Relationship between Developed, Emerging and South Asian Equity Markets: Empirical Evidence with a Multivariate Framework Analysis

Shahzad, Syed Jawad Hussain and Ahmed, Tanveer and Rehman, Mobeen Ur and Zakaria, Muhammad

5 December 2014

Relationship between Developed, Emerging and South Asian Equity Markets: Empirical Evidence with a Multivariate Framework Analysis

Syed Jawad Hussain Shahzad
Lecturer, COMSATS Institute of Information Technology, Pakistan

Tanveer Ahmed
Lecturer, COMSATS Institute of Information Technology, Pakistan

Mobeen Ur Rehman
Lecturer, COMSATS Institute of Information Technology, Pakistan

Muhammad Zakaria
Assistant Professor, COMSATS Institute of Information Technology, Pakistan

Abstract

This study is the first effort to establish a short and long run relationship between developed (US-S&P500 index and UK-FTSE100 index), emerging (DJ TOXX 600) and South Asian (India, Pakistan and Sri Lanka) equity markets. Using the data from Jan 1998 to Dec 2013, this study have tested the unit properties of indexes returns in the presence of two structural breaks applying Clemente et al. (1998) detrended test. The Auto-regressive Bound Testing (ARDL) approach to cointegration is used to determine the cointegration relation. After cointegration is found between the stock markets of interest, Dynamic OLS (DLOS) cointegration equations are applied to estimate long run co-efficients. Short run relationship is determined through Vector Error Correction (VEC) based Granger causality, Impulse Response Function (IRF) and Variance Decomposition Analysis (VDA). Findings reveal that South Asian markets, developed and emerging markets are cointegrated. The impact of developed markets on emerging markets as well as South Asian markets is noted. Stock markets in South Asian countries are closely linked with each other and developed & emerging markets are interlinked. In short run, Indian and S&P500 index are not impacted by the other South Asian and emerging markets. However, FTSE100 index is closely linked with South Asian markets. S&P500 not only impacts emerging markets but also Granger cause South Asian stock market indexes. Correlation between South Asian regional markets have decreased with each other whereas, it have increased with developed and emerging stock markets over time. However, international diversification benefits of South Asian stock markets for potential foreign investors is still evident due to lower long and short run relationship with developed and emerging stock markets.

Key words: South Asia equity markets, Developed equity markets, Emerging equity markets, Market integration, ARDL, VECM Granger causality

Introduction

The flow of capital from one country to another country is beneficial for both the source and host country and a rapid growth in international investment have recently been observed. The reason behind this could be the relaxation of controls on foreign exchange transaction and capital movements, decrease in cost of information and transaction due to improvement in technology, and because of expansion in the multinational operations of major companies (listing of firm on multiple stock exchanges). The degree of integration will be lower between the countries stock exchange and world stock exchanges, in case of higher restrictions is imposed by the country on international capital flow. Most of the Asian countries have imposed restriction on foreign ownership, which in effect discourages the foreign investment.

The risk of a portfolio can be decreased by diversifying the portfolio internationally in sock markets which are not perfectly correlated and where the correlation structure is stable. This diversification advantage has led finance researchers to investigate whether international stock markets are interdependent or not? Higher interdependence among stock exchanges would suggest less diversification advantage for investors. However, an investor from outside the region would find it easier and justifiable to invest in an integrated regional stock exchange. The literature of finance suggests that segmented national capital markets are less efficient than integrated regional stock. Cointegration studies suggest that stock markets in south Asian countries are internationally integrated and thus South Asian markets have important diversification potential for investors.

In addition to stock investors, managers would need to evaluate capital investment in different countries. If capital markets are segmented then investment projects with similar risks must be treated differently. Cointegration among a set of variables (stock market indices), even if they are not stationary, implies these variables will never drift far apart. This means that there exists a long-run equilibrium relationship between the variables and the deviation from this relationship would be temporary. In addition to the diversification and integration, Engle and Yoo (1987) and Clements and Hendry (1995) have further identified the importance of investigating cointegration among international equity markets i.e. if there exist a cointegration then it would mean predictability of atleast one of the dependent variable in the set of cointegrated variables. The higher the cointegration between the set of variable implies that the higher predictable is the dependent variable. Additionally, a low level of comovements among national stock exchanges suggests that there is higher benefit for investors to diversify their portfolios internationally. Boubaker and Jouini (2014) suggest a relation between the returns of emerging capital markets stock indices.

Given the divergent conclusions[1] of the researches in this field, further investigation is required using the data from emerging markets. The data of emerging markets are different because of their lower correlation with the developed markets. Adding stocks from emerging markets to the portfolio of developed markets will be beneficial for the efficient diversification of portfolio (Ajayi & Mehdian, 1995; Bowman & Comer, 2000). The interdependence between stock markets also affects the response of regional stock markets to the common shocks affecting the markets within the region. Further, share market interdependence may be manifest in the presence of causal effects within South Asian share markets leading to the inference that the

[1]There are inconclusive empirical studies on the cointegration relationship between many emerging and developed markets. For details on the linkages between the stock markets see Colm Kearney & Brian M. Lucey (2004).

individual markets are inefficient, because economic theory suggests that cointegration or causal links are unlikely to be observed in efficient markets.

Under the hypothesis of cointegration, stock market movements have a tendency to trend together in the long-run even though experiencing short-run deviations from this common equilibrium path. Evidence of cointegration would suggest, that the stock markets under consideration have a long-run equilibrium relationship that prevents any one from getting too far out of line, at least for an extended period of time. In the present setting, if the national stock market indices are nonstationary and respond to common factors or trends, cointegration implies that equity markets' response to information is not contemporaneous to all stock exchanges; that is, stock market performance differences do not tend to persist. Therefore, this test is expected to identify the nature of stock market links between U.S., UK, emerging and three South Asian equity markets. We use monthly closing values of stock market indices for U.S., UK, DJ STOXX, India, Pakistan and Sri Lanka to determine if the latter three stock markets have a cointegrating structure with U.S., UK and emerging stock markets and within themselves. Finally, whether these linkages differ over the January 1998 to December 2013 time period. The purpose of this paper is to determine the extent of integration and interaction among these equity markets by using methodological procedures based on the recent developments in the theory of cointegration and error-correction analysis. Cointegration tests are important for several economic reasons. First, the SA equity markets are considered promising for regional portfolio diversification. Second, these markets are likely to be susceptible to the fluctuations of regional and international equity markets. Third, investors can benefit from investing in local and global markets, and stock exchange markets can be regulated by policy makers through the analysis of the linkage between CSEE stock markets and developed markets.

In the next section of the paper the concept of cointegration and methodology are described. The results are presented and discussed in Section 3. Concluding remarks are provided in the last section.

Author(s)	**Stock Markets**	**Years**	**Data Type**	**Methods**	**Findings**
Kasa (1991)	Germany, England, U.S., Japan, and Canada	Jan1974 - Aug1990	Monthly	ADF, JC	CE
Arshanapalli & Doukas (1993)	New York, Frankfurt, London, Japan, and Paris	Jan1980 - May1990	Daily	ADF, Cointegration analysis, ECM	I(I) CE, Mixed results
Arshanapalliet al. (1995)	Singapore, Malaysia, Hong Kong, Philippine, Japan, Thailand and U.S.	Jan 1986 - May 1992	Daily	PP, JC, ECM	I(I), CE=2, The integration between Asian and US market is more than that of Asian and Japan.
Richards (1995)	Morgan Stanley Capital International indices	Dec1969 - Dec 1994	Quarterly	JC, EG	little empirical evidence for CE
Janakiramanan & Lamba (1998)	Malaysia, U.S., Australia, New Zealand, Thailand, Hong Kong, Singapore, Indonesia and Japan.	1988 - 1996	Daily	ADF & KPSS VAR by Sims (1980)	I(O) Except for Indonesia, U.S. market has effect on all other markets. The highest influence of U.S. market is more on Australia.
Cha & Oh (2000)	Singapore, Hong Kong, U.S., Taiwan, Korea.	Jan 1980 - Sep 1998	Weekly	DF, ADF VAR ARCH VDA	I(I) Singapore and Hong Kong markets are significantly impacted by U.S.
Chen et al., (2000)	Maxico, Chile, Venezuela, Argentina, Colombia and Brazil.	Feb 1995 - Jun 2000	Daily	ADF & PP JC,ECM	I(I) CE
Huang et al., (2000)	United States, Japan and the South China	Oct 1992 - Jun1997	Daily	Zivot and Andrews (1992) GH,, GC	I(I) Shanghai & Shenzhen CE US →SCGT Shanghai ↔Shenzhen
Masih & Masih (2001)	OECD, Asia, U.S., UK	Jan 1982 - Jun 1994	Monthly	ADF, JC, VECM TY levels VAR	I(I), CE US, Japan and UK weakly

					exogenous
Dekker et al., (2001)	10 Asia Pacific countries	Jan 1987 - May 1998	Daily	Perron Unrestricted VAR Sims (1980) VDC & IRF	Strong linkages
Jang & Sul (2001)	Korea, Japan, Taiwan, Hong Kong, Singapore, Thailand, Indonesia	Oct 1996 - Sep 1998	Daily	GC ADF Cointegration	Unidirectional and bi-directional relationship
Manning (2002)	Thailand, Philippines, Hong Kong, Japan, Malaysia, U.S., Korea, Singapore and Indonesia.	Jan 1988 - Feb 1999	Weekly Quarterly	PP, ADF Johansenmaximum likelihood approach	I(I) except Taiwan Minimum two common trends in these data indicating partial convergence of the indices
Ratanapakorn & Sharma (2002)	US,Europe, Asia, Latin America, Eastern Europe	Jan1990 - Mar 2000	Daily	DF, ADF, PP JC, GC, VDA, IRF	I(I) No CE European ↔US
Chan Leong & Felmingham (2003)	Singapore, Korea, Japanese, Taiwan and HangSeng	Jul1990 - Jul 2000	Daily	ADF & PP MC&VECM	I(O) & I(I) CE
Besslera & Yang (2003)	U.S., U.K., Japan, France, Canada, Australia, Germany and Switzerland.	Jun 1997 - Jun 1999	Daily	VAR, ECM and directed acyclic graphs (DAG)	The only market having long term and strong impact on other markets is that of U.S.
Yanget al., (2003)	U.S., Malaysia, Japan, Hong Kong, Thailand, India, Korea, Pakistan, Taiwan, and Malaysia.	Jan 1995 - May 2001	Daily	VAR ECM	The US substantially influenced the Asianmarkets but was almost unaffected by the Asian markets. Philippines, Japan and Taiwan are isolated markets
Voronkova (2004)	CzechRepublic, Hungary, Poland, UK, France,	Sep1993 - Apr 2002	Daily	ADF, PP, KPSS, Zivot and Andrews (1992)	I(I) CE

	Germany, and the United States			Structural Break, JC, GC, FMOLS	
Click & Plummer (2004)	Indonesia, Malaysia, Philippines, Singapore, and Thailand	Jul 1998 - Dec 2002	Daily	ADF & PP VAR cointegration	I(I) Only one CE
Cerny (2004)	U.S, London, Frankfurt, Paris, Warsaw, and Prague	Jun2003 - Feb 2004	5 minute interval	JC, GC	U.S.→London U.S.→Frankfurt Frankfurt →Paris
Aggarwal & Kyaw (2005)	US, Canada, and Mexico	Jan 1988 - Dec 2001	Daily, Weekly, & Monthly	PP, ADF, KPSS JJ	I(I) CE
Gilmore et al., (2005)	Czech, Hungarian, Polish, German, UK	Jul1995 - Feb 2005	Daily	Hansen and Johansen (1992) recursive cointegration method, the Haldane-Hall (1991) Kalman filter technique	Little evidence of a fairly steady progress toward the integration of the CE equity markets with those of the UK and Germany
Cappiello et al., (2006)	Latvia, Slovenia, Cyprus, Hungary, Poland, Estonia, and Czech Republic.	1994 - 2005	Daily	Movements and regression analysis	CE
Ciner (2006)	US, Canada and Mexico	Jan 1994 - and 17 November 2004	Daily, Weekly	ADF, PP, KPSS JC	I(I) Co-movement is due to IT industry boom
Egert & Kocenda (2006)	Central and Eastern Europe(BUX, PX-50, WIG-20) Western European (DAX, CAC, UKX)	Mid2003 - Early 2005	5-min tick intraday price	JC, GC	No CE No Causality
Li & Majerowska	Poland, Hungary,	Jan 1998 -	Daily	GARCH-BEKK Model	Markets are interlinked.

(2007)	Germany, U.S.	Dec 2005			
Lim, Brooks & Kim (2008)	Singapore, Korea, Philippines, Taiwan, Hong Kong, Malaysia, Indonesia and Thailand.	Jan 1992 – Dec 2005	Daily	Rolling bi-correlation test	Interdependence during crises
Diamandis (2008)	Argentinean, Brazilian, Chilean, Mexican and US	Jan 1988 - Jul 2006	Weekly	VAR	CE
Hooi Lean & Ghosh (2009)	Malaysia, China, India, U.S., Japan	Jan 1991 - Dec 2007	Daily	JJ, GH, TY&GC	The integration of Malaysia is more with China and India as compared to Japan and U.S.
Khan & Park (2009)	Thailand, Malaysia, Korea, Indonesia, Philippines, S&P500, FTSE100, and Japan	Jan 1994 - Dec 1999	Monthly	Time-varying correlation coefficients	Significant increase of residual correlations in the crisis period.
Huyghebaert & Wang (2010)	S. Korea, Hong Kong, Shanghai, Singapore, Shenzhen and U.S.	1992 - 2003	Daily	ADF, PP, JC GC, IRF	I(I) No cointegration and mixed results
Yu, Fung & Tam (2010)	S. Korea, China, Indonesia, U.S. Hong Kong, Japan, Taiwan, Malaysia and Thailand.	Mar 1994 - Dec 2008	-	PP DCA	I(0) Mixed results
Lahrech & Sylwester (2011)	Argentina, Brazil, Chile, Mexico, US	Dec 1988 - Mar 2004	Weekly	DCC multivariate GARCH model	High degree of co-movements
Demian (2011)	Hungary, Poland, the Czech Republic,Slovakia, Baltic states (Estonia) and Eastern Europe states (Romania)	Jan2001 - May2009	Daily	ADF VAR-MC,ECM, GC, IRF	I(I) CE

	Germany, France, UK and Italy				
Boubaker & Jouini (2014)	US, DJ STOXX, CSEE	Oct 2000 - Sep 2012	Monthly	Panel Stationarity test, Panel cointegration tests, PMG	I(I), CE SP500 ↔ DJ STOXX DJ STOXX ↔ CSEE CSEE ↔ S&P500
Note: → and ↔ represent unidirectional causality& bidirectional causality, respectively. I(0) and (I) indicate stationarity at level and first difference, respectively. Abbreviations are defined as follows: DF= Dickey Fuller; ADF= Augmented Dickey Fuller; PP = Phillip Perron; CE = Cointegration exists; JC = Johanson Cointegration; MC = Multivariate Cointegration; GH = Gregory and Hansen (1996); TY = Toda-Yamamoto; GC = Granger Causality; VAR = Vector Autoregressive Model; ARDL = Autoregressive Distributed Lagged; EG = Engle-Granger Cointegration; ECM = Error Correction Model; VECM = Vector Error Correction Model; VDA = Variance Decomposition Analysis; IRF = Impulse Response Function; GARCH = Generalized Auto-Regressive Conditional Heteroskedasticity; DCA = Dynamic Cointegration Analysis; JJ = Johansen and Juselius (1990);					

Methodology

Unit Root Testing

Baum (2004) argues that traditional test of unit root (ADF - Dickey and Fuller (1979); DF-GLS - Elliot et al., (1996); Ng–Perron-Ng and Perron (2001)) are unable to deal with the time series with structural breaks and hence may result in biased conclusions. These tests in the presence of structural breaks can wrongly fail to reject the null hypothesis i.e. unit root exists. Clemente et al., (1998) is considered appropriate for stationarity testing when the data has one or more structural break. Null and alternative hypothesis of Clemente et al., (1998) unit root test for two structural breaks is presented below:

$$H_0:\ y_t = y_{t-1} + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + u_t \qquad (1)$$

$$H_1:\ y_t = u\ + d_1 DU_{1t} + d_2 DTB_{2t} + e_t \qquad (2)$$

In eq. 1 & 2 DTB_{it} presents the pulse variable which takes the value 1 if t = TB_1+1(I =1, 2) and 0 otherwise. Further, DU_{it}=1 if$t > TB_i$ (i=1, 2) and 0 otherwise. The time periods when a mean is modified is indicated through TB and TB (Clemente et al., 1998). In case the innovational outlier cause the structural breaks in time series, following model can be estimated to describe the unit root hypothesis:

$$y_t = \mu + \rho y_{t-1} + \delta_1 DTB_{1t} + \delta_2 DTB_{2t} + d_1 DU_{1t} + d_2 DU_{2t} + \sum_{i=1}^{N} c_i \Delta y_{t-i} + e_t \qquad (3)$$

A two-step procedure is adopted when the shift in mean is assumed to be caused by the additive outliers. To testing the null hypothesis of unit root, the deterministic part of the variable is first removed through the estimationof following model:

$$y_t = \mu + d_1 DU_{1t} + d_2 DU_{2t} + \tilde{y}_t \qquad (4)$$

and, test of unit root is applied by searching for the minimal t-ratio for thenull hypothesis inthe following model:

$$\tilde{y}_t = \sum_{i=1}^{N} \omega_{1i} DTB_{1t-1} + \sum_{i=1}^{N} \omega_{2i} DTB_{2t-1} + \rho \tilde{y}_{t-1} + \sum_{i=1}^{N} c_i \Delta \tilde{y}_{t-i} + e_t \qquad (5)$$

Cointegration Analysis

The Autoregressive Distributed Lag (ARDL) approach of Pesaran et al., (2001) is used to ascertain the long term relationship between selected stock markets. The method has several econometric advantages compared to traditional test of cointegration. It can be applied regardless of the order of integration of the variables and assumes all variables are endogenous[2]. To investigate relationships among stock indices across geographical regions, the following model is analyzed:

$$W = (P, I, S, SP, F, Dj)'$$

---

[2] However, none of the time series should be $I(2)$ as the calculated F statistics cannot determine cointegration in this case. We have applied ADF, DF-GLS and Ng–Perronunit root tests to ensure that no variable is integrated at $I(2)$.

Where P presents Pakistan (Karachi Stock Exchange-100 index), I for India (Bombay Sensex Index), S for Sri Lanka (Colombo CSE All Share Index), SP for S&P500 index, F for FTSE-100 index (F) and Dj presents DJ TOXX. An ARDL representation can be formulated as follows:

$$\Delta P_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 I_{t-1} + \alpha_3 S_{t-1} + \alpha_4 SP_{t-1} + \alpha_5 F_{t-1} + \alpha_6 Dj_{t-1} + \sum_{i=0}^{p} \theta_i \Delta P_{t-i} + \sum_{j=0}^{q} \theta_j \Delta I_{t-j} + \sum_{k=0}^{r} \theta_k \Delta S_{t-k} + \sum_{l=0}^{s} \theta_l \Delta SP_{t-l} + \sum_{m=0}^{T} \theta_l \Delta F_{t-m} + \sum_{n=0}^{u} \theta_l \Delta Dj_{t-n} + \mu_t \quad (6)$$

$$\Delta I_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 I_{t-1} + \alpha_3 S_{t-1} + \alpha_4 SP_{t-1} + \alpha_5 F_{t-1} + \alpha_6 Dj_{t-1} + \sum_{i=0}^{p} \theta_i \Delta I_{t-i} + \sum_{j=0}^{q} \theta_j \Delta P_{t-j} + \sum_{k=0}^{r} \theta_k \Delta S_{t-k} + \sum_{l=0}^{s} \theta_l \Delta SP_{t-l} + \sum_{m=0}^{T} \theta_l \Delta F_{t-m} + \sum_{n=0}^{u} \theta_l \Delta Dj_{t-n} + \mu_t \quad (7)$$

$$\Delta S_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 I_{t-1} + \alpha_3 S_{t-1} + \alpha_4 SP_{t-1} + \alpha_5 F_{t-1} + \alpha_6 Dj_{t-1} + \sum_{i=0}^{p} \theta_i \Delta S_{t-i} + \sum_{j=0}^{q} \theta_j \Delta P_{t-j} + \sum_{k=0}^{r} \theta_k \Delta I_{t-k} + \sum_{l=0}^{s} \theta_l \Delta SP_{t-l} + \sum_{m=0}^{T} \theta_l \Delta F_{t-m} + \sum_{n=0}^{u} \theta_l \Delta Dj_{t-n} + \mu_t \quad (8)$$

$$\Delta SP_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 I_{t-1} + \alpha_3 S_{t-1} + \alpha_4 SP_{t-1} + \alpha_5 F_{t-1} + \alpha_6 Dj_{t-1} + \sum_{i=0}^{p} \theta_i \Delta SP_{t-i} + \sum_{j=0}^{q} \theta_j \Delta P_{t-j} + \sum_{k=0}^{r} \theta_k \Delta I_{t-k} + \sum_{l=0}^{s} \theta_l \Delta S_{t-l} + \sum_{m=0}^{T} \theta_l \Delta F_{t-m} + \sum_{n=0}^{u} \theta_l \Delta Dj_{t-n} + \mu_t \quad (9)$$

$$\Delta F_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 I_{t-1} + \alpha_3 S_{t-1} + \alpha_4 SP_{t-1} + \alpha_5 F_{t-1} + \alpha_6 Dj_{t-1} + \sum_{i=0}^{p} \theta_i \Delta F_{t-i} + \sum_{j=0}^{q} \theta_j \Delta P_{t-j} + \sum_{k=0}^{r} \theta_k \Delta I_{t-k} + \sum_{l=0}^{s} \theta_l \Delta S_{t-l} + \sum_{m=0}^{T} \theta_l \Delta SP_{t-m} + \sum_{n=0}^{u} \theta_l \Delta Dj_{t-n} + \mu_t \quad (10)$$

$$\Delta Dj_t = \alpha_0 + \alpha_1 P_{t-1} + \alpha_2 I_{t-1} + \alpha_3 S_{t-1} + \alpha_4 SP_{t-1} + \alpha_5 F_{t-1} + \alpha_6 Dj_{t-1} + \sum_{i=0}^{p} \theta_i \Delta Dj_{t-i} + \sum_{j=0}^{q} \theta_j \Delta P_{t-j} + \sum_{k=0}^{r} \theta_k \Delta I_{t-k} + \sum_{l=0}^{s} \theta_l \Delta S_{t-l} + \sum_{m=0}^{T} \theta_l \Delta SP_{t-m} + \sum_{n=0}^{u} \theta_l \Delta F_{t-n} + \mu_t \quad (11)$$

The cointegration between the variables is tested by using the critical bound values of Narayan (2005). The F or Wald test statistics, which is a joint significance test of the null hypothesis i.e. no cointegration is tested against the alternative hypothesis, meaning there is cointegration, for equations (6) to (11). $H_0 : \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$ (No cointegration). The respective alternative hypotheses are:
$H_1 :$ $atleast\ one\ of\ the\ \alpha's\ is\ not\ equal\ to\ Zero$ (Cointegration exists).

The null hypothesis of no cointegration is rejected if the F-statistic is higher than upper critical bound values. If the calculated F statistics are below the lower critical bound values then the null cannot be rejected. Results of bound testing are inconclusive if calculated values are between lower and upper critical value band.

If the cointegration is present among the variables, we can apply OLS, Fully Modified OLS (FMOLS) or Dynamic OLS (DOLS) models to obtain long run estimates. FMOLS and DOLS provide better results in comparison to OLS (Chen et al., 1999).However, FMOLS also suppers from a small sample bias (Kao & Chiang, 2000) and DOLS estimator can outperform the FMOLS estimators. Considering the above conclusions, we will estimate the long run coefficients through DOLS estimators.

3.3.2. The Dynamic OLS (DOLS) estimator

DOLS estimator applies parametric adjustment to the errors through the inclusion of past and future values of the differenced I(1) regressors. This parametric adjustment makes estimators unbiased and also corrects the endogeneity. Following model is used to obtain the Dynamic OLS estimator:

$$Y_{it} = \alpha_i + X_{it}^{'}\beta + \sum_{j=-q_1}^{j=q_2} C_{ij}\,\Delta X_{it+j} + v_{it}, \qquad (12)$$

Where X indicates all explanatory variables included in the model and C_{ij} presents the coefficient of a lead or lag of first differenced independent variables. Following is the coefficient of DOLS estimators:

$$\hat{\beta}_{DOLS} = \sum_{i=1}^{N}\left(\sum_{t=1}^{T} z_{it} z_{it}^{'}\right)^{-1}\left(\sum_{t=1}^{T} z_{ij}\,\hat{y}_{it}^{+}\right), \qquad (13)$$

Wherez_{it}= [X_{it}- $\bar{X}_i$, $\Delta X_{i,t-q}$, ... $\Delta X_{i,t+q}$] is vector of regressors, and $\hat{y}_{it}^{+}$($\hat{y}_{it}^{+}$= $y_{it} - \bar{y}_i$) is the dependent variable.

3.2. Causality Analysis

The ARDL bound testing approach only provide the information of cointegration and cannot determine the presence or absence of causality and hence no decision on direction of causality can be made. After confirmation of long run relationship, the direction of short and long run causality can be examined through Granger causality test. The Granger causality test regression models in VECM format can be expressed as follows:

$$\begin{bmatrix} \Delta P_t \\ \Delta I_t \\ \Delta S_t \\ \Delta SP_t \\ \Delta F_t \\ \Delta Dj_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} \beta_{11i}, \beta_{12i}, \beta_{13i}, \beta_{14i}, \beta_{15i}, \beta_{16i} \\ \beta_{21i}, \beta_{22i}, \beta_{23i}, \beta_{24i}, \beta_{25i}, \beta_{26i} \\ \beta_{31i}, \beta_{32i}, \beta_{33i}, \beta_{34i}, \beta_{35i}, \beta_{36i} \\ \beta_{41i}, \beta_{42i}, \beta_{43i}, \beta_{44i}, \beta_{45i}, \beta_{46i} \\ \beta_{51i}, \beta_{52i}, \beta_{53i}, \beta_{54i}, \beta_{55i}, \beta_{56i} \\ \beta_{61i}, \beta_{62i}, \beta_{63i}, \beta_{64i}, \beta_{65i}, \beta_{66i} \end{bmatrix} \times \begin{bmatrix} \Delta P_{t-1} \\ \Delta I_{t-1} \\ \Delta S_{t-1} + \\ \Delta SP_{t-1} \\ \Delta F_{t-1} \\ \Delta Dj_{t-1} \end{bmatrix} \begin{bmatrix} \delta_1 \\ \delta_2 \\ \delta_3 \\ \delta_4 \\ \delta_5 \\ \delta_6 \end{bmatrix} \times (ECM)_{t-1} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \\ \mu_{6t} \end{bmatrix} \qquad (14)$$

Where ECT is error correction term and $\mu's$ are error terms which are assumed to be uncorrelated. $\delta's$ are the coefficients of error correction terms and denote speed of adjustment of

ΔP_t, ΔI_t, ΔS_t, ΔSP_t, ΔF_t and ΔDj_t, towards long run equilibrium. Whereas the coefficients on ΔP_{t-1}, ΔI_{t-1}, ΔS_{t-1}, ΔSP_{t-1}, ΔF_{t-1} and ΔDj_{t-1}, are expected to capture the short run dynamics of the model. In fact, error correction term introduces additional channels through which causality could emerge and equilibrium could be re-established in the events of shocks to P, I, S, SP, F and Dj. Through the ECT, VECM opens up an additional channel for Granger causality to emerge. The VECM approach also distinguishes between short run and long run Granger causality. The short run causality is determined by the significance of combined F statistics of differenced explanatory variables coefficients. Whereas the long run causality is implied by the significance of the lagged error correction term(s) as it is obtained through the long run cointegrating relationship(s).

4. Data and Findings

This paper is an empirical analysis of the short and long-run relationship between the South Asian stock markets (Pakistan, India and Sri lanka), the Standard & Poor's (S&P)500 - benchmark of US equity, Financial Times Stock Exchange (FTSE) 100- benchmark of UK equity and Dow Jones (DJ) Stoxx Europe 600-benchmark for European equity markets indices. Monthly data from January 1998 to December 2013 for the South Asian equity markets and S&P500 index is from Econ Stat and the data for DJStoxx Europe 600 index is from STOXX.com database. The data spans over a long time period and hence believed to capture the historical as well as recent international events. Time trend of the stock markets using natural log of price series is shown in Fig. 1. The plot indicates potential long-run relations between the stock markets. It also shows a sharp decrease in the indexes value at the end of 2001 and in late 2008, an indication of global financial crisis. The potential long run relationship and sudden decrease in prices in response to a shock motivates us to further examine the causal linkages between stock markets.

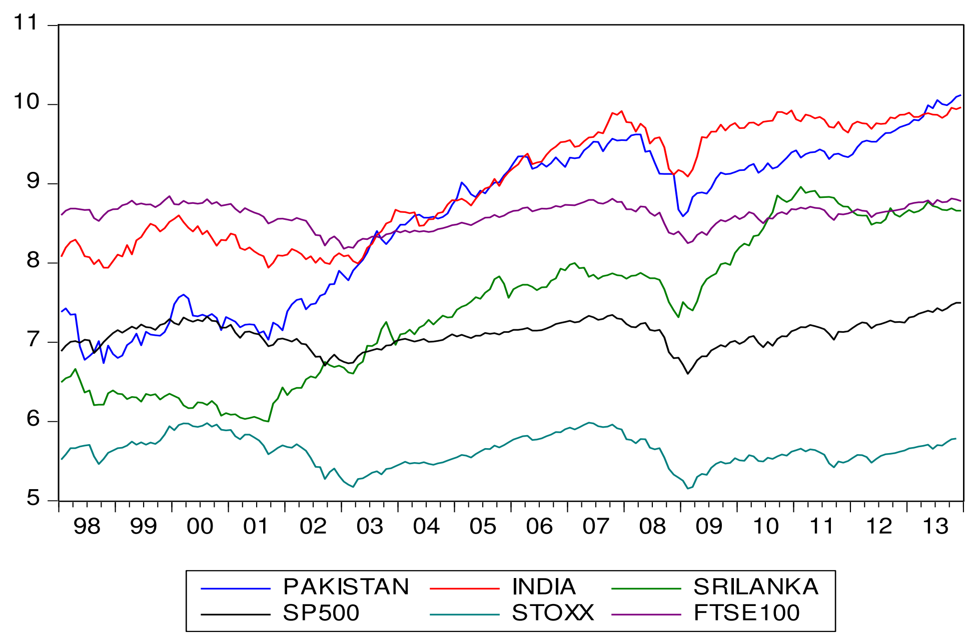

Fig 1: Trend of stock markets over time

Table 1 presents a summary descriptive statistics of the return series used in the analysis for preliminary information about their linkages. For the South Asian countries, the average equity index returns range from 1.8% for Pakistan to 1.199% for India with lower risk since its standard deviation is equal to 7.4%. The FTSE-100 index has the lowest average return compared to all other indices. The DJ Stoxx Europe 600 index behaves similarly to FTSE equity index in terms of average values. In terms of risk, mature equity markets are less risky than the South Asian stock markets (lower standard deviations), which implies that investing in developed markets is safer. The skewness coefficient is negative except for Sri Lanka, and the kurtosis coefficient is almost 3 except Pakistan. The normality hypothesis is not rejected for only one market. The time series data was divided into three sub periods based on the 2001 and 2008 financial crises evident through figure 1; 1998-2001, 2002-2008 and 2009-2013 for correlation analysis of the stock market indexes. The analysis reveals that degree of association between South Asian equity markets have decreased and increased with developed and emerging equity markets over time. However, the relationship between developed and emerging equity markets have remained unchanged over three sample periods.

Table 1: Descriptive statistics and correlation analysis of the equity market returns (January 1998 – December 2013)

	Pakistan	India	Srilanka	S&P 500	FTSE 100	DJ STOXX
Mean	1.807	1.199	1.377	0.430	0.213	0.292
Maximum	27.267	28.255	25.260	10.772	8.654	13.470
Minimum	-36.160	-23.890	-16.820	-16.827	-13.024	-14.134
Std. Dev.	9.092	7.476	7.519	4.608	4.192	4.757
Skewness	-0.534	-0.101	0.434	-0.624	-0.585	-0.570
Kurtosis	5.574	3.669	3.746	3.869	3.380	3.731
Jarque-Bera	62.165*	3.911	10.497*	18.540*	12.142*	14.691*
Correlation Metrix (all Sample)						
Pakistan	1					
India	0.279	1				
Srilanka	0.155	0.267	1			
S&P500	0.138	0.486	0.196	1		
FTSE100	0.129	0.446	0.167	0.850	1	
DJ STOXX	0.166	0.465	0.236	0.832	0.896	1
Correlation Metrix (1998-2001)						
Pakistan	1					
India	0.3689	1				
Srilanka	0.5043	0.3342	1			
S&P 500	0.0204	0.2780	0.2317	1		
FTSE 100	-0.0353	0.1030	0.2584	0.8055	1	
DJ STOXX	0.0135	0.1909	0.2638	0.7453	0.8716	1
Correlation Metrix (2002-2008)						
Pakistan	1					
India	0.2000	1				
Srilanka	0.0350	0.1806	1			
S&P 500	0.1112	0.6059	0.1919	1		

FTSE 100	0.1239	0.5913	0.0733	0.8552	1	
DJ STOXX	0.2211	0.6084	0.2032	0.9004	0.9158	1
Correlation Metrix (2009-2013)						
PAKISTAN	1					
INDIA	0.2902	1				
SRILANKA	-0.1205	0.3361	1			
SP500	0.4528	0.5854	0.1612	1		
FTSE100	0.4512	0.5738	0.2099	0.8923	1	
DJ STOXX	0.4107	0.5839	0.2513	0.8401	0.9019	1

Note: * indicates significance at 1% level.

Tables2 reports the results of Clemente–Montanes–Reyes detrended unit root test with two structural breaks[3]. Results indicate presence of two structural breaks. Pakistan, SP500, FTSE and DJ TOXX indices are integrated of order one i.e. *I*(I) whereas Indian and Sri Lankan are stationary at level i.e. it is integrated of order one, *I*(0). Since all series do not have same level of integration, we will apply ARDL technique to find long run cointegration relationship among variables.

Table 2: Clemente–Montanes–Reyes Unit Root Test with two Structural Break

	Innovation Outlier (IO)			Additive Outlier (AO)			Decision
Series	t-statistic	T_{B1}	T_{B2}	t-statistic	T_{B1}	T_{B2}	
P_t	-14.617**	123	134	-4.871	122	130	I (I)
ΔP_t	-9.481**	131	136	-9.836**	44	133	
I_t	-14.557**	117	136	-10.169**	116	135	I (0)
S_t	-7.070**	131	152	-10.327**	133	151	I (0)
SP_t	-11.965**	127	133	-5.070	127	132	I (I)
ΔSP_t	-6.796**	129	137	-8.741**	128	136	
F_t	-7.055**	23	56	-4.959	122	132	I (I)
ΔF_t	-6.731**	123	131	-9.102**	122	130	
DJ_t	-5.350	117	133	-3.881	116	132	I (I)
ΔDJ_t	-10.247**	63	135	-8.003**	56	62	

Note: **indicates significance at 5% level.

To ascertain the existence of a long run cointegrating relationship among South Asian, developed and emerging stock market indexes, the bounds testing approach is applied. Moreover, the selection of lag length should be performed carefully because an inappropriate lag length may lead to biased results and is not acceptable for policy analysis. Therefore, to ensure that the lag length was selected appropriately, we used the Akaike information criteria (AIC). The order of lags on the first differenced variables is obtained from unrestricted vector autoregressive (VAR). Based on Akaike information criterion (AIC), optimal lag length 1 is selected for causality analysis (Table 3).

[3] The results report presence of two structural breaks in the time series data therefore, we have not reported the results obtained through Clemente–Montanes–Reyes detrended unit root test with one structural break

Table 3: VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3203.862	NA	57227275	34.889	34.994*	34.932*
1	-3166.893	71.12467	56640283*	34.879*	35.613	35.176
2	-3139.420	51.06341	62215418	34.971	36.334	35.524
3	-3114.221	45.19483	70176732	35.089	37.081	35.896
8	-2992.991	55.44505*	1.43e+08	35.728	40.865	37.810

Note: * indicates lag order selected by the criterion

After determining the optimal lag length, we have applied F-statistics to check the existence of long run cointegration among variables[4]. Table 4 provides the F-statistic results. Since the computed F-statistics exceeds the upper critical bounds value, null hypothesis of no cointegration is rejected. We may therefore conclude that there exists long run cointegrating relationship among the variables. F statistics value are 15.780, 14.684, 16.853, 18.327, 18.760 and 13.671 when Pakistan, India, Sri Lanka, SP500, FTSE100 and DJ TOXX indexes are considered as dependent variables (Eq. 6 to 11) respectively. The F statistics are significant at 1% level because it is higher than the upper critical bounds of Narayan (2005).

All six cointegration vectors are significant which indicate the presence of long term relationship between South Asian, developed and emerging stock markets. The authenticity of the long run equations is determined by applying various diagnostic test. All diagnostic tests reject their respective null at 10% significance level and hence conclude that none of the assumptions of Classical Linear Regression Model (CLRM) is violated. Model specification is tested through Ramsey RESET test which indicatesthat models are appropriately specified. Pesaran and Shin (1999) argued that the stability of long and short run estimates can be examined through CUSUM and CUSUMsq tests. Fig. 2 and 3 show the graphs of both CUSUM and CUSUMsq, respectively. Plots of CUSUM and CUSUMsq indicate that results are between critical boundaries at 5% level of significance which confirms that long and short run parameters are accurate and stable. Moreover, these test also infer that the ARDL model is stable for structural breaks.

[4]Data was first tested for cointegration during three sub periods of 1998-2001, 2002-2008 and 2009-2103. There was no cointegration between the indices pre-2001 crises (F statistics values are 3.706, 3.236, 3.116, 4.869, 4.770, and 2.736. However, during 2002 to 2008 markets started integrating with the F static values 7.984*, 5.586*, 7.771*, 5.490*, 6.006* & 4.351. F statistics for the sub period of 2009 onwards are 7.253*, 6.458*, 4.170, 7.392*, 6.279*, 5.766*.

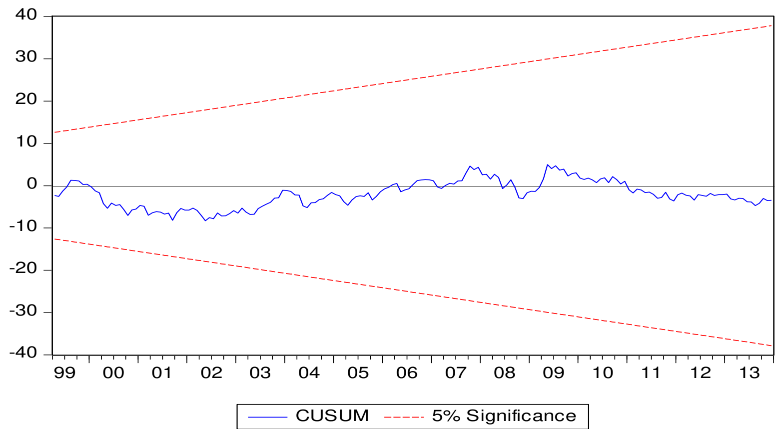

Fig.2. Plot of cumulative sum of recursive residuals

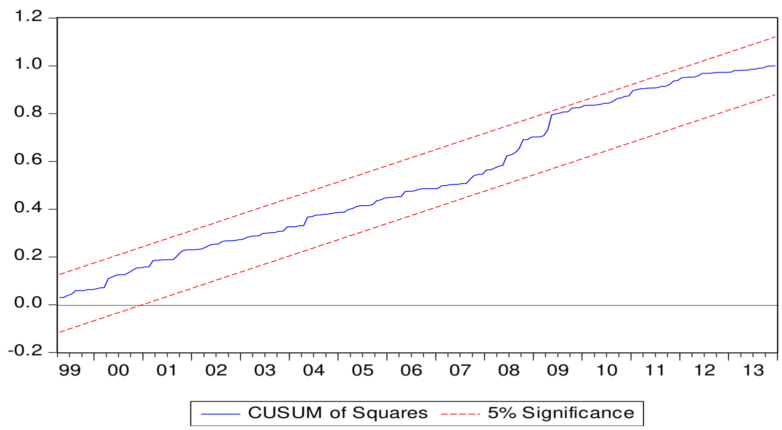

Fig.3. Plot of cumulative sum of squares of recursive residuals

Table 4: Bound Test for Cointegration (1998 – 2013)

Estimated Models	FStatistics	R Square	Diagnostic Tests F-statistics	χ^2Normal	χ^2Serial	χ^2ARCH	χ^2RAMSEY
$Eq.6;\ P_t = f(I_t, S_t, SP_t, F_t, DJ_t)$	15.780*	0.538	17.186*	3.433	0.172(0.829)	2.439 (0.118)	1.436 (0.232)
$Eq.7;\ I_t = f(P_t, S_t, SP_t, F_t, DJ_t)$	14.684*	0.512	15.517*	0.915	0.239 (0.772)	2.315 (0.128)	1.060 (0.304)
$Eq.8;\ S_t = f(P_t, I_t, SP_t, F_t, DJ_t)$	16.853*	0.514	15.636*	2.001	0.231 (0.777)	0.362 (0.545)	0.003 (0.984)
$Eq.9;\ SP_t = f(P_t, I_t, S_t, F_t, DJ_t)$	18.327*	0.494	14.455*	9.847*	0.441 (0.620)	3.785 (0.052)	1.214 (0.271)
$Eq.10;\ F_t = f(P_t, I_t, S_t, SP_t, DJ_t)$	18.760*	0.529	16.615*	14.947*	0.804 (0.420)	4.381 (0.037)	0.033 (0.855)
$Eq.11;\ Dj_t = f(P_t, I_t, S_t, SP_t, F_t)$	13.671*	0.444	11.79225	9.956*	2.822 (0.051)	2.898 (0.089)	0.549 (0.459)

Critical values (lower and upper bound) of the F statistics: intercept and no trend

Tabulated F Statistics (T=80, K=6)

	I(0)	*I(I)*
90% level	2.657	3.776
95% level	3.077	4.284
99% level	4.000	5.397

Note: * indicates that F-statistic falls above the 1%upper bound. Reported critical values are from Narayan (2005).

Tables 6 display the results of DOLS using all market indexes as the dependent variable turn by turn. Both Pakistani and Sri Lanka stock markets have a positive impact of Indian and FTSE100 index. Indian market is only impacted by the Sri Lankan stock returns. SP500 and emerging markets returns have no association with South Asian markets. A positive association exists between South Asian regional markets, which have also further link with the UK stock markets. A possible reason could be the increased listing of Indian and Pakistani firms in the UK stock exchange in the recent few years. Developed and emerging markets relationship can be found in last three columns of table 6. All three indexes are positively and significantly related with each other over the long time period. These findings are inline with a recent conclusion drawn by Sabri Boubaker and Jamel Jouini (2014). They state that developed and emerging markets are cointegrated and also have short run relationship with each other.

	Dependent Variable(s)					
Independent Variable(s)	Pakistan	India	Srilanka	S&P 500	FTSE 100	DJ STOXX
Pakistan	-	0.147 (1.326)	0.138 (0.970)	0.019 (0.504)	-0.025 (-0.925)	0.033 (0.883)
India	0.634* (3.399)	-	0.325*** (1.725)	0.014 (0.271)	0.010 (0.271)	0.045 (0.893)
Srilanka	-0.022 (-0.146)	0.345* (2.840)	-	0.010 (0.237)	0.015 (0.533)	-0.024 (-0.586)
S&P 500	0.453 (0.782)	0.243 (0.518)	-0.279 (-0.478)	-	0.372* (3.796)	0.391* (2.695)
FTSE 100	1.396*** (1.796)	0.341 (0.542)	1.322*** (1.698)	0.542* (2.901)	-	0.816* (4.733)
DJ STOXX	0.806 (1.440)	0.709 (1.582)	-0.602 (-1.072)	0.402* (2.807)	0.350* (3.917)	-
Constant	1.030*** (1.725)	0.237 (0.483)	0.774 (1.283)	0.157 (0.956)	-0.044 (-0.378)	-0.155 (-0.966)
R-squared	0.204	0.352	0.227	0.779	0.861	0.855

The VECM based Granger casualty is applied to examine the strength and direction of causality between stock market indexes of interest. The Granger causality concept presented here is purely in probabilistic terms and not the deterministic (Zellner, 1988). Results of both short and long run causality are reported in Table 7. We have followed Masih and Masih's (1996) interpretation of short run and long run causality in VECM approach. The significance of lagged ECT is determined through t statistics. Short run causality is determined by the significance of Wald test on sum of lags of independent variables in Eq. (14). The results indicate unidirectional causality from India and SP500 to Pakistan. Bidirectional causality exists between Pakistan and Sri Lanka. Unidirectional causality also flows from SP500 and FTSE to Sri Lanka. Pakistan, India, and SP500 impact FTSE100 and DJ TOXX in short run. FTSE100 and DJ TOXX also have a bidirectional short term relationship with each other. The convergence to long term equilibrium, as captured through significance of ECT term in VECM model, is highest -1.331 for FTSE100 index. The speed of convergence is lowestin case of Indian stock exchange i.e. -0.142. These results imply that response of South Asian stock markets' to information shocks is not contemporaneous with developed (S&P500) and emerging countries (DJ TOXX) and the overall performance of these markets is influenced by some common driving fundamental forces. South Asian markets have a long and short run regional relationship. Developed and emerging countries indexes and linked with each other.

Table 7: Vector Error Correction Model: Causality Analysis

	Short-run Causality						Long-run Causality
	P_t	I_t	S_t	SP_t	F_t	Dj_t	ECM_{t-1}
P_t	-	3.505**	5.973*	3.544**	1.721	1.881	-0.158**
		(0.030)	(0.002)	(0.028)	(0.1788)	(0.1524)	[-2.383]
I_t	0.398	-	0.486	0.651	2.234	2.059	-0.142**
	(0.671)		(0.614)	(0.521)	(0.107)	(0.127)	[-2.110]
S_t	6.079*	2.153	-	2.525***	3.934**	0.526	-0.204*
	(0.002)	(0.116)		(0.080)	(0.019)	(0.590)	[-3.484]
SP_t	2.224	1.044	0.820	-	1.777	0.934	-0.169
	(0.108)	(0.351)	(0.440)		(0.169)	(0.392)	[-1.370]
F_t	4.418**	7.207*	1.083	4.245*	-	2.370***	-1.331*
	(0.012)	(0.000)	(0.213)	(0.008)		(0.093)	[-4.490]
Dj_t	2.933***	3.293**	1.243	3.560**	2.842***	-	-0.202*
	(0.053)	(0.037)	(0.288)	(0.024)	(0.058)		[-2.706]

Note: *, ** and *** indicate that values are significance at 1%, 5% and 10% levels of significance respectively. P-values (F-statistics) are in (). Student t-statistics are in [].

Wolde-Rufael (2009) argued that results of Granger causality do not determine the relation beyond the observed time period and hence fails to capture the feedback effect between the variables. Thus Variance Decomposition Analysis (VDA) can be used to determine the direction and strength of causality. It also provides the information on feedback effect between the variables in future (Wolde-Rufael, 2009). Impulse Response Function (IRF) as an alternative to the VDA is also used to check the consistency of our findings. Results (Table 8) of VDA for six equations where Pakistan, India, Sri Lanka, U.S., UK and emerging markets index (DJ TOXX 600)are used as dependent variables are reported from top to down, respectively. All three South Asian stock markets are impacted by own innovative shocks in a quarterly time period framework. Developed and emerging market indexes significantly impact each other. Where S&P 500 index is mainly impacted by its own innovative shocks. FTSE100 index and DJ TOXX 600 are impacted by the U.S. market. S&P500 index explains 50% and 40% of FTSE100 and DJ TOXX600 indexes through its innovative shock. The findings of VDA confirm the findings of VECM granger causality analysis. Similar findings are also evident through Impulse response function (figure 4). Finally, there are six cointegration vectors between Pakistan, India, Sri Lanka, U.S., UK and DJ STOCC market indexes using monthly data from 1998 to 2013.

Table 8: Variance Decomposition Analysis

Variance Decomposition of Pakistan:							
Period	S.E.	Pakistan	India	Srilanka	S&P 500	FTSE 100	DJ TOXX
1	8.946	100.00	0.000	0.000	0.000	0.000	0.000
4	9.380	91.068	4.323	1.367	0.284	1.627	1.327
8	9.401	90.949	4.321	1.459	0.298	1.633	1.337
12	9.401	90.949	4.321	1.459	0.298	1.633	1.337
Variance Decomposition of India:							
1	7.327	6.640	93.359	0.000	0.000	0.000	0.000

4	7.647	8.879	86.137	2.130	1.165	0.620	1.067
8	7.658	9.003	85.951	2.146	1.176	0.653	1.068
12	7.658	9.003	85.950	2.146	1.176	0.653	1.068
Variance Decomposition of Srilanka:							
1	7.257	3.321	4.777	91.901	0.000	0.000	0.000
4	7.772	8.247	6.131	80.313	1.041	1.988	2.277
8	7.789	8.226	6.223	79.993	1.085	2.064	2.406
12	7.789	8.226	6.223	79.993	1.085	2.064	2.406
Variance Decomposition of S&P 500:							
1	4.523	1.534	19.004	0.357	79.103	0.000	0.000
4	4.754	6.778	17.598	1.552	72.968	0.170	0.932
8	4.760	6.828	17.652	1.558	72.805	0.180	0.974
12	4.760	6.829	17.652	1.558	72.804	0.180	0.974
Variance Decomposition of FTSE 100:							
1	4.125	1.861	18.660	0.276	52.562	26.638	0.000
4	4.307	4.219	17.416	0.989	50.375	25.272	1.727
8	4.310	4.236	17.430	0.990	50.322	25.245	1.775
12	4.310	4.236	17.430	0.990	50.322	25.245	1.775
Variance Decomposition of DJ TOXX:							
1	4.624	2.686	18.076	1.073	49.431	11.997	16.734
4	4.889	6.199	16.732	1.768	48.045	11.611	15.642
8	4.893	6.249	16.767	1.779	47.969	11.598	15.636
12	4.893	6.249	16.767	1.779	47.969	11.598	15.636

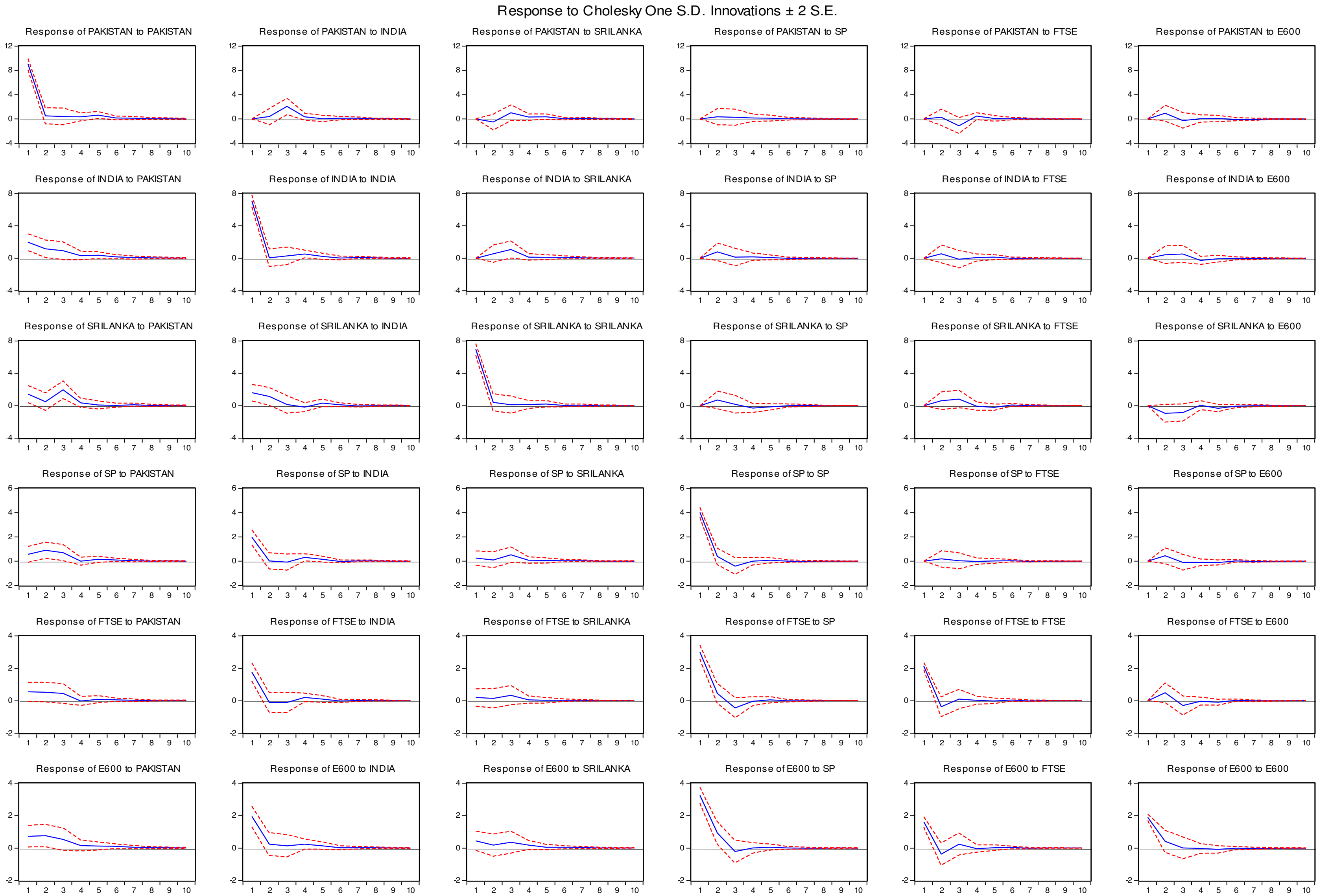

Fig.4. Impulse Response Function Analysis

Conclusion

Using Autoregressive Distributed Lag (ARDL) approach to cointegration (Pesaran et al., 2001) and performing Vector Error-Correction (VECM) Granger causality analysis, this paper is the first attempt to empirically examine the possible links and dynamic interactions between the U.S., UK, emerging and three South Asian stock markets. The data used in this study are monthly stock market index return time series. The sample consists of 192 observations and spans the period from January 1998 to December 2013. The empirical evidence favors the presence of a long-run equilibrium relationship between the U.S., UK, emerging and South Asian stock market movements. The cointegration results, based on the selected equity markets support the view of increased regional as well as international capital market integration.

The VECM, variance decomposition and impulse response analysis confirm the short and long run stock market linkage between U.S., UK, emerging and the South Asian markets. Indian and S&P500 index are not impacted by the other South Asian and emerging markets. However, FTSE100 index is closely linked with South Asian markets. S&P500 not only impacts emerging markets but also Granger cause South Asian stock market indexes. This higher interaction between S&P500 and DJ STOXX indexes appears to be consistent with a recent work on the interaction of developed and emerging stock markets (Boubaker&Jouini, 2014). Cointegration among the three South Asian stock markets implies that cross-exchange price movements are due to common factors or stochastic trends. Finally, we can conclude that there is less cointegration among South Asian,developed and emerging equity market exceptUK market.

Reference

Aggarwal, R., & Kyaw, N. A. (2005). Equity market integration in the NAFTA region: Evidence from unit root and cointegration tests. *International Review of Financial Analysis*, 14(4), 393-406.

Ajayi, R. A., & Mehdian, S. M. (1995). Global reaction of security prices to major US-induced surprises: an empirical investigation. *Applied Financial Economics*, 5(4), 203-218.

Arshanapalli, B., & Doukas, J. (1993). International stock market linkages: Evidence from the pre-and post-October 1987 period. *Journal of Banking & Finance*, 17(1), 193-208.

Arshanapalli, B., Doukas, J., & Lang, L. H. (1995). Pre and post-October 1987 stock market linkages between US and Asian markets. *Pacific-Basin Finance Journal*, 3(1), 57-73.

Baum, C.F., (2004). A review of Stata 8.1 and its time series capabilities. *International Journal of Forecasting*, 20(1), 151–161.

Bessler, D. A., & Yang, J. (2003). The structure of interdependence in international stock markets. *Journal of international money and finance*, 22(2), 261-287.

Boubaker, S., & Jouini, J. (2014). Linkages between emerging and developed equity markets: Empirical evidence in the PMG framework. *The North American Journal of Economics and Finance*, 29, 322-335.

Bowman, R. G., & Comer, M. R. (2000). *The reaction of world equity markets to the Asian economic crisis*. Working paper, University of Auckland.

Cappiello, L., Engle, R. F., & Sheppard, K. (2006). Asymmetric dynamics in the correlations of global equity and bond returns. *Journal of Financial econometrics*, 4(4), 537-572.

Cerny, A. (2004). Stock market integration and the speed of information transmission. Charles University. Center for Economic Research and Graduate Education.

Cha, B., & Oh, S. (2000). The relationship between developed equity markets and the Pacific Basin's emerging equity markets. *International Review of Economics & Finance*, 9(4), 299-322.

Chan Leong, S., & Felmingham, B. (2003). The interdependence of share markets in the developed economies of East Asia. *Pacific-Basin Finance Journal*, 11(2), 219-237.

Chen, B., McCoskey, S., & Kao, C., (1999). Estimation and inference of a cointegrated regression in panel data: a Monte Carlo study. *American Journal of Mathematical and Management Sciences*, 19, 75–114.

Chen, G. M., Firth, M., & MengRui, O. (2002). Stock market linkages: evidence from Latin America. *Journal of Banking & Finance*, 26(6), 1113-1141.

Ciner, C. (2006). A further look at linkages between NAFTA equity markets.*The Quarterly Review of Economics and Finance*, 46(3), 338-352.

Clemente, J., Montanes, A., & Reyes, M., (1998). Testing for a unit root in variables with a double change in the mean. *Economics Letters*, 59(2), 175–182.

Clements, M. P., & Hendry, D. F. (1995). Forecasting in cointegrated systems. *Journal of Applied Econometrics*, 10(2), 127-146.

Click, R. W., & Plummer, M. G. (2005). Stock market integration in ASEAN after the Asian financial crisis. *Journal of Asian Economics*, 16(1), 5-28.

Dekker, A., Sen, K., & Young, M. R. (2001). Equity market linkages in the Asia Pacific region: a comparison of the orthogonalised and generalised VAR approaches. *Global Finance Journal*, 12(1), 1-33.

Demian, C. V. (2011). Cointegration in Central and East European markets in light of EU accession. *Journal of International Financial Markets, Institutions and Money*, 21(1), 144-155.

Diamandis, P. F. (2008). Financial liberalization and changes in the dynamic behaviour of emerging market volatility: Evidence from four Latin American equity markets. *Research in International business and Finance*, 22(3), 362-377.

Dickey, D., & Fuller, W.A. (1979). Distribution of the estimates for autoregressive time series with unit root. *Journal of the American Statistical Association*, 74(366), 427–431.

Égert, B., & Kočenda, E. (2007). Interdependence between Eastern and Western European stock markets: Evidence from intraday data. *Economic Systems*, 31(2), 184-203.

Elliot, G., Rothenberg, T.J., & Stock, J.H. (1996). Efficient tests for an autoregressive unit root. *Econometrica*, 64(4), 813–836.

Engle, R. F., & Yoo, B. S. (1987). Forecasting and testing in co-integrated systems. *Journal of econometrics*, 35(1), 143-159.

Gilmore, C. G., McManus, G. M., & Tezel, A. (2005). Portfolio allocations and the emerging equity markets of Central Europe. *Journal of Multinational Financial Management*, 15(3), 287-300.

Hooi Lean, H., & Ghosh, B. N. (2010). Economic Integration in Asia: Quo Vadis Malaysia? *International Economic Journal*, 24(2), 237-248.

Huang, B. N., Yang, C. W., & Hu, J. W. S. (2000). Causality and cointegration of stock markets among the United States, Japan and the South China Growth Triangle. *International Review of Financial Analysis*, 9(3), 281-297.

Huyghebaert, N., & Wang, L. (2010). The co-movement of stock markets in East Asia: Did the 1997–1998 Asian financial crisis really strengthen stock market integration?. *China Economic Review*, 21(1), 98-112.

Janakiramanan, S., & Lamba, A. S. (1998). An empirical examination of linkages between Pacific-Basin stock markets. *Journal of International Financial Markets, Institutions and Money*, 8(2), 155-173.

Jang, H., & Sul, W. (2002). The Asian financial crisis and the co-movement of Asian stock markets. *Journal of Asian Economics*, 13(1), 94-104.

Kao, C., & Chiang, M.H. (2000). On the estimation and inference of a cointegrated regression in panel data. In: Baltagi, B. (Ed.), Nonstationary Panels, Panel Cointegration, and Dynamic Panels. *Advances in Econometrics*, 15. , JAI Press, Amsterdam, 161–178.

Kasa, K. (1992). Common stochastic trends in international stock markets. *Journal of Monetary Economics*, 29(1), 95-124.

Khan, S., & Park, K. W. K. (2009). Contagion in the stock markets: The Asian financial crisis revisited. *Journal of Asian Economics*, 20(5), 561-569.

Lahrech, A., & Sylwester, K. (2011). US and Latin American stock market linkages. *Journal of International Money and Finance*, 30(7), 1341-1357.

Li, H., & Majerowska, E. (2008). Testing stock market linkages for Poland and Hungary: A multivariate GARCH approach. *Research in International Business and Finance*, 22(3), 247-266.

Lim, K. P., Brooks, R. D., & Kim, J. H. (2008). Financial crisis and stock market efficiency: Empirical evidence from Asian countries. *International Review of Financial Analysis*, 17(3), 571-591.

Manning, N. (2002). Common trends and convergence? South East Asian equity markets, 1988–1999. *Journal of international Money and Finance*, 21(2), 183-202.

Masih, A. M., & Masih, R. (1996). Energy consumption, real income and temporal causality: results from a multi-country study based on cointegration and error-correction modelling techniques. *Energy Economics*, 18(3), 165-183.

Masih, R., & Masih, A. M. (2001). Long and short term dynamic causal transmission amongst international stock markets. *Journal of international Money and Finance*, 20(4), 563-587.

Narayan, P.K. (2005). The saving and investment nexus for China: evidence from cointegration tests. *Applied Economics*, 37(17), 1979–1990.

Ng, S., & Perron, P. (2001). Lag length selection and the construction of unit root test with good size and power. *Econometrica*, 69(6), 1519–1554.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3), 289–326.

Ratanapakorn, O., & Sharma, S. C. (2002). Interrelationships among regional stock indices. *Review of Financial Economics*, 11(2), 91-108.

Richards, A. J. (1995). Comovements in national stock market returns: Evidence of predictability, but not cointegration. *Journal of monetary Economics*, 36(3), 631-654.

Voronkova, S. (2004). Equity market integration in Central European emerging markets: A cointegration analysis with shifting regimes. *International Review of Financial Analysis*, 13(5), 633-647.

Yang, J., Kolari, J. W., & Min, I. (2003). Stock market integration and financial crises: the case of Asia. *Applied Financial Economics*, 13(7), 477-486.

Yu, I. W., Fung, K. P., & Tam, C. S. (2010). Assessing financial market integration in Asia–equity markets. *Journal of Banking & Finance*, 34(12), 2874-2885.

Zellner, A. (1988). Causality and causal laws in economics. *Journal of Econometrics*, 39, 7-21.