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Reassessment of Volatility Transmission Among South Asian Equity Markets

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Abstract

This study investigates the nexus among the South Asian economies. Effects of shocks in the equity market of one country on the equity market of the other country are examined. For empirical analysis, the time series monthly data is used for the period from February 2013 to August 2019. The study focuses on the four larger economies of the region, namely, India, Bangladesh, Pakistan, and Sri Lanka. To investigate for asymmetric effects of positive and negative shocks, EGARCH model is used. The findings show the mix nature of the spillovers between the various pairs of countries. The equity market of Pakistan has two-way spillover effects with the equity market of Bangladesh, but has no association with the equity markets of India and Sri Lanka. The volatility in the equity market of India significantly influences the volatility of the financial markets of Bangladesh and Sri Lanka. Similarly, the capital market of Sri Lanka has a negative association with the equity market of India as well as Bangladesh, but does not affect the equity market of any other country. These findings validate the argument in the literature that geographic location influences the nexus among equity markets. The findings are important for policy-makers and investors.

Keywords: Volatility Spillover, Volatility Persistence, GARCH, EGARCH

JEL Classification Code: G01, G11, G15, C58

1. Introduction

Because of a number of factors, the stock markets of many countries became dependent on each other (In, Kim, Yoon, & Viney, 2001). Technological development and deregulation of markets are the main factors causing interdependence among national markets (Offner, 2000). Deregulation of the market has enhanced the flow of capital from one market to another, thus resulting in linkages among stock markets (Gerrits & Yuce, 1999). Similarly, relaxation in cross-border investment rules, modern channels of transaction, and explanations of multinational corporate sectors also facilitate the capital flows among different equity markets (Arshanapalli & Doukas, 1993). Therefore, understanding interaction among various stock markets is beneficial for investors, regulators and financial institutions.

South Asia's region comprised eight independent countries. India is the largest country by area and population, and has a strong economy followed by Pakistan. However, the economic rankings vary due to rapid economic development taking place in Bangladesh and Sri Lanka (Arshanapalli & Doukas, 1993).

Other South Asian member countries include Nepal, Bhutan, Afghanistan, and the Maldives. According to the World Bank's 2019 statistics, the four major countries (India, Pakistan, Sri Lanka, and Bangladesh) account for more than 70% market capitalization of the whole region. Therefore, the current study focuses on the economies of these four countries. The countries in the region have most shared cultural values. However, there is no extraordinary trade between these countries. They have some political

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and strategic associations that may lead to influencing the economies of each other (Ali & Talukder, 2009). Therefore, the current study aims to investigate the transmission of stock market shocks among the sample countries arising from their political, social, cultural, and strategic partnerships in the region and globally.

Numerous studies examine the association between various equity markets. For example, Mitto (1992) examines the integration between stock markets of Canada and the USA and finds evidence of common movement in an excess return of two markets. Singh, Kumar, and Pandey (2010) explore the relationships among the stock markets of vast blocks of countries including the Asian region, countries of North America, and European countries. Similarly, Abou-Zaid (2011) attempts to discover the common shocks in the economy of the MENA region. Majdoub and Mansour (2014) examine the volatility spillovers among the developed and emerging economy. Yu and Yoon (2019) provide updated evidence about the association and shocks transmission among the equity markets of East Asia. Zhang, Zhuang, Lu, and Wang (2020) provide a comprehensive analysis to investigate the spillover effects among the G20 financial markets.

Few studies also analyze the South Asian stock markets to explore spillover effects among them. For example, Gunasinghe (2005) provides an extensive investigation of the South Asian equity market and interrelationship among them. Sharma and Bodla (2011) examine the association among the few major equity markets of the South Asian region. Iqbal, Saeed, and Shah (2020) investigate the few major economies of the South Asian region and provide insight into the structural breaks and interdependence among them.

All the above-mentioned studies produce mix results about the spillover effect among the markets. The results are sensitive to a methodology used to investigate the spillover effects. The study time duration also influences the directions of relationships because countries continuously change business and trading policies. Further, many studies use simple linear models to examine the association between stock markets. Therefore, in response to the mixed results, the current study aims to provide updated evidence of the spillover effects among the equity markets of South Asian countries by using updated models. The current study uses EGARCH model to investigate the leverage effects.

The results of EGARCH model show that there is leverage or asymmetric effect in all markets, except Bangladesh, which means that volatility is higher after negative shocks compared to positive shock in the context of each country except Bangladesh. The outcomes of bivariate EGARCH models indicate that one-way volatility transmission between most of the South Asian countries, except Bangladesh and Pakistan, have a bidirectional transmission of volatility. The results provide empirical evidence of the transmission of shock across the financial markets of India, Pakistan, Sri Lanka, and Bangladesh, investigating the recent economic fluctuations because of the changes in the political and strategic situation within and across the countries.

The rest of the article is organized as follows: The second section provides a review of the relevant literature. The third section discusses the data and sample, descriptive statistics, and econometric models. The fourth section shows the results of the econometric model and provides a discussion on the findings. The last section contains the study's concluding remarks.

2. Literature Review

Globalization has enhanced the movement of funds among various countries and this has made stock markets dependent on each other. A plethora of studies inspects the volatility spillover among different equity markets. Different studies employed different methodologies. The literature provides mixed results. Some studies have found evidence of spillover and others have not in the time periods they have studied.

Wei et al. (1995) tested for volatility diffusion between the capital market of developing and developed counties. They have used daily data from August 1991 to December 1992 and find the significant transmission of shocks in the capital market of developed countries to equity markets of emerging counties. New York's capital market has significant impacts on the stability of the financial markets in Taiwan and Hong Kong. Yang (2005) explores the relation between Japan, Taiwan, Singapore, Hong Kong, and South Korea. The sample period is from 1990 and 2003, and daily data are used in the study. They find a significant spillover of shocks across the market and correlation among markets increases with an increase in volatilities in the markets. Worthington and Higgs (2007) examine the interdependence among Asian stock markets from January 1993 to June 2006. They have studied linkages among the following countries, Hong-Kong, Singapore, Japan, China, the Philippines, Thailand, Indonesia, Korea, Taiwan, India, and Malaysia. They have used daily data. Their findings suggest that Asian markets are financially integrated.

Singh et al (2009) investigate the fifteen capital markets of the world. The countries include France, Canada, Hong-Kong, Japan, Singapore, United States, Korea, United-Kingdom, China, Germany, Malaysian, and Indonesia. They find that most returns in India and other world markets are interdependent. Mukherjee and Mishra (2010) studied the impact of the stock market fluctuation of India with 12 Asian countries. They have used the GARCH model and found a substantial bidirectional association in these markets. Sharma and Bodla (2011) examine the stock market integration in South Asia. For empirical analysis, they used the daily data of Pakistan, India, and Sri Lanka. Their findings suggest a

unidirectional impact of the Indian capital market on the equity markets of Pakistan and Sri-Lanka. However, they do not investigate the spillover effect among the stock markets.

Diebold and Yilmaz (2011) test the spillover effect between the USA, Chile, Argentina, Mexico, and Brazil. They find that the spillover effect of stock market returns grows steadily. Karolyi (2012) analyzed the transition of asset performance and uncertainty between the stock markets in New York and Toronto. For the period from April 1981 to December 1989, they used daily data. We find that risk and return spreads from one market to another, but their intensity and persistence depend on how volatility is modeled. Neaime (2012) explored the causal links between the US and UK markets, Bahrain, Egypt, Jordan, Morocco, Turkey, Kuwait, and Saudi Arabia. An empirical analysis of weekly data for the January 1995 to 2002 period Shows that economies closer geographically practice a higher variance transfer from one market to another. Furthermore, uncertainty transmits from Bahrain to Saudi Arabia and Kuwait unidirectionally, and from Egypt to Jordan, Morocco, and Turkey. The emerging markets like Pakistan are highly cointegrated with cross-border stock markets and have no cointegration with exchange rate and money market (Ahmed, 2014).

Li and Giles (2015) find a significant transfer of uncertainty from US financial markets into the Asian and Japanese markets. Han, Kutan, and Ryu (2015) investigate the impact of the US market's return and volatility on Korea's representative implied volatility index (VKOSPI). The empirical results show that the US stock market controls VKOSPI and can be used to predict its future level thus exhibiting information connection between the US market and the Korean market. Moreover, Mensi et al. (2016) scrutinize the interaction of the US economy with Brazil, Russia, India, China, and South Africa. Their sampling period is from September 1997 to October 2013. Their findings that all markets are marginally integrated with conditional variance, and that all markets have a leverage effect. The stock markets also have different behavior during the week days (Lu & Gao, 2016).

Dedi and Yavas (2016) review the ties between Germany, China, the UK, Turkey, and Russia's financial markets. The data is used for the sample period from March 2011 to March 2016. The empirical results suggest that volatility transmission exists for the countries studied. The capital market of China market is significantly affected by Russian and Turkish capital markets and the Russian market is affected by Turkey and China. However, they found that most market spillovers were unidirectional. For example, fluctuations spill from the UK market to the German market, but do not spill over from the German market to the UK market.

Rejeb and Arfaoui (2016) investigate the association among equity markets through a comprehensive approach. The major countries of Latin America and the Asian region are included in the sample and compare their interdependence with some developed economies including Japan and the US. By using multiple econometric models, they find that geographical location plays an important role in the interdependence between two equity markets. Overall, they argue that a significant association among the equity markets depends upon various contextual factors.

Mohti et al. (2019) examine the stock market integration between eight emerging markets and four frontier markets in Asia. They used daily data of stock markets to investigate the market nexus and integration for the period from December 2009 to April 2017. They applied multiple tests to see the integration and found a significant market integration in the context of emerging economies. They also observed global and regional effects on the integration among different markets. These findings are more prominent in the case of Pakistan.

Iqbal et al. (2020) highlight and explore the role of structural breaks in the association between equity markets. They use historical monthly data for empirical analysis of South Asian countries for the period from July 2002 to June 2016. They find a significant effect of financial crises and documented significant spillover effects among different economies. However, the study used daily data for the period from July 1, 2002, to June 30, 2016, that does not consider the shocks that occurred in the South Asian stock markets after 2016. The current COVID-19 crisis also influence the stock markets. On average the stock markets crashed in the COVID-19 (Khan et al., 2020). However, some stock markets such as the Indian stock market shows positive average returns during the COVID-19 period (Alam, Alam, & Chavali, 2020).

The above literature points to the multiple factors that influence the spillover effect among different economies. For example, geographical location, the political association between the countries, fluctuation of internal strategic policies of a country, and interaction of the business cycles. In light of this conclusion, the current study attempts to investigate the recent fluctuations in different economies of South Asia in a context in which the political relationships and trade policies are changing continuously over time.

3. Methodology

3.1. Data

Monthly market data has been attained from investing.com. The numeric data for the period from February 2013 to August 2019 is used in the study. KSE-100 index is used for Pakistan. According to the Pakistan stock exchange report "KSE 100-index contains companies having the largest market share from 34 sectors". BSE Sensex index is used for India. BSE Sensex is composed of 30 companies that are most actively traded on the Bombay stock exchange. Colombo All shares index is used for Sri Lanka, and the

stock market report, "the index composed of all companies listed on Colombo stock exchange". Dhaka stock exchange index, DSEX, is used for Bangladesh.

Before proceeding with an in-depth analysis, the descriptive statistics are important to see the characteristics of the variables (Table 1). The sample means of the stock market returns of the selected countries are positive. The stock market returns are the log-returns of each equity market and are obtained through the natural log of $[(P_1)/P_0]\times100$. The positive mean returns indicate that stock prices have increased over the sample period. India has the highest mean return, whereas Sri Lanka has the lowest mean return. Pakistan has the highest standard deviation, whereas Sri Lanka has the lowest. Skewness and kurtosis tell about the nature of the statistical distribution. Pakistan and India have negative skewness, whereas Sri Lanka and Bangladesh have slightly positive skewness. Negative skewness for Pakistan and India shows that the probability of earning returns higher than the mean return is greater in these countries.

Sri Lanka and Bangladesh have positive skewness, which shows that the probability of earning return lower than mean returns is higher in these countries. The value of the Kurtosis coefficient is larger than 3 in the context of each capital market. It indicates that returns in all markets have leptokurtic distribution. The statistical test also validates that data is not distributed normally as the P-value of the Jarque-Bera test is less than 0.05 except the equity market of India that has a normal distribution of the log returns. Further, the trends of stock market returns are also shown in figures (appendix). Panel B of the table provides the correlation matrix between the stock market returns of all the countries. The correlation coefficients are lower that shows that there is a little linear relationship between the equity markets of the countries. Therefore, we extend the analysis towards the advanced model.

Table 1

Panel A: *Descriptive statistics of Returns*

	Pakistan	India	Sri Lanka	Bangladesh
Mean	0.16	0.183	0.021	0.057
Median	0.18	0.27	-0.06	-0.04
Max	8.60	6.24	4.36	5.85
Min	-8.07	-6.85	-4.61	-5.96
Std.Dev	2.35	1.89	1.23	1.82
Sk	-0.09	-0.12	0.09	0.09
Kur	3.70	3.50	4.37	3.53
JB	7.66	4.57	27.62	4.64
Prob	0.02	0.10	0.00	0.00

Panel B: *Cross Correlations of returns*

Market	Pakistan	India	Sri-Lanka	Bangladesh
Pakistan	1			
India	0.16	1		
Sri Lanka	0.17	0.06	1.0	
Bangladesh	0.017	0.00	0.00	1.0

Panel C: *Unit Root Test*

Market	ADF		PP	
	Intercept without trend	Intercept with trend	Intercept without trend	Intercept with trend
Pakistan	-16.72*	-17.16*	-16.71*	-17.14*
India	-17.96*	-17.94*	-18.10*	-18.08*
Sri Lanka	-13.41*	-13.44*	-13.45*	-13.47*
Bangladesh	-14.26*	-14.24*	-14.26*	-14.24*

* Significant at 1 % level of Significance.

3.2. Unit Root Test

In the case of time-series data, investigating the behavior of variables is most important because the stationary and non-stationary data have different statistical tools for analysis. There are various tests for examining the stationarity of data, however in the study, we are using the two most popular tests of unit root, that is, the Augmented Dickey-Fuller test (ADF) and Phillip Perron unit root test (PP). The key difference between the Phillip Perron test and ADF is that the Phillip Perron test allows automatic correction for autocorrelated residuals. Both of the tests are used separately for each country. According to Brooks (2019), "a series with that has constant mean and variance and the auto-covariance also constant is called stationary series"

Panel C of Table 1 provides the results of the stationarity tests. The results of both tests show that the log stock market returns are stationary for each country.

3.3. Empirical Model

The primary purpose of the study is to examine the nexus among the four larger economies of the South Asian region. The study uses multiple models to investigate the relationships among the equity markets. First, the study uses GARCH model to examine the persistence of instability. Second, to investigate the asymmetric effect, Exponential GARCH is used. And finally, to inspect the effect of shocks in one market on the volatility of other markets, the bivariate EGARCH model is employed. The next section provides the numeric presentation of all the above-mentioned models. The following equations show the GARCH (1,1).

$$y_t = \mu + \delta y_{t-1} + u_t, \qquad u_t \sim N(0, \delta_t^2) \tag{3.1}$$

$$\delta_t^2 = \omega + \alpha u_{t-1}^2 + \beta\ \delta_{t-1}^2 \tag{3.2}$$

In equation 3.1, y_t represents the conditional mean of stock returns and y_{t-1} shows the lag term of the stock market returns and its coefficient δ provide the impact of previous year returns and the current returns. Similarly, equation 3.2 represents the conditional variance. The algebraic representation of EGARCH model includes some additional components to allow for checking the leverage effect. Generally, the model can be written as following that developed by Nelson (1991):

$$\ln(\delta_t^2) = \omega + \alpha \ln(\delta_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\delta_{t-1}^2}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] \tag{3.3}$$

Where α is the coefficient ARCH term, γ shows the leverage effect, and β measures the GARCH effect in the model.

Similarly, the bivariate EGARCH model that investigates the volatility spillover between two countries (A and B), can be represented as follow:

$$\ln(\delta_{t(\mathrm{A})}^2) = \omega + \alpha \ln(\delta_{t-1(rsp)}^2) + \gamma \frac{u_{t-1}}{\sqrt{\delta_{t-1}^2}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] + \rho\ Volatality_B \tag{3.4}$$

Where ρ is the measurement of volatility spillover from country B to country A; $\ln(\delta_{t(A)}^2)$ shows the conditional variance of country A, and $Volatility_{(B)}$ represent the volatility series of country B.

4. Empirical Analysis and Discussion

4.1. Empirical Results

The empirical analysis starts from the univariate investigation of the stock returns. The results of GARCH (1, 1) model are summarized in Table 2, which provides a separate column for each country. For Pakistan, ARCH (α) term and GARCH (β) term are highly significant at 1% level. The coefficient of GARCH term is far greater than the coefficient of α term, showing that returns in Pakistan have a memory, which is greater than one period, and volatility of returns is more sensitive to past values than it is to new shocks to the market. In the case of India, the status is slightly different. Here, the α term is lower, but statistically significant at 10%. However, the β term is positive, higher than the coefficient of Pakistan, and significant at 1% level of significance. Here also the coefficient of β term is far greater than the coefficient of ARCH term, indicating that the return series of India is more sensitive to past values compared to new shocks represented by ARCH term. The coefficient of α and β are positive and significant in the case of Bangladesh and Sri Lanka, except β that is not statistically significant in the case of Sri Lanka.

The sum of α + β is near to unity suggesting that shocks to India's return series persist for many future periods. In the case of Sri Lanka, our results show that the value α is significant at 5%, however, β term is not significant. Therefore, the return series of Sri Lanka is sensitive only to new shocks. The value of α and β is not similar to unity, showing that shocks will not last for several times to come. The term and β term for Bangladesh are both extremely important at 1%. The coefficient of β term is far greater than the coefficient of α term this indicates that the return series of Bangladesh is more sensitive to past values than it is to new shocks. The sum of α + β is close to unity and therefore shocks to return series of Bangladesh will persist for many future periods.

Table 2

Panel A: *Estimation of GARCH (1, 1) Models*

The table shows the results for GARCH model that allows to predict the volatility of variable through volatility of the previous year. The values in the parenthesis are p-values of each of the coefficients.

$$\delta_t^2 = \omega + \alpha u_{t-1}^2 + \beta \delta_{t-1}^2$$

	Pakistan	India	Sri Lanka	Bangladesh
Constant, ω	1.51 (0.10)	0.11 (0.24)	0.85* (0.05)	0.20** (0.04)
α	0.17*** (0.00)	0.04* (0.08)	0.13* (0.05)	0.13*** (0.00)
β	0.55*** (0.00)	0.92*** (0.00)	0.30 (0.35)	0.79*** (0.00)
α + β<1	0.72	0.96	0.43	0.92
LL	-770.02	-699.90	-552.21	-660.89
Schwarz Info.Criterion, SIC	4.57	4.16	3.29	3.97

"* shows the significance at 10%"
"** shows the significance at 5%"
"*** shows the significance at 1"
"LL is Log Likelihood"
"SS is Schwarz Info.Criterion,SIC"

Panel B: *Results of EGARCH*

The table shows the results of EGARCH model of the return of equity market for each country. The values in parenthesis are p-values for each of the coefficients.

$$\ln(\delta_t^2) = \omega + \alpha \ln(\delta_{t-1}^2) + \gamma \frac{u_{t-1}}{\sqrt{\delta_{t-1}^2}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right]$$

	Pakistan	India	Sri Lanka	Bangladesh
ω	0.16 (0.35)	0.96*** (0.00)	-0.04 (0.64)	-0.14** (0.02)
α	0.28*** (0.00)	0.13 (0.38)	0.28*** (0.00)	0.27*** (0.00)
γ	-0.19*** (0.00)	-0.27*** (0.00)	-0.12** (0.03)	-8.34 (0.99)
β	0.75*** (0.00)	0.13 (0.59)	0.54*** (0.00)	0.92*** (0.00)
LL	-762.10	-697.07	-550.42	-660.91
SS	4.54	4.16	3.30	3.99

"* shows the significance at 10%"
"** shows the significance at 5%"
"*** shows the significance at 1"
"LL is Log Likelihood"
"SS is Schwarz Info.Criterion,SIC"

The results of EGARCH models for all the equity markets' returns are listed in Panel B of table2. In all markets, the EGARCH model is used to identify asymmetries. The standard GARCH does not allow for the asymmetric effect of positive and negative shocks. However, it is observed that volatility is higher after negative shock compared to positive shock and this is called the leverage effect. Leverage term,, captures asymmetries in the series. If the leverage term is negative and significant then it implies the series shows leverage effect and bad news has more effect on the series compared to the good news. The results show that the coefficients of leverage for all economies is negative and significant except Bangladesh, meaning that there is a leverage effect in all markets except the equity market of Bangladesh.

Volatility Spillover from India, Sri Lanka, and Bangladesh, to Pakistan

Bivariate EGARCH models are estimated to determine whether volatility in stock markets of India, Sri Lanka, and Bangladesh affects the volatility in stock returns of Pakistan. If the spillover coefficient is significant, we can say that volatility in the markets of countries other than Pakistan affects volatility in Pakistan. Table 3 shows that the spillover coefficient from India to Pakistan and the spillover coefficient from Sri Lanka to Pakistan is insignificant. This means that volatility in Indian and Sri Lanka stock markets is not transmitted to Pakistan's stock market. In the case of Bangladesh, the spillover coefficient is significant and this means that stock market volatility is transmitted from Bangladesh to Pakistan. However, since the spillover coefficient is negative, this implies that volatility in the stock market of Bangladesh has an inverse effect on the volatility of the stock market of Pakistan. Besides, in the case of all economies, the leverage effect coefficient is negative and large, suggesting that negative news has a higher impact on volatility than positive news.

Volatility Spillover from India, Sri Lanka, and Pakistan, to Bangladesh

Table 4 gives results of the bivariate EGARCH model that takes the conditional volatility of the Bangladesh equity market as a dependent variable and the volatility of the other countries as an independent variable. Each column provides the separate results for the spillovers of each country on the equity market of Bangladesh.

Table 3: *Volatility Spillover from India, Sri Lanka, Bangladesh, to Pakistan*

The table shows the results of bivariate EGARCH model to investigate the volatility spillover from the equity markets of India, Sri Lanka, and Bangladesh to the equity market of Pakistan. The values in parenthesis are p-values of the coefficients.

$$\ln(\delta^2_{t(Pakistan)}) = \omega + \alpha \ln(\delta^2_{t-1(\text{rsp})}) + \gamma \frac{u_{t-1}}{\sqrt{\delta^2_{t-1}}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] + \rho \ Volatality_{t(India/Lanka/Bangladesh)}$$

	India	Sri Lanka	Bangladesh
ω	0.16 (0.35)	0.17 (0.35)	0.10 (0.44)
α	0.28*** (0.00)	0.29*** (0.00)	0.24** (0.01)
γ	-0.18** (0.01)	-0.19*** (0.00)	-0.17*** (0.00)
β	0.75*** (0.00)	0.75*** (0.00)	0.81*** (0.00)
ρ	-0.01 (0.56)	-0.00 (0.82)	-0.05* (0.08)
LL	-761.96	-762.07	-753.45
SS	4.55	4.55	4.5

"* shows the significance at 10%"
"** shows the significance at 5%"
"*** shows the significance at 1"
"LL is Log Likelihood"
"SS is Schwarz Info.Criterion,SIC"

Table 4: *Volatility Spillover from India, Sri Lanka, Pakistan, to Bangladesh*

The table shows the results of bivariate EGARCH model to investigate the volatility spillover from the equity markets of India, Sri Lanka, and Pakistan to the equity market of Bangladesh. The values in parenthesis are p-values of the coefficients.

$$\ln(\delta^2_{t(Bangladesh)}) = \omega + \alpha \ln(\delta^2_{t-1(rsp)}) + \gamma \frac{u_{t-1}}{\sqrt{\delta^2_{t-1}}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] + \rho Volatality_{t(India/Sri-Lanka/Pakistan)}$$

	India	Sri Lanka	Pakistan
ω	-0.14(0.0)	-0.14(0.2)	-0.10(0.15)
α	0.26(0.00)	0.26(0.00)	0.23(0.00)
γ	0.00(0.95)	0.00(0.96)	-0.00(0.89)
β	0.93(0.00)	0.93(0.00)	0.90(0.00)
ρ	-0.016(0.54)	0.02(0.28)	0.04(0.03)
LL	-660.72	-660.36	-658.28
SS	4.01	3.97	3.99

"* shows the significance at 10%"
"** shows the significance at 5%"
"*** shows the significance at 1"
"LL is Log Likelihood"
"SS is Schwarz Info.Criterion,SIC"

Only in the case of Pakistan, which shows that volatility transmits from Pakistan stock market to Bangladesh stock market, the coefficient of spillover effect is significant. The positive sign of the coefficient indicates that an increase in volatility of the Pakistan equity market causes an increase in the Bangladesh equity market. In contrast, the volatility spillover effect from India and Sri Lanka equity market is not statistically significant. Moreover, there is no evidence of asymmetric or leverage effect because the coefficient of the leverage effect is not statistically significant in the case of all other countries.

Volatility Spillover from India, Bangladesh, and Pakistan, to Sri Lanka

Table 5 summarizes the results of the EGARCH model. In this model, the conditional volatility of the Sri Lankan market is a dependent variable. It investigates the influence of other markets on capital market returns' volatility of Sri Lanka. The coefficient of stock market volatility of India and Bangladesh is negative and significant. This indicates that changes in India's financial market's returns and Bangladesh's capital market are rising Sri Lanka's stock market shocks. On the other hand, fluctuation in Pakistan's stock market returns does not substantially disrupt Sri Lanka's supply of market returns.

Volatility Spillover from, Bangladesh, Sri Lanka, and Pakistan, to India

Table 6 presents the outcomes for transmitting shocks from Bangladesh, Sri Lanka, and Pakistan's financial market to India's stock market. In various countries the spillovers are different. For example, the stock market returns of Bangladesh negatively influence the stability of the Indian capital market. Conversely, the shocks in Pakistan and Sri Lanka's market returns do not significantly affect India's market returns. The table also demonstrates that the shock is transmitted asymmetrically by the entire stock market, i.e., negative shocks (bad news) have a greater impact than positive shocks or good news.

4.2. Discussion

The results provide interesting insights about the association between the major South Asian stock markets. The countries in the region have a shared culture, values, and religion. Therefore, the results are important in highlighting how these countries affect the economic stability of each other. The study provides mixed results for each pair of countries. This finding is in line with the literature that argues that geographical location affects the spillover between two countries. For example, the equity market of Pakistan has no association with the equity markets of India and Sri Lanka. However, the same market has a two-way spillover effect with the market of Bangladesh. Although the directions are inverse, that is Pakistan equity market has a positive effect on the volatility of the Bangladesh equity market, while Bangladesh stock market has a negative impact on the stock market of Pakistan that is also asymmetric in nature. This finding may be explained by the political relationship among the countries.

Table 5: *Volatility Spillover from India, Bangladesh, Pakistan, to Sri Lanka*

The table shows the results of bivariate EGARCH model to investigate the volatility spillover from the equity markets of India, Bangladesh, Sri Lanka, and Pakistan to the equity market of Sri Lanka. The values in parenthesis are p-values of the coefficients.

$$\ln(\delta^2_{t(Sri-Lanka)}) = \omega + \alpha \ln(\delta^2_{t-1(rsp)}) + \gamma \frac{u_{t-1}}{\sqrt{\delta^2_{t-1}}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] + \rho\, Volatality_{t(India/Bangladesh/Pakistan)}$$

	India	Pakistan	Bangladesh
ω	-0.01 (0.87)	-0.04 (0.64)	-0.01 (0.84)
α	0.24** (0.03)	0.28*** (0.00)	0.19** (0.04)
γ	0.13** (0.03)	0.12** (0.04)	0.09 (0.13)
β	0.55*** (0.00)	0.54*** (0.00)	0.65*** (0.00)
ρ	-0.07** (0.02)	0.00 (0.99)	-0.07*** (0.00)
LL	-548.44	-550.42	-541.07
SS	3.30	3.32	3.30

"* shows the significance at 10%"
"** shows the significance at 5%"
"*** shows the significance at 1"
"LL is Log Likelihood"
"SS is Schwarz Info.Criterion,SIC"

Table 6: *Volatility Spillover from, Bangladesh, Sri Lanka, Pakistan, to India*

The table shows the results of bivariate EGARCH model to investigate the volatility spillover from the equity markets of Pakistan, Bangladesh, Sri Lanka, and Pakistan to the equity market of India. The values in parenthesis are p-values of the coefficients.

$$\ln(\delta^2_{t(India)}) = \omega + \alpha \ln(\delta^2_{t-1(rsp)}) + \gamma \frac{u_{t-1}}{\sqrt{\delta^2_{t-1}}} + \beta \left[\frac{|u_{t-1}|}{\sqrt{\delta^2_{t-1}}} - \sqrt{\frac{2}{\pi}} \right] + \rho\, Volatality_{t(Pakistan/Bangladesh/Sri-Lanka)}$$

	Pakistan	Sri Lanka	Bangladesh
ω	0.93*** (0.00)	0.84** (0.01)	0.15* (0.09)
α	0.16 (0.30)	0.14 (0.31)	0.07 (0.30)
γ	-0.26*** (0.00)	-0.25*** (0.00)	-0.17*** (0.00)
β	0.14 (0.55)	0.21 (0.43)	0.82*** (0.00)
ρ	-0.04 (0.15)	-0.06 (0.21)	-0.04* (0.06)
LL	-695.94	-696.37	-685.53
SS	4.17	4.16	4.15

"* shows the significance at 10%"
"** shows the significance at 5%"
"*** shows the significance at 1"
"LL is Log Likelihood"
"SS is Schwarz Info.Criterion,SIC"

The shocks in the equity market of India have a significant impact on the volatility of the financial markets of Bangladesh and Sri Lanka. Similarly, the instability of the equity market of Sri Lanka has a negative association with the equity market of India as well as Bangladesh, but does not affect the equity market of any other country. The findings are not similar to the results of Sharma and Bodla (2011) who found that the equity market of India significantly affects the stock markets of Sri Lanka and Pakistan. The contradiction may be attributed to the time period and methodology selection. However, the results are in line with the findings of (Iqbal et al., 2020) who reported a significant spillover effect from India to Sri Lanka and Bangladesh. The finding also validates the argument of Mukherjee and Mishra (2010) that Indian equity significantly influences the capital market of Sri Lanka.

5. Conclusion

This paper tests for the nexus among the South Asian economies – Pakistan, India, Sri-Lanka, and Bangladesh. For checking the presence of leverage effect, the study employs EGARCH model. To investigate the spillovers among the targeted countries, the bivariate EGARCH model is used. The study uses monthly data from February 2013 to August 2019 for empirical analysis. The results of the econometric model show that there is no leverage effect existing in the stock market of Bangladesh. In contrast, there is a significant leverage effect in the context of India, Sri Lanka, and Pakistan. There are two-way spillovers between the stock returns of Pakistan and Bangladesh. Indian influences the other stock markets, but it is influenced by the shock in the equity market of Bangladesh. The volatility of the equity market of Bangladesh negatively affects the stock returns of all the economies. In contrast, the shocks in the equity market of Sri Lanka do not influence the volatility of any country in the sample. These findings are important for international investors to manage their portfolios effectively and efficiently.

References

Abou-Zaid, A. S. (2011). Volatility spillover effects in emerging MENA stock markets. *Review of Applied Economics, 7*(1076-2016-87178), 107–127.

Ahmed, I. (2014). Emerging Trends of Financial Markets Integration: Evidence from Pakistan. *Journal of Asian Finance, Economics and Business, 1*(1), 15–21.

Alam, M. N., Alam, M. S., & Chavali, K. (2020). Stock market response during COVID-19 lockdown period in India: An event study. *The Journal of Asian Finance, Economics, and Business, 7*(7), 131–137. https://doi.org/10.13106/jafeb.2020.vol7.no7.131

Ali, E., & Talukder, D. K. (2009). Preferential trade among the SAARC countries: Prospects and challenges of regional integration in South Asia. *Joaag, 4*(1), 47–59.

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.

Brooks, C. (2019). *Introductory econometrics for finance.* Cambridge, UK: Cambridge University Press.

Deep Sharma, G., & Bodla, B. S. (2011). Inter-linkages among stock markets of South Asia. Asia-Pacific. *Journal of Business Administration, 3*(2), 132–148.

Diebold, F. X., & Yilmaz, K. (2011). Equity market spillovers in the Americas. *Financial Stability, Monetary Policy, and Central Banking*, 15, 199–214.

Gerrits, R.-J., & Yuce, A. (1999). Short-and long-term links among European and US stock markets. *Applied Financial Economics, 9*(1), 1–9.

Gunasinghe, W. (2005). Behaviour of stock markets in South Asia: An econometric investigation. *South Asia Economic Journal, 6*(2), 165–191.

Hamao, Y., Masulis, R. W., & Ng, V. (1990). Correlations in price changes and volatility across international stock markets. *The Review of Financial Studies, 3*(2), 281–307.

Han, H., Kutan, A. M., & Ryu, D. (2015). Effects of the US stock market return and volatility on the VKOSPI. *Economics: The Open-Access, Open-Assessment E-Journal, 9*(2015-35), 1–34.

In, F., Kim, S., Yoon, J. H., & Viney, C. (2001). Dynamic interdependence and volatility transmission of Asian stock markets: Evidence from the Asian crisis. *International Review of Financial Analysis, 10*(1), 87–96.

Iqbal, H. R., Saeed, S. K., & Shah, S. Z. A. (2020). Structural Breaks and Volatility Spillover in South Asian Economies. *SEISENSE Journal of Management, 3*(1), 64–77.

Khan, K., Zhao, H., Zhang, H., Yang, H., Shah, M. H., & Jahanger, A. (2020). The impact of COVID-19 pandemic on stock markets: An empirical analysis of world major stock indices. *The Journal of Asian Finance, Economics, and Business, 7*(7), 463–474. https://doi.org/10.13106/jafeb.2020.vol7.no7.463

Li, Y., & Giles, D. E. (2015). Modelling volatility spillover effects between developed stock markets and Asian emerging stock markets. *International Journal of Finance & Economics, 20*(2), 155–177.

Lu, X., & Gao, H. (2016). The Day of the Week Effect in Chinese Stock Market. *Journal of Asian Finance, Economics and Business, 3*(3), 17–26. https://doi.org/10.13106/jafeb.2016.vol3.no3.17.

Majdoub, J., & Mansour, W. (2014). Islamic equity market integration and volatility spillover between emerging and US stock markets. *The North American Journal of Economics and Finance, 29*, 452–470.

Mensi, W., Hammoudeh, S., Nguyen, D. K., & Kang, S. H. (2016). Global financial crisis and spillover effects among the US and

BRICS stock markets. *International Review of Economics & Finance, 42,* 257–276.

Mittoo, U. R. (1992). Additional evidence on integration in the Canadian stock market. *The Journal of Finance, 47*(5), 2035–2054.

Mukherjee, K., & Mishra, R. K. (2010). Stock market integration and volatility spillover: India and its major Asian counterparts. *Research in International Business and Finance, 24*(2), 235–251.

Neaime, S. (2012). The global financial crisis, financial linkages and correlations in returns and volatilities in emerging MENA stock markets. *Emerging Markets Review, 13*(3), 268–282.

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica: Journal of the Econometric Society*, *59*(2), 347–370.

Offner, J. M. (2000). 'Territorial deregulation': local authorities at risk from technical networks. *International Journal of Urban and Regional Research, 24*(1), 165–182.

Rejeb, A. B., & Arfaoui, M. (2016). Financial market interdependencies: A quantile regression analysis of volatility spillover. *Research in International Business and Finance, 36*, 140–157.

Sharma, G. D., & Bodla, B. (2011). Inter-linkages among stock markets of South Asia. *Asia-Pacific Journal of Business Administration*, *3*(2), 132–148.

Singh, P., Kumar, B., & Pandey, A. (2010). Price and volatility spillovers across North American, European and Asian stock markets. *International Review of Financial Analysis, 19*(1), 55–64.

Wei, K. J., Liu, Y. J., Yang, C. C., & Chaung, G. S. (1995). Volatility and price change spillover effects across the developed and emerging markets. *Pacific-Basin Finance Journal, 3*(1), 113–136.

Worthington, A. C., & Higgs, H. (2007). *Evidence of financial integration in Asia: an empirical application of panel unit root tests and multivariate cointegration and causality procedures*. University of Wollongong, School of Accounting and Finance Working Paper Series No. 07/09.

Yang, S. Y. (2005). A DCC analysis of international stock market correlations: the role of Japan on the Asian Four Tigers. *Applied Financial Economics Letters, 1*(2), 89–93.

Yavas, B. F., & Dedi, L. (2016). An investigation of return and volatility linkages among equity markets: A study of selected European and emerging countries. *Research in International Business and Finance, 37,* 583–596.

Yu, W., & Yoon, Y. (2019). *The Volatility Comovement among Stock Markets in East Asian Countries.* Chulalongkorn University.

Zhang, W., Zhuang, X., Lu, Y., & Wang, J. (2020). Spatial linkage of volatility spillovers and its explanation across G20 stock markets: A network framework. *International Review of Financial Analysis*, 101454.