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International Information Spillovers and Asymmetric Volatility in South Asian Stock Markets

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Abstract: This is the first comprehensive study to investigate the dynamics of international information spillovers, regional linkages and fundamental forces driving return volatility in the SAARC (South Asian Association for Regional Cooperation) member nation equity markets. We propose a multi-factor model nested within the generalized autoregressive conditional heteroskedasticity framework and enlist comprehensive equity market data. While modeling, we consider global, regional (Asia), and largest neighboring (India) equity markets as sources of information spillover. Our results show that equity returns in all these South Asian markets have positive autocorrelation. The equity markets of India, Pakistan, and Sri Lanka have some degree of global integration; however, their degree of regional integration is comparatively higher. The stock markets of Bangladesh and Nepal, in contrast, lack both global and regional integration. We find limited evidence of neighborhood (India) spillover effect on other markets in the sample. The stock markets of Bangladesh, India and Pakistan stock markets exhibit asymmetric volatility responses, while Nepal exhibits an inverted asymmetric volatility response, and in contrast Sri Lanka exhibits a symmetric volatility response to return shocks. Finally, most of these markets experience volatility spillover effects from the US, Asia, and India stock markets.

Keywords: spillover effects; comovement; asymmetric volatility; Bangladesh; India; Nepal; Pakistan; Sri Lanka

JEL Classification: G10; G14; G15

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1. Introduction

Global integration of equity markets has given rise to an extensive literature on linkages between volatility transmission, equity returns and information spillovers (Bae and Zhang 2015; Koutmos and Booth 1995; Li and Giles 2015; Srivastava et al. 2015; Vo and Ellis 2018). Volatility is considered a fundamental phenomenon of equity market activity, widely accepted to be negatively correlated with lagged returns, i.e., the asymmetric volatility effect (Avramov et al. 2006; Black 1976; Christie 1982), with earlier studies such as Lo and MacKinlay (1990) and Conrad et al. (1991) examining the differential predictability of volatility and the impact of information spillovers to provide evidence of the one-way asymmetric predictability of larger capitalized US stocks on smaller stock returns (Pyun et al. 2000). Within this literature, larger emerging South Asian Association for Regional Cooperation (SAARC) equity markets such as India have attracted intense investor and research interest, however empirical research into spillovers, asymmetric volatility and comovements between smaller regional markets has remained significantly underexplored (Bekaert and Harvey 1997; Bekaert and Wu 2000; Habiba et al. 2020; Rahman et al. 2017).

Motivated by this research gap towards building and stimulating research in this under-charted region, this paper is the first comprehensive study to investigate the dynamics of international information spillovers, regional linkages and fundamental forces driving

return volatility in SAARC nation equity markets. This is also the first paper to distinguish international spillovers into the global, regional (Asia) and largest neighborhood (India) market. Enlisting a multi-factor model nested within a generalized autoregressive conditional heteroskedasticity (GARCH) framework and comprehensive data from 2000 to 2019 (pre-COVID 19 pandemic), we model and compare information spillover and asymmetric volatility effects across five SAARC countries—Bangladesh, India, Nepal, Pakistan and Sri Lanka, and examine the extent to which volatility in the comparatively smaller equity markets of Bangladesh, Nepal, Pakistan and Sri Lanka, is influenced by the U.S., Asian and the Indian equity stock markets. To characterize the behaviors of investors in these markets, we analyze the impact of positive and negative return shocks on volatility.

Our results show that equity returns in all these SAARC markets have positive autocorrelation and the magnitude of the autocorrelation is as high as 16.5% for Nepal and Sri Lanka. The equity markets of India, Pakistan and Sri Lanka have some degree of global integration and a comparatively higher degree of regional (Asia) integration whereas the Bangladesh and Nepal stock markets are more isolated. We find significant evidence of information spillover from the Indian to other neighboring markets, mainly for volatility spillovers. The stock markets of Bangladesh, India and Pakistan exhibit asymmetric volatility responses, the Nepalese stock market exhibits an inverted asymmetric volatility response, and the Sri Lankan stock market exhibits a symmetric volatility response to return shocks. Though our results translate the political economy of the region, there is potential for portfolio diversification in these markets due to less correlated or negatively correlated stock returns in the region.

Our paper adds to current literature in three major ways. First, our main contribution is that this is the first comprehensive study on information spillover and asymmetric volatility in the SAARC countries, an underexplored geographical region. Current literature is substantially oriented towards global market integration in mature or larger emerging equity markets, leaving a significant research gap (Bekaert and Wu 2000; Bekaert et al. 2009; Komatsubara et al. 2017). With information being a key driver of market volatility, the link between investor trading patterns and their impact on stock prices has significant implications for international investors, fund managers and policymakers. In addition, emerging markets arguably have differentiated characteristics not only because of varying levels of economic development but also due to their nascent origins wherein information efficiencies or asymmetries, volume of trading, and level of investor information can be driving forces in market volatility (Avramov et al. 2006; Javaira and Hassan 2015; Kumar and Tsetsekos 1999). It is therefore important to increase our understanding of these underexplored equity markets and sources of volatility not only for international portfolio investors and risk diversification but also from a national policy and regulatory decision perspective.

Second, we extend current literature by being the first to model for international spillovers from 3 different sources: global, regional (Asia), and largest neighborhood (India), and the first to test investor behavior and market efficiency in these markets (the level of autocorrelation on return series). We explicitly model first order and second order moments while capturing information spillovers in returns and volatility.

Third, many studies examining volatility in international markets focus on special events such as a market crash, a specific market (such as the US), or a specific source of risk (Bekaert and Harvey 1997; Bekaert and Wu 2000; Bekiros et al. 2017). However, comovements within various Asian financial markets are also significant for investors, financial institutions, and governments and it is vital to understand how the asymmetric volatility phenomenon plays out and affects investor behaviour, especially in markets where financial literacy is lower and trading by uninformed or less informed investors may exhibit herding behavior which can impact the stock returns process very differently (Avramov et al. 2006; Chang et al. 2000; Chiang and Zheng 2010; Corsetti and Pesenti 2005; Dungey and Gajurel 2014, 2015).

The remainder of the paper is organized as follows: Section 2 reviews the relevant literature including a brief overview of the SAARC equity markets; Section 3 elaborates the empirical framework and data; Section 4 provides the results and discussions and finally, Section 5 concludes the paper.

2. Review of Literature

2.1. An Overview of the SAARC Markets

The SAARC countries are the least studied and underexplored markets in Asia. SAARC was established in 1995 in Dhaka, Bangladesh, with the aim of accelerating the economic, social, and cultural development and bettering the welfare of the citizens of its member nations. It is comprised of eight countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. These nations display significant variations in size, equity market characteristics, economic development, legal and institutional settings, trading mechanisms, regulatory environment, and level of global and regional integration (Gajurel 2019; Rahman et al. 2017). As a results, each market can act and react differently to the nature and effect of global spillovers and shocks as well as investor strategy and policy initiatives.

Developing markets such as SAARC nations, compared to developed countries, also have relatively higher levels of individual investor participation with lower access to information, which contributes to higher levels of market manipulation, more pronounced noise and herding behaviour, and lower presence of institutional investors. This can impact investor behaviour, lead to higher market volatility, and market destabilization, thus making these markets overall more fragile (Chang et al. 2000; Lao and Singh 2011). In contrast, in developed markets, even individual investors can have access to investing resources and tools and markets research reports (American Association of Individual Investor—www.aaii.com, accessed on 1 July 2021). Though many of these emerging SAARC equity markets have been considered underdeveloped, segmented, not fully integrated and more likely be influenced by local factors, financial deregulation and opening of domestic markets to international investors has been found to increase market volatility due to the oscillating nature of international capital flows (Bekaert and Harvey 1997, 2003; Bekaert and Wu 2000; Habiba et al. 2020; Kumar and Tsetsekos 1999; Rahman et al. 2017). Kumar and Tsetsekos (1999) argue that "emerging" markets have differentiated characteristics not only because of varying levels of economic development but also due to their nascent origins. Key drivers connected to market volatility in emerging markets include information asymmetries (Kumar and Tsetsekos 1999); volume of trading (Javaira and Hassan 2015); and the amount of investor information (Avramov et al. 2006; Gajurel 2019).

However, these differing levels of integration, volatility spillovers and asymmetric information transmission in these emerging markets are also key for investors to benefit from portfolio and risk diversification. With continuing rise in growth, foreign investor sentiment has been turning progressively positive, fueling multi-dimensional investigations into the nature, forces, interactions, and transmission linkages driving volatility diversification (Li and Giles 2015).

India is one of the largest emerging equity markets in the world, the sixth largest global economy in terms of GDP in 2020 and a population of approximately 1.4 billion. It is the largest economy in the SAARC region and a significant trading partner of the neighboring countries of Bangladesh, Nepal, Pakistan, andSri Lanka. In the 1990's, it opened its capital markets to international investors, strengthened regulatory structures, and introduced advanced information technology. Its two largest stock exchanges are the Bombay Stock Exchange (www.bseindia.com, accessed on 1 July 2021), the oldest stock exchange in the continent of Asia, and the National Stock Exchange (www.nseindia.com, accessed on 1 July 2021).

Bangladesh is the second largest SAARC nation, ranked the 38th largest economy in the world. Its first stock exchange, the Dhaka Stock Exchange (DSE, www.dsebd.org, accessed on 1 July 2021), was incorporated in 1952 at the East Pakistan Stock exchange,

while Bangladesh was still a part of Pakistan. The exchange started automated trading in 1998 and established the DSE Chittagong and DSE Sylhet offices in 2007 and 2008 respectively. It became a member of the World Federation of Exchanges in 2016. Pakistan is the third largest economy in the SAARC sample countries, and the 43rd largest economy in the world. A period of low economic growth and political instability in the 1970's, lead to an era of privatization and liberalization in the 1980's–90's. Its largest stock exchange, the Karachi Stock exchange (KSE), was set up in 1947. The Lahore Stock exchange was established in 1970, followed by the Islamabad stock exchange in 1989. In 2016, the operations of all three exchanges were merged to form the Pakistan Stock Exchange Limited (www.psx.com.pk, accessed on 1 July 2021) with trading floors in Karachi, Lahore, and Islamabad. Sri Lanka ranked 66th largest economy in the world in terms of GDP in 2020. A prolonged civil war that spanned 25 years and ended in 2009, created an economic downturn and substantially affected the country's growth, economy, and equity markets (Srianantha kumar and Narayan 2015). The Colombo Stock Exchange (www.cse.lk, accessed on 1 July 2021) was established in 1985 with the amalgamation of two stock brokerages–the Share Brokers Association (SBA) and the Colombo Brokers Association. Nepal is the smallest economy in the sample group and the 97th largest economy in the world. The Securities Exchange Center Ltd. was established in 1976 and converted into the Nepal Stock exchange (NEPSE, www.nepalstock.com, accessed on 1 July 2021) in 1993. The NEPSE opened its trading floor in January 1994. Nepal became a member of World Trade Organization in 2004. Table 1 provides a summary of key indicators for the sample markets.

Table 1. Fundamental Indicators.

	Bangladesh	India	Nepal	Pakistan	Sri Lanka
Market capitalization (in $ billion)	64.42	2290	15.84	41.6	15.72
Number of listed companies	611	5215	212	544	289
Market cap/GDP ratio	18.3	80.8	47.6	14.6	18.7
Population (in million)	163	1370	29	217	22

Source: Compiled from various World Bank Reports and other country specific security exchange commissions' publications.

2.2. Literature on Asymmetric Volatility and Information Spillover

Volatility refers to the risk of change to a stock price caused by the continuous adjustment to new information whereas asymmetric volatility is the negative relationship between volatility and unexpected return shock (Avramov et al. 2006), or in other words, the phenomenon where negative shocks increase market volatility by more than positive shocks of the same magnitude in mature markets. Engle (2004) examines the impact of dynamic (asymmetric) volatility and the use of autoregressive conditional heteroskedasticity (ARCH) models to forecast long horizon volatility and risk while French and Roll (1986) suggest that trading activity itself could be creating volatility in stock prices and that differences in time flow of information have significant impact on variance.

Asymmetric volatility is attributed to three key sources: (1) the financial leverage effect (Black 1976; Christie 1982), (2) the volatility feedback effect (Campbell and Hentschel 1992; French et al. 1987), and (3) investor behavior theories (Avramov et al. 2006; French and Roll 1986). The financial leverage effect connects stock price volatility to changes in its financial leverage, where a drop in returns leads to a decline in firm value, making its equity riskier and increasing its volatility. Literature often interprets the leverage effect and the asymmetric effect synonymously. However, leverage effect can be observed though lower frequency data such as quarterly or annually whereas asymmetric effect can be better measured with high frequency data such as daily as well. The volatility feedback effect suggests that an increase in market volatility leads to a higher risk premium, and a decline in stock price, which increases volatility. Investor behavior theories suggest that the asymmetric volatility arises due to biases of investors under uncertainty (Horpestad et al. 2019).

Research from the 1970's and 1980's that enlist the theory of efficient markets combined with rational expectation theory (where investors have access to all available information and form homogeneous expectations to maximize rational utility), was unable to explain excess volatility (Demirer and Kutan 2006; Fama 1970). Many of these studies argued that crisis periods and high uncertainty created anomalies facilitating such deviations (Economou et al. 2016). However more recent behavioral finance literature has provided extant evidence and explanations of excess volatility that affect the pricing mechanism and trading decisions of investors (Javaira and Hassan 2015), including market conditions and behavior such as herding, where investors mimic the action of others instead of making decisions based on market fundamentals and cause excess volatility (Banerjee 1992; Lam and Qiao 2015). So, herding behavior can represent a rational act of utility maximization (rational herding), though not an informed trading strategy or an irrational act of choosing to imitate others in a time of uncertainty or imitate those considered to be better informed (Blasco et al. 2012; Lam and Qiao 2015).

Some studies argue that uninformed trading and herding behavior can raise market volatility, while papers such as Avramov et al. (2006) offer a trading-based argument, governed by the dynamics between informed and uninformed traders, for the asymmetric effect in daily volatility of individual stock returns. Avramov et al. (2006) conclude that trading by uninformed investor (or herding phenomenon) has a strong/robust effect on the relationship between daily volatility and lagged return. In line with the rational expectation model, trading by uninformed investors increases volatility after stock price decline, while trading by informed investors reduces volatility after stock price increases. Depending on the level of information and market dominated by informed or less informed investors and speculators can increase the volatility and fragility of a market where asymmetric volatility is driven by the selling activity of uninformed traders, particularly small-size trades.

Information spillover effects, contagion and comovements at the individual country level as well as dynamic linkages between mature and emerging markets has an extensive body of literature (Cornelius 1992; Dungey and Gajurel 2014; Harvey 1991; King and Wadhwani 1990; Koutmos and Booth 1995; Lee et al. 2004; Sarwar 2012; Syriopoulos 2011). Early literature in international spillover effects had a strong focus on special events such as the U.S. stock market crash of October 1997, the 2007–2009 global financial crisis (Baur 2012; Bekaert et al. 2014; Dungey and Gajurel 2015) and recent Covid-19 Pandemic (Chaudhary et al. 2020). Studies such as King and Wadhwani (1990) investigate why stock markets around the world with vastly different economic environments, including the US, fell dramatically and uniformly in the October 1997 crash and argue that rational agents infer information from markets, creating a channel through which international information transmission and financial contagion can take place. Shiller et al. (1991) examine U.S. and Japanese institutional investors during the market crash of 1987 to conclude attitude and behavioral similarities in both markets and crash transmission mechanisms. Koutmos and Booth (1995) investigate the transmission mechanism of price and volatility spillovers across the New York, Tokyo, and London stock markets to conclude that, comparatively, national markets were more interdependent after the October-1997 crash.

A large cross section of the spillover literature focuses on mature markets in the US, Europe, South-East Asia, and Latin America (Bekaert and Harvey 2003), while others focus on mature and emerging Asian markets such as Tokyo, China, Singapore, Japan, and South Korea (Cornelius 1992; Hamao et al. 1990; Huyghebaert and Wang 2010; Koutmos and Booth 1995; Yousaf et al. 2020). Some volatility studies focus on specific sectors (Kyriazis 2019; Trabelsi 2018; Yip et al. 2020). Studies such as Syriopoulos (2011) focus on major Balkan equity markets, namely Romania, Bulgaria, Croatia, Turkey, Cyprus, and Greece to examine the risk and return profile of international portfolios allocated by investors compared to allocations in developed markets of Germany and the US. Lee et al. (2004) investigate second board markets for evidence of spillovers from NASDAQ returns and volatilities to Asian market returns and volatilities to find strong evidence of lagged returns and volatility spillovers from NASDAQ to the Asian markets. Li and Giles (2015) examine

the shock and volatility spillovers between the developed equity markets in the US, Japan and six emerging Asian nations including China, India, Indonesia, Malaysia, Philippines, and Thailand between 1993–2012.

More recent research, after many global financial crises, has expanded its focus on special events research to include comovements between international markets, attributed to factors such as globalization (Bekaert et al. 2009; Dungey and Gajurel 2014, 2015; Morana and Beltratti 2008; Rua and Nunes 2009) and increased comovements within sectors (Gajurel and Chawla 2022). Studies such as Bekaert and Harvey (1997) examine returns and returns volatility in emerging markets to conclude that though liberalization can increase correlation between domestic market returns of emerging markets and the world market, it does not increase domestic market volatility. Srianantha kumar and Narayan (2015) investigate the US and emerging Asian stock markets for the period between 1992–2014 to argue that the extended and extensive contagion effect of 1997 could have been caused by increased global stock market integration. Boyer et al. (2006) investigate the global transmission of country specific events to argue that stock market crises are spread globally through the asset holdings of international investors. As expected, comovement linkages are found to be particularly strong now between major mature markets such as the US and Europe. Overall, as compared to studies in earlier decades, more recent studies find that with increased integration of global markets and technological advances, integration and transmission effects have also strengthened significantly.

The paragraphs above explore the research progression of asymmetric volatility from the 1970's towards the more recent US, international and country-level studies in developed and emerging equity markets focusing on herding behaviours, volatility, information spillovers and co-movements. However, the connection of emerging SAARC member nations in South Asia to this literature remains tenuous and fairly limited. Within current studies, there is a strong focus on individual country-specific volatility modeling. For example, Goudarzi and Ramanarayanan (2011) enlist asymmetric ARCH models to study the impact of good and bad news on volatility in the Indian stock market during the 2008–2009 global financial crisis. Husain and Uppal (1999) use daily stock price data to examine stock return volatility in Pakistan with results implying current market volatilities being significantly affected by past volatilities, while Basher et al. (2007) use daily stock price data to examine time-varying risk return relationship in the Bangladesh equity markets with results displaying significant serial correlation indicating stock market inefficiency. Gajurel (2019) examines asymmetric volatility for the Nepalese stock market and finds an inverted asymmetric volatility effect. No previous study, to our knowledge, has investigated these countries in relation to each other and to the US. This paper intends to address this research gap.

3. Empirical Framework

To capture information spillovers from international equity markets to the stock markets in our sample countries, we propose a multi-factor model nested within a GARCH framework so that we can embed information spillovers both in first order moment and second order moment conditions along with the asymmetric response of return shocks on the volatility. In this section we formalize our model, and describe our sample and data.

3.1. The Multi-Factor Model

We extend a global Capital Asset Pricing Model (CAPM) to a multi-factor model by including two additional factors: the Asian factor and Indian factor. The literature suggest that emerging and/or developing equity markets could be more integrated at the regional level considering their trade and finance linkages including the similar trading time window in the region which may have information spillover. Regarding the Indian factor, the Indian equity market is one of the largest emerging equity markets in the world, the Indian economy is the largest economy in the South Asian region, and India is an important trading partner for neighboring countries. Bekaert et al. (2007) suggest that

equity returns in emerging equity markets also exhibit autocorrelation. Therefore, we include first lag of the dependent variable as an explanatory variable. Considering the global, Asian and Indian factors, we specify our multi-factor model as follows:

$$r_{i,t} = b_{0,i} + b_{1,i} f_{W,t} + b_{2,i} f_{AS,t} + b_{3,i} f_{IN,t} + \theta r_{i,t-1} + \varepsilon_{i,t};\ \varepsilon_{i,t} \sim i.i.d.(0, \sigma_{i,t}) \quad (1)$$

where the return $r_{i,t}$ is the equity market index of country i at time t.[1] $f_{W,t}$ is the global factor, and $b_{1,i}$ captures the global factor exposure of country i and measures the degree of global integration. If the sample equity markets have some degree of global integration, we anticipate that $b_{1,i} \neq 0$. In other words, if there is a systematic information spillover effect in returns of country i from the global market then $b_{1,i} \neq 0$. f_{AS} is the Asian factor, and $b_{2,i}$ captures the level of regional integration or systematic effect of information spillovers from the returns on aggregate Asian equity market to the returns on the equity market of country i. It is anticipated that economies are more integrated at the regional level than the global level and tend to have information spillover, we hypothesize that $b_{2,i} \neq 0$ and $b_{2,i} > b_{1,i}$. f_{IN} is the Indian factor, and if there is significant information spillover from the Indian equity market to other equity markets in South Asia, we anticipate that $b_{3,i} \neq 0$. When $i = IN$, we restrict $b_3 = 0$. θ measures the degree of autocorrelation. If the market is efficient we anticipate that $\theta = 0$.

Theoretically the factors in the model follow a latent process. For ease of empirical implementation of the model, we use observed variables as proxies. For the global factor we use returns on the US aggregate equity market index because the US stock market is not only the largest equity market in the world but also has strong influence over other international equity markets. Similarly, we use return on the Asian aggregate equity index as a proxy for f_{AS}, and return on the Indian aggregate equity index as a proxy for f_{IN}. To obtain an intuitive interpretation of the estimates in Equation (1), we orthogonalized the factors. The Asian factor is orthogonalized by regressing the aggregate stock market returns for Asia on the US stock returns for the sample period and then taking the residuals of this regression as the Asian factor. Similarly, we regress the Indian equity returns on the global factor and Asian factor and take the residuals as the Indian factor.[2]

3.2. Modeling Asymmetric Volatility and Volatility Spillover

Since the seminal financial time series model introduced by Engle (1982) and generalized by Bollerslev (1986), the generalized autoregressive conditional heteroskedasticity (GARCH) models have remained a dominant econometric framework for volatility modeling. A stylized fact of financial volatility is that negative shocks tends to have a different impact on volatility than positive shocks. In general, volatility tends to be higher in a down market than in an up market. There are several ways to incorporate such asymmetric effect into a GARCH model and a well-established asymmetric model is the Exponential GARCH (EGARCH) model of Nelson (1991).[3] The literature also suggests that financial markets also exhibit volatility spillovers. To capture volatility spillovers in our sample markets we incorporate volatility spillovers from the global, Asian and Indian markets and specify the conditional variance equation as follows:

$$\begin{aligned} log(\sigma^2_{i,t}) \quad = \quad & \omega_i + \alpha_i |z_{i,t-1}| + \gamma_i z_{i,t-1} + \beta_i log(\sigma^2_{i,t-1}) \\ & + \phi_{W,i} log(\hat{\sigma}^2_{W,t}) + \phi_{AS,i} log(\hat{\sigma}^2_{AS,t}) + \phi_{IN,i} log(\hat{\sigma}^2_{IN,t}). \end{aligned} \quad (2)$$

In Equation (2) $\sigma^2_{i,t}$ is the conditional variance of market i at time t, $\sigma z_{i,t-1} = \varepsilon_{i,t-1}/\sigma_{i,t-1}$, $\hat{\sigma}^2_i$s are the conditional variances of the source markets for information spillovers. γ captures the asymmetric volatility effect. If we anticipate that negative shocks can have a larger impact on volatility, we would expect γ to be negative.[4] ϕs capture the magnitude of international volatility spillover effects. We restrict $\phi_{IN} = 0$ when $i = IN$. Since our goal is not to compare various models and not to forecast, but to investigate asymmetric volatility effect, we choose a GARCH(1,1) process.[5] Therefore, we embed the information spillovers

from the international markets (source of information) into the domestic markets (recipient markets) into our modeling framework, in Equations (1) and (2), which are the mean and variance equations respectively.

In our empirical set-up we estimate parameters for each market separately. An alternative to this approach is a system approach of multivariate GARCH (MGARCH approach) where parameters are estimated jointly for all the sample markets. As we have five markets under consideration ($n = 5$) and three additional factors in the mean and variance equations, as pointed by de Almeida et al. (2018), it is not feasible to estimate parameters in conventional MGARCH models when $n = 5$ or $n = 10$ which ask for covariance stationarity and positive definiteness of conditional covariance matrices. In addition, as indicated by a low level of correlation among the sample equity markets,[6] the MGARCH approach (implying cross-market volatility spillover) would be less appropriate.

3.3. Sample, Data, and Summary Statistics

There are eight members countries in the South Asian Association for Regional Cooperation (SAARC), namely: Afghanistan, Bangladesh, Bhutan, India, Nepal, Maldives, Pakistan, and Sri Lanka. Among these countries Afghanistan does not have a stock market and data for Bhutan and Maldives is unavailable. Consequently, our sample includes Bangladesh, India, Nepal, Pakistan and Sri Lanka. While many countries in our sample started financial development and liberalization policies between the late 1980s and mid-1990s, our sampling period covers a 20-year period, from 2000 to 2019. We exclude the COVID 19 pandemic period in our sample because these markets were closed for a substantial period during the pandemic. With the exception of Nepal, data for country specific equity indices along with the Asian and the US equity indices are from the Thompson Reuters Datastream database. Table 2 shows Datastream tickers for the respective markets. For Bangladesh, the aggregate stock market index (BDTALSH) data is only available until 25 January 2013 as the index was discontinued after this date. From 28 January 2013 onwards, there is data available on a broad stock market index (BDDSEXL) based on the Dhaka Stock Exchange. Data for the Nepal stock market is collected manually from the annual reports of the Security Board of Nepal, the Nepal Stock Exchange, and other publications in their archives. We synchronize the data, considering the 5-day working week—Monday to Friday and have used data lapping technique for synchronization. Considering time zone differences for the proxy variables we have for the factors, we include lag spillover effects from the US market and contemporaneous spillover effects from theAsian and Indian markets (Day 02 in Asia = Day 01 in the US).

Table 2. Ticker of equity indices in Datastream.

Equity Markets	Ticker/Symbol
US	TOTMKUS
Asia	TOTMKAS
Bangladesh	BDTALSH (until 25 January 2013) BDDSEXL (since 28 January 2013)
India	TOTMKIN
Pakistan	TOTKMPK
Sri Lanka	TOTMKCY

The graphs in Figure 1 show evolution of the equity market indices of the South Asian countries in our sample along with the US and Asian equity markets over last 20 years. For ease of comparison, all these indices are indexed to 100 at the beginning of the sample period. The evolution of the price process in the South Asian equity markets is more rapid than the equity markets of the US and Asia. For example, over the sample period, while the US stock market index increased by a factor of 2.4, the Bangladeshi, Indian, Pakistani and Sri Lankan markets have evolved by a factor of 7 and the Nepalese equity market

index increased by a factor of 4. During their peaks, however, these markets had even higher increase in price. For example, during its peak (around 2017), the equity index of Pakistan was as high as 9 times of its 2000 value. Similarly, the Sri Lankan market peaked at 9 folds around 2011 while Bangladeshi market rose to new heights of 14 times in 2011. The Nepalese stock market index reached at its peak in late 2016 with an increase of 7 times. During the global financial crisis period of 2007–2009, we can observe that while India and Pakistan saw a sharp decrease in the stock prices, Bangladesh, Sri Lanka and Nepal experienced only a slight decline in stock prices.

Figure 2 plots the return series for these markets. Among the sample equity markets, theIndian and Pakistani markets exhibit high volatility until 2009 which reduces in the latter half of the sample period. While Sri Lankan market shows higher volatility during the 2001–2006 period, the Bangladeshi market shows high volatility during 2011–2013. The Nepalese stock market remained volatile all the time with some exceptions around 2002–2006 as evident from many spikes (positive and negative). The return graphs also clearly show the volatility clustering in all these stock markets. Such volatility clustering indicates that volatility shocks today will influence the expected volatility in some periods in the future. Such heteroskedasticity in return series signifies our choice of GARCH framework for modeling volatility for these markets.

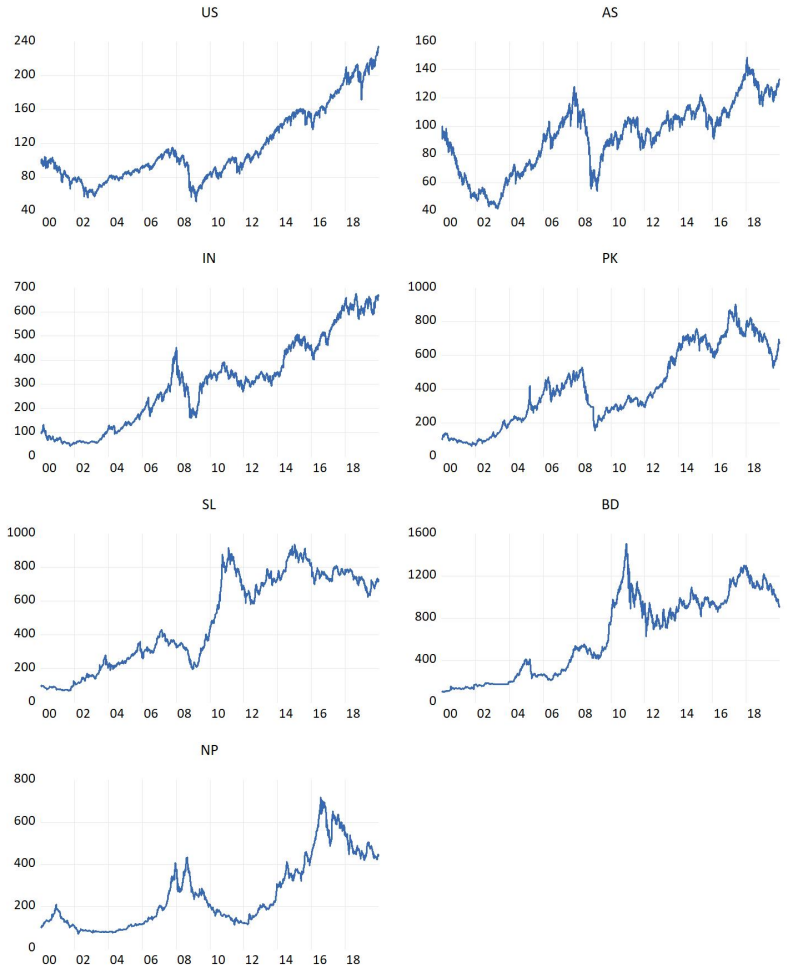

Figure 1. Equity market indices. This graph shows the evolution of the aggregate equity market indices for the sample countries. US, AS, IN, PK, SL, BD and NP refer to the US, Asia, India, Pakistan, Sri Lanka, Bangladesh, and Nepal respectively. The sample period is from 4 January 2000 to 31 December 2019. In each graph, x-axis shows the time and y-axis shows the index value. The equity indices are indexed to 100 at the beginning of the sample period. Data source: Datastream.

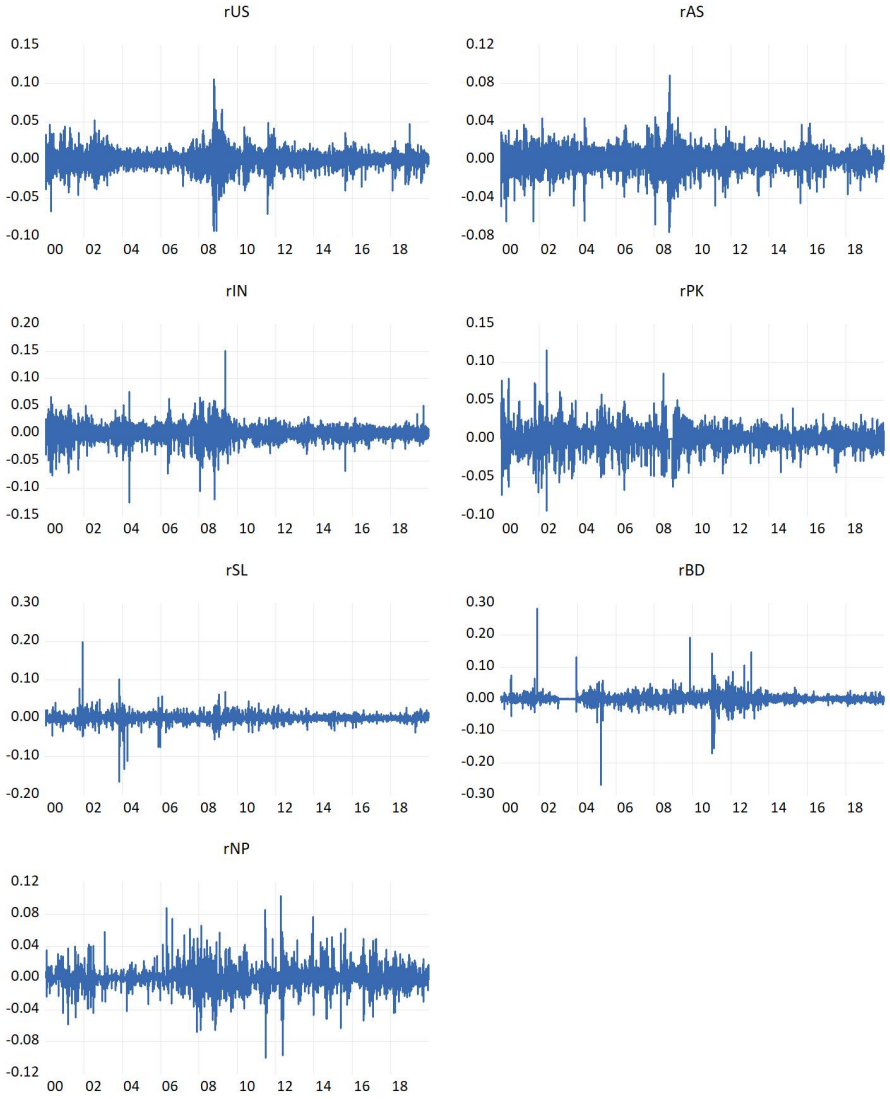

Figure 2. Equity returns. This graph shows the return on the aggregate equity market indices for the sample countries. rUS, rAS, rIN, rPK, rSL, rBD and rNP refer to the return on US, Asia, India, Pakistan, Sri Lanka, Bangladesh, and Nepal stock indices respectively. The sample period is from 4 January 2000 to 31 December 2019. In each graph, x-axis shows the time and y-axis shows the return. Data source: Datastream.

The conditional variance graphs in Figure 3 show high volatility and low volatility periods for the equity markets in our sample. The cases of high volatilities in given markets could be induced by country specific news and/or the international news. For example, we see a large increase in conditional variances for the US, Asian, India, Nepal, Pakistan and Sri Lanka during the global financial crisis. Bangladesh, for example, has experienced very high volatility during 2002, 2005, 2010 and 2012–2013. The stock market of Nepal, except for 2004–2006, has gone through relatively high volatility over the sample period. Please note that Nepal went through an civil war and had a significant number of political events during the sample period which may have affected the stock market of the country.

The descriptive statistics of the return series for the equity market indices are provided in Table 3. The table reveals that average daily return for the South Asian stock markets is about 0.04% with varying range between minimum and maximum of daily returns. The standard deviation of daily return is highest for India (1.409%) followed by Bangladesh (1.396%) while it is lowest for Sri Lanka (1.066%). Among the sample markets from SAARC,

the distribution of stock returns is skewed left for India and Pakistan and is skewed right for Bangladesh, Nepal and Sri Lanka.

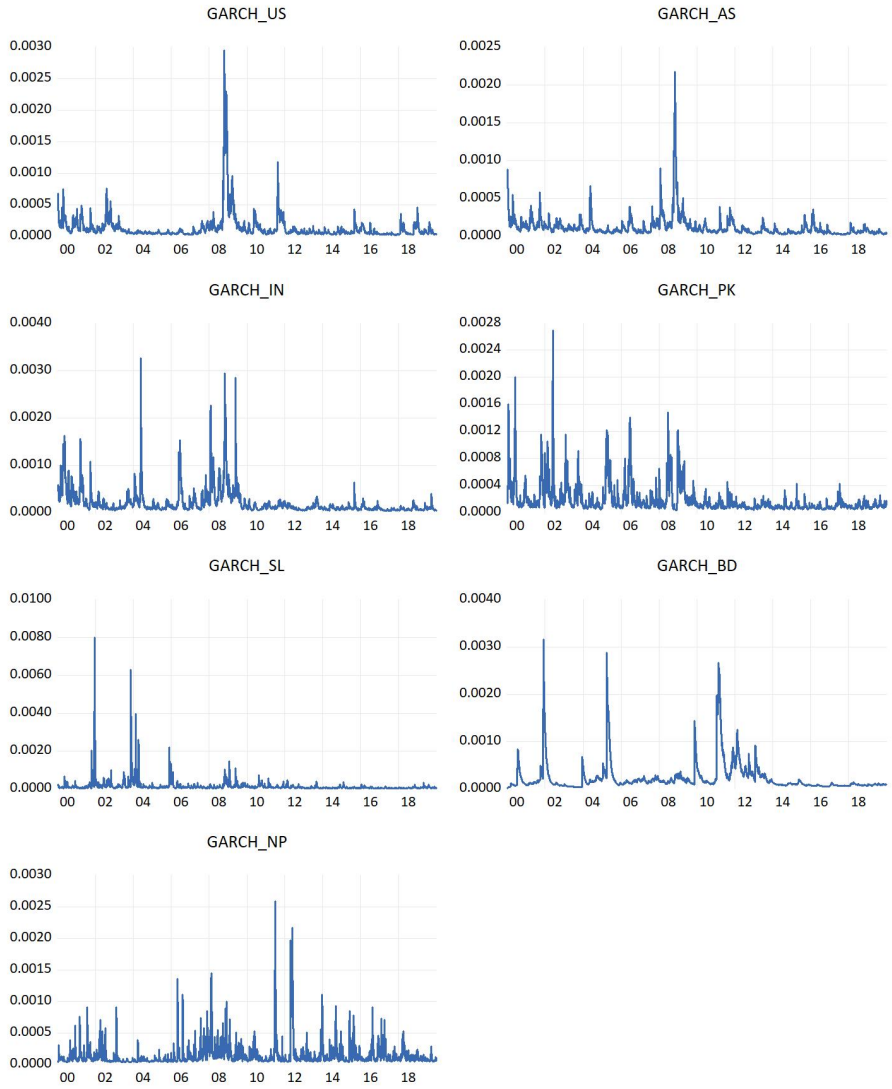

Figure 3. Conditional variances. This graph shows the conditional variances of the aggregate equity market indices for the sample countries. GARCH_US, GARCH_AS, GARCH_IN, GARCH_PK, GARCH_SL, GARCH_BD and GARCH_NP refer to conditional variances for the equity return series of the US, Asia, India, Pakistan, Sri Lanka, Bangladesh, and Nepal respectively. The sample period is from 4 January 2000 to 31 December 2019. In each panel, x-axis shows the time and y-axis shows the conditional variance. The conditional variances are estimated as GARCH(1,1) process with the mean equation: $r_{i,t} = \mu + e_{i,t}$.

Table 4 provides the correlation matrix of stock returns for the South Asian stock markets including the US and Asian stock markets. The correlation matrix reveals that the stock markets in the region are less correlated or even negatively correlated. For example, correlation coefficient between R_{BD}, and R_{NP}, and R_{BD}, and R_{SL} are small yet negative, while the correlation coefficient between R_{NP}, and R_{SL} is 0.009. The highest correlation coefficient is found for India and Pakistan, yet it is 0.098. Such low level of correlation between the markets indicates that the equity markets in the region are more independent and isolated.

Table 3. Descriptive Statistics

	R_{US}	R_{AS}	R_{BD}	R_{IN}	R_{NP}	R_{PK}	R_{SL}
Mean	0.016	0.006	0.042	0.038	0.030	0.037	0.038
Median	0.027	0.046	0.000	0.052	0.000	0.000	0.000
Maximum	10.604	8.853	28.402	15.078	10.259	11.566	19.901
Minimum	−9.332	−7.556	−26.907	−12.593	−10.069	−9.377	−16.667
Std. Dev.	1.138	1.064	1.396	1.409	1.142	1.353	1.066
Skewness	−0.281	−0.463	0.654	−0.521	0.278	−0.214	0.026
Kurtosis	12.100	8.437	86.228	12.115	14.102	8.380	51.524
Observations	5217	5217	5217	5217	5217	5217	5217

Note: R_{US}, R_{AS}, R_{BD}, R_{IN}, R_{NP}, R_{PK}, and R_{SL} refer to return on equity market indices of the US, Asia, Bangladesh, India, Nepal, Pakistan and Sri Lanka respectively. The sample period is from 4 January 2000 to 31 December 2019.

Table 4. Correlation Matrix.

	R_{US}	R_{AS}	R_{BD}	R_{IN}	R_{NP}	R_{PK}	R_{SL}
R_{US}	1.000	0.498	−0.009	0.195	−0.001	0.079	0.088
R_{AS}	0.498	1.000	0.019	0.471	−0.004	0.095	0.074
R_{BD}	−0.009	0.019	*1.000*	*0.013*	*−0.002*	*0.015*	*−0.007*
R_{IN}	0.195	0.471	*0.013*	*1.000*	*−0.026*	*0.098*	*0.046*
R_{NP}	−0.001	−0.004	*−0.002*	*−0.026*	*1.000*	*−0.014*	*0.009*
R_{PK}	0.079	0.095	*0.015*	*0.098*	*−0.014*	*1.000*	*0.033*
R_{SL}	0.088	0.074	*−0.007*	*0.046*	*0.009*	*0.033*	*1.000*

Note: R_{US}, R_{AS}, R_{BD}, R_{IN}, R_{NP}, R_{PK}, and R_{SL} refer to return on equity market indices of the US, Asia, Bangladesh, India, Nepal, Pakistan and Sri Lanka respectively. The sample period is from 4 January 2000 to 31 December 2019. The values in Italics represent the matrix for the SAARC markets.

4. Results

4.1. Results on International Information Spillover Effects

The results from the multi-factor model nested within the EGARCH for the South Asian equity markets are reported in Table 5. The results reveal that the Indian, Pakistani and Sri Lankan equity markets have some degree of global integration—the coefficient estimates for b_1 are 0.231, 0.075 and 0.07 respectively. For example, 1% point change in the return on global factor leads to about 0.23% point change in the Indian stock returns. From the International CAPM perspective, these coefficients can be interpreted as the beta of a country specific equity portfolio with respect to the global factor and indicates that these markets are exposed to global systematic risk. In other words, these markets experience significant information spillover (in returns) from global equity markets. The two other equity markets, namely Bangladesh and Nepal, however, are not exposed to the global factor indicating that these markets are not influenced by the global factor or are not exposed to the global systematic risk. In comparison, the South Asian equity markets, except for India, have volatility spillover from the global equity markets (to be more precise, the US equity market). The lack of volatility spillover effects in the Indian stock market may indicate that the information spillover is more systematic and channelled through the first order moment and not necessarily making the market more volatile. The negative sign of ϕ_W for Nepal and Sri Lanka suggests that an increase in global volatility leads a decrease in volatility in these markets.

Regarding information spillovers from Asia, we find significant evidence of spillover effects in both returns and volatility for the SAARC equity markets. India, Pakistan and Sri Lanka have systematic exposure to the Asian equity market. The coefficient estimates for b_2 are 0.572, 0.102 and 0.024 respectively. In addition, the Indian and Pakistani markets are more exposed to the Asian factor than the global factor, suggesting that international spillovers from the regional markets have greater impact than the global market spillovers.

Again, the Bangladesh and Nepal stock markets are not aligned with the Asian stock markets. We, however, find significant volatility spillover from the Asian markets to the SAARC markets.

While assessing the influence of the Indian market on the neighboring markets, we find limited evidence. While the stock market in Bangladesh and Pakistan are affected positively, the influence is negative for the Nepalese and Sri Lankan stock markets. The coefficient b_3 is statistically significant for only Bangladesh. When examining the volatility spillover effect from the Indian markets to neighboring markets, we find that the Bangladeshi, Pakistani and Sri Lankan markets have positive effects while the Nepalese market has negative effects. Such heterogeneous influence of the Indian stock market on the neighboring markets suggests for significant potential for portfolio diversification.

Table 5. Regression Results.

	R_{IN}	R_{BD}	R_{NP}	R_{PK}	R_{SL}
Mean Equation					
$b_{0,i}$	0.026 **	0.037 **	−0.043 ***	0.033 **	0.018 *
	0.012	0.016	0.008	0.013	0.010
θ $(r_{i,t-1})$	0.033 ***	0.041 ***	0.164 ***	0.101 ***	0.166 ***
	0.012	0.014	0.014	0.013	0.013
$b_{1,i}$ (f_W)	0.231 ***	−0.007	0.002	0.075 ***	0.070 ***
	0.012	0.012	0.008	0.012	0.008
$b_{2,i}$ (f_{AS})	0.572 ***	0.009	−0.007	0.102 ***	0.024 **
	0.014	0.015	0.011	0.014	0.010
$b_{3,i}$ (f_{IN})		0.137 ***	−0.007	0.015	−0.009
		0.008	0.007	0.010	0.007
Variance Equation					
ω_i	−0.174 ***	−0.052 ***	−0.181 ***	−0.185 ***	−0.205 ***
	0.009	0.001	0.004	0.006	0.005
α_i (ARCH)	0.212 ***	0.080 ***	0.291 ***	0.241 ***	0.274 ***
	0.011	0.002	0.007	0.008	0.006
γ_i (Asymmetry)	−0.059 ***	−0.024 ***	0.020 ***	−0.066***	0.007
	0.007	0.002	0.004	0.006	0.004
β_i (GARCH)	0.973 ***	0.993 ***	0.917 ***	0.956 ***	0.974 ***
	0.003	0.000	0.003	0.003	0.002
$\phi_{W,i}$	0.001	-0.010 ***	0.008 ***	0.003 **	−0.003 *
	0.002	0.000	0.002	0.001	0.002
$\phi_{AS,i}$	0.016 ***	0.018 ***	0.010 **	0.005	0.010 ***
	0.004	0.001	0.004	0.004	0.003
$\phi_{IN,i}$		0.004 ***	−0.009 ***	0.007 ***	0.003 ***
		0.000	0.002	0.002	0.001
Adjusted R-squared	0.221	−0.019	0.006	0.018	0.030
Log likelihood	−7431	−8239	−7283	−7973	−6484
Observations	5216	5216	5216	5216	5216

Note: ***, **, * indicate statistical significance at 1%, 5% and 10% respectively. Standard errors are reported below the coefficient estimates.

4.2. Evidence of Asymmetric Volatility and Autocorrelation

The autoregressive coefficient estimate θ in the mean equation is statistically and economically significant for all the SAARC equity markets. The autocorrelation is about 3%

for India, about 4% for Bangladesh, about 16% for Nepal, about 10% for Pakistan and about 17% for Sri Lanka. The results suggest that the returns on these stock markets are predictive. The price process in these markets follows the continuation of apparent past 'trends' in prices and investors are optimistic in bull markets and pessimistic in bear markets. The positive autocorrelation is also consistent with ideas put forward by Campbell et al. (1993) and Avramov et al. (2006) who argue that non-zero autocorrelation implies trading by uninformed investors whereas zero autocorrelation implies trading by informed investors. The finding of autocorrelation also implies that these markets are less efficient and could have a strong presence of noise traders. Our results align with the literature that the returns in emerging markets are, to some extent, predictable (Bekaert and Harvey 1997).

The results for the variance equation show that ARCH effect (α) and GARCH effect (β) are statistically significant and positive for all the markets, suggesting that return shocks increase volatility and that volatility is time varying. Our primary focus is on the asymmetric volatility. All equity markets except for Sri Lanka have statistically significant estimate for γ. While the sign of the coefficient estimate is negative for India, Bangladesh and Pakistan, the sign of the coefficient estimate for Nepal is positive.[7] The positive coefficient implies that positive shocks increase volatility by more than negative shocks. In other words, when good news hits the market, stock prices react favorably, causing volatility to rise. While the asymmetric effect results for the India, Bangladesh and Pakistan are as anticipated and align with existing literature (Bekaert and Wu 2000), inverted asymmetric results for equity markets have rarely been found in literature.

Th inverted asymmetric effect in the Nepalese equity market could be explained by its innate institutional features. The Nepalese stock market is very young and investing in stocks (trading) is a recent phenomenon. There is lack of institutional investor trading (Paudel 2010) andindividual investors are the largest contributors in stock trading. Investors may not be well informed and trades could be based on incomplete information or, even irrational (often referred as noise traders). Individual investors with no or less information act on noise as if it were information that would give them an edge (Black 1976). Whenever good news comes out in the market, noise traders in Nepal rush to put money into the stock markets expecting to have higher returns. Hellwig (1980) and Wang (1993) state that trading by uninformed investors leads to a rise in volatility while informed trading reduces it. Avramov et al. (2006) argue that price changes due to uninformed investors will be reversed, increasing volatility by more than price changes due to informed investors. The results for γ, along with positive sign of estimate for the θ, the AR(1) coefficient, indicate that uninformed investors play a significant role in the Nepalese stock market.

Our findings have several implications for investors in these markets. As these markets are found to be less efficient, investors with better or more information could earn abnormal returns using different trading strategies. In some cases, general investors should also be attentive to prevalent of 'pumping and dumping' scheme. Selling off during bearish market due to loss aversion and rushing to buy in bullish market due to 'fear off missing out' may not necessarily be a good decision, particularly from long-term investment perspective. The markets in the region do not respond to positive and negative shocks in the same way. For example, markets in India, Bangladesh and Pakistan respond more aggressively to negative shocks, which could lead to panic among investors and may rush to follow the herd (rationally and/or irrationally). Therefore, they may end up selling at low and latter buy high when market bounces back with bullish trend. Investors can develop some hedging strategies to overcome downside risk. The markets are also influenced by the global market and the aggregate Asian market. Investors should pay due attention to global and Asian market fundamentals and news while making their investment decisions. The equity markets in SAARC region have varying degrees of comovement and varying degrees of effects from the Indian market which provide investors cross-border portfolio diversification benefit in the region. Finally, from a volatility spillover perspective, investors in these markets should pay attention to the global and regional stock market volatility.

4.3. Robustness of the Results

Our results are robust to different checks. We also examine the asymmetric volatility effect using non-synchronized data for each market without international spillover effects as some of these markets have different trading weekdays. The results are very similar. Furthermore, considering the potential for fat tails in returns series, the GARCH models are re-estimated with Generalized Error Distribution. Our results are robust to alternative error distribution specifications. For brevity of space, these results are not reported here but are available upon request. Although the sample equity markets are still dominated by domestic investors (individuals and/or institutional), we have also used USD denominated indices and re-estimated the model. The results from this model are very similar to the results reported earlier.

5. Conclusions

In this first comprehensive study of SAARC countries, we use daily data and investigate the dynamics of international information spillovers, regional linkages, and the asymmetric volatility phenomenon. Drawing on stock markets of Bangladesh, India, Nepal, Pakistan, and Sri Lanka, we are the first study to distinguish international spillovers into three sources: global, regional (Asia), and largest neighborhood (India) market. We enlist the exponential generalized autoregressive conditional heteroskedastic (EGARCH) framework to model asymmetric volatility spillovers across these emerging equity markets. Our results indicate that there is room for international investors to take advantage of portfolio diversification due to less correlated or negatively correlated stock returns in the region. The results are also of interest to policymakers and fund managers.

By analyzing international information spillover and asymmetric volatility of stock markets in the SAARC countries, we find that Indian, Pakistani and Sri Lankan markets experience significant information spillovers in returns from the global and Asian equity markets whereas the Bangladesh stock market experiences significant spillover effects (in returns) from the Indian market. However, all these stock market experience significant volatility spillover effects from international markets. While we find that volatility increases more in response to positive shocks than in response to negative shocks for India, Bangladesh and Pakistan, the effect is opposite for Nepal, an inverted asymmetric effect. We also find a positive autocorrelation of returns in all the markets, indicating dominance of noise trading activity in these markets. Our results further show that the equity markets of India, Pakistan and Sri Lanka have some degree of global integration and a higher degree of regional (Asia) integration whereas the Bangladesh and Nepal stock markets are more isolated. The volatility of these markets is subject to country specific news/information and political-economic changes over the past two decades. Accounting for those events and information in the modeling would be important as it would shed additional light on regional linkages. We have left this avenue for further research on this topic.

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Notes

1 Return is computed as a first log difference, $r_{i,t} = ln(P_{i,t}) - ln(P_{i,t-1})$ where P is the value of the aggregate equity index.

2 To be more precise, the Asian factor and Indian factor are market specific idiosyncratic factors.

3 An advantage of EGARCH is that that it does not require non-negativity constraints on parameters.

4 Zivot (2009) mentions that when the shock, ε_{t-1}, is positive or there is "good news", the total effect of the shock is $(1+\gamma)|\varepsilon_{t-1}|$ and when ε_{t-1} is negative or there is "bad news", the total effect of the shock is $(1-\gamma)|\varepsilon_{t-1}|$.

5 Hansen and Lunde (2005) argue that GARCH(1,1) is usually sufficient to capture the volatility clustering properties of financial data.

6 See Table 4 for cross-market correlation coefficient.

7 Note that in TGARCH models, the sign of γ is opposite of that in EGARCH model. The econometric/financial interpretation, however remains the same.

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