COVID-19 and index returns of sub-continent: An exploration via Markov-Switching model

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ABSTRACT

This paper empirically investigates the relationship between stock market returns and COVID-19 cases. The dataset consists of the daily frequency of hallmark indices of Pakistan, India, and Bangladesh from January 2019 to November 2020. The methodologies applied in the paper are ARCH-GARCH and two-state Markov-Switching Model (MSM), a better approach for structural breaks, in all indices. The findings reveal that internal and external factors jointly contribute to the volatility of index returns in Pakistan and Bangladesh, but internal factors affect India's volatility transmission. MSM finds that the negativity of returns increases, while the positivity decreases in both states during the COVID-19 period with higher variance and low persistence in transition probability than the pre-COVID-19 phase. In the final MS model, COVID-19 cases depict significant relation with index returns in states1 while insignificant in state2. The probability of staying state1 is not persistent, whereas state2 is persistent during COVID-19 crises with higher duration.

Keywords: Markov-Switching Model, Index Returns, Probability, COVID-19 Cases, Duration.

INTRODUCTION

In December 2019, Wuhan city faced a pandemic latter called COVID-19; it rocked the foundation of almost all economies and proved a bigger challenge than the great recession (Just and Echaust, 2020). It spread swiftly around the globe because of travelling, and within four months, it hit 200 countries, then the World Health Organization (WHO) declared it a global pandemic. During the first phase of COVID-19, different countries banned fights, quarantine people, and imposed lockdown, resulting in contracted growth by lesser production, consumption, and economic activities (Waheed et al. 2020). These activities affect the layman and default the small business

and proved a nightmare for stock markets. Small firms looked for bailout packages while large firms faced a decline in consumption, employee health-related issues and limited production capacity. These large listed firms badly impact the stock markets by direct or indirect channels (Cepoi, 2020).

Stock markets are the backbone and representative of the capitalistic economic system and subject to rapid change by any unwanted negative phenomena like COVID-19. The COVID-19 rocked the foundation of stock markets that led to investment uncertainty (Baker et al. 2020). All well-known stock markets suffered huge losses during the first quarter of 2020 (Cepoi, 2020). Bloomberg reveals during the first quarter S&P 500 index declined 27%, the DAX index declined 38%, while Nikkei dropped 29%. In MARCH, the United States markets hit by the circuit breaker mechanism four times in 10 days. Similarly, the United Kingdom stock market indexes and FTSE faced a decline of more than 12% worse after 1987 (Al-Awadhi et al. 2020).

The COVID-19 showed a contagion effect in different stock markets, but developing countries markets had to struggle more. The sub-continent countries like Pakistan, India, and Bangladesh fall in the bracket of underdeveloped economies. Their stock markets are not a match with world-class stock markets, so COVID-19 hit the countries badly. From February to MARCH 2020, a vast, abrupt and dynamic downward trend (KSE dropped from m 43,000 to 28000; NSE dropped from 12,200 to 7,500, whereas DSX dropped from 4,700 to 3,600). In this period, every index has faced a historically low value. The figure01 shows KSE and NSE recovered while DSX could not reach the threshold of early 2019. Even NSE crosses the initial index value from the starting period of the sample.

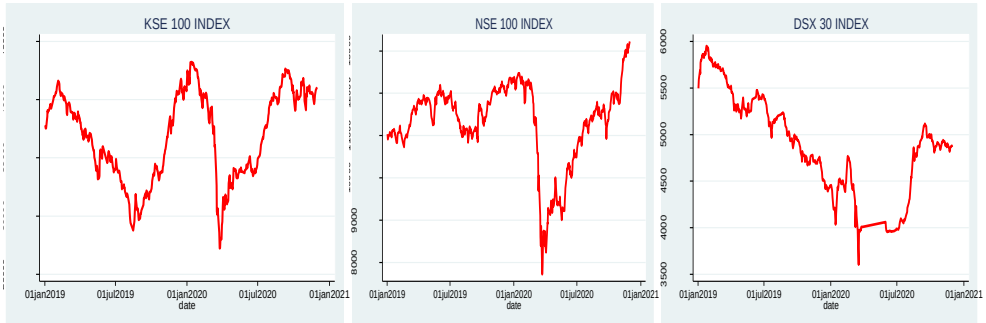


Figure 1: KSE100 index, NSE100 index, DSX30 index from 02-01-2019- 30-09-2020

The governments started to announce bailout packages to offset losses and smooth working of secondary markets to revive investors' confidence in developed countries. As a result, stock indexes partially recovered after the first quarter, but a great deal of financial uncertainty remains in the markets (

Cepoi, 2020). It was not possible for the countries of the sub-continent because of the limited financial capacity. This capacity was the hindrance for a bailout package and resulted in a great uncertainty worth investigating phenomena.

Uncertainty is a natural and prominent issue in decision making; it gets significance when dealing with a financial decision because it may be a blessing or bone for any individual, firm or country. There are many methodologies and procedure adopted in the existing literature to cope with the problem of uncertainty. We can solve the issue of uncertainty with the help of probability approaches. A rational person not only gives weightage to the probability of success or failure in any economic or non-economic decision but also strives to accept a probabilistic model with higher accuracy. In this modern and complex financial decision-making era, probability models got the importance of better predictability. Different studies are carried out in Pakistan to discover the connection between the Stock market returns and COVID-19 ((Ahmad,2020; Riaz et al., 2020; Shafi et al., 2020; Khan 2020)). The difference between my from other studies is the application of the Markov-Switching Model (MSM). It is an ideal toolbox devised to estimate recurrent switches between bull and bear markets and allows measuring the probabilities and duration of such regime shifts occurring.

The recent literature adequately deals with the COVID-19 and stock market nexus and found diverse relationship (Just & Echaust, K. 2020; Baek et al. 2020; Waheed et al. 2020; Khan et al. 2020). Most studies based on mean value methods like OLS are not a better way to deal with stock markets' dynamic nature during the COVID-19 period. Some studies focus on the COVID-19 and stock market relationship in the context of Pakistan. However, their methodology is not robust to account for this dynamic shift. Those previously used models include applied quantile regression (Waheed et al., 2020) and event study (Khan et al., 2020), for instance. Simiarly, Aslam et al. (2020) focus on the EGARCH and MS model's stock market volatility, while localpublication focuses on OLS or descriptive methods. Mirza et al. (2020) applied MSM to tackle the probability estimation but ignores the COVID-19 crisis that is a determinant of return and volatility fluctuation during the COVID-19 phase. A robust methodology for the relationship between COVID-19 and index returns for different probabilistic states is the study's contribution. It is a dire need for research for developing economies like Pakistan, India and Bangladesh. Thus, this study will help ascertain the probability, volatility and nature of the relationship in different regimes in sample stock market indices. This study will provide benefits to investors, regulators and policymakers for formulating a better strategy.

LITERATURE REVIEW

Stock Markets During COVID-19

The literature reveals the devastative impact of COVID-19 on economies and the stock markets. The tone of papers focuses on the short-run impact of COVID-19 on stock markets return and its associated volatility (Baker et al. 2020; Haroon and Rizvi, 2020; Liu et al. 2020; Morales and Andreosso-O'Callaghan, 2020; Okorie and Lin, 2020; Zhang et al. 2020). Some of the papers used confirmed cases of COVID-19 and death data as the independent variable to check the stock market behaviour in different economies at time series of panel setting (Waheed et al., 2020; Khan et al.2020; Just & Echaust, 2020; Baek et al., 2020.) We find conflicting empirical findings regarding the linkage of stock market index return and COVID-19 crises. Most of the studies reveal a negative impact of COVID-19 on stock markets return (Baek, Mohanty, & Glambosky., 2020; Khan et al., 2020; Ashraf; 2020), while some argue no relationship (Just & Echaust,2020; Waheed et al. 2020). It is a logical point that COVID-19 is the main reason for economic shocks that transmits eventually in every economy. However, its impact is different because of each economy's unique circumstances and formation, but no index is safe. Most studies are based on the mean value method like OLS, which is not a better way to deal with the dynamic relationship of stock market returns during COVID-19.

Some studies focus on the COVID-19 and stock market relationship in the context of Pakistan. However, their methodology is not robust to deal with this dynamic shift like Waheed et al. (2020) applied quantile regression, Khan et al. (2020) used the event study. Aslam et al. (2020) focus stock market volatility by EGARCH and MS model. In contrast, local publication focuses on OLS or descriptive methods, and similar behaviour is noted in other sample counties like India and Bangladesh with few exceptions. MSM can estimate the better model for the relationship between COVID-19 cases and stock market index returns. This method split the data into different regimes and provides a detailed analysis that helps decision-making and policy design. This method is emerging in the field of volatility modelling and spillover estimation. Mirza, Nazir, & Ali (2019) focused on the stochastic process in Markov setting with states probability in the Pakistan Stock Exchange (PSX) context. They applied the MSM and Monte Carlo method for forecasting on KSE 100 index Returns in different regimes from the daily data of 2010-2015 and found it superior. They recommended MSM helpful future research as a better procedure for portfolio analysis stocks instead of stock index.

Waheed et al. (2020) link the stock market returns and COVID-19 cases data in Pakistan. They used data from February to April 2020 daily and applied the ARIMA methodology, exponential smoothing and quantile regression for predicting the index for May and June. They found the contradicting result about with prevailing literature as KSE has a positive relationship with COVID-19 because with the increase of COVID-19 cases, KSE index returns increase. As of timely intervention of the Pakistani government or very limited data span like February to April data. Khan et al. (2020) extended the empirically work and tested the KSE100, KSE30 and KMI 30 index relationship with event study methodology. Their analysis used 160 estimation period while 61 for the event window and found a negative impact of COVID-19 on returns in the post-event window. They found significantly negatively impacted stock returns of all indices of Pakistan. They provide future direction by using other top indices of the world in future research.

Volatility and Stock Market Return

During the COVID-19 crises, stock markets' volatility increased manifold across the globe that hindered the investment decision of individuals, corporations, and institutes. It is an unwanted reason like terrorism, oil prices shuffle, and COVID-19. Aslam et al. (2020) checked the relationship between terrorism on the volatility of PSX. The authors used the data from 2000-2018 and applied EGARCH (1, 1) and MS model. The study also used terrorist attacks, index return, gold, exchange rate and oil price data to achieve robust volatility. They found an increase of the stock market volatility and overreaction of investors by terrorist attacks. Shahrestani & Rafei (2020) checked the association of oil price fluctuation and its impact on Iran's stock market. They applied a Markov switching Vector Autoregressive model on oil prices and Tehran Stock exchange from 2002 to 2017 based on two regimes. The researcher found a regime-dependent impulse response function from the oil price shock toward the stock market index. They found that estimation parameters are different in different regimes, and transition probability revealed that regimes are persistent.

COVID-19 Related Volatility

Many researchers point out that COVID-19 cases and deaths are reasons for volatility that drained stock markets' growth, even markets touch historically low values. Baek, Mohanty, & Glambosky (2020) empirically tested the US stock market's volatility and risk for the pre-COVID-19 period and during the COVID-19 crises. They applied MSM under AR methodology, and found volatility is affected by micro indicators like interest rate, bond yield, and COVID-19. The negative news impact badly

that increase idiosyncratic risk in different industries. They also found a change in volatility is different in different regimes.

DATA AND METHODOLOGY

As COVID-19 a recent issue so data availability is limited, I used the data of COVID-19 from 2nd February 2020 to 30th November 2020 whereas stock market indexes like KSE100, NSE100 and DSX from January 2019 to 30th November 2020 on daily bases. This study uses patients confirmed cases a proxy of COVID-19, whereas the index returns each country of sub-continent is used as a returns.

Daily returns are calculated using the equation $rt = l\,(Ct) - l\,(Ct\text{-}1)$. Here, *rt* and *Ct* denote the daily returns and closing value of the index at day t, respectively. Further details of variables are given in table I (see appendix)

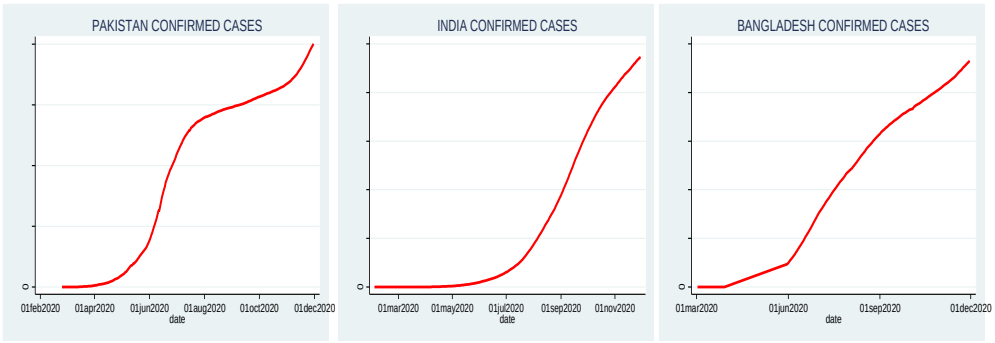


Figure 2: Confirmed cases of Pakistan, India, and Bangladesh from 02-01-2019- 30-09-2020 (source: World Health Organization)

Figure 2 reveals a confirmed case of COVID-19 in every country of the sub-continent. India has the highest COVID-19 cases; Pakistan has the lowest; Bangladesh cases are approximately equal as Pakistan, but the population difference is enormous. This study used the return series in the empirical model because graphs of KSE, NSE, and DSX reveal unit root. The Augmented Dickey-Fuller test checks this non –stationarity. We also check the first-order autocorrelation in the return series, so the auto-regression term added in the model where applicable in Markov Switching Model (MSM). The ARCH test also performed that shows each index has the issue of conditional heteroscedasticity, so ARCH and GARCH modelling also applied (see appendix-table II).

MSM introduced by Quandt (1972), while Hamilton (1989) extended it in a non-linear setting with AR term. The MSM is applied to the series, which are considered to transition in unobserved regimes or states. The duration and time to shift regimes are assumed random. This technique is

better when we can check the growth transition and duration in each regime like expansion and recession. We applied dynamic MSM because the abrupt change in series requires a dynamic model; it allows a quick adjustment after the process changes in each state. Equations are given as;

Equation 1: $rt \mid st = b0st\ (r) + ert \mid st$

Equation 2: $rt \mid st = b0st(r) + b1st\ (log\text{-}r) + b2std.cases + ert \mid st$

Here "r" represent KSE, NSE and DSX return at time *t*, while the confirmed cases are differenced for each sub-continent country. st are states or regimes at time t and e is error; here d represent difference while l as the lag of variable

The model of the studies assume that intercept and explanatory variable switches in both regimes, which depends on transition probabilities from state 1(j) to state 2(i)

$$Prob\ i\ j = Prob(st+1=i \mid st=j) \quad j=1,2\ i=1,2$$

The above probability equation shows if the value of the probability of states is near 1; it means the state is persistent and calculated by the Maximum Likelihood Method. The p11 is interpreted as an absolute value, whereas p12 is (1-pp11).

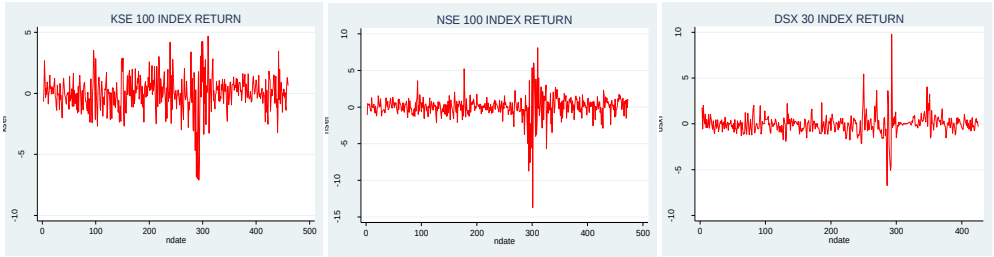


Figure 3: return graphs of KSE100 index, NSE100 index and Dsx100

Table 1. ARCH-GARCH Estimation

	Pakistan		India		Bangladesh	
	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
cases	0.00	-1.05	0.00	-0.37	0.00	8.17***
Constant	0.28	2.99**	0.26	1.62	-0.05	-0.9
L.ARCH	0.21	3.16*	0.50	3.59*	0.94	5.9***
L.gARCH	0.76	12.57***	0.29	0.83	0.19	2.66**
Constant	0.07	1.98**	0.76	1	0.01	-0.38

Note: *** p<.01, ** p<.05, * p<.1; index return of each country is dependent variable whereas cases are independent variables like other parameters ARCH and GARCH term.

In the first phase of analysis, I estimated the ARCH-GARCH model only on each country's index returns. I tried to check the effect of ARCH-ARCH on the index return. Table 03 shows that ARCH and GARCH parameters are significant in KSE and DSX returns, while the only ARCH is significant in NSE returns. Internal and external factors contributed to the volatility of returns in KSE and DSX returns, while only internal factors contributed to NSE. COVID-19 cases significantly impact the return only in Bangladesh, while other economies have no significant relationship.

Table 2. Pre-Covid and Covid Time All Countries

	Pakistan		**India**		**Bangladesh**	
	Pre_Covid Coeff.	Covid Coeff.	Pre_Covid Coeff.	Covid Coeff.	Pre_Covid Coeff.	Covid Coeff.
State1	-0.15*	-5.5***	-3.6***	.-8.4***	.-0.18***	-0.04
State2	2.41***	0.19**	0.03	0.36***	1.64***	7.53***
sigma	1.04	1.33	0.88	1.65	0.60	1.21
p11	0.98		0.41		0.95	
p21	0.45		0.01		0.73	
Duration State1	44	2	1.7	1	21	
Duration State2	2	82	126	36	2	

Note: *** p<.01, ** p<.05, * p<.1; Pre-covid model represents the data before the break while covid model represent after a break in index return series, applied switching the intercept term in all models.

Before estimating the final MSM on the COVID-19 cases, I applied the MSM model on all return series in the univariate setting by splitting the data because we find a structural break in all series. Table 05 reveals that both states are significant. However, state1 represents a negative mean return, while state2 represents positive mean returns. Although the coefficients are different yet the direction is the same in selected indices of the sub-continent. The sigma volatility in mean return during the COVID-19 phase is higher than before the COVID-19 period. It means return and volatility in both states across countries hold the same relationship. The probability of staying in p11 is persistent in KSE and DSX returns, while NSE shows persistence in p12. The analysis confirms that the duration of the probability of state1 is higher in the pre-COVID-19 phase. In a nutshell, I say the relationship's negative magnitude increases while the positive degree of relationship weakens during the COVID-19 period with higher variance and low persistence in transition probability.

Table 3. Final M-S Model with COVID-19 Cases as Switching Parameter

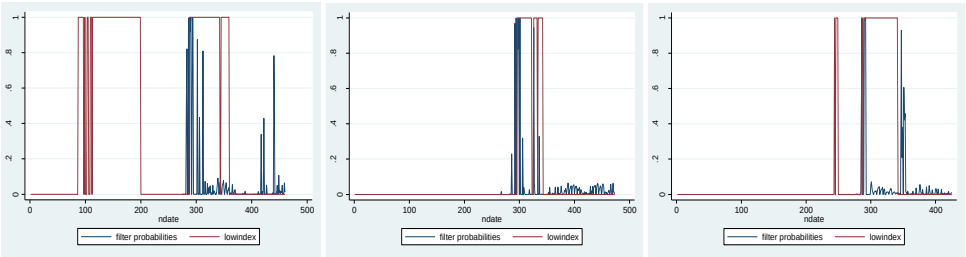
Variables	PAKISTAN		INDIA		BANGLADESH	
	Model1	Model2	Model1	Model2	Model1	Model2
	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.	Coeff.
L.index return		0.03 (0.06)		-0.19*** (0.06)		-0.12 (0.09)
State1	-4.84*** (0.51)	-4.78*** (0.51)	-8.42*** (0.92)	-6.77*** (0.82)	-3.99*** (0.55)	-4.9*** (1.40)
Cases	0.01*** (0.00)	0.01** (0.00)	0.0*** (0.00)	0.0** (0.00)	0.0*** (0.00)	0.0 *** (0.00)
State2	0.41*** (0.12)	0.42*** (0.12)	0.59*** (0.17)	0.65*** (0.18)	0.12 (0.1)	0.12 (0.1)
Cases	-0.00 (0.00)	-0.0 (0.00)	-0.00 * (0.00)	-0.00 * (0.00)	0.00 (0.00)	0.00 (0.00)
sigma	1.20	1.20	1.60	1.60	1.10	1.20
p11	0.34	0.33	0.01	0.38	0.68	0.34
p21	0.05	0.05	0.05	0.04	0.02	0.04
Duration State1	2	2	1	2	3	2
Duration State2	21	20	18	28	41	37

Note: *** p<.01 ** p<.05 * p<.1; Standard Error in brackets; Model 1 represent without the lag of index return with an option of switching for intercept and cases series while model 2 in each model represent MS model with a first lag because of autocorrelation issue.

Model 1 of Pakistan shows KSE100 return is highly significant in both states; state 1 represents the negative state, while state2 represents the positive mean return. During the COVID-19 time phase, the mean return of the KSE100 index is -4.84%, while the mean return of State 2 is 0.41%. The COVID-19 cases are insignificant in state1 & state2. The probability of staying state 1 in the next period is 34%, so p11 is not persistent while p12 is 95%, so p12 is highly persistent. The duration of state1 (negative state) is only two days, while in state2 (positive phase) is 21 days. In model 2, the behaviours of the parameters are approximately the same as in model 1. Model 1 of India shows NSE100 return is highly significant in both states; state 1 represents the negative state, while state2 represents the positive mean return. During the COVID-19 time phase, the mean return of the NSE100 index is -8.42%, while the mean return of State 2 is 0.59%. The COVID-19 cases are negatively related but insignificant in state2 on the conventional level. The probability of staying state 1 in the next period is 01 %, so p11 is not persistent while p12 is 95%, so p12 is highly persistent. Duration of state1 (negative state) is only 1day, while in state2 (positive phase) it is 18

days. In model 2, the behaviours of the parameters are approximately the same as in the model.

Model 1 of Bangladesh shows DSX30 return is highly significant in state1 while insignificant in state2; state 1 represents the negative state while state2 represents positive mean return. During the COVID-19 time phase, the mean return of the DSX30 index is -3.99%, while the mean return of State 2 is 0.12%. The COVID-19 cases are not significant in state1 and state2. The probability of staying state 1 in the next period is 68 % so p11 is persistent while p12 is 98%, so p12 is highly persistent. The duration of state1 (negative state) is only 3 days, while in state2 (positive phase) is 41 days. In model 2, the parameters' behaviour (coefficients, probability and duration) deviate a little then model 1, but the direction of the relationship remains the same. I find internal and external factors contribute to the volatility of index return in the KSE100 index and DSX30 index, while only internal factors impact the volatility transmission in NSE. I faced many data-related issues before modelling; all counties' indices have serial correlation, unit root and structural break. We applied every remedy before the estimation and modelling. MSM without COVID-19 impact shows the negative magnitude of relationship increases. In contrast, the relationship's positive intensity weakens in both states during the COVID-19 period with higher variance and low persistence in transition probability. In final MSM, COVID-19 has insignificant & negative relation with index return in state2 in all indices. Index returns of all KSE, NSE and DSX highly significant in both states; state 1 represents the negative state while state2 represents positive mean return. The probability of staying state 1, i.e., p11, is not persistent while P12 is persistent. In simple words, negative returns are "not persistent" while positive return or "persistent" with higher duration.



Note Filtered probabilities across regimes of MSM; KSE100 index return VS COVID-19 cases, NSE100 index Return VS COVID-19 cases and DSX30 index return VS COVID-19 cases.

CONCLUSION

This paper tests empirically the influence of COVID-19 on the stock market return of all countries of the sub-continent. The COVID-19 crises attacked the foundational pillar of capitalistic phenomena, i.e., stock markets. COVID-19 crises impact India worse as its economy break negative growth

record of the last fifty years while Pakistan performed better. The COVID-19 cases were also highest in India in comparison with other countries of the sub-continent. The dataset consists of the daily frequency of the KSE100 index, NSE100 index and DSX30 index from 1st January 2019 to 30th November 2020, whereas COVID-19 confirmed cases data taken from February to November 2020.

The mythologies applied in the paper are ARCH-GARCH and two states Markov-Switching Model (MSM), a method suitable for structural breaks, in all indices. Before estimation, different problematic assumptions have been tested like unit root, structural break, serial correlation, conditional heteroskedasticity to check the existence and apply appropriate methods to tackle them. The ARCH-GARCH method reveals that ARCH and GARCH terms are statistically significant in the KSE 100 and DSX30 index return series, whereas the ARCH term is significant in the NSE100 index. The findings reveal that internal and external factors contribute to the volatility of index return in Pakistan and Bangladesh, while only internal factors impact India's volatility transmission. MSM without COVID-19 impact shows the negative magnitude of relationship increases, whereas the positive degree of relationship weakens in both states. Another finding depicts a higher variance and low persistence in transition probability during the COVID-19 period.

In final MSM, COVID-19 cases have an insignificant relation with index return in both states of all countries of sub-continent at the conventional level. Index returns of all countries are highly significant in both states; state 1 represents the negative state, while state2 represents the positive mean return. The probability of staying state 1, i.e., p11, is not persistent while P12 is persistent. In simple words, negative returns are not persistent, while positive return persistent with higher duration. This study provides investors with an opportunity for better decision-making; policymakers formulate a better policy to immune the stock markets during COVID-19 crises; regulators plan the contingent or bailout plans and incentivize through tax relaxation to safeguard the stock markets for normal functioning.

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Appendix

Table I. Variable Description

Variables	Description
KSER	Pakistan Stock Market (KSE100 index) return calculated by closing value
NSE100	National Stock Exchange (NSE100 index) return calculated by closing value
DSXR	Dhakka Stock Exchange (DSX 30 index) return calculated by closing value
Cases	Difference of Confirmed COVID-19 cases of Pakistan, India and Bangladesh

Table II. Necessary Tests and Associated P-values

	Pakistan	India	Bangladesh
Unit Root Index (KSE100,NSE100,DSX30)	0.67	0.687	0.64
Unit root Return (Return of KSE,NSE,DSX)	0.00	0.01	0.01
Correlation (index and cases)	0.05 (-0.15)	0 (-0.26)	0.06 (-0.14)
ARCH lm test	0.02	0.00	0.00
Portmanteau (Q) statistic	0.00	0.03	0.00

() in parenthesis magnitude of correlation on the bases of full sample data