



STOCK MARKET CO-INTEGRATION AND VOLATILITY SPILLOVERS IN SOUTH AND EAST ASIA: DO INTERNATIONAL RELATIONS MATTER?

Sabeen Khurram Khan¹, *Muhammad Umer Quddoos², Humaira Kousar³, Arslan Ahmad Siddiqi⁴

¹Assistant Professor, Department of Management Sciences, COMSATS University, Islamabad, Pakistan.

²Associate Professor, Department of Commerce, Bahauddin Zakariya University, Multan, Punjab, Pakistan.

³Lecturer, Department of Management Sciences, COMSATS University, Islamabad, Pakistan.

⁴Chief Regional Officer, ConnecTech Private Limited, Islamabad, Pakistan.



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ABSTRACT

The main objective of this study is to examine the level of co-integration between Asian stock markets of China, India, Pakistan, and Sri Lanka. This study also investigates volatility spillover between the stock markets of the above-mentioned countries in the context of their foreign relations with each other. The question is multi-dimensional in its nature, but this study focuses only on the behavior of equity markets in investigating the research problem- whether volatility transmits among the selected Asian equity markets and from developed markets, namely, the USA, the UK, Japan, and Singapore, and whether the political relations among the states can cast influence upon trends and behavior of the stock markets of the countries. No pairwise long-run relationships appear to exist between above four Asian markets, and they are not co-integrated pairwise with the equity markets of the USA, UK, Japan, and Singapore. Therefore, fund managers of the US, UK, Singapore, and Japan can get the benefits of portfolio diversification by investing in Asian stock markets.

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*Corresponding Author's Email: umerattari@bzu.edu.pk || ORCID: <https://orcid.org/0000-0002-1498-6822>

INTRODUCTION

International portfolio diversification has long been advocated as an effective way to achieve higher risk-adjusted returns than domestic investment alone. One can safeguard one's investment from country-specific risks, but this diversification benefit depends crucially on the relative size, frequency, and persistence of idiosyncratic and common shocks (Jorion 1985).

Since returns on securities have less correlation with other countries than within a country, there is a weak correlation due to different economic, institutional, political, and even psychological factors. But these factors have to be studied in order to assess their impact on international diversification. This study also helps investors to examine and analyse the efficiency and reaction of the market to favorable and adverse local and international news.

International diversification has opened a new area of optimum Currency area, which discusses the interlinkage of economies for reviewing the suitability for creation of a monetary union, as discussed by Mundell (1961), Baele et al (2004), and Goetzmann *et al* (2002). Along with this issue, volatility transmission is very critical for policymakers and regulators. Authorities around the world have been collaborating with each other in order to reduce and minimize the effects of volatility transmission. Piesse and Hearn (2005),

Janakiraman and Lamba (1998), and Hamao et al. (1991) have argued in favor of collaboration between different countries as it reduces the risk and increases the investment opportunities, resulting in the prosperity of the region.

In the study, our main objective was to examine the level of co-integration of the above-mentioned countries and whether there is any evidence of volatility transmission from these markets to developed markets such as the USA, UK, Japan, and Singapore. One of the main reasons for studying the above-mentioned markets is that they are located in the same region, and economies like China and India are turning into a few of the most important economic powers of the developing world. Besides that, these four countries command a huge number of resources in the form of working-age population, vast land areas, and natural resources as well. Economic progress seems to be the only common ground between these countries.

LITERATURE REVIEW OF CO-INTEGRATION ANALYSIS

Several studies explore the relationship between regional markets all over the world. Only a few studies have been conducted to explore the long-run relationship among equity markets of South Asia. The possible reason is the historical and geopolitical situation of the region, which is marred by conflicts and a credibility deficit. However, now these countries have started realizing that better economic and trade cooperation can help to alleviate the poverty of the region.

Elfakhani Said, Arayssi Mahmoud and Smahta Hanin A (2008) researched the equity markets of some Arab countries and the USA to examine whether international diversification was possible despite the rapid growth of globalization. They gathered the data from these markets from 1997 to 2002. They employed ADF and JMA tests to examine the co-integration and diversification among the markets. The results of the tests showed that the markets of Kuwait were co-integrated with the markets of Jordan, Tunisia, and Saudi Arabia, and the markets of Tunisia and Jordan were co-integrated. Thus, they provided opportunities for diversification to the investors. Only the markets of Morocco, Kuwait, and Jordan were co-integrated with that of the USA.

Azad Sohel A.S.M. (2007) conducted research to examine whether any contagion effect existed between three major stock markets of South Asia,

like China, Japan, and South Korea. He also checked if these markets are individually and jointly efficient. He used the random walk hypothesis to find out the individual efficiency of markets, and for joint efficiency of markets he depended on contagion and co-integration. The results of the research presented that the hypothesis of individual market efficiency failed in the case of Chinese markets, but it remained successful in the case of the markets of Japan and South Korea. The test for co-integration failed in all the markets; however, the test for contagion was not rejected.

Glezakos, Merika, and Kaligofiris (2007) investigated the long-run and short-run relationships among Greek stock exchanges and major world equity markets. They employed Cointegration Analysis and the Granger Causality Technique to check long-run equilibrium relationships by taking monthly data of ten equity markets. They found a significant relationship with the USA stock market with all other markets. They also noticed a strong influence of Germany and the DJ index on the Athens stock exchange.

Choudhry and Lin (2007) find that the Asian crisis affected the dominance of Japan and US stock markets on Far East countries' markets. The effect of the Asian crisis 1997-98, the crash of the Thai baht, and depreciation of currencies in the region is analyzed by researchers. The data from January 1988 to December 2002 are taken from eight countries and the USA. Empirical investigations are carried out by applying the fractional unit root test and the Johansen multivariate co-integration test. The co-integration of markets of Far East countries is found in both post and pre periods of the Asian crisis. The domination of US and Japan stock markets is also found in the markets of these countries.

Aggarwal and Kyaw (2005) examined the integration of three equity markets before and after the NAFTA agreement. The data set is taken from 7 years before NAFTA and after from 1988-2001. The data is taken on a daily, weekly, and monthly basis. The NAFTA agreement increased trading liberalization and minimized barriers between the USA, Canada, and Mexico. Previous studies failed to find the co-integration of financial markets in the NAFTA region. But this analysis tried to find this integration on different frequencies. Aggarwal and Kyaw used a co-integration test for trends in methodology. They concluded the study with the result that the formation of NAFTA increased the integration of the stock markets between the USA,

Canada, and Mexico; in post-NAFTA time, the removal of trade barriers and restrictions integrated the region.

Aggarwal *et al.* (2005) tried to find the integration of the European stock market by using Co-integration Analysis and Haldane and Hall (HH) Kalman filter methodology. The formation of the European bloc after long periods of cold wars and conflicts was important for the region to compete with American and Asian economies in the era of globalization. This study checked how much European markets are integrated. Different analysts tried to find the result of equity markets integration in Europe, but because of different bank centered, market controlled and mixed systems in countries create difficulties for general decision-making. The data from 1983-2002 is taken from the full set of European equity markets daily and checked its convergence with the UK, USA, and Germany markets. The conclusion showed that the European markets' integration increased with the passage of time after taking actions from the euro zone.

Lamba (2005) examined the short- and long-run relationship between the stock markets in the South Asian region and other major developed markets. The main emphasis of this research is whether South Asian stock markets have any short- and long-run relationships with each other and the impact of the Asian financial crisis and the September 11, 2001, attacks on these stock markets. Cointegration and vector error correction mechanisms have been used to examine the existence of these relationships.

The author selected India, Pakistan, and Sri Lanka to represent the South Asian markets. The countries that were taken from the developed markets were based on the financial and economic influence of the developed markets on these South Asian markets: France, Germany, Japan, the UK, and the US. The data on daily stock prices from July 1997 to December 2003 were taken.

To investigate the presence of long-run relationships, Johansen's and Juselius cointegration model have been used. The results indicate that there is the existence of at least one cointegrating equation among South Asian countries and major developed markets. While for India, the results were conflicting; he used a 1% significance level, and he found one cointegration equation.

He also found that the US, UK, and Japan have a strong influence on the Indian stock market, and this influence continued even after September 11, 2001. On the other hand, Pakistan and Sri Lanka are found

to be isolated from the other major developed markets during the whole period covered in the sample size. However, when the interdependence of South Asian countries was checked, they concluded that these countries are coordinating with each other but at a very slow rate.

Suchismita and Mukherjee (2005) analyzed the correlation among the Indian stock market and major stock markets of Asia in recent years and also the relationship among Asian stock markets and the US stock market. After liberalization of the Indian capital market, its integration with the other Asian financial markets has increased through different ways like foreign portfolio investment and AGR/GDR method. They investigated the relationship between two developed stock markets, namely the US and Japan, and seven other Asian financial markets: India, Hong Kong, Malaysia, Korea, Singapore, Taiwan, and Thailand. The daily data set used was for six and a half years, commencing from 1st January 1999 to 30th June 2004, and all the stock prices were converted into US dollars with a base at 1st January 1999, and this was done to include the effect of exchange rates. The authors used Co-integration and Granger Causality test techniques to investigate the correlation among stock markets. The results of the bivariate co-integration indicate that there is no evidence of bivariate integration of the Indian stock market with any one of the Asian stock markets or the US stock market. On the other hand, when all the markets were considered, the authors found evidence of a single co-integration between all markets and the DJIA, but there is evidence of no cointegration between the S&P 500 and all markets. But when all the Asian markets were taken into account, including Japan, there is evidence of a single co-integrating equation.

Causality results of this study illustrate that the US market has a strong influence on all markets, but S&P 500 returns do not have any strong impact on the Japanese market. Whereas Japanese market returns seem to have led all the markets, including US stock indices. Existence of bi-directional causality is observed between Indian, Japanese, and Korean stock returns.

On the whole, the results of this study show that Indian stock markets were strongly integrated with Singapore, Malaysia, South Korea, Taiwan, and Thailand but cointegrated at a very low rate with the US S&P Index. Suchismita (2005) examines the presence of long-run relationships of the Indian equity market with the Asian equity markets and the US by using multivariate cointegration analysis and

the Granger causality test. Results indicate that the Indian equity market is not found isolated from Asian equity markets. Moreover, the US equity market is found integrated with the Indian equity market. The Indian equity market is also found to exert some influence on Asian equity markets. The Indian equity market appears to belong to the group of Asian markets cointegrated with them and with the US equity market. However, the level of integration among Indian and Asian markets is generally low, so the possibility of portfolio diversification still exists, and there is no threat of capital flight in case of a financial crisis in the region.

Narayan, Smyth and Nandha (2004) examined the linkages between the equity markets of Pakistan, Sri Lanka, India and Bangladesh. They used the Granger Causality Approach and the Multivariate Cointegration Framework. In the long run, stock prices of Sri Lanka, India and Bangladesh Granger-cause stock prices in Pakistan. They also found that uni-directional Granger causality flows from the Pakistan equity market to the Indian equity market. This happens from Pakistan to the Indian and Sri Lankan equity markets in the short run. Unidirectional causality is also observed between equity prices in Sri Lanka and equity prices in the Indian equity market. However, the equity market of Bangladesh is found exogenous.

They also investigated the linkages of the Pakistani equity market with international equity markets. These linkages are very important for the Government of Pakistan, which wanted to attract foreign investments, and also to international investors who sought to maximize return via diversification. They have explored the linkages of the Pakistan equity market with the seven most influential markets: the USA, the UK, Japan, France, Hong Kong, Singapore, and Germany. For this purpose, Correlation analysis, co-integration analysis, and the Error Correction Model have been employed to check the integration by using weekly country indices from January 1988 to December 1993. They found Pakistan equity market has a low correlation of returns with other markets. Thus, it is an attractive prospect to international investors for optimizing returns by diversifying risk. They also concluded that the Pakistani equity market is not integrated with other markets.

Hassan (2003) investigated the long-run relationship between share prices in the Gulf region by applying the cointegration technique developed by Johansen (1988, 1991, 1992) and Johansen and Juselius (1990).

By using a vector error correction mechanism, this study also analyzed the existence of short-run dynamics of prices by applying intertemporal Granger causality. The data used in this study were collected from the Arab Monetary Fund. The focus was mainly on GCC countries including Kuwait, Bahrain, Oman, and Saudi Arabia. Of these four countries, three countries were selected on the basis of the availability of weekly data on share prices.

The results of the ADF indicated that the variables are integrated of order one at level, whereas the cointegration test results suggest that Kuwait and Bahrain both possess a long-term and constant relationship. For the existence of short-run relationships, the Granger-causality test is used. The results point out that, except for Oman, which causes Kuwait, the variables are not related in the short run at any significance level. So, the short-run changes in Kuwait and Bahrain are affected only because of their trend values.

On the basis of the results obtained from this study, one can conclude that investors from Gulf countries can have a potential benefit if they invest in other stock markets. In turn, these countries will have greater efficiency by removing the ownership constraint, at least for the Gulf Countries (GCC citizens. In order to achieve their objectives, GCC will need to work on the liberalization of their domestic stock market and coordinate with the stock market of other GCC countries to establish a single stock market in the region.

Dekker *et al.* (2001) dealt with the short-term dynamics and proved that the influence of the US market on daily stock price movements at several Asian markets is much more than that of the Japanese market. He made use of a generalized VAR (Vector Autoregressive Approach) approach. In this paper, nine Asian equity markets have been taken to investigate the transmission of equity returns and volatility among them. Six of these markets are emerging markets (Malaysia, Indonesia, Taiwan, the Philippines, Thailand, and Korea), while the remaining three are regarded as developed (Japan, Singapore, and Hong Kong). Data have been taken from 1988 to 2000.

Roca (1999) examines the co-integration among financial markets of Australia, Japan, USA, UK, Hong Kong, Korea, Singapore, and Taiwan. He employed the Johansen Cointegration Technique by using weekly stock prices to check interlinkages among these equity markets. He also used the Granger Causality Test to investigate the direction of

causality. Results showed that Australian markets have a significant long-run relationship with USA and UK markets. However, there is no evidence of the existence of co-integration between Australian and other equity markets.

Masih and Masih (1997) also investigate the association and causation among various US stock indices in relation to the stock market crash of 1987. They choose five major indices, including the Dow Jones from the US, the NIKKEI from Japan, the FTSE from Britain, the CAC7 from France, and the German stock index, the DAX8. They employ a series of econometric methodologies, including Granger causality and the error correction mechanism for determining the short-term relationship among these five indices. They also employ the Vector Autoregressive (VAR) model and impulse-response functions and conclude that not all, but some scrips from the stock markets of Thailand Granger-cause the volatility in the Philippine financial markets.

Kasa (1992) explores common stochastic trends in the stock markets of the U.S., the U.K., Japan, Germany, and Canada. By using monthly and quarterly data from 1974 to 1990, and applying the Johansen co-integration technique, he found a single common stochastic trend driving these countries' stock markets. He concludes that integration in these financial markets exists. In other words, the stock markets of these countries move together.

In the above discussion, we reviewed different studies regarding the presence of volatility transmission among different countries regionally and globally. We have also discussed different methodologies used by researchers in their studies to investigate this issue. Only few studies discussed this matter for some countries of this region. in this respect. That's why we aimed to comprehensively study the regional volatility transmission within stock markets of Pakistan, China, India and Sri Lanka and also with major developed stock markets (USA, UK, Singapore and Japan) by using VAR.

Transmission of information and movement of prices across equity markets can be examined by using two broader approaches.

GARCH Approach

(a) VAR Framework

This study uses these methodologies to test the long-run association among the equity markets of Pakistan, China, India, and Sri Lanka via (a)Bivariate Exponential GARCH Methodology and

(b) VAR Framework

Univariate time series models attempt to predict and forecast the future on the basis of their own previous information. That is why these are commonly called atheoretical models. Financial econometrics literature generally discusses two types of classifications in this regard. One is an autoregressive process (AR), and the other is a moving average process (MA).

An AR process can be defined as the current value of a variable. W depends upon its own past values. That is

$$w_t = \alpha_0 + \alpha_1 w_{t-1} + \alpha_2 w_{t-2} + \dots + \alpha_p w_{t-p} + \varepsilon_t$$

Whereas according to the MA process, the value of variable w is a function of its current and past error terms, which are white noise.

$$w_t = \beta_0 + u_t + \phi_1 u_{t-1} + \phi_2 u_{t-2} + \dots + \phi_q u_{t-q}$$

If both AR and MA processes are combined, then the output is an ARMA model, which shows that. W is a function of its own historical values and also of its white noise error terms.

$$w_t = \lambda + \sum_{i=1}^p \alpha_i w_{t-i} + \sum_{i=1}^q \phi_i u_{t-i} + u_t$$

$$\text{Where } \lambda = \alpha_0 + \beta_0$$

Financial models are generally linear in their means but nonlinear in their variances. Policymakers, regulators, and people from academia remain more interested in risk. It might be due to the saying that "take care of risk; profit will take care of itself.

Risk is generally measured with the help of volatility in financial markets. In finance, volatility is the most important and widely discussed area. Different reasons can be attributed to this importance. When investors find the price fluctuations over a very short period of time, which may be as short as a day or a few hours, they may not be in a position to have any logical reasoning for this. Most financial and economic literature is based on the risk-averse nature of investors. A risk-averse investor is one who always avoids taking risks. So, if risk is increased, a reduced level of economic activity is likely to happen.

There are some other reasons responsible for the importance of volatility. It is changeable of some underlying variable, for example, stock prices, exchange rates, etc. The more variables fluctuate over a period of time, the more volatility will remain. There are various reasons with which volatility can be associated. Policymakers, regulators, and academia have always tried to identify and provide

rectification for such lacuna causing volatility. But in recent history, we have been witnessing another category of volatility which does not arise from domestic reasons but results from the transmission of shocks across regions and international stock markets. It has acquired an important place in the literature of international finance, international economics, and international financial architecture. This study also relates to the transmission of shocks that transfer from one market to another. Various methodologies have been suggested through the literature. We have decided to employ more than one methodology as per the needs of the analysis, such as bivariate EGARCH to check volatility transmission from one market to another market and Johansen methodology to check the long-run relationship. Additionally, various descriptive statistics have been provided to augment the analysis.

One of the most important conditions to analyze any financial time series is to check its stationarity. If financial data is non-stationary, then regressing a variable on other variables generally results in spurious or twaddle regression. Financial time series like stock prices are said to have random walk phenomena, which predicts that the price today is a function of the price yesterday and a random shock. This concept makes forecasting of financial data a wasteful exercise. In the same way, various autoregressive moving average (ARMA) models assume time series to be stationary. Therefore, first of all, we test the financial time series for stationarity. To test the stationarity of data, unit root tests proposed by Dickey and Fuller (1979) and Phillips and Perron (1988) are used. The Augmented Dickey-Fuller test investigates the presence of a unit root in an autoregressive model. A simple AR (1) model is $y_t = \rho y_{t-1} + u_t$, where y_t is the variable under study, t is the time period, ρ is a coefficient, and u_t is the error term. The regression model can be written as $\Delta y_t = (\rho - 1)y_{t-1} + u_t = \delta y_{t-1} + u_t$, where Δ is the first difference operator. This test assumes that the errors are statistically independent and have a constant variation. This assumption is very strict and may not be true for some data, whereas the Phillips-Perron test is more flexible and, therefore, is also used.

In the Phillips-Perron test, the error terms can be weakly dependent and heterogeneously distributed. If two series are nonstationary, then there is a possibility that a linear combination of these may be stationary. If it happens, then these series are called co-integrated. Financial time series are not generally following normal distribution. Therefore, we use the

Jarque-Bera test for normality and acquire the statistical values for kurtosis and skewness as well.

As mentioned earlier, two major methodologies have been employed to investigate the volatility transmission and co-integration, which are

4.1 Bivariate Exponential GARCH

4.2 Co-integration Analysis

Johansen Co-integration analysis (long-run relationship analysis)

This study intends to examine the spillover volatility among the financial markets. This volatility spillover generally is supposed to exist among the markets already having long-term relationships. The co-integration models are usually used to find out the long-run equilibrium among various variables. Although there are various techniques through which we can check co-integration, the bi-varied nature of this study provides directions to focus the discussion on Johansen's methodology. The null hypothesis is that "no relationship exists among the series". If long-run equilibrium is present, then these series are called co-integrated. Johansen (1988, 1991), and Juselius (1992) apply the maximum likelihood process to establish the occurrence of a co-integrating equation in several nonstationary time series. It greatly depends on the relationship between the rank of a matrix and its characteristic roots.

To understand Johansen's method, have a look at the following general autoregressive representation for vector Y , which contains n variables, all of which are $I(1)$, $Y_t = \mu + B_1 Y_{t-1} + B_2 Y_{t-2} + \dots + B_k Y_{t-k} + \epsilon_t$ {4.1}

where μ is an $(n \times 1)$ vector of constants, k is the maximum lag, ϵ_t is assumed to be a $(n \times 1)$ vector of Gaussian error terms, and A is a $(n \times n)$ matrix of coefficients.

The above vector autoregressive process can be retransformed as: $\Delta Y_t = \mu + \Pi_1 \Delta Y_{t-1} + \Pi_2 \Delta Y_{t-2} + \dots + \Pi_{k-1} \Delta Y_{t-(k-1)} + \Pi Y_{t-k} + \epsilon_t$ {4.2}

Where

$$\Pi_i = -[I - B_1 - B_2 - \dots - B_i] \quad i = 1, 2, 3, \dots, k-1$$

$$\Pi = -[I - B_1 - B_2 - \dots - B_k]$$

Here, the three variables in Y_t . The ΠY_t gives information regarding the nature of co-integration among the three variables.

The main objective of Johansen's test is to test the rank of Π . And in doing so, there can be three cases. C-I: Rank $(\Pi) = n$, i.e., full rank, which means that its rank is equal to the number of linearly independent rows and that should equal the number of rows. So all elements/variables of W_t are stationary.

C-II: Rank (Π) = 0 (i.e., Π is a null matrix); this implies that the variables in are not cointegrated, as there are no linear combinations of the variables in which are stationary. Thus, there is no long-run relationship between the variables in Y_t . Equation {4.2} in this case reduces to the traditional VAR model in first differences, i.e.

$$\Delta W_t = \mu + \Pi_1 \Delta W_{t-1} + \Pi_2 \Delta W_{t-2} + \dots + \Pi_{k-1} \Delta W_{t-(k-1)} + \varepsilon_t \quad \{4.3\}$$

C-III: Rank (Π) = r , $0 < r < n$; this implies that ΠW_{t-k} is $I(0)$, that is, the variables in W_t are cointegrated. Equation {4.2} thus takes the error-correction form. The rank r in this case determines the number of distinct cointegrating vectors that exist between the variables in Y_t .

They have suggested two likelihood ratio tests for the detection of the number of co-integrated vectors. One of them is known as the maximal eigenvalue test, which is used to evaluate the null hypothesis that there are at most r co-integrating vectors versus the alternative of $r + 1$ co-integrating equations. The maximum eigenvalue statistic is defined as;

$$\lambda_{\max} = -T \ln(1 - \lambda_{r+1})$$

Where $\lambda_{r+1}, \dots, \lambda_n$ are the $n-r$ smallest squared canonical correlations (eigenvalues from the Π matrix) and T = the number of observations.

The second test is based on trace statistics rather than cointegrated factors, which test the null hypothesis of r cointegrating vectors versus the alternative of at least r cointegrating vectors. This statistic is defined as $\lambda_{\text{trace}} = -T \sum \ln(1 - \lambda_i)$

Schwarz Information Criterion (SIC) is used to select the number of lags required in the co-integration test. If the Johnston and Juselius test of co-integration provides evidence in favour of rejecting the null hypothesis that both stock series are co-integrated in the long run, then we can say that the observed equilibrium relationship between the two-stock series is driven by the same set of factors and is expected to continue. To test multivariate co-integration, the approach used is Vector Autoregressive (VAR). This assumes all the variables in the model are endogenous. By inserting a Vector Error Correction Term, we capture the short-run divergence of prices from their respective equilibrium values.

VECTOR Error correction mechanism (short run analysis)

If the variables are co-integrated, then residuals from the equilibrium regression can be utilized for the estimation of the error correction model and to assess the long-run and short-run effects of the variables and

have a look at the insight of the adjustment coefficient, which actually is the coefficient of the lagged residual term of the long-run relationship.

The coefficient (statistic) of the error correction term, which is also the coefficient of adjustment speed, shows how strongly the deviation from equilibrium feeds back into the system. If it is significant, it shows long-run causality of variables and vice versa.

There are many reasons for the importance of VECM. It measures the correction from disequilibrium in the period. Due to formulate in terms of first differences, which trend eliminates from the variables and resolves the problem of spurious regression. These models fit into a general-to-specific approach to econometric modeling, which best fits the given data set. Two co-integrated variables imply that there is some adjustment process which prevents errors in the long-run relationship. So, concepts of co-integration and the error correction mechanism (VECM) are closely related.

RESULTS AND DISCUSSIONS

Before we check the linkages among the stock markets, the market index series is examined to determine whether they are stationary using the Augmented Dickey and Fuller (ADF) (1979, 1981) and Phillips-Perron (PP) (1988) tests on the market index levels and their first differences. No stock index was found to be stationary at levels. However, rejection of the hypothesis of non-stationarity in first differences for all markets implies that the variables are integrated of order one.

This study intends to investigate portfolio diversification opportunities and volatility transmission with respect to Pakistan, China, Sri Lanka, and India. United States of America, Japan, Singapore, and the United Kingdom have also been taken to check the transmission of volatility from developed countries to each of the selected Asian countries. From every country, one stock market index has been chosen as a proxy for their stock market performance. From Pakistan, the KSE 100 index has been included in the sample; from China, the SSE; from Sri Lanka, the CSE Sensitive index; and from India, the BSE 200 index has been included. From the United States of America, Japan, Singapore, and the United Kingdom, we will use the S&P 500 index, NIKKEI 225 index, STI 100 index, and FTSE 100 index, respectively. All the indices are denominated in local currency units. In this study, we used daily data starting from July 1, 1997, to December 31, 2009.

Table 1: Correlation Matrix

	RUSP	RUKP	RSLP	RSGP	RPKP	RJPP	RINP	RCHP
RUSP	1							
RUKP	0.4999	1						
RSLP	-0.0032	0.0449	1					
RSGP	0.2153	0.3911	0.0691	1				
RPKP	0.0191	0.0267	5.87E-05	0.0651	1			
RJPP	0.1128	0.3071	0.0431	0.5107	0.0319	1		
RINP	0.1989	0.3148	0.0323	0.4738	0.0614	0.3233	1	
RCHP	0.0143	0.0392	0.0076	0.1373	0.0129	0.1221	0.1018	1

Source: Authors' compilations

The table above displays the results of correlation analysis among the equity markets of Pakistan, China, India, and Sri Lanka. There is no significant correlation exists among major South Asian equity markets. Indian equity market is more correlated with major world equity markets than Pakistan and China.

Co-integration Analysis

To check the dynamic relationships among the eight stock markets, we tested for long-term relationships in the logarithms of the eight stock indices.

Table 2 Multivariate Co-integration Analysis Trace Statistics. (Pakistan, China, India and Sri Lanka)

Hypothesized			
No. of CE(s)	Eigen value	Statistic	Critical Value
None *	0.11450	54.07264	47.85613
At most 1	0.007021	24.32604	29.79707
At most 2	0.00187	6.125627	15.49471
At most 3	0.000583	1.506962	3.841466

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Source: Authors' compilations

The above table displays the results of the multivariate co-integration analysis for Pakistan, China, India, and Sri Lanka. The model is applied under the assumption of a constant and linear trend in the co-integration vector. Lags are chosen to minimize SIC (Schwarz Criterion) and set at 1 in first-order differences. Trace test indicates one co-integrating vector at the 0.05 level. Maximum Eigenvalue test also confirms the presence of one co-integrating vector at $\alpha = 0.05$. Thus, the Trace test statistics lead to a rejection of the null hypothesis of no co-integrating relationship, but not the null hypothesis of at least one co-integrating vector. As they will move together in the long run, there can be a possibility of short-term deviation, yet when long-run relationships are present between those markets. We examined this between the Pakistani equity markets and other Asian markets by following the error correction model:

$$\Delta PK_t = \alpha_0 + \gamma Y_{t-1} + \sum_{j=1}^p \alpha_{1j} \Delta PK_{t-j} + \sum_{j=1}^p \alpha_{2j} \Delta CH_{t-j} + \sum_{j=1}^p \alpha_{3j} \Delta IN_{t-j} + \sum_{j=1}^p \alpha_{4j} \Delta SL_{t-j} + \varepsilon_t$$

Where $Y_{t-1} = PK_{t-1} - \beta_1 CH_{t-1} - \beta_2 IN_{t-1} - \beta_3 SL_{t-1}$.

Vector Error Correction Model is a restricted VAR for co-integration analysis. It is designed for using non-stationary series that are known to be co-integrated. The VECM restricts the long-run behavior of variables to converge to their co-integrating relationships. The co-integrating term is known as the error correction term because the deviation from long-run equilibrium is steadily corrected through partial short-run modifications. The results from the co-integration equation for Pakistan's case with selected Asian countries are presented in Table 1 in the Appendices; it is found that with all selected countries, the coefficients of error correction are found positive and statistically significant. This means that, except for the Sri Lankan case, all the selected countries are showing no such signs of convergence and hence suggesting no long-run stability in the model.

Table 3 Multivariate Cointegration Analysis Trace Statistics. (Pakistan, USA, UK, Japan and Singapore)

Hypothesized			Critical Value
No. of CE(s)	Eigenvalue	Statistic	
None *	0.012765	94.76424	88.80380
At most 1	0.009011	53.16648	63.87610
At most 2	0.004146	23.85679	42.91525
At most 3	0.002449	10.40535	25.87211
At most 4	0.000762	2.467100	12.51798

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Source: Authors' compilations

When we investigated the integration of Pakistan's markets with developed countries- the United States, the United Kingdom, Japan, and Singapore- we found 1 co-integrating vector at the 0.05 level. Max Eigenvalue test also confirms the presence of 1 cointegrating vector at $\alpha = 0.05$.

The results from the co-integration equation for Pakistan's case with selected developed block are presented in Table 2 in Appendices; it is found that with all selected countries the coefficients of error correction are found negative but statistically insignificant. This is inconclusive as far as long-term stability in the model is concerned.

Table 4 Multivariate Cointegration Analysis Trace Statistics. (China, USA, UK, Singapore and Japan)

Hypothesized			Critical Value
No. of CE(s)	Eigenvalue	Statistic	
None *	0.020081	99.60042	88.80380
At most 1	0.007992	47.20256	63.87610
At most 2	0.005658	26.47648	42.91525
At most 3	0.002889	11.82038	25.87211
At most 4	0.001682	4.347550	12.51798

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Source: Authors' compilations

When we investigated the integration of China with developed countries, the United States, the United Kingdom, Japan, and Singapore, we found 1 co-integrating vector at the 0.05 level. Max Eigenvalue test also confirms the presence of 1 cointegrating vector at $\alpha = 0.05$.

The results from the co-integration equation for China's case with selected developed countries are presented in Table 3 in Appendices; it is found that with all selected countries the coefficients of error correction are found negative and statistically significant except for the US, whose VEC coefficient is found positive. This means that, except for the USA, all the selected countries are showing signs of convergence and hence suggesting no long-run stability in the model for China.

Table 5 Multivariate Cointegration Analysis Trace Statistics of (India, USA, UK, Singapore and Japan)

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value
None *	0.009479	91.82867	88.80380
At most 1	0.009021	60.98975	63.87610
At most 2	0.005730	31.64597	42.91525
At most 3	0.003191	13.03842	25.87211
At most 4	0.000830	2.689799	12.51798

Trace test indicates 1 cointegrating eqn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Source: Authors' compilations

When we examined the integration of India with developed countries, the United States, the United Kingdom, Japan, and Singapore, we found 1 co-integrating vector at the 0.05 level. Max Eigenvalue test does not confirm the presence of 1 cointegrating vector at $\alpha = 0.05$.

The results from the co-integration equation for India's case with selected developed countries are presented in Table 3 (Appendices); it is found that with all selected countries, the coefficients of error correction are found negative and statistically significant except for the US, whose VEC coefficient is found positive (just like China's case). This means that, except for the USA, all the selected countries are showing signs of convergence and hence suggesting no long-run stability in the model for India.

Table 4 (Appendices) displays the results of the multivariate Co-integration analysis for Pakistan, China, India and Sri Lanka for data from 2005 to 2009. Lags are chosen to minimize SIC and set at 1 in first differences. Trace test indicates zero co-integrating vector at the 0.05 level. Max Eigenvalue test also confirms the absence of any co-integrating vectors at $\alpha = 0.05$. This shows that from 2005 to 2009, correlation among these Asian markets decreased. However, different studies showed increasing integration among

markets of other regions. The reason for less integration of these four Asian Markets than before 2005 can be their political and regional issues, or it can be because of the International Financial Crises.

When we break down the data and investigate co-integration of Pakistani equity markets with major developed countries, USA, UK, Japan, and Singapore. The results are presented in Table 5 (Appendices). We found long-run equilibrium among these markets. This shows that portfolio diversification's chances are decreasing among these equity markets.

Results for China (2005-2009) are presented in Table 6 (Appendices), with major developed countries USA, UK, Singapore, and Japan showing increasing integration among these markets. According to Trace statistics, there is 1 co integrating eqn(s) at the 0.05 level. Maximum Eigen value indicate test indicates 2 co-integrating eqn(s) at the 0.05 level. That's why international investors' benefits of portfolio diversification, by reducing risk, in these markets are declining.

A bivariate analysis has also been carried out to explore the possibility of pairwise long-term relationships among Stock market indices, and results are displayed in the table below.

Table 6 Bivariate Cointegration Analysis Trace Statistics (Pakistan, China, India, Sri Lanka)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value
PKP & CHP			
None	0.000777	3.822474	15.4947
At most 1	0.000702	1.814051	3.8415
PKP & INP			
None	0.001716	5.887374	15.4947
At most 1	0.000101	0.326651	3.8415
PKP & SLP			
None	0.003285	10.68547	15.4947
At most 1	1.06E-05	0.034164	3.8415
CHP & INP			
None	0.002124	5.854938	15.4947
At most 1	0.000141	0.363274	3.8415
CHP & SLP			
None	0.001091	3.702289	15.4947
At most 1	0.000342	0.883267	3.8415
INP & SLP			
None	0.003062	9.948637	15.4947
At most 1	5.77E-06	0.018674	3.8415

Trace test indicates no cointegrating eqn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Source: Authors' compilations.

Table7 Bivariate Cointegration Analysis Trace Statistics (Pakistan, USA, UK, Singapore and Japan)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value 0.05
PKP & USA			
None	0.001530	5.202406	15.4947
At most 1	7.61E-05	0.246390	3.8415
PKP & UK			
None	0.001665	5.692997	15.4947
At most 1	9.21E-05	0.298188	3.8415
PKP & SGP			
None	0.001945	6.512361	15.4947
At most 1	6.51E-05	0.210866	3.8415
PKP & JPP			
None	0.001216	4.346069	15.4947
At most 1	0.000126	0.407032	3.8415

Trace test indicates no cointegrating eqn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Source: Authors' compilations

We can see from the results displayed in the above Tables 5.17 and 5.18 that there is no evidence of bivariate co-integration among the four Asian markets, i.e., Pakistan, China, India, and Sri Lanka. We did not find pairwise co-integration among Pakistan and all four developed markets, USA, UK, Japan, and Singapore. Results show there is no pairwise long-term relationship between these markets.

CONCLUSIONS AND POLICY RECOMMENDATIONS

This study investigates the presence of volatility transmission and long-run relationship among regional equity markets of Pakistan, China, India, and Sri Lanka. China's importance is growing exponentially for its neighboring countries as well as for the whole world. It has had very close relations with Pakistan for many decades. Whereas Pakistan's relationship with India has shown many ups and downs since the independence of both countries (1947). We tried to find the integration of equity markets of Pakistan and China as well as Pakistan and India. These markets represent a significant part of Asian markets. Many studies have shown that regionally integrated markets progress more rapidly than isolated ones. If countries of the same region have a long-run relationship, then the chances of an optimum currency area increase, whereas a diversification strategy to reduce risk is not workable there.

To check the long-run relationship and volatility transmission from developed stock markets, stock indices of four major developed countries, USA, Japan, Singapore, and UK, have also been taken. To examine the volatility transmission, two methodologies have been used. First of all, bivariate Exponential GARCH has been used to check the presence of transmission within each pair of all eight countries for the period from July 1997 to December 2009. Secondly, Multivariate as well as bivariate co-integration analysis has been employed to check co-integration among these equity markets. On the basis of these methodologies, mixed results have been obtained.

- Johanson and Juselius Trace Statistics in this study indicated that Asian markets are integrated within a group. We found one co-integrating equation, which means a long-run relationship exists among these equity markets. Thus, according to multivariate co-integration analysis, markets are integrated, and there exists a long-term association among these markets. However, bivariate analysis indicates that no pairwise co-integration exists among the equity markets of China and India, which are two major

emerging markets of the region. This can be due to low trade between these countries. Thus, investors of these two countries can get the benefits of portfolio diversification by investing in these countries. We also found that no pairwise long-run relationship exists between Asian markets (China, India, Pakistan, Sri Lanka), and they are not co-integrated pairwise with the equity markets of the USA, UK, Japan, and Singapore. Therefore, fund managers of the US, UK, Singapore, and Japan can get the benefits of portfolio diversification by investing in Asian stock markets.

- Results of shorten sample period 2005-2009 of multivariate and bivariate co-integration analysis show that Asian countries are becoming integrated with major developed countries but with low pace than the countries of other regions. Opportunities for portfolio diversification still exist here, hence need to regulate the financial sector and resolve political and other internal issues to attract capital inflow from all over the world. It's the duty of the government to provide political stability, an investor-friendly environment, and security to international investors to gain foreign direct investment via this channel.

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APPENDIX A VECM (Short Run Analysis)

Table 1 Causality in the VECM (Short Run Analysis) (Pakistan, China, India and Sri Lanka)

Cointegrating Eq: CointEq1	
<u>LPKP</u> (-1)	1.000000
<u>LCHP</u> (-1)	0.015388 (0.12687) [0.12129]
<u>LINP</u> (-1)	0.009763 (0.16975) [0.05751]
<u>LSLP</u> (-1)	-1.255874 (0.13048) [-9.62522]
C	0.302907
Error Correction: D(LP KP) D(LCHP) D(LINP) D(LSLP)	
CointEq1	-0.014861 -0.002312 -0.003508 0.000637 (0.00287) (0.00250) (0.00192) (0.00171) [-5.17538] [-0.92489] [-1.82548] [0.37240]

Table 2 Causality in the VECM (Short run Analysis) (Pakistan, USA, UK, Japan, Singapore)

Cointegrating Eq: CointEq1	
<u>LPKP</u> (-1)	1.000000
<u>LUSP</u> (-1)	-2.342119 (0.70667) [-3.31429]
<u>LUKP</u> (-1)	6.393280 (0.86192) [7.41748]
<u>LSGP</u> (-1)	-0.077490 (0.42011) [-0.18445]
<u>LJPP</u> (-1)	-3.484644 (0.47613) [-7.31870]
@TREND (7/01/97)	-0.001005 (0.00012) [-8.28570]
C	-11.23768
Error Correction: D(LP KP) D(LUSP) D(LUKP) D(LSGP) D(LJPP)	
CointEq1	-0.005341 0.000293 -0.001964 -0.000671 0.002747 (0.00157) (0.00080) (0.00072) (0.00083) (0.00082) [-3.40312] [0.36591] [-2.72821] [-0.80731] [3.33556]

Table 3 Causality in the VECM (Short run Analysis) (China, USA, UK, Japan, Singapore)

Cointegrating Eq: CointEq1	
<u>LCHP</u> (-1)	1.000000
<u>LUSP</u> (-1)	24.27552 (3.55316) [6.83209]
<u>LUKP</u> (-1)	-4.150354 (2.75433) [-1.50685]
<u>LSGP</u> (-1)	-15.41228 (2.46349) [-6.25626]
<u>LJPP</u> (-1)	-1.918338 (1.78192) [-1.07656]
@TREND(7/01/97)	0.003616 (0.00063) [5.77649]
C	-14.67625
Error Correction: D(LCHP) D(LUSP) D(LUKP) D(LSGP) D(LJPP)	
CointEq1	-0.000868 -0.000565 0.000243 0.001220 0.000435 (0.00042) (0.00025) (0.00023) (0.00023) (0.00025) [-2.06470] [-2.21461] [1.06980] [5.32776] [1.71884]

Table 4 Causality in the VECM (Short-run Analysis) (India, USA, UK, Japan, Singapore)

Cointegrating Eq: CointEq1	
<u>LINP</u> (-1)	1.000000
<u>LUSP</u> (-1)	1.948360 (0.36358) [5.35883]
<u>LUKP</u> (-1)	-1.650996 (0.44346) [-3.72301]
<u>LSGP</u> (-1)	-0.624898 (0.21616) [-2.89095]
<u>LJPP</u> (-1)	-0.867949 (0.24506) [-3.54184]
@TREND(7/01/97)	-0.000575 (6.2E-05) [-9.21155]
C	5.584579
Error Correction: D(LINP) D(LUSP) D(LUKP) D(LSGP) D(LJPP)	
CointEq1	-0.006723 -0.001316 0.003133 0.001769 0.005422 (0.00231) (0.00181) (0.00163) (0.00188) (0.00186) [-2.91276] [-0.72826] [1.92499] [0.94177] [2.91904]

APPENDIX B Multivariate Cointegration Analysis (2005-2009)

Table 5 Multivariate Cointegration Analysis Trace Statistics of (Pakistan, China, India, Sri Lanka 2005-2009)

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value
None	0.011067	24.44314	47.85613
At most 1	0.003786	10.20904	29.79707
At most 2	0.002951	5.357485	15.49471
At most 3	0.001233	1.577602	3.841466

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Table 6 Multivariate Co-integration Analysis Trace Statistics (Pakistan, USA, UK, JPP, SGP)

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value
None *	0.032064	91.91965	88.80380
At most 1	0.020164	50.23824	63.87610
At most 2	0.011469	24.18452	42.91525
At most 3	0.005247	9.430959	25.87211
At most 4	0.002111	2.703006	12.51798

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**MackinnonHaug-Michelis(1999)p-values

Table 7 Multivariate Cointegration Analysis Trace Statistics (China, USA, UK, Singapore and Japan 2005-2009)

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value
None *	0.033844	103.7659	88.80380
At most 1	0.028654	59.72941	63.87610
At most 2	0.009883	22.54607	42.91525
At most 3	0.006290	9.843400	25.87211
At most 4	0.001386	1.773484	12.51798

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Table 8 Multivariate Cointegration Analysis Trace Statistics (India, USA, UK, Singapore and Japan 2005-2009)

Hypothesized No. of CE(s)	Eigenvalue	Statistic	Critical Value
None *	0.029264	76.01895	69.81889
At most 1	0.018997	38.03161	47.85613
At most 2	0.007805	13.50094	29.79707
At most 3	0.002217	3.478564	15.49471
At most 4	0.000501	0.640409	3.841466

Trace test indicates 1 cointegrating egn(s) value at the 0.05 level.

*denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values

Table 9 Bivariate Cointegration Analysis Trace Statistics 2005-2009

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Prob**
PKP & CHP				
None	0.002548	5.589308	15.49471	0.7434
At most 1	0.001817	2.326200	3.841466	0.1272
PKP & INP				
None	0.003596	4.850746	15.4947	0.8245
At most 1	0.000190	0.243433	3.8415	0.6217
PKP & SLP				
None	0.003102	4.479505	15.4947	0.8613
At most 1	0.000395	0.505859	3.8415	0.4769
CHP & INP				
None	0.005573	8.468495	15.4947	0.4167
At most 1	0.001032	1.320191	3.8415	0.2506
CHP & SLP				
None	0.003600	6.321793	15.4947	0.6575
At most 1	0.001335	1.708737	3.8415	0.1911
INP & SLP				
None	0.004743	8.834200	15.4947	0.3809
At most 1	0.002151	2.753888	3.8415	0.0970

Trace test indicates no cointegrating egn(s) value at the 0.05 level.

*Denotes rejection of the hypothesis at the 0.05 level.

**Mackinnon Haug-Michelis (1999) p-values