) Point Optimal Test

The ERS point optimal test has been found to dominate other commonly used unit root tests, when a time series has an unknown mean or a linear trend. This test is based on the following quasi-differencing regression:

$$d(y_t \mid a) = d(x_t \mid a)' \delta(a) + \eta_t \qquad (4)$$

where $d(y_t \mid a)$ and $d(x_t \mid a)$ are quasi-differenced data for y_t and x_t respectively and η_t is the error that is independently and identically distributed. Details on computing quasi differences are given in Elliott, Rothenberg and Stock (1996). In equation (4), y_t is the variable whose time series properties are tested, x_t may contain a constant only or both a constant and time trend and $\delta(a)$ is the coefficient to be estimated. ERS recommend the use of $\overline{a}$ for a in equation (4) that is computed as $\overline{a} = 1 - 7/T$ when x_t contains a constant and $\overline{a} = 1 - 13.5/T$ when x_t contains a constant and time trend. In the ERS point optimal test, the null and alternative hypotheses tested are $\alpha = 1$ and $\alpha = \overline{a}$ respectively. The relevant test statistic (P_T) to test the above null hypothesis is:

$$P_T = (SSR(\overline{a}) - (\overline{a})SSR(1)) / f_0 \tag{5}$$

where SSR is the sum of squared residuals from equation (4) and f_0 is an estimator for the residual at frequency zero. In making inferences, the test statistic calculated is compared with the simulation based critical values of ERS. In the empirical analysis, the four unit root tests are conducted with a constant and a time trend in the test equations.

Impulse Response and Forecast Error Variance Decomposition Analysis

Given that India is the largest country in this region, the study also examines the generalized impulse responses of Sri Lanka, Pakistan and Bangladesh to a price shock in India. Following Pesaran and Shin (1998), this can be represented by the following. If X_t has a VAR representation of the following form:

$$\Delta X_t = \mu + \sum_{i}^{p} \phi X_{t-i} + e_t$$

where μ is a vector of constant terms and is a vector of Gaussian error terms with $E(e_t) = 0$ and $E(e_t e_t') = \Sigma = (\sigma_{ij})$. The generalized impulse response of X_{t+n} relating to a unit shock in the jth variable at time t is: $Z_n \Sigma \varepsilon_j / \sigma_{ij}$ $n = 0, 1, 2 \ldots.$

Where $Z_n = \phi_1 Z_{n-1} + \phi_2 Z_{n-2} + \ldots + \phi_p Z_{n-p}$ $n = 1, 2, 3, \ldots$ and $Z_n = 0$ for $n < 0$.

The forecast variance of i, n periods hence takes place due to the innovations in the jth variable. This can be calculated as:

$$\sigma_{ij}^{-1} \sum_{k=0}^{n} (\varepsilon'_i Z_k \Sigma \varepsilon_j)^2 / \varepsilon'_i Z_k \Sigma Z'_k \varepsilon_j \quad i,j = 1,..$$

The above equations will hold in a system of cointegrated variables.

4. Empirical Results

Table 4 presents the unit root test results for the log levels of the four stock market indices.

Table 4: Unit Root Tests for Log Levels of Stock Price Indices				
Country	ADF	PP	DF-GLS	ERS
Panel A: Constant				
Bangladesh	-1.922 (7)	-1.626 (2)	-1.819 (7)[b]	2.543 (7)[b]
India	-2.449 (0)	-2.529 (2)	-1.844 (0)[c]	4.862 (0)
Pakistan	-1.708 (0)	-1.708 (0)	-1.690 (0)[c]	4.423 (0)
Sri Lanka	0.408 (1)	0.250 (4)	-0.055 (1)	11.152 (1)
Panel B: Constant and linear trend				
Bangladesh	-2.705 (7)	-2.430 (3)	-2.528 (7)	1.834 (7)[a]
India	-2.540 (0)	-2.641 (2)	-2.185 (0)	11.231 (0)
Pakistan	-1.519 (0)	-1.519 (0)	-1.678 (0)	14.253 (0)
Sri Lanka	0.690 (0)	0.346 (3)	-0.348 (1)	43.950 (0)

Notes:
1. a, b and c imply significance at the 1%, 5%, 10% level, respectively.
2. The numbers within brackets for the DF-GLS and ERS statistics represents the lag length of the dependent variable used to obtain white noise residuals.
3. The lag length for the DF-GLS equation was selected using Akaike Information Criterion (AIC).
4. The numbers within brackets for the PP statistics represent the bandwidth selected based on Newey-West method using Bartlett Kernel.
5. The numbers within brackets shown for the ERS statistic indicate the spectral OLS AR based on SIC.

Panel A of Table 4 presents results when a constant is included in the test equation. The results show that the stock index of Bangladesh is stationary in levels at the five per cent level under the *DF-GLS* and *ERS* unit root tests. The stock price indices for India and Pakistan exhibit a unit root at the 10% level under the DF-GLS test. For Sri Lanka the series is non-stationary under all four unit root tests providing support for weak-form market efficiency. Panel B of Table 4 presents unit root test results when a constant and a time trend are included in the test equation. The results show that all four stock price indices behave as random walks except that of Bangladesh under the ERS test.

Table 5 presents unit root test results for the logs of the first differences of the series. The results indicate that all four series are stationary under ADF, PP and ERS unit root tests. Stock returns for India and Pakistan are not stationary under the DF-GLS unit root test.

Table 5 Unit root tests for log first differences of stock price indices

Country	ADF	PP	DF-GLS	ERS
Panel A: Constant				
Bangladesh	-3.681 (11)[a]	-6.859 (4)[a]	-2.623 (6)[a]	1.739 (0)[a]
India	-10.572 (0)[a]	-10.537 (2)[a]	-1.052 (5)	1.738 (0)[a]
Pakistan	-10.025 (0)[a]	-10.024 (2)[a]	-0.931 (5)	2.644 (0)[b]
Sri Lanka	-7.549 (0)[a]	-7.660 (3)[a]	-7.584 (0)[a]	1.153 (0)[a]
Panel B: Constant and linear trend				
Bangladesh	-4.751 (11)[a]	-6.830 (4)[a]	-4.959 (11)[a]	3.717 (0)[a]
India	-10.520 (0)[a]	-10.488 (2)[a]	-1.510 (5)	3.771 (0)[a]
Pakistan	-10.163 (0)[a]	-10.194 (4)[a]	-1.721 (5)	4.033 (0)[a]
Sri Lanka	-7.983 (0)[a]	-8.038 (3)[a]	-7.732 (0)[a]	2.648 (0)[a]

Notes:
1. a and b imply significance at the 1% and 5% level, respectively.
2. The numbers within brackets for the DF-GLS and ERS statistics represents the lag length of the dependent variable used to obtain white noise residuals.
3. The lag length for the DF-GLS equation was selected using the Akaike Information Criterion (AIC).
4. The numbers within brackets for the PP statistics represent the bandwidth selected based on Newey-West method using Bartlett Kernel.
5. The numbers within brackets for the ERS statistic indicate the spectral OLS AR based on SIC.

Cointegration tests are carried out next. The cointegration test results presented in Table 6 indicate four cointegrating vectors for the six bivariate models, the India FTSE-All Share, India-FTSE-S&P, Pakistan-FTSE-S&P and All Share-S&P. The multivariate tests indicate three cointegrating vectors implying the existence of three common stochastic trends in the system of four variables.

Table 6: Results of Johansen-Juselius Maximum Likelihood Cointegration Test

Null Hypothesis			95% critical value	
	<u>mλ</u>	<u>Trace</u>	<u>mλ</u>	Trace
India FTSE-Pakistan FTSE				
$r = 0$	10.18	13.31	15.87	20.18
$r \leq 1$	3.13	3.13	9.16	9.16
India FTSE-All Share				
$r = 0$	19.48	26.28	15.87	20.18
$r \leq 1$	6.79	6.79	9.16	9.16
India FTSE-S&P				
$r = 0$	41.70	50.80	15.87	20.18
$r \leq 1$	9.10	9.10	9.16	9.16
Pakistan FTSE-All Share				
$r = 0$	6.96	8.48	15.87	20.18
$r \leq 1$	1.52	1.52	9.16	9.16
Pakistan FTSE-S&P				
$r = 0$	41.25	48.90	15.87	20.18
$r \leq 1$	7.64	7.64	9.16	9.16
All Share - S&PGerman				
$r = 0$	34.68	37.19	15.87	20.18
$r \leq 1$	2.51	2.51	9.16	9.16
All				
$r = 0$	44.64	116.89	28.27	53.48
$r \leq 1$	39.76	72.24	22.04	34.87
$r \leq 2$	26.05	32.47	15.87	20.18
$r \leq 3$	6.42	6.42	9.16	9.16

Granger causality tests are performed to see if lags of changes in stock markets indices cause changes in other stock market returns. The Granger causality tests involve estimation of the multivariate regressions:

$$\Delta P_{It} = \alpha_1 + \psi_1 \Delta P_{It-1} + \psi_2 \Delta P_{SLt-1} + \psi_3 \Delta P_{Pt-1} + \psi_4 \Delta P_{Bt-1} + v_{1t} \quad (7)$$

$$\Delta P_{SLt} = \alpha_2 + \gamma_1 \Delta P_{SLt-1} + \gamma_2 \Delta P_{It-1} + \gamma_3 \Delta P_{Pt-1} + \gamma_4 \Delta P_{Bt-1} + v_{1t} \quad (8)$$

$$\Delta P_{Pt} = \alpha_3 + \phi_1 \Delta P_{Pt-1} + \phi_2 \Delta P_{It-1} + \phi_2 \Delta P_{SLt-1} + \phi_4 \Delta P_{Bt-1} + v_{3t} \quad (9)$$

$$\Delta P_{Bt} = \alpha_4 + \delta_1 \Delta P_{It-1} + \delta_2 \Delta P_{SLt-1} + \delta_3 \Delta P_{Pt-1} + \delta_4 \Delta P_{Bt-1} + v_{4t} \quad (10)$$

Where P_{It}, P_{SLt}, P_{Pt}, and P_{Bt} indicate respectively the stock price indices of India, Sri Lanka, Pakistan and Bangladesh.

Table 7 presents summary statistics for the results of Granger causality tests.

Table 7: Results of LR Tests of Granger non-causality

Null Hypothesis	Chi-square test statistic
ΔP_{It} does not Granger cause $\Delta P_{SLt}, \Delta P_{Pt}, \Delta P_{Bt}$	$\chi^2(3) = 1.29(0.73)$
ΔP_{SLt} does not Granger cause $\Delta P_{It}, \Delta P_{Pt}, \Delta P_{Bt}$	$\chi^2(3) = 3.12(0.37)$
ΔP_{Pt} does not Granger cause $\Delta P_{It}\, \Delta P_{SLt}\, \Delta P_{Bt}$	$\chi^2(3) = 0.08(0.99)$
ΔP_{Bt} does not Granger cause $\Delta P_{It}\, \Delta\, \Delta P_{SLt}\, P_{Pt}$	$\chi^2(3) = 1.46(0.69)$

Note: The figures within brackets after the Chi-square statistics indicate the corresponding upper tail probabilities for the reported Chi-square values.

The chi square statistics for the LR causality tests are all below the 5 per cent critical value of 7.81 suggesting bi-directional causality between all the indices. The null hypothesis that changes in the India FTSE does not cause changes in the stock market indices of Sri Lanka, Pakistan and Bangladesh cannot be rejected at the 0.73 level of significance and that the stock price indices of Sri Lanka, Pakistan and Bangladesh do not cause changes in the India FTSE cannot be rejected at the 0.50 level of significance.

Similarly the hypothesis that the changes in the stock price indices of India, Pakistan and Bangladesh do not cause changes in the Sri Lanka All Share Index cannot be rejected at the .95 per cent level of significance while the hypothesis that changes in the Pakistan FTSE does not cause changes in the stock indices of India, Sri Lanka and Bangladesh cannot be rejected at the .99 level of significance. The hypothesis that changes in the Bangladesh S&P do not cause changes in the India FTSE, Sri Lanka All Share Index and Pakistan FTSE cannot be rejected at the 0.69 level of significance and the hypothesis that changes in the India FTSE, Sri Lanka All Share Index and Pakistan FTSE do not cause changes in the Bangladesh S&P cannot be rejected at the 0.77 level of significance. These results appear to be consistent with the multivariate cointegration results.

Impulse Response Analysis

This section examines the generalized impulse responses of Pakistan, Bangladesh and Sri Lanka to a price shock in India. Figures 1-6 show the generalized impulse response functions for each country with respect to a standard deviation price shock in India.

Figure 1 shows the generalized impulse response function of the India FTSE with response to a price shock in India of the India FTSE and the generalized impulse response of the Pakistan FTSE to a standard deviation shock of the India FTSE. Figures 2 and 3 show the impulse response of Bangladesh and Sri Lanka respectively to a standard deviation shock of the India FTSE. A standard deviation shock in the India FTSE has greater and more variable effect on the Sri Lanka and Pakistan stock price indices. Figure 1 indicates that prices diverge up to a time horizon of 30 and beyond that point, a price shock in India affects Pakistan with a time lag. Figure 3 indicates that a price shock in India affects Sri Lanka with a time lag up to a time horizon of about 80 and beyond that point prices move in the opposite direction. In Bangladesh on the other hand, the effect of a standard deviation shock of the India FTSE is smaller and appears to wane with time.

Figure 1

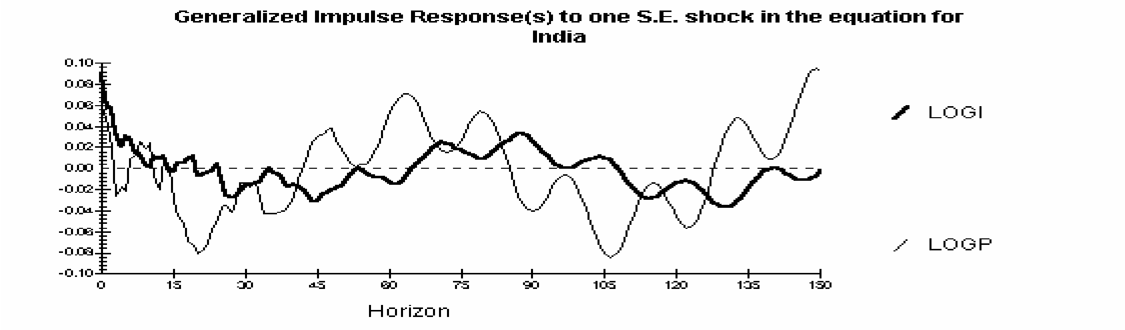


Figure 2

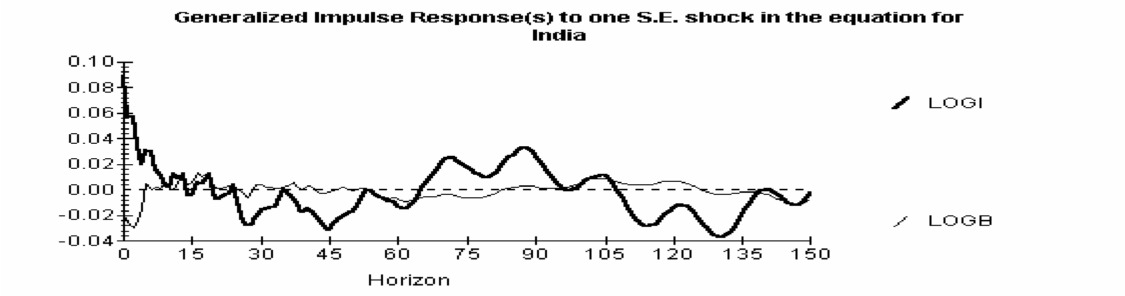
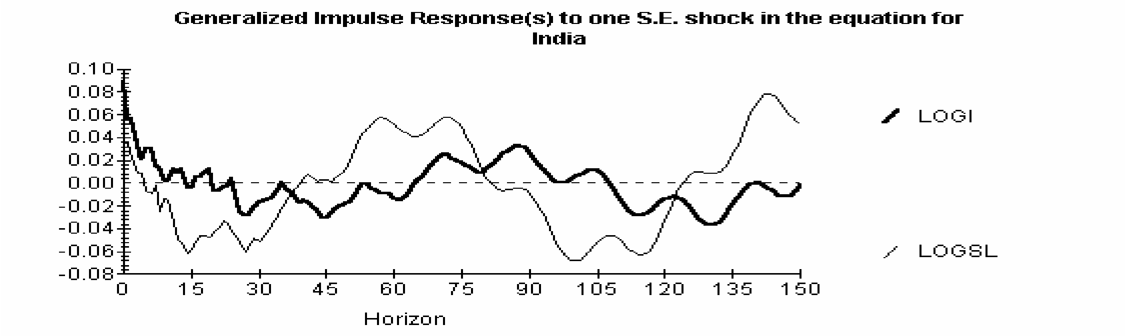


Figure 3



5. Conclusion

This paper examines weak form efficiency in the stock markets of India, Sri Lanka, Pakistan and Bangladesh and the degree of linkage between these markets. The classical unit root tests support weak form efficiency for all four countries while the DF-GLS and ERS tests do not support weak form efficiency for Bangladesh. Hence, the post-deregulation stock markets of South Asia appear in general to be efficient except in the case of Bangladesh for which the results are mixed.

The multivariate cointegration tests reveal that the markets share three long run stochastic trends. These results are further supported by the Granger causality tests which reveal statistically significant causal relationships between the stock markets. The generalized impulse response functions show that stock price shocks in India have a greater effect on the stock market of Pakistan than those of Sri Lanka and Bangladesh.

The results of this study, particularly those of the multivariate tests, have important implications for investors and government policy makers in these countries. The identified relationships can be used by local and international investors to predict the movements of stock markets in order to invest in profitable stock markets. Government policy makers can take necessary steps to improve corporate disclosures in a timely manner so that stock prices reflect all available information instantly.

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Notes:

[1] According to Fama (1970) a market is weak form efficient if a person cannot devise a rule to consistently beat the stock market using past share prices.

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