Asian Economic and Financial Review
ISSN(e): 2222-6737
ISSN(p): 2305-2147
DOI: 10.18488/journal.aefr.2020.107.790.807
Vol. 10, No. 7, 790-807.

URL: www.aessweb.com

NEXUS BETWEEN ECONOMIC VOLATILITY, TRADE OPENNESS AND FDI: AN APPLICATION OF ARDL, NARDL AND ASYMMETRIC CAUSALITY

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Article History
Received: 6 April 2020
Revised: 22 May 2020
Accepted: 25 June 2020
Published: 15 July 2020

Keywords
Foreign direct investments
Economic volatility
Trade openness
Nonlinear unit roots
Nonlinear autoregressive
Distributed lag
Asymmetry causality
South Asia.

JEL Classification:
O40; Q32; Q43.

ABSTRACT

The motivation behind this study is to examine whether regional economic volatility and trade openness has influenced the pattern of foreign direct investment (FDI) inflows in select South Asian countries during the period 1975–2019. In order to do so, we applied several nonlinear tests, including the unit root test, ordinary least squares (OLS) test, autoregressive distributed lag (NARDL) test, and causality test. The findings of the nonlinear unit root test suggested that the variables are stationary at the first deviation, following nonlinear systems. Furthermore, the presence of nonlinearity in empirical estimations has been proven through nonlinear OLS and Brock Dechert Scheinkman (BDS) tests. Referring to the results of the Wald test with NARDL, a long-term asymmetrical relationship between the research variables has been confirmed, and long-term and short-term asymmetry was also observed in all tested empirical models. Furthermore, the results of the study on directional causality and asymmetric assumption support the feedback hypothesis in explaining the directional causality between regional economic volatility, trade openness, and inflows of FDI.

Contribution/ Originality: To the best of our knowledge, this is the first empirical study that has investigated the asymmetrical relationship between regional economic volatility, trade openness, and inflows of FDI in South Asian countries by applying NARD and asymmetric directional causality tests. It has been established that a long-term asymmetrical relationship exists between research variables and bidirectional causal effects. These findings are in line with the common perception that less volatility and trade internationalization increases foreign capital flows in the economy.

1. INTRODUCTION

In recent decades, incoming foreign direct investment (FDI) in developing countries has emerged as one of the essential sources of domestic capital and long-term investment. During the period between 1990 and 2018, the global stock of FDI increased elevenfold, from $2.2 trillion to $25 trillion; however, the global GDP grew threefold during the same period (Taguchi & Yining, 2017). The propositions for FDI-led economic growth, especially in developing countries, is well documented in empirical literature (See: Abdouli & Hammami, 2017; Ayanwale, 2007;

Azman-Saini, Law, & Ahmad, 2010; Flora & Agrawal, 2017; Karimi & Yusop, 2009; Nistor, 2014; Tekin, 2012; Tiwari & Mutascu, 2011; Wijeweera, Villano, & Dollery, 2010). It has been suggested that the contributory role played by FDI in the process of economic growth is multifold, as it involves knowledge sharing, technology transferals, market expansion, financial market development, and capital formation. It is, therefore, understandable why developing nations persistently seek foreign investment, either in the form of long-term capital investment or ownership claims, which are commonly known as equity investments.

There is a widespread belief among international institutions, academics, policymakers, and researchers that FDI has a huge positive impact on the economic growth of developing countries. FDI plays a major role in economic expansion when there is a shortage of domestic savings (Ali & Malik, 2017; Sokang, 2018). FDI has, therefore, emerged as the most important external resource in developing countries over recent years, and it has become a significant part of the capital formation in these countries, despite the fact that their share in the global distribution of FDI is minimal and is potentially in decline (Younus, Sohail, & Azeem, 2014).

On the other hand, a growing number of empirical studies have explored the key determinants that stimulate incoming FDI in the host country (See: Ali & Guo, 2005; Dellis, Sondermann, & Vansteenkiste, 2017; Ibrahim, 2019; Kok & Ersoy, 2009; Nunnenkamp, 2002; Obwona, 2001; Qamruzzaman, 2015; Rolfe, Ricks, Pointer, & McCarthy, 1993; Sajilan, Umar Islam, & Anwar, 2019; Vijayakumar, Sridharan, & Rao, 2010; Wach & Wojciechowski, 2016). From an empirical perspective, it is evident that studies have either concentrated on specific countries, explored the key determinants of incoming FDI, or explored the FDI-economic growth nexus using different econometric techniques. However, regional effects on incoming FDIs have not yet been comprehensively investigated. Therefore, the motivation of this study was to discover new insights in order to answer the following question: Do regional macroeconomic fundamentals, namely economic growth volatility, trade openness, financial development, and gross capital formation, influence incoming FDI? Certain aspects of this study are innovative; for example, to the best of our knowledge, this is the first empirical study that has investigated regional macroeconomic fundamentals and how they relate to inflows of FDIs in select South Asian countries between 1970–2018. Second, in terms of investigation method, we applied the nonlinear unit root test proposed by Kapetanios, Shin, and Snell (2006), the nonlinear ordinary least squares (OLS) and nonlinear autoregressive distributed lag (ARDL) tests proposed by Shin, and the directional causality was investigated by applying an asymmetry causality test proposed by Hatemi-J (2012).

From the findings of the study, we observed that the research variables followed a nonlinear stationary process. Furthermore, nonlinear tests that follow nonlinear OLS and Brock Dechert Scheinkman (BDS) test statistics have determined the fact that a nonlinear relationship exists between incoming FDI in select South Asian countries and the behavior of regional macroeconomic fundamentals. An asymmetry causality test established a unidirectional causality in the South Asian economy running from positive shocks in regional economic growth to positive shocks in incoming FDI, which the feedback hypothesis had also revealed.

The structure of this paper is as follows: Section II presents a summary of the relevant literature. The variable definitions and econometric methodologies are explained in detail in Section III. Section IV contains the empirical model results and interpretations, and the conclusion is presented in Section V.

2. LITERATURE REVIEW

The nature of the relationship between FDI and economic growth is not clearly understood, particularly as it pertains to regional outputs and employment. The theoretical and empirical literature has identified some of the preconditions that are necessary in order for FDI to stimulate national growth, although their importance may vary dramatically by region. Although the mechanisms through which FDI stimulates regional economies have largely been ignored, new growth theories suggest that FDI has played a pivotal role.

Regional and interregional economic integration efforts are an important feature of today's economic landscape, and they have a direct impact on FDI flows. The motivation behind such efforts is to accelerate and expedite the process of FDI by opening up investment liberalization and market integration through direct cooperation on investment projects in host countries. In Te Velde and Bezemer's (2006) study, they argue that interregional integration increases regional trade and inflows of FDI in the host country. Furthermore, regional integration accelerates economic growth and increases investment.

FDI has played a crucial role in the formation of supply chains and production networks in developing countries. Involvements in economic integration should improve an economy's business environment, which, in turn, makes a country a more interesting prospect for foreign investors. FDI pertains to international investment in which the investor obtains a lasting interest in an enterprise in another country. Involvement in supranational economic structures significantly lowers transaction costs between foreign production and exportation.

Over the past three decades, the Asian economy—South Asian countries in particular—have experienced substantial economic growth from FDI contributions. With regard to economic progress, the role of FDI in industrialization is evident. Furthermore, empirical studies also examine how FDI stimulates capital accumulation, technology transferals, knowledge sharing, human capital development, and international trade expansions (Bende-Nabende, Ford, & Slater, 2001).

From a theoretical perspective, if we follow the traditional neoclassical growth model, FDI merely increases the investment rate, resulting in a transitional growth per capita, under the assumption that technological progress is exogenous. Under the new "endogenous" growth theory in which technological progress is endogenous, however, FDI is considered to have a permanent growth effect through technological transfers and spillovers.

Tuluce, Dedeoglu, and Yaprak (2018) have investigated the role of the regional economic performance of Black Sea Economic Cooperation (BSEC) countries on incoming FDIs during the 1994–2013 period using data from nine countries. Fixed effects econometrics techniques and random effects models were applied when exploring the key determinants that stimulate inflows of FDI in BSEC countries. The study found that regional economic growth, market size, and exchange rates significantly affected inflows of FDI. The effects of regional economic growth on inflows of FDI were positively established (See: Guerin & Manzocchi, 2009; Jaumotte, 2004; Te Velde & Bezemer, 2006). Regional economic growth intensifies regional integration, the mitigation of trade barriers, and the optimization of economic resources and investment flexibility. Furthermore, regional integration can lead to more extra-regional investment, which may not lead to more FDI in each member country.

Moudatsou and Kyrkilis' (2011) study focused on the relationship between FDI-led regional economic growth in European Union (EU) and Association of Southeast Asian Nations (ASEAN) countries by carrying out causality tests for the 1970-2003 period. The findings of the study presented growth-driven FDI in EU countries and feedback hypothesis in ASEAN countries. As a result, they suggested that regional economic growth and country-specific economic performance play a critical role in acquiring FDI into the economy.

Investment rules govern cross-border investments in the region in order to regulate the treatment and protection of FDI, which subsequently contributes to the "investment climate". FDI inflows are foreign investments that allow host countries to reduce transaction costs and enhance domestic market expansion. Dennis (2006) conducted a study in order to explain the role of trade liberalization on encouraging inward FDI in the Middle East and North Africa (MENA). The findings revealed that trade liberalization strengthens the process of economic integration and employment generation. The consequent effect presented in the study is that welfare contributions from FDI inflows increase substantially.

Another group of findings in the empirical literature focus on the nexus between regional economic growth and inflows of FDI (See: Bende-Nabende et al., 2001; Brock, 2005; Changbiao, 2010; Chen, Sheng, & Liu, 2010; Mullen & Williams, 2005; Sun & Parikh, 2001). In Iwasaki and Suganuma's (2015) study, they assess the effects of regional economic growth on the inflow of FDI in 71 regions in Russia between 1996 and 2011 by applying System-GMM. The findings of the study establish a long-term association between regional economic growth and inflows of FDI. Further evidence in Chun-Chien and Chih-Hai's (2008) study commended FDI contributions for research and development (R&D), as well as capital and technological sharing, which have significantly contributed towards the sustainable economic growth of China, particularly in the long-term.

The effects of regional integration on FDI are also available in the literature. In the study of Te Velde (2011), it is obvious that regional integration does not significantly influence the inflows of FDI. However, countries with regional trade agreements experienced an increase in FDI, provided that trade liberalization and investment provisions acted as a motivational factor to attract foreign investors.

3. METHODOLOGY AND VARIABLE DEFINITIONS

3.1. Variable Definitions

The annualized time series data was used to explore new insights covering 44 years of observations of the period between 1975 and 2019. The variables used in the study are: Regional economic growth volatility (hereafter $V_{olatility}$), which is measured by the standard deviation of economic growth; regional trade openness, which is measured by the sum of imports and exports in the South Asian economy; and the inflow of FDI, which is measured by FDI as a percentage of the GDP of respective countries, which include Bangladesh, India, Pakistan, and Sri Lanka. The selection of the country's sample depends purely on the availability of long-term data. All the research data were extracted from world development indicators published by the World Bank and the observations were converted into a natural logarithm.

3.2. Estimation Techniques

In the study, we performed several econometric techniques in order to unveil certain types of information. When investigating variables and the order of integration, we applied traditional unit root tests: ADF (Dickey and Fuller (1979), P-P (Phillips and Perron, 1988) and KPSS (Kwiatkowski, Phillips, Schmidt, and Shin, 1992), assuming linear stationary processes and nonlinear unit root tests proposed by Kapetanios, Shin, and Snell (2003) and Kruse (2011). Furthermore, the BDS (Broock, Scheinkman, Dechert, & LeBaron, 1996) nonlinearity test and the nonlinear ordinary least squares (NOLS) estimation techniques were employed in order to establish the presence of a nonlinear relationship between inflows of FDIs in selected South Asian countries and regional economic volatility, trade openness, financial development, and capital formation. The coefficient of nonlinear positive and negative shocks to regional growth volatility and trade openness and how they relate to inflows of FDI were estimated through the application of a nonlinear ARDL test proposed by Shin, Yu, and Greenwood-Nimmo (2014). Finally, the asymmetric causal relationship was also investigated following an asymmetry causality test proposed by Hatemi-J (2012).

3.2.1. The Kapetanios et al. (2003) Test

There is a growing dissatisfaction with the standard linear Autoregressive Moving Average model (ARMA) framework that investigators use to test unit roots (Kapetanios et al., 2003). Much of this arises from the fact that, in several areas of economics, a theoretical prediction of stationarity is confounded in practice by the persistent failure of the standard Dickey-Fuller (DF) test to reject the null of a unit root (Rose, 1988; Taylor, Peel, & Sarno, 2001). In order to resolve this issue that is related to the linear unit root test, Kapetanios et al. (2003) introduced an alternative nonlinear exponential smooth transition autoregressive (ESTAR) process, which is comprehensively stationary.

Therefore, following Kapetanios et al. (2003), Liu and He (2010) and Galadima and Aminu (2020), this paper specifies the ESTAR model as:

$$\Delta Y_t = \beta Y_{t-1}\{1 - exp(-\theta Y_{t-1}^2)\} + \varepsilon_t \qquad t = 1,2 \dots T \quad (1)$$

Where Y_t is the demeaned or detrended time series of interest, β and θ is an unknown parameter, the term $\{1 - exp(-\theta Y_{t-1}^2)\}$ is the exponential transition function adopted to represent the nonlinear adjustment, and ε_t is the stochastic term that is assumed to be normally distributed with a zero mean and a constant variance.

Hence, from Equation 1, we test the following hypotheses:

$$H_0: \theta = 0 \quad (2)$$

and

$$H_1: \theta > 0 \quad (3)$$

Obviously, according to Davies (1987), directly testing the null hypothesis (1) is not feasible, since β is not identified under the null. Resolving this issue, Kapetanios et al. (2003) suggest applying (Luukkonen, Saikkonen, & Teräsvirta, 1988) and deriving a t-type test statistic. In addition to the reparameterization of Equation 1 and the obtaining of a first-order Talyor series approximation to the ESTAR model under the null, the auxiliary regression is calculated.

$$\Delta Y_t = \delta Y_{t-1}^3 + error \qquad (4)$$

This suggests that it is easy to acquire the value of t-statistics for $\delta = 0, against\ \delta < 1,$ as:

$$t_{NL} = \frac{\hat{\delta}}{s.e.(\hat{\delta})} \quad (5)$$

Where $\hat{\delta}$ is the ordinary least squares (OLS) estimate of d, and $s.e.(\hat{\delta})$ is the standard error of the^ d. However, it is noteworthy that the t_{NL} the statistic does not follow an asymptotic standard normal distribution.

3.2.2. The Kruse (2011) Test

Kapetanios et al. (2003) proposed an ESTAR-based nonlinear unit root test with the assumption that the location parameter 'c' in the smooth transition function is equal to zero (See Equation 1 for empirical study), which has become popular among researchers. However, a growing number of studies have observed the fact that the coefficient of 'c' is significant, such as Michael, Nobay, and Peel (1997), Sarantis (1999), Taylor et al. (2001), and Rapach and Wohar (2006). Kruse (2011) has argued that the exclusion of basic assumptions leads to the nonstandard testing problem. Therefore, in order to mitigate the location parameter issue, modified test statistics are used (Abadir & Distaso, 2007). The modified ESTAR specification is represented in Equation 6.

$$\Delta Y_t = \alpha Y_{t-1} + \delta Y_{t-1}\{1 - exp(-\theta(Y_{t-1} - c)^2\} + \varepsilon_t \qquad t = 1,2 \dots T \quad (6)$$

Where $\varepsilon_t \sim$ iid(0, σ^2). If the smoothness parameter γ approaches zero, the ESTAR model becomes a linear AR(1) model, i.e. $Y_t = \alpha Y_{t-1} + \varepsilon_t$, which is stationary if $-2 < \alpha < 0$ NOLS. Therefore, the modified ADF regress can be represented in Equation 7.

$$\Delta Y_t = \sum_{j=1}^{p} \alpha_j Y_{t-j} + \gamma_1 Y_{t-1}^3 + \gamma_2 Y_{t-1}^2 + \varepsilon_t \qquad t = 1,2 \dots T \quad (7)$$

In the equation, the null hypothesis $H_0: \theta = 0$ becomes $\gamma_1 = \gamma_2 = 0$ with the alternative hypothesis of $\gamma_1 < 0; \gamma_2 \neq 0$, where γ_2 stems from the fact that the location parameter 'c' is allowed to take nonzero values. Therefore, according to Yıldırım (2017), a standard wild test is not appropriate for deriving test statistics, rather Kruse (2011) proposed a modified Wald test, widely known as "the Kruse test", by integrating the procedure initiated by Abadir and Distaso (2007). That is presented in Equation 8.

$$\tau = t^2_{\beta_{2=0}} + 1(\hat{\beta} < 0)t^2_{\beta 1=0} \qquad (8)$$

3.2.3. Nonlinear Autoregressive Distributed Lagged (NARDL)

Over the past few years, the concept of nonlinearity between dependent and explanatory variables has become one of the key aspects involved when assessing relationships in empirical investigations. In line with nonlinearity, Shin et al. (2014) introduced a new nonlinear cointegration equation, which has become widely known as an NARDL, by incorporating two sets of additional explanatory variables in the equation: positive and negative shocks.

As this new proposed concept estimates both long-term and short-term, a growing number of empirical studies have extensively applied this concept to their respective studies (See: Ali, Shan, Wang, & Amin, 2018; Qamruzzaman & Jianguo, 2018a; Qamruzzaman & Jianguo, 2018b; Qamruzzaman & Jianguo, 2018c). The breakdown of positive and negative shocks in explanatory variables can be computed using Equations 9 and Equation 10.

$$\begin{cases} POS(Y_{volatility})_t = \sum_{k=1}^{t} lnY_{volatility}{}_k^{+} = \sum_{K=1}^{T} MAX\left(\Delta lnY_{volatility}{}_k, 0\right) \\ NEG(Y_{volatility})_t = \sum_{k=1}^{t} lnY_{volatility}{}_k^{-} = \sum_{K=1}^{T} MIN\left(\Delta lnY_{volatility}{}_k, 0\right) \end{cases} \qquad (9)$$

$$\begin{cases} POS(TO)_t = \sum_{k=1}^{t} lnTO_k^{+} = \sum_{K=1}^{T} MAX(\Delta lnTO_k, 0) \\ NEG(TO)_t = \sum_{k=1}^{t} lnTO_k^{-} = \sum_{K=1}^{T} MIN(\Delta lnTO_k, 0) \end{cases} \qquad (10)$$

Following Shin et al. (2014), the partial asymmetry cointegration equation can now be obtained by inserting positive and negative shocks of the explanatory variable into the standard symmetric equation and the new nonlinear ARDL, as follows:

$$\begin{aligned} \Delta lnFDI_{t,i} = \alpha_0 &+ \sum_{i=1}^{n} \mu_1 \Delta lnFDI_{t-i} + \sum_{i=0}^{m} \mu_2^{+} \Delta lnPOS(Y_{volatility})_{t-i} + \sum_{i=0}^{k} \mu_2^{-} \Delta lnNEG(Y_{volatility})_{t-i} \\ &+ \sum_{i=0}^{r} \mu_3^{+} \Delta lnPOS(TO)_{t-i} + \sum_{i=0}^{r} \mu_3^{-} \Delta lnNEG(TO)_{t-i} + \gamma_0 lnFDI_{t-1} \\ &+ \gamma_1^{+} lnPOS(Y_{volatility})_{t-1} + \gamma_1^{-} lnNEG(Y_{volatility})_{t-1} + \gamma_2^{+} lnPOS(TO)_{t-1} \\ &+ \gamma_2^{-} lnNEG(TO)_{t-1} + \omega_t \quad (11) \end{aligned}$$

In Equation 11, 'm', 'n' and 'r' denote the optimal estimated lag length for a model. A standard Wald test will then be performed in order to determine the long-term asymmetric effects, from financial development, trade openness, FDI, inflation, and economic growth, using the following null hypothesis of symmetry:

$$H_0 = (\gamma_1^{+} = \gamma_1^{-});\ (\gamma_2^{+} = \gamma_2^{-})$$

against the alternative hypothesis of asymmetry:

$$H_1 = (\gamma_1^{+} \neq \gamma_1^{-});\ (\gamma_2^{+} \neq \gamma_2^{-})$$

The rejection of the null hypothesis confirms the existence of the asymmetrical effects, from regional economic growth volatility and trade openness to inflows of FDI in the long term. Long-term elasticity can be computed using: $Y_{volatility}{}^{+} = \frac{-\gamma_1^{+}}{\gamma_0}$; $Y_{volatility}{}^{-} = \frac{-\gamma_1^{-}}{\gamma_0}$; $TO^{+} = \frac{-\gamma_2^{+}}{\gamma_0}$; $TO^{-} = \frac{-\gamma_2^{-}}{\gamma_0}$.

To investigate the existence of a long-term asymmetric relationship, Shin proposed a bound test, which is a joint test of all lagged levels of regressors. The Wald F-test is utilized to test the null hypothesis if there is no asymmetric relationship: $H_0: \gamma_0 = \gamma_1^+ = \gamma_1^- = \gamma_2^+ = \gamma_2^- = 0$ against the alternative hypothesis: $H_1: \gamma_0 \neq \gamma_1^+ \neq \gamma_1^- \neq \gamma_2^+ \neq \gamma_2^- \neq 0$

The rejection of the null hypothesis demonstrates a long-term and short-term asymmetric relationship between financial development, trade openness, FDI, inflation, and economic growth in Bangladesh.

3.2.4. Asymmetry Causality Test by Hatemi-J (2012)

The investigation of an asymmetrical relationship between variables using an empirical test requires two additional sets of data that represent the breakdown of a variable into cumulative positive and negative changes. The initial idea of variable breakdown into positive and negative changes was initiated by Granger and Yoon (2002) in their study that explored hidden cointegration tests. Hatemi-J (2012) built upon their work on causality analysis, interpreting it as an asymmetry causality test. According to Hatemi-J (2012), the sense that positive and negative changes may not produce similar effects on the dependent variable is asymmetry. Furthermore, Hatemi-J (2012) initiated the causal investigation between two variables, namely y_{1t} and y_{2t} , using a random walk proposition, and defined this relationship in Equation 12 and Equation 13:

$$y_{1t} = y_{1\,t-1} + \varepsilon_{1\,t} = y_{10} + \textstyle\sum_{i=1}^{t} \varepsilon_{1t} \qquad (12)$$

and

$$y_{2t} = y_{2\,t-1} + \varepsilon_{2\,t} = y_{20} + \sum_{i=1}^{t} \varepsilon_{2t} \qquad (13)$$

Where *t=1, 2……T*, the constants $y_{1,0}$ and $y_{2,0}$ are the initial values, and the values $\varepsilon_{1t}$and ε_{2t} explain the white noise disturbance term. The positive and negative shocks can be computed as $\varepsilon_{1t}^+ = MAX(\varepsilon_{1t}, 0)$, $\varepsilon_{2t}^+ = MAX(\varepsilon_{2t}, 0)$, $\varepsilon_{1t}^+ = MIN(\varepsilon_{1t}, 0)$ and $\varepsilon_{2t}^+ = MIN(\varepsilon_{2t}, 0)$, respectively. Therefore, we can represent $\varepsilon_{1t} = \varepsilon_{1t}^+ + \varepsilon_{1t}^-$, and $\varepsilon_{2t} = \varepsilon_{2t}^+ + \varepsilon_{2t}^-$. So, Equation 12 and Equation 13 can be reproduced in Equation 14 and Equation 15 through the integration of the broken down variables:

$$y_{1t} = y_{1\,t-1} + \varepsilon_{1\,t} = y_{10} + \sum_{i=1}^{t} \varepsilon_{1t}^+ + \sum_{i=1}^{t} \varepsilon_{1t}^- \qquad (14)$$

and

$$y_{2t} = y_{2\,t-1} + \varepsilon_{2\,t} = y_{20} + \sum_{i=1}^{t} \varepsilon_{2t}^+ + \sum_{i=1}^{t} \varepsilon_{2t}^- \qquad (15)$$

In order to capture the asymmetric effects of all the variables, the positive and negative shocks of all variables can be computed using Equation 16:

$$Y_{volatility,t}^+ = \sum_{i=1}^{t} \varepsilon_{1t}^+ , Y_{volatility,t}^- = \sum_{i=1}^{t} \varepsilon_{1t}^- ,, TO_t^+ = \sum_{i=1}^{t} \varepsilon_{3t}^+ , TO_t^- = \sum_{i=1}^{t} \varepsilon_{3t}^- , \qquad (16)$$

The next step is to investigate the causal relationship by applying a vector autoregressive (VAR) model with an order of *p*. The innovative lag can be determined by following the process of Hatemi-J (2003; 2008); Equation 17 can be employed to select the optimal lag length in a VAR situation:

$$HJC = ln(|\bar{A}_J|) + q\left(\frac{n^2 lnT + 2n^2 \ln(lnT)}{2T}\right), q = 0, \dots \dots . p \quad (17)$$

where $\overline{A}_J$ stands for the determinants of the VAR covariance matrix of the error correction term in the VAR model, 'q' stands for the lag order, 'n' specifies the number of the equation, and 'T' denotes the number of observations.

4. EMPIRICAL MODEL ESTIMATIONS AND INTERPRETATIONS

4.1. Unit Root Test Results

Table 1 presents the results of the following commonly-used unit root tests: ADF (Dickey and Fuller, 1979), P-P test (Phillips and Perron, 1988) when the null hypothesis of the variable has a unit root, as well as the KPSS test (Kwiatkowski et al., 1992) when the null hypothesis of the variables has no unit root, including the assumption of constants and trends. The results of the study have unveiled a mixed integration order, which implies that the variables were stationary at one level and/or after the first difference.

Table 1. Linear unit root test

	ADF		P-P		KPSS	
	With Constant	**With Constant & Trend**	**With Constant**	**With Constant & Trend**	**With Constant**	**With Constant & Trend**
FDI_{BD}	-1.350	-3.056	0.116	-1.718	0.694**	0.188**
FDI_{IND}	-1.218	-3.213*	-1.274	-3.122	0.7641***	0.1288*
FDI_{PAK}	5.3998	18.1695	-0.718	-4.468***	0.8862***	0.1668**
FDI_{SL}	-1.375	-2.5676	-1.379	-2.393	0.7955***	0.1297*
TO	-2.768**	-2.651	-3.24**	-3.623**	0.121	0.080
$Y_{volatility}$	-3.170**	-3.146	-3.44**	-3.793**	0.125	0.092
ΔFDI_{BD}	-8.885***	-8.895***	-3.069**	-3.102	0.132	0.106
ΔFDI_{IND}	-8.605***	-8.663***	-6.678***	-5.432***	0.2394	0.166**
ΔFDI_{PAK}	-21.32***	-24.82***	-6.412***	-6.311***	0.3434	0.1404*
ΔFDI_{SL}	-6.28***	-6.379***	-6.285***	-6.396***	0.0692	0.0359
ΔTO	-6.230***	-6.282***	-6.599***	-6.498***	0.173	0.173**
$\Delta Y_{volatility}$	-7.338***	-7.572***	-3.999***	-4.016***	0.088	0.088

Table 2 presents the results of the nonlinear unit root test following the procedure introduced by Kapetanios et al. (2003). The tests were conducted with a constant [case 1] and trend. The test results of FDI inflows and regional GDP volatility in Bangladesh, India, and Pakistan confirmed the presence of a nonlinear unit root by rejecting the null hypothesis of the linear unit root test at a level of 1%, and a significance with the constant and trend at a level of 5%. Furthermore, trade openness presented a nonlinear unit root test with 5% significance with a constant.

Table 2. KSS nonlinear unit root test results

Series				**With Constant**	**With Constant & Trend**
Foreign direct investment _Bangladesh				-2.244	-3.239*
Foreign direct investment _India				-1.970	-4.963***
Foreign direct investment _Pakistan				-1.021	-4.526***
Foreign direct investment _Sri Lanka				-0.253	-0.506
GDP_volatility regional				-6.306***	-3.228*
Regional Trade Openness				-3.405**	0.424
Critical value Kapetanios. et al. (2003)					
			Case 1	Case 2	Case 3
		1%	-2:82	−3:48	−3:93
		5%	−2:22	−2:93	−3:40
		10%	−1:92	−2:66	−3:13

Note: The critical values were taken from Table 1, Kapetanios et al. (2003), the asymptotic critical values of Case 1, Case- 2, and Case 3 indications at level, constant, and constant and trend, respectively.

Table 3 displays the results of the Kruse unit root test (2011). Taking into account the test statistics, the null hypothesis of the linear unit root test was rejected by FDI inflows in Bangladesh, India, and Sri Lanka at having 1% significance. Furthermore, trade openness and GDP volatility also rejected the null hypothesis at having 10% significance. These findings imply that the following research variables—regional economic growth volatility, trade openness, and FDI inflows in Bangladesh, India, and Sri Lanka—follow a nonlinear stationary process.

Table 3. Kruse nonlinear unit root test results

Series				With Constant	With Constant & Trend
Foreign direct investment _Bangladesh				2.420	20.078***
Foreign direct investment _India				15.212***	20.469***
Foreign direct investment _Pakistan				4.786	8.013
Foreign direct investment _Sri Lanka				16.128***	26.021***
GDP_volatility regional				9.927*	10.067
Regional Trade Openness				2.026	11.515*
Asymptotic Critical Values of t-statistic					
			Case 1	Case 2	Case 3
		1%	13.15	13.75	17.10
		5%	9.53	10.17	12.82
		10%	7.85	8.60	11.10

4.2. Nonlinearity Test

Table 4 reports the NOLS estimates for the nonlinear model that follows a polynomial function of degree four, which was found to be the most appropriate model given the information criteria. The null hypothesis of the linear relationship was rejected at 1% significance, which implies that the relationship between regional economic growth volatility, trade openness, and inflows of FDI in Bangladesh, India, Pakistan, and Sri Lanka is nonlinear.

Table 4. Nonlinear ordinary least Square (NOLS)

	Bangladesh		India		Sri Lanka		Pakistan	
Variable	Coff.	Prob.	Coff.	Prob.	Coff.	Prob.	Coff.	Prob.
$\Delta Y_{volatility}$	-6.979	0.019	-1.278	0.073	-2.220	0.654	-1.623	0.1977
TO	5.156	0.070	1.092	0.087	-9.587	0.0266	4.262	0.9961
$(Y_{volatility})2$	-11.19	0.076	4.991	0.057	3.004	0.4617	12.955	0.1443
$(Y_{volatility})3$	86.693	0.070	-76.874	0.054	-23.42	0.3506	-12.541	0.1297
$(Y_{volatility})4$	-21.624	0.067	19.432	0.053	24.727	0.2778	32.912	0.1233
(TO)^2	-28.921	0.007	-2.140	0.085	19.831	0.0254	-0.538	0.9309
(TO)^3	1.110	0.008	0.102	0.081	-0.755	0.0269	0.037	0.8753
(TO)^4	-0.014	0.008	-0.001	0.078	0.0095	0.0285	-0.0069	0.8229
R-squared	0.894		0.951		0.934		0.911	
Adj R-sq	0.861		0.937		0.915		0.885	
F-statistic	27.308		67.869		50.515		35.457	
$W_{GDP\_valatility}$	74.514***		11.714***		11.947***		16.570***	
$W_{Trade\ openness}$	21.748***		41.254***		25.674***		49.711***	

Note: W indicates the standard Wald test results; *** indicates 1% significance.

We then chose to use the nonlinear BDS approach proposed by Broock et al. (1996) in order to detect the VAR residuals. The null hypothesis in the BDS test with independent and identical distributions was rejected, which means that the time series had nonlinear characteristics under different dimensions (m = 2, 3, ..., 6). As shown in Table 5, the BDS test results indicate that the null hypothesis of linear dependence was rejected at a level of 1%, demonstrating that the nonlinear model was more suitable for detecting short-term relationships between regional economic growth, trade openness, financial development, capital formation and inflows of FDI in certain South Asian countries.

Table 5. Results of BDS statistics from VAR residuals

	BDS Statistics	
Dimension	**Y Volatility**	**TO**
2	0.061***	0.188***
3	0.120***	0.311***
4	0.151***	0.398***
5	0.166***	0.457***
6	0.161***	0.491***

Note: *** indicates the significance of nonlinear dependency at a level of 1%.

Table 6. Dynamics of the long-term and short term estimations

	Bangladesh	India	Pakistan	Srilanka
Panel – A: Long-run model estimation				
C	-5.212***[7.694]	-17.709***[0.435]	-3.22***[0.872]	-2.533***[0.504]
ΔFDI(-1)	-0.873***[0.409]	-0.32***[0.095]	-0.755***[0.068]	0.613***[0.082]
$\Delta Y^{+}_{Volatility}$ (-1)	0.425***[0.729]	0.19***[0.038]	0.086***[0.981]	3.843**[0.633]
$\Delta Y^{-}_{Volatility}$ (-1)	1.244***[0.82]	0.132***[0.276]	0.771**[0.222]	-0.423***[0.829]
TO^{+} (-1)	-4.945**[0.23]	2.371**[0.133]	-0.696***[1.747]	0.088***[0.617]
TO^{-} (-1)	1.921***[0.633]	-0.475**[0.004]	0.486***[0.107]	0.206***[0.392]
Panel –B: Short-run model estimation				
ΔFDI(-1)	-	-0.374**[0.188]	-0.735***[0.241]	-0.383**[0.192]
ΔFDI(-2)	-0.471**[1.359]	-0.725**[0.288]	-0.624***[0.206]	-0.652***[0.112]
ΔFDI(-3)	0.526***[0.823]	-0.285**[0.322]	--	--
$\Delta Y^{-}_{Volatility}$ (-1)	-1.301***[0.357]	8.291**[6.646]	5.733**[4.717]	13.838***[4.206]
$\Delta Y^{-}_{Volatility}$ (-2)	-1.302**[0.158]	-5.863**[5.829]	7.931**[4.051]	-7.427***[3.442]
$\Delta Y^{-}_{Volatility}$ (-3)	-1.652**[0.394]	10.618**[6.432]	7.423[3.804]	10.602**[3.524]
$\Delta Y^{+}_{Volatility}$ (-1)	-1.999**[0.604]	-12.976**[5.537]	-12.159*[4.149]	-4.195***[2.016]
$\Delta Y^{+}_{Volatility}$ (-2)	-7.113**[0.943]		-10.755*[2.972]	1.213**[1.971]
$\Delta Y^{+}_{Volatility}$ (-2)	-	-2.583*[3.04]	-1.615**[2.133]	-0.482***[14.082]
ΔTO^{-} (-1)	-	-	-18.324*[5.495]	-0.305**[15.029]
ΔTO^{-} (-2)	6.695*[2.802]	-	- -	-1.871**[15.147]
ΔTO^{-} (-3)	2.007**[3.339]	4.954**[9.268]	15.501*[4.528]	-2.595**[2.463]
ΔTO^{+} (-1)	1.437**[9.452]	-5.02**[3.929]	7.337**[2.283]	-7.772**[2.685]
ΔTO^{+} (-2)	-	9.586**[4.407]	2.841**[2.062]	8.677*[1.625]
ΔTO^{+} (-3)	-0.209*[3.202	-	-	1.967**[0.514]
ECT(-1)	-0.574(0.001)	-0.721(0.002)	-0.315(0.004)	-0.351(0.009)
F*pass*	13.772***	12.294***	9.494***	6.645**

Note: ***/**/* denote the level of significance as 1%/5%/10, respectively.

4.3. NARDL Estimations

We then proceeded to estimate the extent of the impact of regional economic growth volatility and trade openness on the inflow of FDI by means of a nonlinear framework by using Equation 11. The original NARDL model results are presented in Table 6. We then proceeded to estimate the existence of a joint cointegration test in the nonlinear Equation 11. We found test statistics that were higher than the upper boundary of the critical value[1] of a 1% level of significance ($F(BD)_{pss} = 13.77$, $F(IND)_{pss} = 12.294$, $F(PAK)_{pss} = 9.949$, and $F(SL)_{pss} = 16.755$), so that we could come to a conclusion in favor of an asymmetric association between examined variables. Furthermore, the coefficients error correction term (ECT_{t-1}) was observed in case all tested models were negative and statistically significant at a 1% level of significance. This supports the previous confirmation of a long-term cointegration.

Table 7. Long-term relationships

Model Estimation				
	Bangladesh	**India**	**Pakistan**	**Sri Lanka**
Panel A: Long-term coefficient estimation				
	0.486***[0.729]	0.593***[0.037]	0.113***[0.981]	-6.269**[0.633]
	1.424**[0.819]	0.411**[0.260]	1.020**[0.222]	0.689**[0.828]
	-5.664***[0.229]	7.403***[0.301]	-0.922**[0.174]	-0.143***[0.609]
	2.202**[0.633]	-1.484***[0.995]	0.644***[0.107]	-0.335**[0.389]
Panel B: Long-term and short term asymmetry test				
$W_{LR}^{GDP volatility}$	14.521***	25.741***	22.861***	16.971***
$W_{LR}^{Trade\ openness}$	21.045**	16.852***	11.907***	9.813***
$W_{SR}^{GDP volatility}$	14.254***	12.549***	9.884***	12.341***
$W_{SR}^{Trade\ openness}$	9.754***	8.214***	8.741***	22.624**

Note: ***/**/* denote the level of significance as 1%/5%/10, respectively.

Table 7 (Panel A) displays the results of the long-term positive and negative shocks of regional economic growth volatility and trade openness on inflows of FDI in Bangladesh, India, Pakistan, and Sri Lanka. The empirical model output establishes the fact that positive shocks in regional economic growth are positively linked to inflows of FDI in select South Asian countries, except for Sri Lanka. Similarly, negative shocks in regional economic growth volatility are positively associated with inflows of FDI in South Asian countries.

When considering positive and negative shocks in trade openness, we observed the fact that positive shocks in trade openness produced negative results for Bangladesh (a coefficient of -5.664), Pakistan (a coefficient of -0.922), and Sri Lanka (a coefficient of -0.143) in terms of receiving inflows of FDI. However, positive shocks in regional trade openness were positively correlated to FDI inflows in India (a coefficient of 7.403). Furthermore, negative shocks in regional trade openness were positively correlated with inflows of FDI in Bangladesh (a coefficient of 2.202) and Pakistan (a coefficient of 0.644). On the other hand, a negative correlation was also established in terms of inflows of FDI in India (a coefficient of -1.484) and Sri Lanka (a coefficient of -0.335).

We also performed a standard Wald test in order to investigate the symmetrical relationship. In Table 7 (Panel B), W_{LR} indicates a Wald test with a null hypothesis of the long-term symmetrical relationship (L_{GDP}^{+} $=L_{GDP}^{-}$ and L_{TO}^{+} $=L_{TO}^{-}$), as well as a null hypothesis of the short-term symmetrical relationship W_{SR} (S_{GDP}^{+} $=S_{GDP}^{-}$ and S_{TO}^{+} $=S_{TO}^{-}$). Given that the results of the standard Wald test in both the long-term and short-term was a null hypothesis, the symmetrical relationship was rejected at a 1% significance level. Therefore, it can be concluded that there is a prevailing asymmetrical relationship between regional economic growth volatility, trade openness,

[1] Following Shin et al. (2014), we adopted a conservative approach to the choice of critical values, employing k = 4

financial development, gross capital formation and incoming FDI in selected South Asian countries, both in the short-term and long-term.

Finally, we ascertained the robustness and stability of the model's estimation by performing several residual-based diagnostics tests. The results of the residual diagnostic test are exhibited in Table 8. The residual test shows that the model was free from serial correlation, the error terms were distributed normally, and there were no homoscedasticity problems. Moreover, Ramsey's RESET test also confirms the model's construction validity. Estimations of the model's stability were investigated by applying a residual recursive test proposed by Pesaran, Shin, and Smith (2001), commonly known as the CUSUM of the square recursive residual test, which determines the model's stability by estimating whether the parameters have a 5% significance level (See Figures 1 to 8).

Table 8. Residual diagnostic test results

Empirical Model Estimation				
	Bangladesh	**India**	**Pakistan**	**Sri Lanka**
R^2	0.744	0.721	0.651	0.633***
$F^2_{statistics}$	7.04***	7.37***	3.574***	5.022***
$x^2_{Autocorrelation}$	1.97(0.197)	1.52(0.217)	1.541(0.451)	1.223(0.274)
$x^2_{Heteroskedasticity}$	0.45(0.951)	1.12(0.261)	0.974(0.714)	1.045(0.155)
$x^2_{Normality}$	21.64(0.292)	2.21(0.182)	3.511(0.774)	2.812(0.114)
x^2_{RESET}	0.52(0.263)	1.43(0.155)	1.114(0.524)	1.054(0.254)
CUSUM	Figure 1	Figure 3	Figure 5	Figure 7
CUSUM of Square	Figure 2	Figure 4	Figure 6	Figure 8

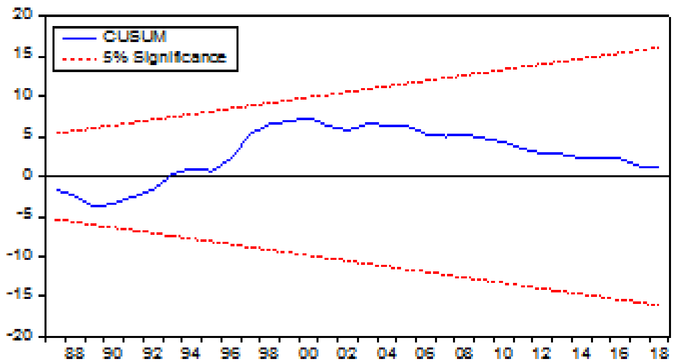

Figure 1. CUSUM test for Bangladash

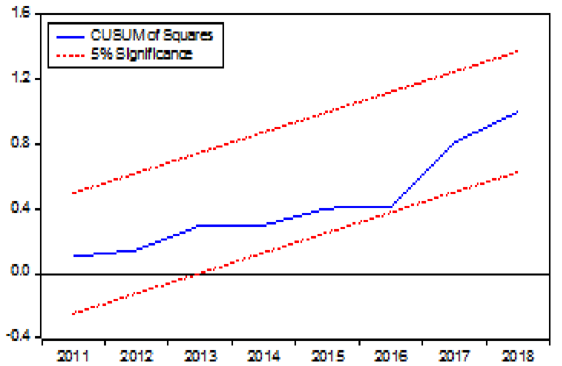

Figure 2. CUSUM of square test for Bangladash

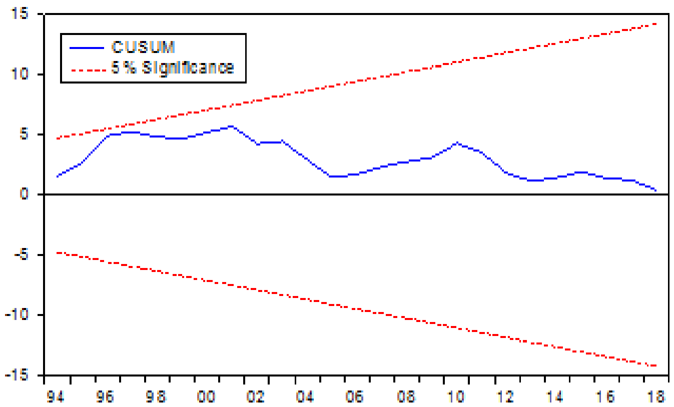

Figure 3. CUSUM test for India

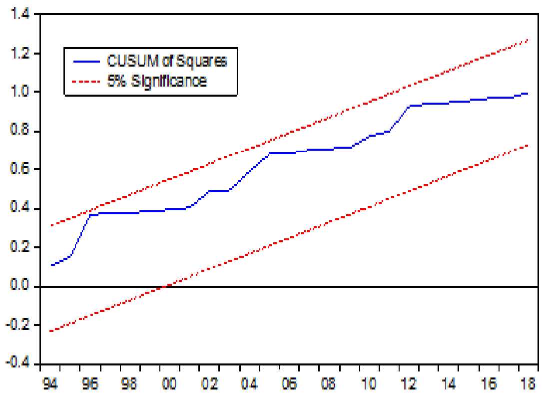

Figure 4. CUSUM of square test for India

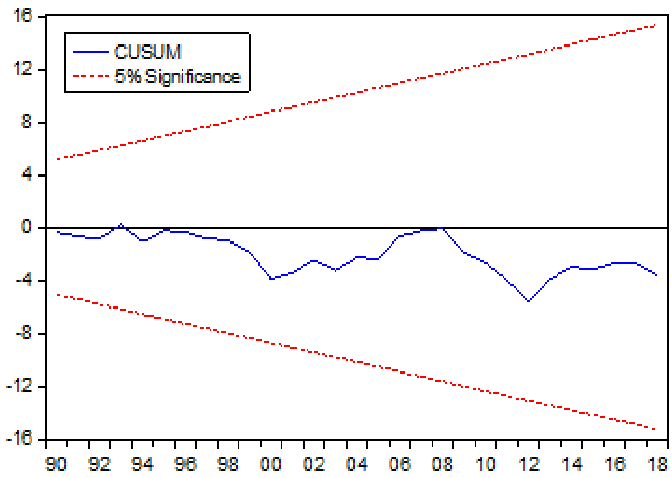

Figure 5. CUSUM test for Pakistan

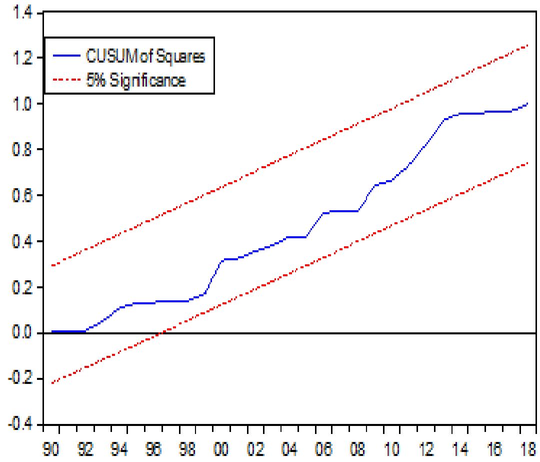

Figure 6. CUSUM of square test for Pakistan

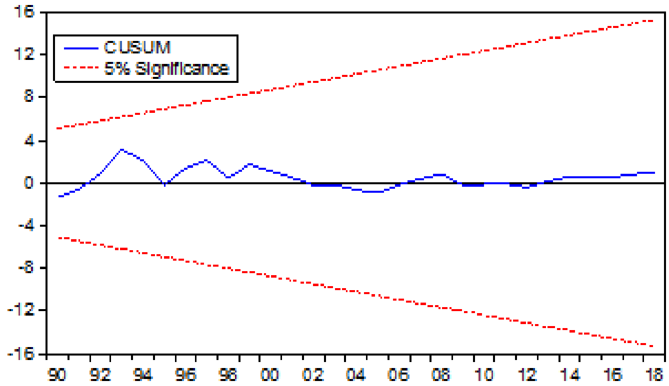

Figure 7. CUSUM test for Sri Lanka

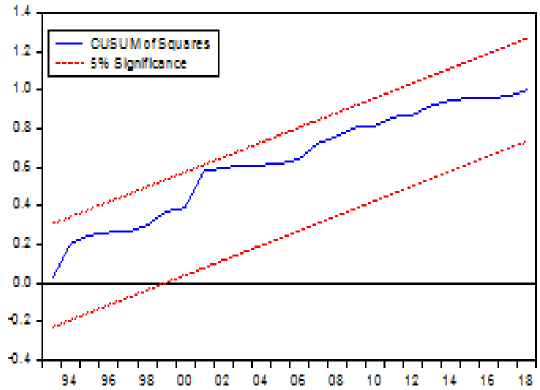

Figure 8. CUSUM of square test for Sri Lanka

4.4. Asymmetric Causality Test

The results of the asymmetric causality test displayed in Table 9 include the positive and negative shocks of the following independent variables: Regional economic growth volatility and trade openness. A number of causal relationships have been revealed using the asymmetry test; however, we focused on explaining the effects of positive and negative shocks on inflows of FDI in certain South Asian countries. With regard to Bangladesh, we observed a prevailing bidirectional causality between positive shocks in regional economic growth and inflows of FDI $[GDP_{volatility}{}^{+} \leftrightarrow \text{FDI}]$. Furthermore, unidirectional causality also appears when explaining the causal effects between negative shocks in regional economic growth and inflows of FDI, as well as positive shocks in regional trade openness and inflows of FDI. The findings of the study suggest that, in addition to Bangladesh's attributes, inflows of FDI in Bangladesh are also guided by regional economic behavior.

With regard to India, the findings of the study disclosed bidirectional causality between negative shocks in regional economic growth and inflows of FDI $[Y_{volatility}{}^{-} \leftrightarrow \text{FDI}]$. In addition, unidirectional causal effects occurred between positive shocks in regional economic growth and inflows of FDI $[Y_{volatility}{}^{+} \rightarrow \text{FDI}]$, as well as positive shocks in trade openness and inflows of FDI $[TO^{+} \rightarrow \text{FDI}]$. With regard to Pakistan, the findings of the disclosed unidirectional causality between inflows of FDI and negative shocks in regional economic growth $[\text{FDI} \rightarrow Y_{volatility}{}^{-}]$, as well as positive shocks in regional economic growth and inflows of FDI $[Y_{volatility}{}^{+} \rightarrow \text{FDI}]$.

With regard to Sri Lanka, it is evident in the causality test results that there is bidirectional causality between negative shocks in regional economic growth volatility and inflows of FDI $[Y_{volatility}{}^{-} \leftrightarrow \text{FDI}]$. Furthermore, unidirectional causality has been exposed in terms of positive shocks in regional economic growth [$Y_{volatility}{}^{+}$→FDI] and trade openness [TO^{+}→FDI] on inflows of FDI.

Table 9. Asymmetric causality test

	Bangladesh		India		Pakistan		Sri Lanka	
Null Hypothesis	**F-Stat**	**Prob.**	**F-Stat**	**Prob.**	**F-Stat**	**Prob.**	**F-Stat**	**Prob.**
FDI ≠ > Y_N	1.322	0.282	2.558	0.092	4.216	0.012	5.545	0.008
Y_N ≠ >FDI	4.444	0.025	4.179	0.023	1.779	0.184	3.314	0.048
FDI ≠ >Y_P	4.288	0.015	1.243	0.301	0.399	0.673	0.900	0.416
Y_P ≠ >FDI	3.331	0.050	3.781	0.018	4.451	0.024	9.503	0.000
FDI ≠ >TO_N	0.794	0.461	0.864	0.430	0.736	0.485	1.080	0.350
TO_N ≠ >FDI	0.384	0.684	0.170	0.844	0.882	0.422	2.448	0.101
FDI ≠ >TO_P	1.144	0.332	1.419	0.255	0.433	0.651	0.072	0.930
TO_P ≠ >FDI	3.162	0.057	4.316	0.011	1.740	0.189	8.880	0.000
TO_P ≠ >TO_N	3.488	0.041	3.488	0.041	3.488	0.041	3.488	0.041
TO_N ≠ >TO_P	0.594	0.557	0.594	0.557	0.594	0.557	0.594	0.557
Y_P ≠ >Y_N	10.704	0.000	10.704	0.000	10.704	0.000	10.704	0.000
Y_N ≠ >Y_P	0.918	0.408	0.918	0.408	0.918	0.408	0.918	0.408

5. CONCLUSION

Inflows of FDI are subject to certain macroeconomic fundamentals of the host economy, especially in developing economies. In empirical studies, a growing number of researchers have attempted to explore and explain these factors. However, the motivation of this study was to uncover new insights with regard to the role of regional macroeconomic fundamentals in attracting FDI in the South Asian countries of Bangladesh, India, Pakistan, and Sri Lanka. In this study, empirical evidence and a number of econometrical investigations have been established using a nonlinear framework for the period between 1975 and 2019. The key findings of the empirical investigation are as follows: First, in order to establish variables in order of integration, we performed both linear and nonlinear unit root tests. According to the conventional unit root tests (ADF, P-P and KPSS), all the variables were stationary at one level or after the first difference, and no variable established an order of integration after the second difference. Nonlinear unit root tests were performed by following the tests of Kapetanios et al. (2003) and Kruse (2011). The findings of the study revealed that, in Bangladesh, India, and Pakistan, the impact of regional economic growth volatility, regional financial development, and regional gross domestic capital formation on FDI inflows follow the nonlinear process and are stationary. After ascertaining nonlinearity in the empirical model, we performed a nonlinear OLS and BDS test, and the findings confirmed nonlinearity. Second, in order to assess the magnitude of regional economic growth volatility and trade openness in the nonlinear framework, we applied the nonlinear framework proposed by Shin, breaking down the variables into positive and negative shocks. The remaining asymmetries confirmed the presence of an asymmetric relationship between regional economic growth volatility, trade openness, and incoming FDI. Third, the findings of the asymmetry causality test made it evident that positive shocks in regional economic growth stimulated the inflow of FDI in Bangladesh, India, Pakistan, and Sri Lanka. Furthermore, positive shocks in regional trade openness also accelerated inflows of FDI in these countries during the period studied. The findings of this study have shown that, in addition to country-specific macroeconomic fundamentals, regional economic activities are also important in terms of encouraging foreign investors and increasing capital investments with foreign participants.

Funding: The study received a research grant from The Institute of Advanced Research (IAR), United International University (Grant Reference: UIU/IAR/02/2019-20/BE/14).
Competing Interests: The authors declare that they have no competing interests.
Acknowledgement: Authors are extremely grateful to the editor of this journal and two anonymous referees for their constructive comments on an earlier version of this manuscript.

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