



Action for Action: Mad COVID-19, Falling Markets and Rising Volatility of SAARC Region

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Abstract

The Southern Region has reported a large number of contagious pandemic outbreaks. These epidemics brought threats to human health and resulted in serious economic losses. The COVID-19 is a global virus and has weakened the global financial markets with significant effect on stock returns and market volatilities. The study obtained a dataset about the financial market structure of South Asian Association for Regional Cooperation (SAARC) Countries. The purpose of the study is to determine the effect of 2019-nCov on stock market performance of SAARC member states. The study considered indexes of the National Stock Exchanges of each country and applied an event study approach for estimating the impact of Mad COVID-19 on the stock returns and market volatilities with an event window of 25 days of severe pandemic hits. The CAR approach proved the declining effect of Mad COVID-19 on the stock returns of SAARC countries. Asymmetric GJR-GARCH Model estimated the changeable volatility and proved the increase in volatility with COVID-19 as a negative shock. SAARC Region significantly reacts to Mad COVID-19 with falling markets and rising volatility.

Keywords COVID-19 · Cumulative abnormal returns · Event study methodology · GJR-GARCH model · South Asian Association for Regional Cooperation (SAARC) · Volatility effect

The manuscript is original and has not been presented, published before and is not currently being considered for publication elsewhere.

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1 Introduction

Cheval et al. [1] the evolutionary changes in natural mechanisms and occurrences which may be caused by human practices resulted in environmental hazards that are disastrous to both health, communities and the environment. They conceptualized COVID-19 pandemic as a hazard that is a source for outburst of various infectious diseases which increases the rate of mortality and state of morbidity across wide geographical regions and causes significant disruptions in both social, economic and political sectors. Yousef [2] the re-emerging COVID-19 outbursts in Hubei, China in December 2019 and spread all around the globe with approximately 27 million confirmed cases reported and more than 9 lac deaths recorded in 212 countries during May 2020. Ayittey et al. [3] highlighted the economic effects of novel coronavirus: approximately all the affected countries were to shut down their economic infrastructure, quick workout for contingency plans and announcement of emergency economic aid packages, intense disruption in global supply chains, drastic food shortening, imbalanced asset prices, effected MNCs and local business environment with limited trading activities, immense social distancing, lockdowns, curfews, tourism crisis and restricted flight operations. Li et al. [4] COVID-19 has imperilled the world financial market as well as brought devastating effects to the global economy. Emerging economies could experience significant threat from abnormal pandemic outbreaks because of scarce medical resources, poor viral detection technology and less accurate pandemic data. Jian et al. [5] the re-emerging unprecedented pandemic explosions are not only hazardous to human health but also bring severe economic crises, which can be determined through variations in the returns of different stock markets.

Kumar [6] data analytics and relevant techniques are proved useful to track and monitor any pandemic effects like SARS-CoV (2003) and novel COVID-19. He monitored the COVID-19 infections in India through data clustering. Temesgen et al. [7] applied data analytics and estimated relationship between longitudinal CD4 count and survival time of HIV/TB Co-infected Patients through joint modeling. Liu et al. [8] the study applied big data mining and determined the transferal patterns and associated risks of coronavirus outburst among six major cities of China through social contacts. Atkins et al. [9] estimation and modelling of changeable volatility is highly focused for mathematical modelling of financial data sets. Yang et al. [10] high frequency financial data i-e trading volumes and trading intervals, mainly highlights two perspectives: stock volatility and financial markets noise. High frequency financial data is highly useful for comprehensive research and conception of financial markets behaviour. Yousef [2] studied the spillover effect of novel coronavirus on the indices of major G7 stock markets and proved that coronavirus significantly increases stock market volatility. Atkins et al. [9] implied data analytics and proved data derived from news sources play an important role in predicting stock volatility movement, previously applied for modelling of cancer subtypes, studied by Saddiki et al. [11].

The core objective of the study is to add relevance to the existing studies on the significant effect of pandemic outbreaks on the stock market's performance.

Thomas [12] reported COVID-19 as Bad, Mad and Dangerous. The current study determined the impact of Mad COVID-19 breakout on the stock returns of selected SAARC countries: India, Pakistan, Bangladesh, Srilanka and Nepal by applying an event study methodology i-e Cumulative Abnormal Returns (CAR) statistical approach during the event window of 25 days i-e ($t = -25, 25$), the period of severe COVID-19 hit to SAARC region. Liu et al. [13] the world stock markets are highly interdependent and interlinked to each other. The events that led to the global financial crisis like the outburst of global pandemic COVID-19 had a significant spillover effect on the stock markets of other countries. Asymmetric GJR-GARCH model is applied to study the volatility effect of COVID-19 on the stock market fluctuations of SAARC Countries.

1.1 SAARC Region

SAARC stands for The South Asian Association for Regional Cooperation, established in 1985. It is the geopolitical union and intergovernmental organization of 8 member states of Southern Asia including: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Srilanka documented by Sultana and Reza [14]. SAARC states are highly populated, covering about 23.75percent of the global population and have a significant contribution to more than 15percent of global economic productivity. SAARC member states consist of nations that share common borders, ethnicity, shared culture and historical common threads like British imperialism with a number of socio-political differences. These nations collectively make an integrated “Condominium” of trans-boundary Rivers, ocean with combined ecological system and shared mountain ranges. The region also has the same endowment for economic productivity proposed in Swamy [15]. SAARC regions located geographically closer to countries suffer from the hardest hit by COVID-19, proposed in Kugelman [16]. There were catastrophic consequences of COVID-19 in the South Asian Region with no immediate vaccination. Only lockdowns, social distancing, shutdown of business activities and educational institutions were meant to control the contagious COVID-19.

1.2 Emerging Infectious Diseases and Coronavirus in SAARC Countries

The South Asian Region is the hotspot that reported re-emerging infectious diseases as the major cause of deaths, highlighted in Zaidi et al. [17]. In the year 2000, the Southern states reported about 3.7million deaths caused by infectious diseases including: diarrhoea, pneumonia and measles. They reported India as having the second largest infected population in the world with HIV AIDS and hepatitis and tuberculosis continuing to affect millions. Laxminarayan [18] reported significant increase in the burden of emerging and re-emerging infectious diseases such as Avian influenza (2007), MERs-Cov (2012), Zika and Ebola (2014) in SAARC countries. Karunathilake [19] SAARC Region is greatly affected by the situation created by pandemic COVID-19. Wagner and Scholz [20] reported that the rampant COVID-19 outbreak had affected more than 1.9 billion people in South Asian

Countries. Menon [21] reported in BBC News that the number of coronavirus cases in SAARC states is comparatively very low than surrounding countries such as Denmark, United States, United Kingdom, Russia, Portugal, Australia, Qatar and New Zealand. Babu et al. [22] highlighted that the preparedness of SAARC countries for pandemic COVID-19 was inadequate, measured by Global Health Security Index (GHSI) in 2019. The maximum possible score is 100 and the score for SAARC countries were: India (46.5), Bhutan (40.3), Pakistan (35.5), Nepal (35.1), Bangladesh (35.0), Srilanka (33.9), Maldives (33.8) and Afghanistan (32.3). The consequential uncertain preventive measures resulted in demand and supply side shocks which negatively impacted the growth prospects of the Southern economies and reported serious fluctuations in Asian stock markets, documented in Mishra and Mishra [23]. Inam [24] International The News reported the post-COVID-19 effects in Southern Asia which include lockdowns, health barriers, social distancing, shutdown of educational institutes, quarantines, curfews, limited business activities, economic downturn, increased trend of protectionism, isolationism, racism, inequality and ethnocentrism. In short, the infectious COVID-19 threatens South Asian Region's social as well as economic infrastructure [25]. According to The World Bank estimates, the South Asian states experienced about 2.7percent shrink in economic activity in 2020. All these serious economic consequences resulting from Mad COVID-19 have brought attention towards the study of Asian stock markets. Table 1 below shows the detail of novel coronavirus spread in SAARC Region, reported from The World Health Organization Report no.102 [26] on May 1, 2020. The total number of confirmed COVID-19 cases were 62,823 and total deaths were 1,771. India reported the highest hit with 35,043 confirmed cases with 1147 deaths. Pakistan and Bangladesh occupied 2nd and 3rd positions with 16,817 and 7,667 confirmed cases and 385 and 168 deaths respectively. Bhutan had only 7 cases, 57 cases in Nepal and 396 cases in Maldives without any death. In Srilanka only 7 people died from COVID-19.

United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) [27] highlighted the economic growth outlook of SAARC Region and reported the decrease in trend from +6.8% (2017), +6.1% (2018) and – 2.7% (June 2020). Figure 1 below shows the Detail of different sectors affected due to

Table 1 Novel coronavirus spread Situation in SAARC Region. *Source:* WHO, situation report, 102 [26]

Countries	Total Confirmed cases	Total Deaths
India	35,043	1147
Pakistan	16,817	385
Bangladesh	7667	168
Afghanistan	2171	64
Srilanka	665	7
Maldives	396	0
Nepal	57	0
Bhutan	7	0
Total cases	62,823	1771

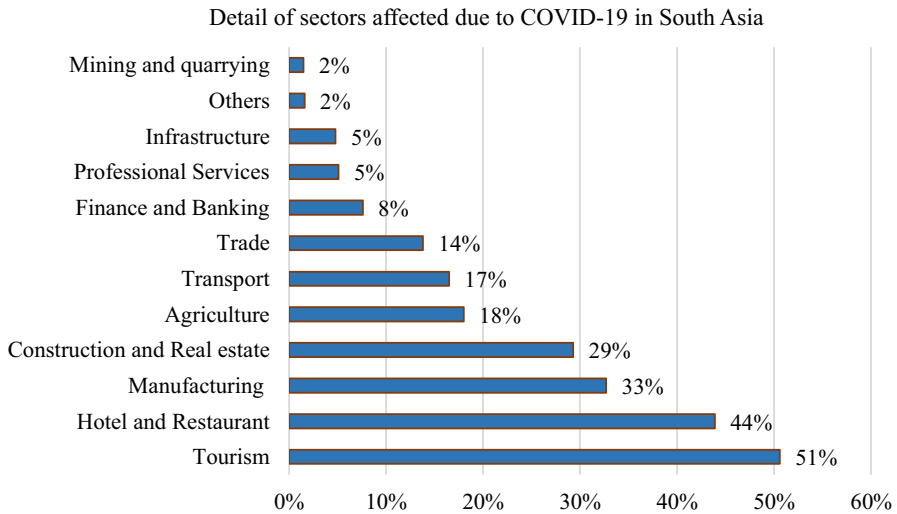


Fig. 1 Detail of sectors affected due to COVID-19 in South Asia. *Source:* UNESCAP-SSWA online Survey [27]

COVID-19 in South Asia, tourism is the major sector intensely impacted by COVID-19 in South Asia and contributes about 9percent GDP in Southern Region. Hotel and restaurants were in 2nd position with 44percent weighted score, manufacturing 33percent, agriculture 18percent, trade (14percent) and finance and banking sector (8percent). Mining and quarrying is the least affected sector with only 2percent.

The re-emerging global virus COVID-19 had a significant impact on the stock market performance of SAARC countries [28]. The World Bank in South Asia Economic Focus Spring 2020 reported the sharp increase in volatility of South Asian equity markets, decline in value of stock market returns with multiplication of the COVID-19 shock effects from surrounding borders. Figure 2 below shows the Volatility effects of Southern Region stock markets. S&P 500 shows highest stock market volatility but there were reasonably less variations in the stock returns of South Asian markets. Shanghai experienced the lowest stock market fluctuations.

2 Literature Review

Rolander [29] COVID-19 pandemic situation has created Madness all around the globe. Baker et al. [30], Fernandes [31], Gormsen and Koijen [32] and Ibrahim Yousef [2] documented that there are very few but rapidly increasing numbers of studies that evidenced the impact of coronavirus on the variations in stock market returns. He et al. [33] estimated the spillover effects of COVID-19 pandemic on daily returns of different stock markets. Yousef [2] investigated the spillover effect of re-emerging COVID-19 on the top G7 stock markets indices by considering the effect of number of everyday new cases and the expected growth rate in new cases on the standard deviations of the top G7 stock indices returns. The time varying



Fig. 2 Detail of Volatility effects of South Asian stock markets. *Source:* (South Asia Economic Focus Spring 2020) [21]

volatility effect is determined by using GJR-GARCH and GARCH models during January 2020 to May 2020. By considering the results of COVID-19 coefficients, the study proved the positive effect of COVID-19 on the volatility of G7 stock markets. Samrat et al. [34] applied the widely known statistical approach named Susceptible Infected Recovered (SIR) model for epidemic trend analysis of COVID-19 among eight member states of SAARC Region. For estimation of epidemic trend the study implied Short (20 days), Middle (90 days) and Long term (180 days) model, and proved the maximum reproduction number ($R_0 = 1.33$) for Pakistan and minimum reproduction number ($R_0 = 1.07$) for Bhutan. Nanda et al. [35] implied two statistical forecasting models: ARIMA model and SIR model and newcasted and forecasted the potential spread of novel coronavirus among SAARC states. The study predicted the increase of 35,000 confirmed cases, death cases will be mounted to 600 and recoveries to 1600 till April end with ARIMA model. The SIR Model predicted peak infection periods i-e 95th to 120th day of the viral outbreak period with 0.25 and 0.007 values of β and γ respectively. Bhattacharjee [36] studied the hurdles resulting from COVID-19 and the future trends in SAARC countries. Hamid Hussain in IBA Business Review [37] documented the reaction of PSX KSE-100 to novel coronavirus for February and March and reported the declining trend of stock market returns with the increase in coronavirus confirmed cases. He also highlighted the abnormality in stock returns of different industrial sectors including: airline, hotel industry, travel industry, finance and banking, textile, automobile and energy sectors. Only the utility sectors and goods and services sectors worked well. Basistha [38] investigated the effect of novel coronavirus on the performance of Indian Stock markets. The study estimated the volatility of two indices: S&P BSE SENSEX and Nifty during September 2019 to July 2020. The study also compared the stock returns of the two indices for pre-COVID-19 situation and post-COVID-19 situation and proved that stock returns were higher during pre-COVID-19 period

and decreased to the bottom line in the post-COVID-19 situation. He applied the GJR-GARCH model for estimating the spillover effect of COVID-19 on the two indices and proved the presence of time varying volatility effect during the pandemic period. Mishra et al. [39] estimated the effect of coronavirus on financial markets of India by using the Markov Switching Bayesian Vector Autoregressive model. The study proved that the effect of coronavirus on stock returns is harder than GST (Goods and Services Tax) and Demonetization. Faculties of humanities and social sciences, University of Ruhuna [40] reported the declining trend in stock markets of Srilanka with significant effect on social and economic development due to the coronavirus outbreak. They also highlighted the negative impact of COVID-19 on different industrial sectors. Aktar et al. [41] investigated the varied reaction of Bangladesh stock market to the coronavirus outbreak and documented the immediate as well as negative reaction of stock returns to the COVID-19 breakout which varies over time. Asian Development Bank [42] reported that in Nepal the tourism sector is intensely affected by COVID-19 with a significant declining percentage.

2.1 Extreme Value Theory (EVT)

EVT provides a strong theoretical basis for description of extreme events based on statistical modelling. Many studies have estimated extreme variations in financial stock markets e.g. currency rises, economic downturn and the rising credit defaults by applying EVT. Gilli and Kellezi [43] the study applied EVT for estimating risk measures and then determined its effect on major stock market indices i.e S&P 500. Mei-Ping et al. [44] applied EVT and determined the weakening effect of SARS viral breakout on the integration of Asian stock markets. This study applied EVT for determining the effect of Infectious pandemic COVID-19 on the stock market performance of SAARC Region.

2.2 Contagion Effect

Lee et al. [45] documented contagion effect as the transmission of market changes in a country to other countries resulting from a major financial event and interdependence between countries. Previous studies mostly considered the contagion effect of financial events e.g. Boyer et al. [46], Caporale et al. [47]. Very few studies have focused on the contagion effects of natural disasters like the earthquake, documented in Lee and Wang [48] earthquake in Japan had significant contagion effect on Asian stock markets and tsunami and earthquake in Southeast Asia (2004). Babu et al. [49] proved the significant contagion effect of the US Financial crisis of 2007 on SAARC Nation stock markets. Okorie and Lin [50] the study considered the top 32 countries affected from pandemic including Pakistan and proved the significant contagion effect of Pandemic COVID-19 on both stock returns and market volatilities. The current study determined the contagion effect of Mad COVID-19 on South Asian stock returns and market volatilities.

3 Methodology

The current study examined the impact of novel coronavirus pandemic on the stock market performance of SAARC Countries. The study used event study methodology for eliciting the effect of severe global pandemic on the stock market returns of SAARC Countries. Selmi and Bouoiyour [51] event study methodology is the best approach for measuring the steeper changes in the stock market returns resulting from an uncertain event. In this study the uncertain event is the Mad COVID-19 pandemic. Asymmetric GJR-GARCH Model is implied for determining the variations in the stock market yield of SAARC Region. Each country is assumed to be indicated by their respective National Stock exchanges. India (Bombay Stock Exchange S&P BSE SENSEX), Pakistan (Pakistan Stock Exchange PSX KSE-100), Bangladesh (Dhaka Stock Exchange DSEX), Srilanka (Colombo Stock Exchange ASPI) and Nepal (Nepal Stock Exchange NEPSE). Many studies have examined the Causal Impact of financial shocks in developed economies to the developing economies. Iqbal et al. [52] evidenced different studies that investigated the stock spillover effect in developed markets and its transmission to South Asian Markets. The study proved strong integration of South Asian markets with the global markets with the resulting volatility effect experienced during financial crises in the developed economies. Abbas and Khan [53] highlighted the volatility spillover effect among Pakistan, Srilanka, India, Singapore, China, USA and UK. They considered the presence of trade relationships between South Asian countries and Developed economies as the main reason for spillover effect. Golam et al. [54] the best measure for stock market performance is the consideration of composite market indexes, first preference will be for broad market indexes e.g. FTSE 100, NYSE Composite Index and S&P 500. Baek et al. [55] COVID-19 outbreak has brought striking fluctuations in the U.S. Stock markets. This study implied the S&P 500 index as a benchmark index for studying the volatility effect. Historical databases of all indices are used for data collection.

3.1 Confirmed case of Novel Coronavirus

As COVID-19 arises from China (Wuhan) in December, 2020 and has created a threatening situation for the global economy especially for neighbouring developing economies of China including India, Pakistan, Bangladesh, Iran and Afghanistan documented in Yaseen et al. [56]. A Confirmed case of Novel Coronavirus is one which has “breath-shortness, anosmia, suffering from fever, coryza and infected respiratory tract”. WHO [26] reported 186,040 confirmed cases of COVID-19 and about 9000 death cases in SAARC member states on May 1, 2020.

3.2 The Estimation Window

Vryghem [57] defined the estimation window as the time duration which describes the information for normal return occurring prior to the event window. In the study the estimation window is of 120 days from August 8, 2019 to December 13, 2019, which is the normal return period occurring pre-COVID-19 pandemic situation.

3.3 The Event Window

The event window is the period specified for studying the impact of stock market returns of the identified indices of SAARC member states. Monthly returns form the basis for studies involving longer time periods and daily returns form the basis for short-term event studies. Vryghem [57] highlighted from the referenced studies that short-term event windows can be as short as two-days and longer event windows can be as long as sixty-month period, documented in Gregory [58] and Lummer and McConnell [59]. [60] The World Health Organization declared COVID-19 infectious outbreak as a global pandemic on March 11, 2020. Hartwig Schafer, Vice President, Southern Region, The World Bank [61] reported March 11, 2020 the period when novel coronavirus hardly hit South Asian countries. The current study is based on the severe pandemic periods in SAARC states with an event window of 25 days from February 4, 2020 to April 14, 2020 ($t = -25, 25$). ' t_{-1} ' is 25 days pre-COVID-19 declaration as pandemic period and ' t_1 ' is 25 days post-COVID-19 declaration as pandemic period.

3.4 S&P 500 Index

The S&P 500 Index (Standard and Poor's 500 Index), started in 1957 and is a market capitalization weighted index, composed of 500 largest public limited companies listed on US Stock Exchange. The S&P 500 Index is considered as a standardised barometer for measuring the market of US equities and a market-adjusted benchmark for studying many other funds, documented in Asem and Alam [62]. Syed et al. [63] indexes of both developed and developing markets had significant impact on each other. They proved significant short-term and long run linkages between stock markets of South Asia, UK, US and emerging economies. They highlighted that the S&P 500 not only affects emerging stock markets but also had a significant Granger causation effect on stock market indexes of the Southern Region.

3.5 Cumulative Abnormal Returns (CAR) Approach

The study referenced CAR approach from previous studies [64] and applied it for estimation of the impact of re-emerging COVID-19 outbreak on the stock market performance of selected SAARC Countries. " $AR_{i,t}$ " is the Abnormal return

component assigned to global pandemic novel coronavirus event, calculated as the deviation of expected return from the actual return of the indices during the event window. COVID-19 is a shock and causes a significant decrease in the stock market returns (value) of the country. For calculating ($AR_{i,t}$), we need to estimate the Expected returns ($ER_{i,t}$) of index (i) during time t. Market Model (MM) is applied and stock market returns of each country's index is regressed against the S&P 500 index for examining benchmark effects. Selmi and Bouoiyour [51] evidenced that the most commonly used method for determining stock returns is the market model. The equation used for regression analysis:

$$R_{i,t} = \alpha_i + \beta_i R_{mf,t} + \varepsilon_{i,t} \quad (1)$$

In Eq. 1, $R_{i,t}$ is the daily return of identified indexes (i) at time t of selected SAARC countries and $R_{mf,t}$ is the daily stock return of the S&P 500 benchmark (a value-weighted) Index for the event period. α_i and β_i are the regression parameters and $\varepsilon_{i,t}$ is a random error term. The daily stock returns are estimated as:

$$R_{i,t} = \ln \left(\frac{P_{i,t} \text{ (Closing price of Index(i) at time t)}}{P_{i,t-1} \text{ (Closing price of Index(i) at time t - 1)}} \right) * 100,$$

The daily stock returns for benchmark S&P 500 Index are estimated as:

$$R_{mf,t} = \ln \left(\frac{P_{m,t} \text{ Closing price of Index(m) at time t}}{P_{m,t-1} \text{ Closing price of Index(m) at time t - 1}} \right) * 100,$$

Abnormal returns for event time ($t=t_{-1}, t_1$) are calculated by Eqs. 2 and 3:

$$AR_{i,t} = R_{i,t} - ER_{i,t} \quad (2)$$

$$ER_{i,t} = \hat{\alpha}_i + \hat{\beta}_i R_{mf,t} \quad (3)$$

In Eq. 2, $AR_{i,t}$ is the Abnormal stock returns and in Eq. 3 $ER_{i,t}$ is the Expected Return for identified indexes (i) at time t of selected SAARC countries and $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the error-free estimation parameters computed by using Ordinary Least Square (OLS) statistical analysis.

As ($CAR_{i,t}$) shows the compounding of daily abnormal returns of stocks of identified indices of SAARC countries and are widely used for measuring the performance of stock returns in reaction to the zoonotic COVID-19. The expected value for CAR is "0" indicating no abnormal returns. Equation 4 shows the calculation of CAR:

$$CAR_{i,t} = CAR_{i,t-1} + AR_{i,t} \quad (4)$$

This study used t-statistics for determining the statistical significance of CAR approach during time period t. In Eq. 5, shows t-statistics for $CAR_{i,t}$ and test ' $H_0 = CAR$ has statistically significant difference from zero'. When t-statistics > 1.96 , indicated acceptance of H_0 with strong impact of the Mad COVID-19 outbreak on Southern stock markets t_{CAR} . σ_{CAR} shows the standard deviation of CAR.

$$t_{CAR} = \frac{CAR_{i,t}}{\sigma_{CAR} / \sqrt{n}} \quad (5)$$

For determining the statistical significance of our t-test results, i-e $H_0: CAR_{i,t} = 0$, P -value is utilized. P -value is determined by using the expression on MS Excel “T.DIST (t_{CAR} , Df , cumulative distribution function)”. If P -value < 0.05 , shows the significant effect of the Mad COVID-19 outbreak on the stock returns of the Southern Region.

3.6 GJR-GARCH Model

The study applied the GJR-GARCH Model for determining the spillover effect of novel Coronavirus on stock market volatility of selected SAARC countries. Ali [65] documented that the GJR-GARCH Model was introduced by Glosten, Jagannathan and Runkle for determining the time-varying effect of positive and negative shocks on the volatility of stock markets. Sakthivel et al. [66] documented the limitation of GJR-GARCH model i-e the implication of symmetrically volatile reaction to negative and positive shocks. For this the conditional variance can be assumed as the magnitude of the lagged residuals and hence does not make up for their sign. And asymmetric conditional volatility responses known as leverage effect to positive and negative information can be determined by squaring ϵ_{t-1} when it is negative (Glosten and Runkle [67] and Ibrahim [2]). The following expression used for estimation of GJR-GARCH Model:

$$h_t = \alpha_0 + \sum_{j=1}^q \alpha_j \epsilon_{t-j}^2 + \sum_{i=1}^p \beta_i h_{t-i} + \sum_{k=1}^r \gamma_k I_{t-1} \epsilon_{t-1}^2 \quad (6)$$

where $I_{t-1} = 0$ if $\epsilon_{t-1} > 0$ and $I_{t-1} = 1$ if $\epsilon_{t-1} < 0$, depending upon whether ϵ_{t-1} is below or above the threshold value i-e 0.

In Eq. 6, h_t shows conditional variance, ϵ_{t-1}^2 has differential effects on conditional variance. When ϵ_{t-1} is positive, the total effect is caused by $\alpha_1 \epsilon_{t-1}^2$, when ϵ_{t-1} is negative, the total effect is caused by $(\alpha_1 + \gamma_1) \epsilon_{t-1}^2$. γ_i is the coefficient of leverage effect, if $\gamma_i = 0$ no leverage effect, $\gamma_i > 0$, leverage effect is present, indicating high volatility with negative shocks, $\gamma_i < 0$, leverage effect is present, indicating low volatility with negative shocks. α_1 and β_1 are estimation parameters that can be estimated by maximizing the log likelihood.

Introduction of a dummy variable in conditional mean and conditional variance equation play an important role in determining the effect of COVID-19 on volatility of identified indices of SAARC countries. So GJR-GARCH model implied in the study is modified as:

$$y_t = \mu + \epsilon_t \quad (7)$$

$$h_t = \omega + \alpha_1 : \epsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma_i I_{t-1} \epsilon_{t-1}^2 + \lambda_1 Covid_t \quad (8)$$

Equation 7 is the conditional mean equation, μ is the average return and Eq. 8 is the conditional variance equation and ω is the function of mean volatility. $Covid_t$ is the dummy variable which is assumed to be zero for the pre-COVID-19 declaration as pandemic period and 1 for post-COVID-19 declaration as pandemic period.

4 Hypothesis Development

H_{1a} : The Mad COVID-19 outbreak had a significant effect on the stock returns of SAARC Region.

H_{0a} : The Mad COVID-19 outbreak had no significant effect on the stock returns of SAARC Region.

H_{1b} : The Mad COVID-19 outbreak had a significant effect on the volatility of stock markets of SAARC Region.

H_{0b} : The Mad COVID-19 outbreak had no significant effect on the volatility of stock markets of SAARC Region.

5 Results and Interpretation

The study determined the effect of the Novel Coronavirus outbreak on the stock market performance of SAARC Countries. As the evidence proved that all the zoonotic diseases like HIV AIDS, TB, SARS, Avian Influenza, COVID-19 etc. had a sharp effect on the stock returns of SAARC countries.

5.1 CAR Statistical Analysis

Table 2 above represents the results of CAR for the indices of selected SAARC Countries. $CAR_{i,t}$ values show cumulative abnormal returns for the indices during $t = -25, 25$. For S&P BSE SENSEX and PSX KSE-100 the values were relatively stable before COVID-19 pandemic declaration i.e March 11, 2020, but after COVID-19 severe hit there was dramatic decrease in stock returns of Indian markets with values fluctuating between $-32.0939, -31.4330, -25.7189, -19.3569$, and -19.1999 . For Pakistan, the peaked negative values of stock returns are $-38.5342, -36.7238, -33.3266$ and -29.7360 . Bangladesh is in 3rd position among SAARC countries, Srilanka and Nepal hit by COVID-19 after February, 2020. DSEX responded strongly to COVID-19 in initial days, documented in Aktar et al. [41] $CAR_{i,t}$ values were positive before COVID-19 for DSEX and ASPI, but this study considered the periods during COVID-19 pandemic declaration and its severe hit, so values of returns were positive and less negative for $t = -25, 20$ and -15 i.e. $-1.8433, 6.7543$ and 4.2521 for DSEX and $-0.7018, -1.0747$ and -4.2361 for ASPI. DSEX and ASPI faced tough times for a short period after COVID-19 pandemic declaration with maximum negative values of -13.8543 and -9.8851 for Bangladesh, $-27.7124, -24.7647$ and -19.0917 for Srilanka. Nepal showed least and delayed effect among SAARC states and showed a declining trend with negative

Table 2 Results of CAR for the indices of selected SAARC Countries. *Source:* Author's Calculations

Days	S&P BSE SENSEX		PSX KSE-100		DSEX		ASPI		NIPSE	
	$CAR_{i,t}$	t-test P -value	$CAR_{i,t}$	t-test P -value	$CAR_{i,t}$	t-test P -value	$CAR_{i,t}$	t-test P -value	$CAR_{i,t}$	t-test P -value
-25	3.3652	-6.0444 0.0000	1.7921	-7.3205 0.0000	-1.8433	-4.0109 0.0006	-0.7018	-8.1489 0.0000	-1.7771	-2.0443 0.0000
-20	2.7075	-6.6170 0.0000	0.9874	-8.1480 0.0000	6.7543	-4.1924 0.0003	-1.0747	-8.7439 0.0000	3.8386	-2.1324 0.0000
-15	0.0031	-7.2622 0.0000	-4.3806	-8.8563 0.0000	4.2521	-5.0460 0.0002	-4.2361	-9.4197 0.0000	10.4092	-2.4719 0.0000
-10	-3.8014	-7.9225 0.0000	-7.3731	-9.5197 0.0000	-0.3807	-5.8510 0.0000	-6.5328	-10.0488 0.0000	9.7849	-3.1754 0.0000
-5	-10.9913	-8.5567 0.0000	-20.5586	-10.2092 0.0000	-3.5234	-6.4020 0.0000	-16.1633	-10.6682 0.0000	-0.2935	-3.9880 0.0000
-1	-19.1999	-8.9996 0.0000	-21.8161	-10.5305 0.0000	-9.8851	-6.7626 0.0000	-18.8350	-10.7940 0.0000	5.6597	-4.4146 0.0000
0	-14.4815	-9.1267 0.0000	-33.3266	-10.8760 0.0000	-5.5660	-6.5009 0.0000	-24.7647	-10.7541 0.0000	3.9959	-5.3244 0.0000
1	-31.4330	-9.5703 0.0000	-36.7238	-10.7350 0.0000	-13.8543	-6.7173 0.0000	-7.7124	-0.2031 0.0000	-1.3558	-6.3738 0.0000
5	-25.7189	-8.9871 0.0000	-25.1599	-10.3455 0.0000	-8.4333	-5.7683 0.0000	-19.0917	-9.1785 0.0000	-7.7744	-7.3218 0.0000
10	-32.0939	-8.6458 0.0000	-29.7360	-10.6234 0.0000	-7.1556	-5.4109 0.0000	-16.7390	-8.7613 0.0000	-10.9399	-7.9995 0.0000
15	-19.3569	-7.4711 0.0000	-26.5751	-10.6329 0.0000	-4.9545	-5.1610 0.0000	-15.0755	-8.4825 0.0000	-10.7936	-8.6156 0.0000
20	-17.7836	-7.2786 0.0000	-38.5342	-11.0240 0.0000	-6.0553	-5.4018 0.0000	-14.4819	-8.3451 0.0000	-17.9794	-9.6671 0.0000
25	-16.7308	-7.2208 0.0000	-29.4225	-9.6776 0.0000	-6.2246	-5.3903 0.0000	-14.5629	-8.2454 0.0000	-19.6094	-9.9524 0.0000

values of -19.6094 and -17.9794 for a very short period. Results of T-statistics shows t -values > 1.96 for all indices stock returns, so ' $H_0 = CAR$ is significantly different from zero' is accepted. The P -values of all indices are < 0.05 significance level, indicating significant negative effect of Mad COVID-19 outbreak on the stock returns of India, Pakistan, Bangladesh, Srilanka and Nepal. Hence H_{1a} proved. Hamid Hussain in IBA Business Review [37] reported 4.68% (1336.03 points) decline in KSE-100 index stock returns with the increasing number of coronavirus cases in Pakistan.

5.2 Graphical Representation

The Fig. 3 above shows a graph, indicating CAR for S&P BSE SENSEX, PSX KSE-100, DSEX, ASPA and NEPSE during the period of COVID-19 hit SAARC countries. The $CAR_{i,t}$ or the indices during $t = -25, 25$ shows relatively stable values before COVID-19 pandemic declaration, but after the severe hit of Mad COVID-19 there was seen a dramatic decrease in the values. S&P BSE SENSEX shows dramatic decrease in stock returns with fluctuating values moving between $-32.0939, -31.4330, -25.7189, -19.3569,$ and -19.1999 . The performance of KSE-100 stock returns experienced significant decline with the increase in the hitting intensity of COVID-19 viral outbreak. $CAR_{i,t}$ during COVID-19 shows more negative values of $-38.5342, -36.7238, -33.3266$ and -29.7360 . DSEX faced a tough time for a short period after COVID-19 pandemic declaration with maximum negative values of -13.8543 and -9.8851 , clearly indicated with negative peaks. Colombo Stock Exchange ASPI experienced a slight nosedive decrease for short period after COVID-19 pandemic hit with maximum negative values of $27.7124, -24.7647$ and -19.0917 of $CAR_{i,t}$. There was immediate recovery in stock returns of ASPI. Nepal experienced less intense and delayed effects of coronavirus among SAARC

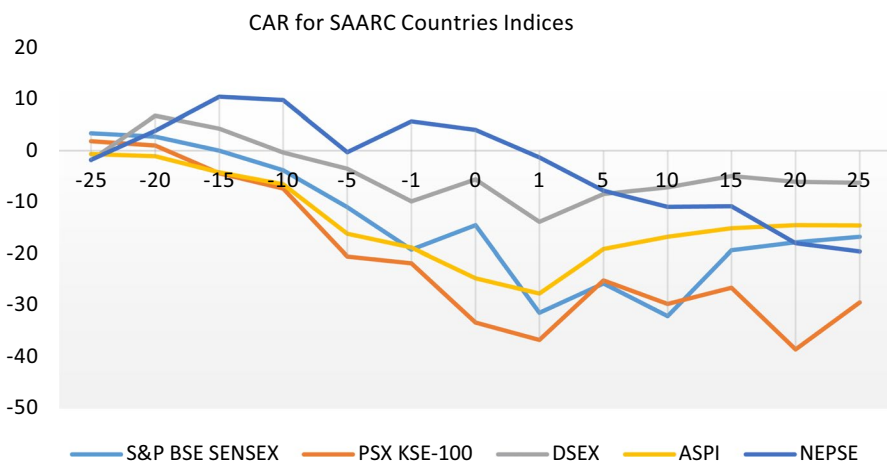


Fig. 3 CAR for SAARC Countries indices: S&P BSE SENSEX, PSX KSE-100, DSEX, ASPA and NEPSE. *Source:* Author's calculations

Table 3 Results of Augmented-Dickey-Fuller test for Stationarity of time series. *Source:* Author's calculations

Countries	T-statistics	P-value
S&P BSE SENSEX	– 13.29	0.000
PSX KSE 100	– 11.07	0.000
DSEX	– 11.20	0.000
ASPI	– 6.22	0.000
NEPSE	– 8.45	0.000

Table 4 Results of ARCH-LM test for ARCH Effect. *Source:* Author's Calculations

Countries	Chi-square statistics			
	Lag value	(Chi^2)	Df	P-value
S&P BSE SENSEX	1	8.838	1	0.003
PSX KSE 100	1	41.111	1	0.000
DSEX	1	41.153	1	0.000
ASPI	1	40.048	1	0.000
NEPSE	1	42.398	1	0.000

countries. The graph shows a declining trend with negative values of – 19.6094 and – 17.9794 for a very short period.

5.3 GJR-GARCH Model

5.3.1 Unit root test

The important condition for implication of the GARCH model is the presence of stationarity in the time series. The Augmented-Dickey-Fuller test proposed by two American Statisticians D.A. Dickey and W.A. Fuller (1979), tested ' $H_0 =$ time series has a unit root'. If P -values of ADF test are less than 1percent critical level, we reject H_0 , indicating that entire time series data is stationary.

In above Table 3, we summarize the results of the ADF test. All indices for SAARC countries have P -values < 1percent critical level. Therefore we reject the null hypothesis for the presence of unit root in time series, indicating stationarity in the entire time series data. Now we can use the series for developing the GJR-GARCH model.

5.3.2 ARCH-LM Test

For detection of heteroscedasticity in time series data we applied ARCH effect test. The ARCH-LM (Lagrange Multiplier) test proposed by Engle (1982), used for estimation of ARCH effect in the time series data. ARCH-LM test examine $H_0 =$ there is no ARCH effect in the data series. H_0 will be accepted, if the values of chi-square statistics are > 0.05 significance level and if the values are < 5% significant level we reject H_0 . Hence the ARCH effect is present.

Table 4 above shows the results of ARCH-LM test for ARCH Effect using Chi-square statistics. The P -values of ARCH-LM test are $< 5\%$ critical level for all the indices. The results indicated rejection of the null hypothesis, so a significant ARCH effect is present in the series which is supportive for further analysis.

5.3.3 Breusch-Godfrey-LM Autocorrelation Test

The study applied Breusch-Godfrey-LM Autocorrelation test, proposed by Breusch and Godfrey (1978), used for examining $H_0 =$ no serial correlation. If the P -value is $> 5\%$ critical level, H_0 is accepted.

Table 5 above shows the results of the Breusch-Godfrey-LM Autocorrelation test. The P -values for all the indices are > 0.05 significance level, indicating acceptance of H_0 i-e no autocorrelation is present in time series data.

5.3.4 GJR-GARCH Model Results

GJR-GARCH model is used for estimation of Contagion effect of mad coronavirus on the stock market volatility in the SAARC region.

Table 6 above shows the estimation results of GJR-GARCH model for determining the Contagion effect of stock market volatility in the SAARC region. Chen et al. [68] the presence of asymmetric conditional volatility in GARCH models is verified by the asymmetric parameters. Results indicate that the coefficient of ARCH (α) and GARCH (β) for all the indices were positive and statistically significant with P -values < 0.05 , indicating existence of ARCH effect and presence of volatility clustering among the indices studied. ' μ ' represents the mean of returns and ' ω ' represents the function for mean volatility, $\omega > 0$, $\alpha > 0$ and $\beta > 0$ ensures the positivity of the conditional variance. $\alpha + \beta$ shows the sum of the ARCH and GARCH coefficients with values > 1 , indicating persistence in the asymmetric volatility. ' γ ' represents the coefficient of leverage effect, if $\gamma = 0$ i-e no asymmetric volatility, if $\gamma < 0$ i-e asymmetric volatility is present, indicating low volatility with negative shocks like COVID-19 and if $\gamma > 0$ i-e asymmetric volatility is present, indicating more volatility with the negative shocks like Pandemic COVID-19 than positive shocks. The values for coefficient of leverage effect shows $\gamma > 0$ for all indices of SAARC member countries with significant P -values < 0.05 i-e asymmetric volatility is present, indicating that the impact of negative shocks like COVID-19 Pandemic is higher on the volatility of stock indexes of SAARC countries. So H_{1b} is accepted. Mishra and Mishra [23] proved the outbreak

Table 5 Results of Breusch-Godfrey-LM Autocorrelation test. *Source:* Author's Calculations

Countries	(Chi^2)	Df	P -values
S&P BSE SENSEX	0.000	1	0.9980
PSX KSE 100	0.402	1	0.5260
DSEX	0.027	1	0.8687
ASPI	0.000	1	0.9996
NEPSE	0.352	1	0.5528

Table 6 Results of GJR-GARCH Model for estimating Stock market volatility. *Source:* Author's Calculations

GJR-GARCH Mean Equation Parameters	S&P BSE SENSEX		PSX KSE 100		DSEX		ASPI		NEPSE	
	Coefficient	Z. value	Coefficient	Z. value	Coefficient	Z. value	Coefficient	Z. value	Coefficient	Z. value
μ P-value	0.0197 0.227	1.21	-0.8696 0.000	-3.50	0.0005 0.753	0.31	0.0013 0.168	1.38	-0.0023 0.410	-0.82
Variance Equation										
ω P-value	0.8528 0.000	3.98	-2.2293 0.005	-2.84	0.2429 0.021	2.32	0.8568 0.000	4.04	0.2049 0.000	3.64
α P-value	1.5530 0.001	3.25	0.0757 0.430	0.79	1.3636 0.001	3.31	1.9126 0.004	2.87	1.1949 0.005	2.82
β P-value	0.7170 0.000	10.40	1.1075 0.000	6.35	0.2444 0.047	1.98	0.1905 0.002	3.08	0.3786 0.000	4.53
$\alpha + \beta$	2.27		1.1832		1.608		2.1031		1.5735	
γ P-value	1.5632 0.000	4.48	0.3540 0.033	2.13	0.5286 0.005	3.14	1.5706 0.000	4.50	0.5418 0.002	3.16

of the corona pandemic had a significant effect on the returns as well as volatilities of Asian stock markets including Pakistan, India and Bangladesh.

6 Conclusion

This study significantly extends the previous studies that proved the negative effect of contagious viral infections on stock market performance. As the re-emerging viral infections are burdening the SAARC countries with serious negative effects on both human health and economic progression. This study estimated the impact of the Mad COVID-19 outbreak on the stock market returns and volatility effects of selected SAARC countries. The number of coronavirus cases were comparatively low in SAARC economies but due to inadequate preparation, the uncertain preventive measures brought serious economic consequences. SAARC states experienced uncertain spirals of coronavirus which led to variation in stock returns and their volatilities. The study applied CAR approach and proved the declining effect of Mad COVID-19 on the stock returns of SAARC countries. India and Pakistan experienced significant decline in stock returns with the increase in the hitting intensity of COVID-19 viral outbreak. Bangladesh and Srilanka face tough times with a slight nosedive only for a short period after COVID-19 pandemic and markets of Nepal were less responsive to the coronavirus. The GJR-GARCH model was applied to determine the volatility effect of the indices and findings indicate the significant increase in volatility of stock indexes of SAARC countries with the negative shocks like COVID-19 Pandemic. Therefore, the study proved significant reactions of SAARC countries to Mad COVID-19 severe hits, with falling markets and rising volatility.

7 Areas of further Study

The study only estimated the effect of Infectious pandemic COVID-19 outbreak on stock market performance of selected SAARC countries. The COVID-19 spread all around the globe, so other geographical zones can be considered for further study. Coronavirus is responsible for causing significant decline in the high level of global economic productivity and a considerable source for setting out its ultimate effect on every perspective related to the financial sector can provide an effective area for further study Ibrahim [2]. The study used CAR event study methodology, other relevant approaches including symmetric/ asymmetric GARCH models, BHAR approach, Granger Causality analysis can be implied with different event windows.

8 Implications

The study, along with academic contribution, is a source for exploring the financial market behavior of the SAARC member states during re-emerging pandemic outbreaks. The study provides insights to financial advisors, financial investors

regarding the behavior of stock market returns in reaction to hazards like novel coronavirus. The study considered re-emerging epidemic diseases like COVID-19 as a negative shock which increased stock market volatility and resulted in falling future markets. The businesses and participants of financial markets must be aware of these negative shocks and their negative effects on the performance of stock markets and they must be prepared to combat the challenges resulting from similar global pandemics.

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Authors' Contribution The study has a significant contribution for providing financial outlook of the SAARC member states during pandemics. The study proved re-emerging epidemic diseases like COVID-19 as a negative shock which increases stock market volatility and resulted in falling future markets. The participants of financial markets must be aware of these negative shocks and their negative effects on the performance of stock markets and they must be prepared to combat the challenges resulting from similar global pandemics.

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Data Availability Historical databases of all selected indices are used for data collection. The data that support the findings of this study are available on request.

Declarations

Conflict of interest There is no Conflict of Interest regarding the authorship or publication of this article.

Code availability Excel spreadsheet is used for analysis and are available on request.

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