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Event study on the reaction of the developed and emerging stock markets to the 2019-nCoV outbreak

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ABSTRACT

With a sample of 49 stock market indices of the developed and emerging markets in the world using the standard event methodology, this paper aims to examine the impacts of the 2019-nCoV outbreak on the global stock markets. Previous studies have supported that macroeconomic news and firm-specific news do impact the stock market returns. This study provides evidence for global stock market reactions to epidemics. The study concludes that the 2019-nCoV outbreak has significantly impacted the global stock markets with the Asian stock markets being hit the hardest. Further, the study also analyzed the impacts of lockdowns/restrictions imposed by the economies to contain the 2019-nCoV outbreak. This study evidences that early lockdowns/restrictions imposed by the nations have yielded positive results in containing the spread of the novel coronavirus, thus, rebuilding the investor's confidence and sharp reversal in the stock market returns. The statistical results establish a high and moderate negative correlation between the cumulative abnormal returns (CARs) and the cumulative cases and deaths both country-wise and that of the world indicating that the cross-country variation in the evolution of cases and fatality rates led to such stock market reactions impacting the market sentiments and anticipation for the future.

1. Introduction

In the past two decades, the world has acknowledged some severe disease outbreaks including the SARS, MERS, and H1N1. The news about these outbreaks does impact the investor's behavior which in turn is reflected in the stock market indices. A live example of such a stock market reaction to global pandemics is the 2019-nCoV outbreak. Stock markets all over the world have crashed since January 2020. Developed economies like the US, Spain, and Italy have been hit hard by the outbreak. The disease that spread in Wuhan city of China, one of the emerging markets, has not only affected China but also the remaining parts of the world. While the bigger economies are busy fighting the novel coronavirus, their stock markets are performing the worst. The daily returns data of the stock markets reveal that the global stock markets have crashed by an average of approx. Twenty-three percent. While the Dow Jones Industrial Average has experienced a high of 29348 and a low of 18591, since the start of the year 2020, which is approximately 37 percent; the Shanghai Composite experienced a high of 3115 and a low of 2660, approximately 15 percent. The developed economies seem to have been badly hit by the outbreak. Moreover, the economies have also taken steps to contain the spread of the novel coronavirus. Other nations have taken lessons from the cases in Italy and the United States. Many nations have implemented early lockdown/restrictions to restrict the spread of the pandemic. These steps not only curb the spread of the disease but also prevent the economies from economic adversities. However, to draw appropriate statistical inferences, this event study has been conducted.

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2. Literature review

The review of event study literature can be divided into two parts, viz., the studies which generated methodologies and test statistics for event studies, and the studies which implemented the event study methodologies proposed by the former studies. The studies conducted by Dimson (1979), Brown and Warner (1980 & 1985), Dyckman et al., 1984, Corrado (1989), Boehmer et al., 1991, Cowan (1992), Corrado and Zivney (1992), Campbell and Wesley, 1993, Park (2004), Kolari & Pynnonen, 2010 & Kolari & Pynnonen, 2011), Luoma and Pynnonen (2010), Ataullah, Song, & Tippett, 2011, Luoma (2011) and Dutta (2014) provide the event study methodologies in detail along with suggestions of best parametric and non-parametric test statistics with their power to detect the statistical significance of the results. While Dimson (1979) advocates the aggregated coefficient method, Brown and Warner (1980 & 1985) supports the market model for estimating the abnormal performance. While Dyckman et al., 1984 and Boehmer et al., 1991 show strong evidence for parametric tests, Corrado (1989), Cowan (1992), Corrado and Zivney (1992) and others provide supporting evidence for non-parametric tests dominating asymmetric distributions which daily return generally possess. Dutta (2014) provides a good review of both parametric and non-parametric tests in event studies while concluding that non-parametric and sign tests are better than parametric tests.

Nikkinen et al. (2006), Cai et al. (2009), Gumus et al. (2011), Sorokina et al. (2013), Ghanem and Rosvall (2014), Belgacem et al. (2014), and Seda et al. (2018) have studied the impact of macroeconomic news announcements on the stock markets. While Gichema (2007), Mehndiratta and Gupta (2010), Miglani (2011), Rohit et al. (2013), Ogada and Kalunda (2017), Ahsan et al. (2014), Patel and Prajapati (2014), and Muthukamu and Rajamohan (2015) have studied the impact of dividend and bonus issue announcements on the share prices; Patro et al. (2014), Pandey and Jaiswal (2017) and Elad (2017) have studied the impact of devaluation, demonetization, and acquisition news on stock prices. Almost all the studies have found significant impacts of the events.

Kim et al. (2020) conducted an event study to examine the impacts of food-related epidemics on the financial performance of restaurants and found that the epidemics impact the restaurant industry negatively. Chen et al. (2007) used the event study method to find the impacts of the SARS outbreak on the performance of the Taiwanese hotel stocks and supported a negative impact. Donadelli et al. (2017) examined the investor's behavior based on dangerous disease outbreaks with the data of 102 pharmaceutical companies listed on the NYSE and conclude that although the disease spread is bad news for the mainstream, some group of market traders view it as good news and profitable trading strategies leads to significant positive returns.

Few studies have also been conducted to examine the uncertainty effect on the returns on other instruments such as gold, bitcoins, crude oil, etc. Demir et al. (2018) considered the log returns on Bitcoin as the dependent variable for a sample period from July 2010 to November 2017 using the Bayesian Graphical Structural Vector Autoregressive (BGSVA) model along with the Ordinary Least Squares (OLS) and the Quantile-on-Quantile (QQ) Regression estimations to analyze the prediction power of the economic policy uncertainty (EPU) index on the daily returns. They used a 60-days rolling estimation window and found significant positive impacts at higher quantiles suggesting Bitcoin as a good instrument for hedging during uncertainty. Bilgin et al., 2018 studied the impact of four uncertainty measures on gold prices applying the nonlinear autoregressive-distributed lag (ARDL) model on monthly data from January 1997 to May 2017 to find that the increase in EPU leads to an increase in gold prices. Gozgoret. al., 2019 studied the impact of uncertainty measures on gold returns and volatility using the BGSVA model on a sample period from February 1997 to December 2017. They found that the current gold prices depend on the lagged values of the US Real Effective Exchange Rate returns as well as the Geopolitical Risks index while the current Gold price volatility exclusively depends on the previous level of its volatility. They suggested gold as a hedging option for small, medium, and long terms. Zhang & Yan, 2020 studied the impact of EPU on crude oil prices using the dynamic conditional correlation United States EPU and the West Texas Intermediate (WTI) crude oil returns on the data from February 1985 to May 2019 to find that they are negatively correlated. Thereafter, they applied the network connectedness method and found that the impact of US EPU indices is stronger when other major international events occur.

The review of the literature does not reveal any previous event study to have been conducted to study the global stock market reaction to the global pandemic. Although few event studies have been conducted, they either focused on a single industry or a single market. Few studies such as Demir et al. (2018), Bilgin et al., 2018, Gozgoret. al., 2019 and Zhang & Yan, 2020 beautifully explains the relationship between uncertainty measures and the returns on various investment opportunities. However, an event study on the impacts of global disease outbreaks on the stock market is needed in the finance literature. Conducting an event study to examine the stock market reaction to the 2019-nCoV outbreak will let the stakeholders access the market reaction well in advance in the future. Hence, we move forward to conduct this event study.

3. Objectives, scope and research methodology

3.1. Objectives and scope

This study aims to examine the impacts of the 2019-nCoV outbreak being declared as a Public Health Emergency of International Concern on the global stock markets. For this purpose, the daily returns of the selected indices both before and after the declaration made by the WHO have been analyzed. The null hypothesis that "the abnormal returns on and around the event day are less than or equal to zero", implicates that the 2019-nCoV outbreak being declared the Public Health Emergency of International Concern has not impacted the global stock markets. If, the null hypothesis is rejected the study will conclude that the global pandemic has impacted the global stock markets. Further, the study also aims to examine whether the lockdown/restrictions imposed by the economies have led to a recovery in the stock market returns. The null hypothesis that "the mean returns after the imposition of lockdown/restriction less than or equal to zero", implicates that the lockdown/restrictions imposed by the economies have not impacted their stock market returns. Further, the study aims to relate the stock market reactions to the cross-country variation in the evolution of infection and fatality rates.

3.2. Event

In an event study, we need to determine the event, the event date, the event window, the estimation window & the estimation model. The declaration of the 2019-nCoV outbreak as a Public Health Emergency of International Concern by the WHO is the event for the first part of the study, the event date is January 30, 2020, and the event window consists of 61 days from t_{-30} to t_{+30} days. The estimation window is of 90 days from t_{-120} to t_{-31} days. Only trading days have been considered.

3.3. Sample and Selection Criterion

Economies of the USA, the U.K., Spain, Italy, France, Germany, China, Canada, Brazil, Turkey, Switzerland, Belgium, Netherlands, India, and almost the whole world has been worst hit by the global pandemic. To empirically conclude in this regard, we need to analyze the data of the stock exchanges of these economies. The stock exchanges have many indices and considering all of them in the sample is not possible. Hence, the leading index from the developed and emerging markets has been considered. The details of the sample are given in Table 1. Few previous event studies have considered the daily returns of the indices (for example, Sorokina et al. (2013); Ghanem & Rosvall, 2014; Patro et al., 2014). Instead, the index returns have always been used as the benchmark for estimating the expected return of the securities. For analyzing the daily returns of an index we need a benchmark index. What should be the benchmark to measure the performance of a benchmark? Equal Weighted Index is an option. However, the All Country World Index which is a market capitalization-weighted index designed by Morgan Stanley Capital International and provides a broad measure of equity-market performance throughout the world has been used as the benchmark estimate of the expected returns of the indices in the sample. The benchmark index is composed of data from 23 developed and 26 emerging markets. Hence, we move forward with a sample of 49 indices each of them representing these markets to test the impacts of the first event. Many nations imposed lockdown/restrictions to contain the spread of the novel coronavirus spread. These lockdowns have helped contain the spread of the pandemic. The dates for 28 economies (14 developed & 14 emerging) were available. However, the indices for which data was available for at least 15 days post-announcement have been included in the sample. Hence, the sample size for testing the impacts of the second event arrived at only 25.

3.4. Adjustments made

The event day is the declaration day by the WHO. The news flashed after 13:30 h (Geneva). Most of the markets had enough time to react. However, for some economies, the announcement was at a time when the trading hours had already ended. So these markets might have reacted to the news the next day. Hence, for such economies, the event day has been shifted to January 31, 2020. The Shanghai stock exchange didn't operate from 24th January to February 02, 2020. Hence, the event day for this stock exchange has been

Table 1
Details of the sample.

Developed Markets (N = 23)		Emerging Markets (N = 26)	
COUNTRY	LEADING STOCK INDEX	COUNTRY	LEADING STOCK INDEX
USA	DOW 30	CHINA	SHANGHAI SE[a]
SPAIN	IBEX 35	TURKEY	BIST 100
ITALY	FTSE MIB	BRAZIL	BOVESPA
GERMANY	DAX 30	SOUTH KOREA	KOSPI
FRANCE	CAC 40	RUSSIA	MOEX RUSSIA INDEX
UK	FTSE 100	INDIA	SENSEX-30
BELGIUM	BEL 20	CHILE	CLX IPSA
SWITZERLAND	SMI	POLAND	WIG20
NETHERLANDS	AEX	CZECH REPUBLIC	SE PX
CANADA	S&P/TSX	PERU	S&P/LIMA GENERAL
PORTUGAL	PSI 20	PAKISTAN	KARACHI 100
AUSTRIA	ATX	MALAYSIA	KLCI
ISRAEL	TA-35	PHILIPPINES	PSEI COMPOSITE
SWEDEN	OMXS-30	MEXICO	S&P BMV IPC
IRELAND	ISEQ	INDONESIA	IDX COMPOSITE
NORWAY	OSE BENCHMARK	SAUDI ARABIA	TASI
AUSTRALIA	S&P/ASX-200	UAE	ADX GENERAL
DENMARK	OMXC20	THAILAND	SET
JAPAN	NIKKIE 225	QATAR	QE GENERAL
FINLAND	OMX HELSINKI	COLOMBIA	COL CAP COLOMBIA
SINGAPORE	STI	GREECE	ATHENS GEN COMPOSITE
HONG KONG	HANG SENG	SOUTH AFRICA	SA TOP 40(JTOPI)
NEW ZEALAND	NZX-50	ARGENTINA	S&P MERVAL
		EGYPT	EGX-30
		HUNGARY	BUDAPEST SE
		TAIWAN	TPEX-50

[a] The Stock market didn't operate from 24th January to 02nd February 2020

shifted to February 03, 2020. The benchmark index did not match for few dates of few indices. The missing figure has been adjusted with the average of the day before and the day after figures to calculate the benchmark return.

3.5. Estimation procedure

For calculating the estimates or the normal returns, we need to select an estimation model. The estimation model is applied to the daily returns during the estimation window. Once, the estimation model is finalized the estimated/expected/normal daily returns are calculated. The data of the estimation window (the period just before the event window) is used to calculate the normal returns. Many models have been used in event studies for calculating the normal returns. Dyckman et al., 1984 analyzed three models and concluded that the OLS market model reveals better results. Hence, we have taken the OLS Market Model for calculating the normal returns. The normal return, $\mathbf{E(R_{it})}$, is calculated as:

$$ER_{it} = \alpha + \beta R_{mt} \tag{1}$$

Where.

α & β are intercept and slope coefficients of the OLS regression model.

$\mathbf{R_{mt}}$ is the rate of return on the benchmark index (ACWI) on day t.

The alpha and beta co-efficient are calculated with the data available for the 90 days from t_{-120} to t_{-31}.

3.6. Calculation of Abnormal Returns

The daily abnormal returns of each of the indices in the sample are to be calculated for conducting the event study. For this, we need to calculate the actual daily returns of the indices for the entire observations. To arrive at the abnormal returns, these actual returns are required to be compared with the estimates of the daily returns (normal returns) that would have resulted in case such an event never occurred. Now we have calculated the normal returns as per eq. (1) above. We subtract the same from the actual daily returns and the resultant is our abnormal daily returns. The abnormal return, $\mathbf{AR_{it}}$, is calculated as:

$$AR_{it} = R_{it} - ER_{it} \tag{2}$$

Where.

$\mathbf{AR_{it}}$ is the abnormal return on index i on day t;

$\mathbf{R_{it}}$ is the actual return on index i on day t; and.

$\mathbf{ER_{it}}$ is the normal return on the index i on day t (eq. (1) above).

For calculating the actual daily return of the sample indices as well as the benchmark index, the log-returns have been used (as in Elad, 2017). The actual return, $\mathbf{R_{it}}$, is calculated using the log function in the MS-excel as below:

$$R_{it} = LN\left(\frac{P_{it}}{P_{it-1}}\right) X\ 100 \tag{3}$$

Where.

LN= Log of natural number.

$\mathbf{P_{it}}$ = Price of index i on day t; and.

$\mathbf{P_{it-1}}$ = Price of index i on day before day t.

3.7. Aggregation of Abnormal Returns

The abnormal daily returns of each day for each of the indices are aggregated to analyze the common reaction of the stock indices to the event. This aggregation is for the 61 days event window. The aggregated abnormal daily returns are then divided by the sample size (**N**) to arrive at the average abnormal return as follows:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \tag{4}$$

Where.

$\mathbf{AAR_t}$ is the Average Abnormal Return on day t, and.

N is the number of indices.

These AARs are then used to calculate the cumulative average abnormal return (CAARs) for the event window. The purpose of calculating the AARs and the CAARs is to arrive at the cross-sectional as well as time-series aggregation for the event period.

3.8. Calculation of Test Statistics

Now the results need to be tested for significance. To test for significance, we use the t-statistics. The t-statistics for AARs are calculated by dividing the AARs by the aggregate estimation period standard deviation of the daily returns. The t-statistics for CAARs is calculated by dividing the CAARs by the product of the aggregate estimation period standard deviation of the daily returns and the square root of the absolute value of the event day plus 1. For this purpose, the following formula is used to calculate the estimation period standard deviation of daily abnormal returns:

$$\sigma_{i,\ e} = \sqrt{\frac{\sum_{-120}^{-31} (AR_{it} - AAR_e)^2}{n}} \tag{5}$$

Where.

$\sigma_{j,e}$ is the estimation period standard deviation of daily returns.

AAR_e is the average abnormal return of index i for the estimation period; and.

n is the number of days in the estimation period.

Now, the aggregate estimation period standard deviation, $\sigma_{N,e}$, is calculated as follows:

$$\sigma_{N,\ e} = \sqrt{\frac{\sum_{i=1}^{N} \sigma_{i,e}^2}{N^2}} \tag{6}$$

As discussed earlier, the t-statistics for AARs is calculated as:

$$AAR_t\ t = \frac{AAR_t}{\sigma_{N,e}} \tag{7}$$

Similarly, the t-statistics for CAARs is calculated as:

$$CAAR_t\ t = \frac{CAAR_t}{\sigma_{N,e}\sqrt{N_{t+1}}} \tag{8}$$

Where.

$CAAR_t$ is the cumulative average abnormal return on day t.

N_{t+1} is the absolute value of event day t plus 1 (e.g. for event day −10, the absolute value is 10 and $N_{t+1} = 11$).

Further, the test statistics as calculated in the Paired *t*-Test and the Wilcoxon's Signed-Rank Test have also been analyzed. Further, the Corrado test statistic, a non-parametric test, developed by Corrado (1989) as modified by Ataullah, Song, & Tippett, 2011 has been used in this study. Ataullah, Song, & Tippett, 2011 simplified the equation as:

$$\mathbf{t}_{\mathbf{Corrado}} = \sqrt{\frac{3}{N(T^2 - 1)}} \sum_{i=1}^{n} [2\mathbf{K}(\mathbf{AR}_{\mathbf{it}}) - (\mathbf{T} - 1)] \tag{9}$$

Where.

N is the sample size.

T is the total number of abnormal returns for the index or in other words, the total number of days (in our case, it is 151).

$K(AR_{it})$ is the rank of the abnormal return of the i index in the 151 days.

Ataullah, Song, & Tippett, 2011 have also modified the Corrado equation to measure the t-statistics for the cumulative abnormal returns for shorter event windows. The equation is as below:

$$\mathbf{t}_{\mathbf{Cor(modified)}} = \sqrt{\frac{3}{M(T+1)(T-M)}} \sum_{i=1}^{n} [2\mathbf{K}(\mathbf{CAR}_{\mathbf{itM}}) - \mathbf{M}(\mathbf{T}+1)] \tag{10}$$

Where.

$K(CAR_{itM})$ is the sum of the $K(AR_{it})$ for the period M.

M is the length of the Event Window.

3.9. Interpretation of Results

The t-values obtained from the above calculations will be used to test the hypothesis of the study. If the AARs and the CAARs are positive and significant, it infers that the market reacted positively and the returns on the event day and post-event period were more than those during the pre-event period. Although the event window consists of 61 days, the test statistics of the CAARs on and around event day will also be compared (as in Campbell et al., 1997; Park, 2004; Kolari & Pynnonen, 2010; Babita et al., 2012; Pandey & Jaiswal, 2017; Seda et al., 2018; and many similar studies). If the *t*-test statistic (in absolute value) is greater than the critical values, the relevant abnormal return is statistically significant. The critical t-value for different instances has been reflected in Table 2.

Table 2
Critical t-value for different Samples Sizes.

Sector	N	Degree of Freedom	t-value (2-tailed)	
			1% level	5% level
All Data	49	48	2.68	2.01
Developed Markets	23	22	2.82	2.07
Emerging Markets	26	25	2.79	2.06
Europe, Middle-East and Africa	28	27	2.77	2.05
Americas	8	7	3.50	2.36
Pacific	5	4	4.60	2.78
Asia	9	8	3.36	2.31

Table 3
Results of the normality test.

Variable\Test	Shapiro-Wilk	Anderson-Darling	Lilliefors	Jarque-Bera
DOW 30-US	0.401	0.711	0.932	0.568
IBEX 35-SPAIN	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
FTSE MIB-ITALY	0.177	0.147	0.317	0.431
DAX 30-GERMANY	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
CAC 40-FRANCE	0.157	0.539	0.842	0.163
FTSE 100-UK	0.158	0.097	0.084	**0.038**
BEL 20-BELGIUM	0.183	0.171	0.186	0.648
SMI-SWITZERLAND	0.395	0.569	0.517	0.419
AEX-NETHERLAND	**0.021**	**0.007**	0.099	0.252
S&P TSX-CANADA	0.589	0.672	0.629	0.177
PSI-PORTUGAL	**0.045**	**0.017**	**0.010**	0.258
ATX-AUSTRIA	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
TA 35-ISRAEL	**0.001**	**0.038**	0.054	**<0.0001**
OMX S30-SWEDEN	0.821	0.675	0.815	0.648
ISEQ-IRELAND	0.634	0.478	0.618	0.818
OSE BENCHMARK-NORWAY	0.896	0.707	0.730	0.885
S&P ASX 200-AUSTRALIA	**<0.0001**	**0.001**	**0.001**	**<0.0001**
OMXC 20-DENMARK	0.871	0.854	0.552	0.699
NIKKIE 225-JAPAN	0.055	0.119	0.419	**0.023**
OMX HELSINKI-FINLAND	0.334	0.166	0.264	0.333
STI-SINGAPORE	0.571	0.242	0.242	0.685
HANG SENG-HONG KONG	0.125	0.123	0.332	0.111
NZX 50-NEW ZEALAND	**0.001**	**0.011**	**0.014**	**<0.0001**
SANGHAI SE-CHINA	0.852	0.869	0.744	0.930
BIST 100-TURKEY	**0.001**	**0.033**	0.178	**<0.0001**
BOVESPA-BRAZIL	0.186	0.086	0.284	0.688
KOSPI-SOUTH KOREA	0.116	0.079	0.153	0.321
MOEX RUSSIA INDEX	0.281	0.377	0.513	0.339
SENSEX 30-INDIA	**<0.0001**	**0.001**	**0.005**	**<0.0001**
CLX ISPA-CHILE	**<0.0001**	**<0.0001**	**0.001**	**<0.0001**
WIG-POLAND	**0.029**	**0.022**	**0.002**	**0.009**
SE PX-CZECH REPUBLIC	0.118	0.320	0.798	0.162
S&P LIMA GEN-PERU	0.732	0.882	0.992	0.711
KARACHI 100-PAKISTAN	0.520	0.742	0.851	0.637
KLCI-MALAYSIA	0.166	0.254	0.189	0.120
PSEI COMPOSITE-PHILIPPINES	0.064	**0.030**	0.099	0.441
IPC-MEXICO	0.106	0.075	0.151	0.630
IDX COMPOSITE-INDONESIA	0.728	0.578	0.617	0.431
TASI-SAUDI ARABIA	0.982	0.861	0.777	0.785
ADX GENERAL-UAE	**0.000**	**0.001**	**0.007**	**<0.0001**
SET-THAILAND	0.321	0.334	0.219	0.657
QE GENERAL-QATAR	**0.007**	**0.019**	**0.032**	**0.001**
COL CAP-COLOMBIA	0.634	0.692	0.733	0.573
ATHENS GENERAL COMPOSITE-GREECE	0.101	0.514	0.865	**0.011**
SOUTH AFRICA TOP 40	0.979	0.977	0.924	0.851
S&P MERVEL-ARGENTINA	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
EGX 30-EGYPT	**<0.0001**	**<0.0001**	**0.001**	**<0.0001**
BUDAPEST SE-HUNGARY	0.330	0.194	0.100	0.435
TPEX 50-TAIWAN	**0.013**	**0.015**	0.063	**0.011**

Note: The figures in bold indicate significant being less than the p-value of 0.05.

4. Quantitative analysis and discussion

4.1. Normality of data

A total of 7399 daily returns are available across 49 indices; 151 observations for each index. Out of these, 4410 observations are for the period from t_{-120} to t_{-31} days (estimation period). The normality of the data has been checked. For the normality, we move to test the normality of the data of the estimation period using the Shapiro-Wilk, Anderson-Darling, Lilliefors and Jarque-Bera tests (using the XLSTAT add-in in MS-excel) with the following hypotheses:

H_0: The sample is normally distributed.

Ha: The sample is not normally distributed.

Table 3 depicts the results of the normality test. The computed p-value for the returns of the stock index of Spain, Germany, Austria, Australia, New Zealand, India, Chile, Poland, UAE, Qatar, Argentina, and Egypt for all the four tests is less than the alpha value of 0.05, thus, making the results significant and rejecting the null hypothesis while accepting the alternate hypothesis that the sample is not normally distributed. About 65 percent of the sample passed the normality test as per the Shapiro-Wilk test. The Anderson-Darling and Jarque-Bera tests were negative for 63 percent of the sample and about 74 percent of the sample was normally distributed as per the results of the Lilliefors test. Most of the data follow a normal distribution. Dyckman et al., 1984 compared event study methodologies and found that the non-normality of returns does not affect the inferences drawn by the *t*-test. Their results supported Brown and Warner (1985). Hence, we proceed forward with the analysis of the data.

4.2. Test Statistics for the entire sample

Table 4 depicts the AARs and CAARs for the event window of 61 days. The empirical results depict 16 negative average abnormal returns during the pre-event period and 19 negative average abnormal returns during the post-event period. The event day also experienced a negative return. While only a single average abnormal return is significant in the pre-event period, 12 significant average abnormal returns are noticed in the post-event period.

The AAR on the event day is also significant. While none of the cumulative average abnormal returns are significant in the pre-event period, the post-event period experienced 15 significant CAARs. The CAAR on the event day is also significant. The average abnormal

Table 4
Daily AARs, CAARs, and t-values for the pre & post-event period.

Pre-event Period					Post-event Period				
Days	AAR	AAR t-value	CAAR	CAAR t-value	Days	AAR	AAR t-value	CAAR	CAAR t-value
t_{-30}	0.29	1.81	0.29	0.33	T	−0.38	−2.36*	−0.80	−4.94**
t_{-29}	0.00	0.02	0.30	0.33	t_{+1}	−0.31	−1.90	−1.11	−4.84**
t_{-28}	0.07	0.44	0.37	0.42	t_{+2}	0.29	1.77	−0.82	−2.93**
t_{-27}	0.07	0.42	0.43	0.51	t_{+3}	0.14	0.84	−0.69	−2.12*
t_{-26}	−0.01	−0.04	0.43	0.51	t_{+4}	0.41	2.52*	−0.28	−0.77
t_{-25}	0.03	0.19	0.46	0.56	t_{+5}	−0.17	−1.05	−0.45	−1.13
t_{-24}	0.17	1.04	0.63	0.78	t_{+6}	−0.13	−0.80	−0.58	−1.35
t_{-23}	0.01	0.09	0.64	0.81	t_{+7}	−0.15	−0.90	−0.73	−1.58
t_{-22}	−0.07	−0.46	0.57	0.73	t_{+8}	0.18	1.14	−0.54	−1.11
t_{-21}	−0.11	−0.70	0.45	0.60	t_{+9}	−0.12	−0.77	−0.67	−1.30
t_{-20}	0.13	0.78	0.58	0.78	t_{+10}	−0.01	−0.06	−0.68	−1.26
t_{-19}	−0.15	−0.92	0.43	0.59	t_{+11}	−0.11	−0.71	−0.79	−1.41
t_{-18}	−0.15	−0.92	0.28	0.40	t_{+12}	0.09	0.54	−0.70	−1.20
t_{-17}	−0.03	−0.18	0.25	0.37	t_{+13}	0.03	0.17	−0.68	−1.11
t_{-16}	0.05	0.32	0.30	0.45	t_{+14}	0.29	1.77	−0.39	−0.62
t_{-15}	0.18	1.09	0.48	0.74	t_{+15}	−0.23	−1.40	−0.62	−0.95
t_{-14}	0.32	1.96	0.80	1.27	t_{+16}	−0.27	−1.67	−0.89	−1.33
t_{-13}	−0.19	−1.14	0.61	1.01	t_{+17}	−0.55	−3.40**	−1.44	−2.09*
t_{-12}	−0.02	−0.11	0.59	1.02	t_{+18}	0.21	1.32	−1.22	−1.73
t_{-11}	−0.10	−0.62	0.49	0.88	t_{+19}	0.11	0.71	−1.11	−1.53
t_{-10}	−0.05	−0.34	0.44	0.82	t_{+20}	−0.96	−5.92**	−2.07	−2.79**
t_{-9}	0.16	0.98	0.60	1.17	t_{+21}	−1.04	−6.43**	−3.11	−4.09**
t_{-8}	−0.07	−0.41	0.53	1.09	t_{+22}	−0.76	−4.72**	−3.87	−4.99**
t_{-7}	−0.13	−0.82	0.40	0.87	t_{+23}	1.38	8.51**	−2.50	−3.14**
t_{-6}	−0.06	−0.39	0.33	0.78	t_{+24}	−1.07	−6.59**	−3.56	−4.40**
t_{-5}	−0.14	−0.89	0.19	0.48	t_{+25}	−0.90	−5.56**	−4.46	−5.40**
t_{-4}	0.18	1.12	0.37	1.03	t_{+26}	−1.80	−11.13**	−6.27	−7.44**
t_{-3}	−0.63	−3.91**	−0.26	−0.81	t_{+27}	−0.53	−3.30**	−6.80	−7.93**
t_{-2}	0.05	0.33	−0.21	−0.74	t_{+28}	−1.75	−10.83**	−8.56	−9.81**
t_{-1}	−0.21	−1.31	−0.42	−1.83	t_{+29}	0.08	0.52	−8.47	−9.55**
T	−0.38	−2.36*	−0.80	−4.94**	t_{+30}	−2.08	−12.85**	−10.55	−11.70**

* Significant at p-value of 0.05 (5% level) **Significant at p-value of 0.01 (1% level).

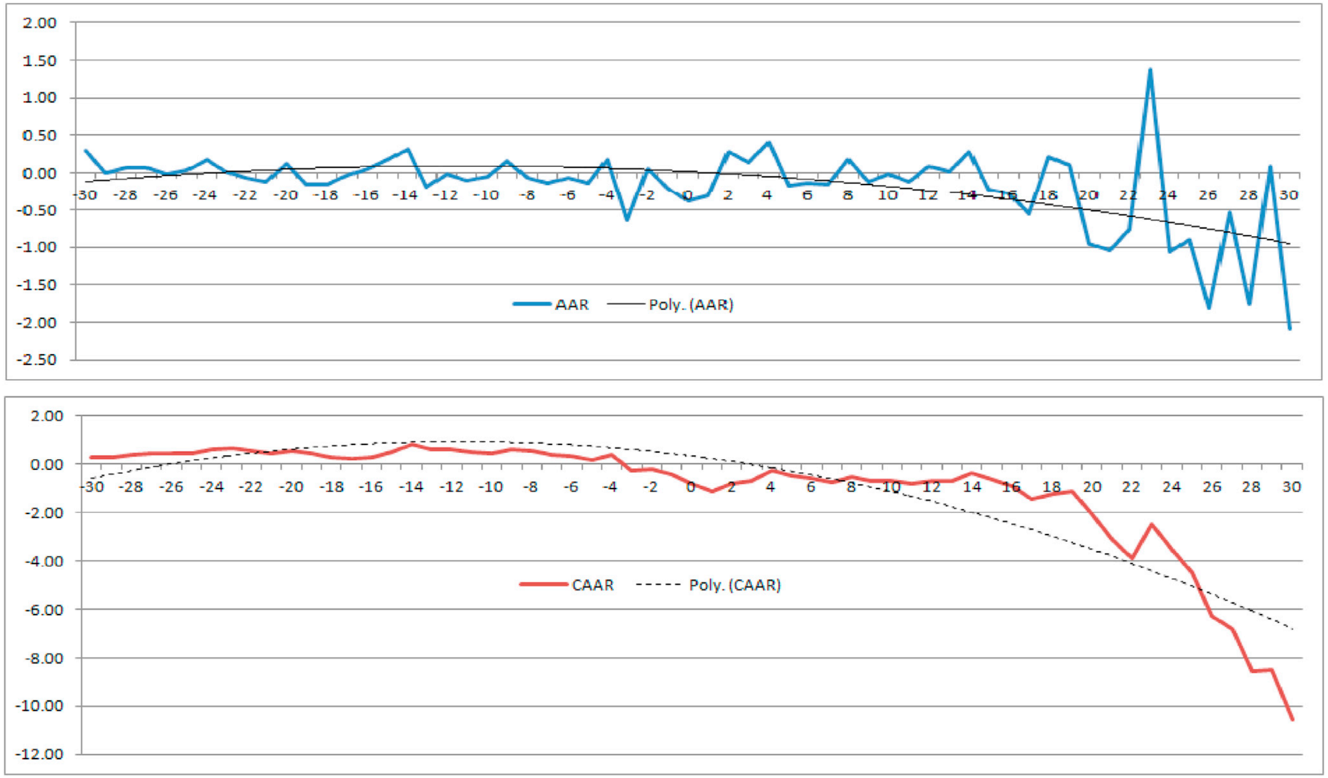


Fig. 1. Trend of AARs and CAARs for the Event window (t_{-30} to t_{+30} days).
Source: Prepared from the results of the data analysis

Table 5
AARs and CAARs around event day.

Window Period	AAR	t_{AAR}	CAAR	t_{CAAR}
−7 to +7	−0.08	−0.52	−1.26	−2.00
−3 to +3	−0.15	−0.93	−1.06	−2.47*
−1 to +1	−0.30	−1.86	−0.90	−3.21**

*Significant at p-value of 0.05 (5% level) **Significant at p-value of 0.01 (1% level).

Table 6
Results of the *t*-test and the Wilcoxon's Signed Rank test

Mean		Paired *t*-Test			Wilcoxon Signed-Rank Test			
Pre	Post	t-value	t-critical	p-value	Z-value	p-value	W-value	W-critical
−0.014	−0.325	**2.493**	2.045	0.019	**2.129**	0.033	**129**	137

Note: The figures in bold are *significant at a p-value of 0.05 (5% level).*

Table 7
Test statistics of Corrado's Rank Test for the pre & post-event period.

Pre-event Period				Post-event Period			
Days	$t_{Corrado}$	Days	$t_{Corrado}$	Days	$t_{Corrado}$	Days	$t_{Corrado}$
t_{-30}	−1.475	t_{-15}	−0.639	t_{+1}	1.845	t_{+16}	1.088
t_{-29}	−0.295	t_{-14}	−3.120**	t_{+2}	−3.107**	t_{+17}	3.608**
t_{-28}	−1.468	t_{-13}	0.724	t_{+3}	−2.081*	t_{+18}	−0.642
t_{-27}	−0.911	t_{-12}	−1.049	t_{+4}	−4.254*	t_{+19}	−2.075*
t_{-26}	−0.560	t_{-11}	−0.003	t_{+5}	0.505	t_{+20}	4.277**
t_{-25}	−0.803	t_{-10}	0.249	t_{+6}	1.488	t_{+21}	4.503**
t_{-24}	−1.780	t_{-9}	−2.973**	t_{+7}	0.403	t_{+22}	1.884
t_{-23}	0.455	t_{-8}	0.737	t_{+8}	−2.304*	t_{+23}	−5.509**
t_{-22}	0.095	t_{-7}	0.203	t_{+9}	0.754	t_{+24}	5.283**
t_{-21}	1.062	t_{-6}	0.351	t_{+10}	−0.855	t_{+25}	1.839
t_{-20}	−1.881	t_{-5}	0.842	t_{+11}	0.941	t_{+26}	5.991**
t_{-19}	−0.354	t_{-4}	−1.599	t_{+12}	−1.216	t_{+27}	0.429
t_{-18}	0.334	t_{-3}	5.217**	t_{+13}	−0.813	t_{+28}	5.217**
t_{-17}	−0.567	t_{-2}	−1.173	t_{+14}	−3.998**	t_{+29}	−1.586
t_{-16}	−0.088	t_{-1}	−0.295	t_{+15}	0.839	t_{+30}	5.932**

* Significant at p-value of 0.05 (5% level) **Significant at p-value of 0.01 (1% level).

returns are significant at p-value of 0.05 (5% level) on 2 days i.e., t & t_{+4} and at 1% level of significance on 11 days (t_{+17}, t_{+20} to t_{+28} and t_{+30}).

More significant average abnormal returns on and after event day indicate that the information had affected the stock market. Since the returns are negative, the impact is negative. Fig. 1 is the graphical representation of the AARs and the CAARs for the 61 days event window. The trend line in both graphs could be seen going downwards from the date of the announcement. The downward trend, too, supports the statistical inference of the significant negative impact of the 2019-nCoV outbreak.

However, an analysis of shorter event windows may infer some more information. So we proceed for analyzing the AARs and CAARs around the event day with a shorter period.

Table 5 represents the AARs and the CAARs around the event day with a shorter period ranging 3 days, 7 days, and 15 days including the event day. It can be seen that the average, as well as the CAARs for a window period of 15 days, is not significant. The empirical data reflects that although the average abnormal returns for the shorter event window period 7 and 3 days are not significant, the CAARs for both periods are significant. This indicates that the AARs on event day as well as during the pre-event and post-event days up to 3 days have been impacted by the information. The impact up to 3 days before the event also signifies that the market had anticipated the information and reacted accordingly.

When we compare the test-statistics for the pre and post-event period with the help of the Paired *t*-Test (calculated using data analysis in MS-Excel) and the Wilcoxon's Signed Rank Test (calculated by the calculator provided on the website of Social Science Statistics) (results in Table 6), we find that the t-value, z-value as well as W-value are also significant at a p-value of 0.05 (5% level). Although not significant at 1%, the results infer that there exists a significant difference between the mean AARs of the pre and post-event periods in the event window.

The parametric tests above have indicated significant abnormal returns after the announcement of the news. Now we move to analyze the results of the non-parametric tests. Table 7 depicts the test statistics for the Corrado (1989) for the pre and post announcement days. The $t_{Corrado}$ values indicate 3 significant abnormal returns in the pre-announcement period while 14 significant

Table 8
Test Statistics of the Modified Corrado Test around the event day.

Window Period (M)	$t_{Cor(modified)}$	Window Period (M)	$t_{Cor(modified)}$	Window Period (M)	$t_{Cor(modified)}$
−7 to +7	**−4.596**	−3 to +3	**2.557**	−1 to +1	**11.168**

Note: Figures in bold indicate significant at a p-value of 0.01 (1% level).

Table 9
Number of significant AARs and CAARs in different markets during the event window.

Markets	AARt		CAARt	
	Pre	Post	Pre	Post
Developed	10	14	6	13
Emerging	1	9[a]	1	10[a]
Europe, Middle East & Africa	5	17	0	15
Americas	0[a]	0[a]	0	2
Pacific	3	9[a]	0	11[a]
Asia	5	14	3	30

[a] The event day returns are not significant.

Table 10
Test statistics of CAARs in different markets during the shorter event windows.

Markets	−7 to +7	−3 to +3	−1 to +1
Developed	0.32	−1.75	−1.96
Emerging	−2.27*	−1.98	−2.69*
Europe, Middle East & Africa	−1.29	−2.15*	−1.19
Americas	−0.22	0.55	0.59
Pacific	1.78	2.58	−3.23*
Asia	−2.84*	−4.81**	−8.33**

* Significant at p-value of 0.05 (5% level) **Significant at p-value of 0.01 (1% level).

Table 11
Results of the Paired *t*-Test.

Indices	Declaration day	Mean		(t-critical = 2.14 at alpha 0.05)	
		Pre (t_{-15})	Post (t_{+15})	t-value	p-value
FTSE MIB-Italy	Mar 10, 2020	−2.05	−0.31	−0.89	0.39
IBEX35-Spain	Mar 16, 2020	−2.66	0.76	**−2.64**	0.02
DAX30-Germany	Mar 20, 2020	−2.41	1.21	**−2.73**	0.01
CAC40-France	Mar 16, 2020	−2.54	0.75	**−2.72**	0.01
FTSE100-UK	Mar 23, 2020	−1.58	0.79	−1.81	0.05
BEL20-Belgium	Mar 17, 2020	−2.90	1.21	**−3.21**	0.00
TA35-Israel	Mar 19, 2020	−2.27	0.54	**−2.75**	0.01
ISEQ- Ireland	Mar 27, 2020	−1.44	0.27	−1.02	0.16
OSE Benchmark-Norway	Mar 12, 2020	−1.81	0.61	**−2.15**	0.02
S&P ASX200-Australia	Mar 23, 2020	−1.94	1.23	**−2.35**	0.02
OMXC20-Denmark	Mar 11, 2020	−1.07	0.15	−1.27	0.11
NZX50-New Zealand	Mar 25, 2020	−1.10	0.62	−1.55	0.07
Shanghai-Composite-China	Feb 03, 2020	−0.24	0.66	**−2.78**	0.01
WIG-Poland	Mar 13, 2020	−3.17	0.65	**−2.73**	0.01
SE PX-Czech Republic	Mar 16, 2020	−1.85	0.40	**−2.23**	0.02
KLCI-Malaysia	Mar 16, 2020	−0.87	0.31	−1.54	0.07
TASI-Saudi Arabia	Mar 25, 2020	−1.33	0.62	−1.58	0.07
QE General-Qatar	Mar 11, 2020	−0.94	−0.33	−0.68	0.25
COL CAP- Colombia	Mar 24, 2020	−3.48	1.76	**−2.34**	0.02
ADX-General-UAE	Mar 26, 2020	−1.16	0.53	−0.97	0.17
BSE-SENSEX-India	Mar 24, 2020	−2.59	1.14	**−2.15**	0.02
South Africa Top 40	Mar 26, 2020	−1.24	0.57	−1.04	0.16
S&P MERVAL- Argentina	Mar 21, 2020	−2.54	0.99	−1.68	0.06
MOEX RUSSIA INDEX	Mar 30, 2020	−1.06	0.25	−0.86	0.20
BUDAPEST SE- Hungary	Mar 30, 2020	−1.67	0.07	−1.07	0.15

Note: Figures in bold are significant at a p-value of 0.05 (5% level).

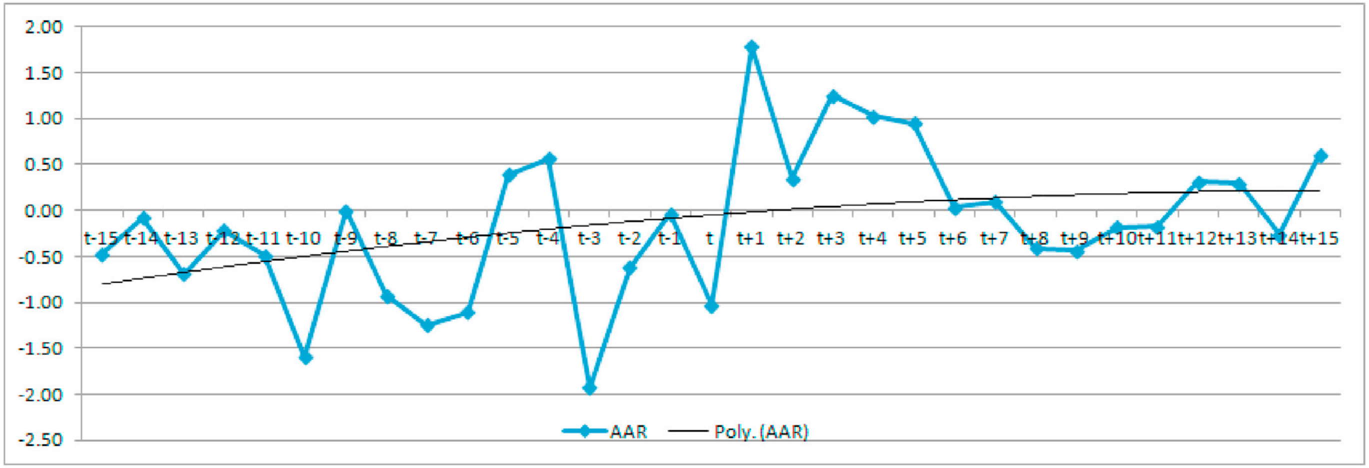
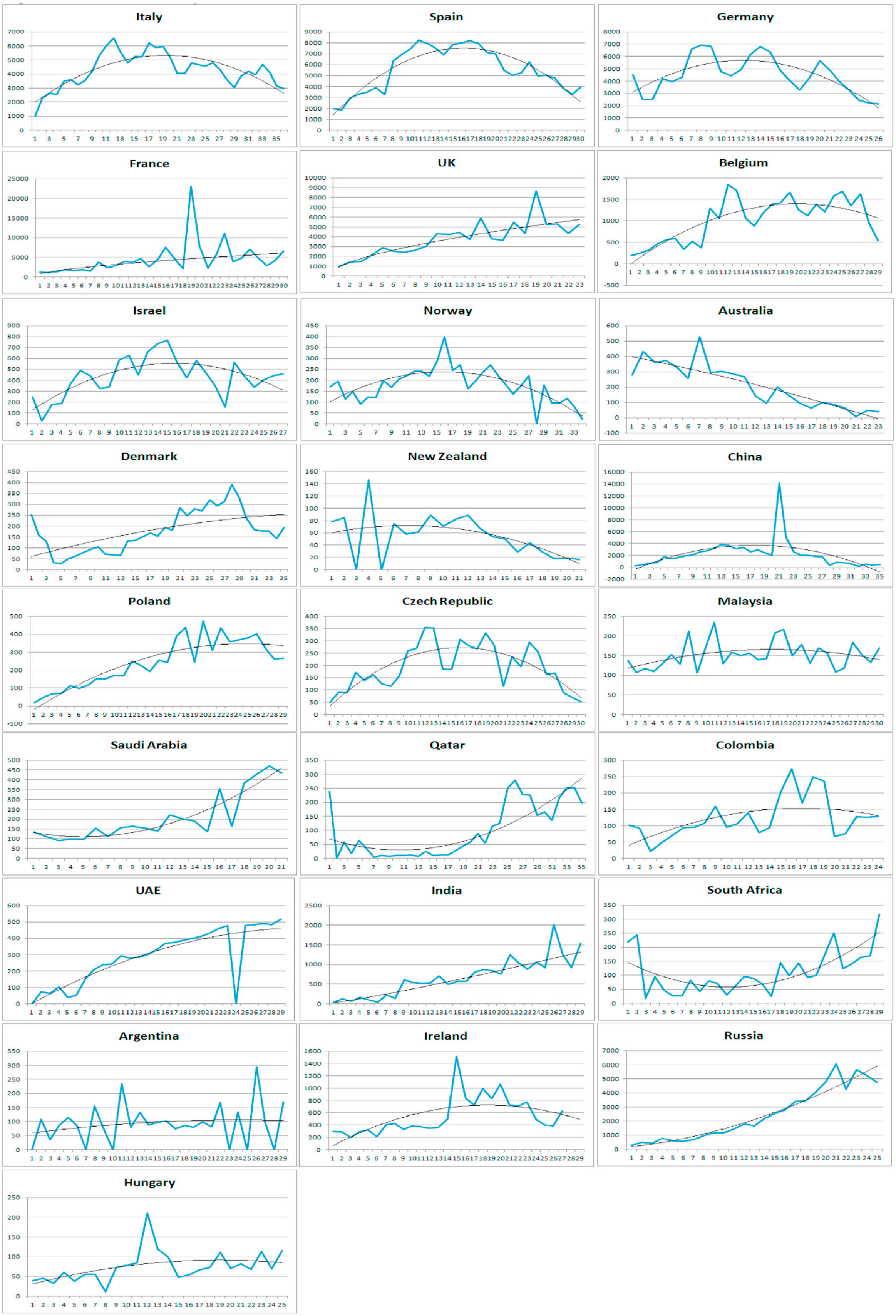


Fig. 2. Trend of AARs during the t-15 to t+15 days around lockdown/restrictions.
Source: Prepared from the results of the data analysis



(caption on next page)

abnormal returns in the post-announcement period. Although the test statistics on the event day being 1.658 does not indicate significant change on the event day itself, more significant returns in the post-event period indicate that the market returns have been impacted. For more accurate interpretation, we analyze the results of the modified Corrado test-statistics around the event day.

Table 8 represents the $t_{Cor(Modified)}$ values around the event day. We have calculated the values for 15 days, 7 days, and 3 days around the event day. The test statistics indicate that CARs for all three event windows are significant at a p-value of 0.01 (1% level). Hence, it can be inferred that the ARs during the shorter window period is significant and indicates that the event has significantly impacted the returns in the developed as well as emerging markets in the world.

4.3. Region-wise impact of 2019-nCoV outbreak

To generate more specific results, we have studied the abnormal returns data separately for the developed and emerging markets and also based on continental divisions as Europe, Middle East & Africa, Americas, Pacific, and Asia. The AARs, CAARs and the test statistics for all the days have not been provided to conserve space. However, the number of significant AARs and CAARs (at 5% level) for these markets and the AARs, CAARs, and the test statistics around the event day for a shorter event window has been provided in Tables 9 and 10 respectively.

The analysis of the test statistics for different markets revealed that abnormal returns have been significant in most of the cases after the announcement day. In the developed market the pre-announcement AARs are significant for 10 days and 14 days is the post-announcement period, including the event day. Similarly, the cumulative returns for 6 days in the pre-announcement period and 13 days in the post-announcement period including the event day indicate that the developed markets started reacting before the announcement. It rejects the efficient market hypothesis. The developed markets already had information about the declaration of international health emergency and started adjustments beforehand. The results of the emerging markets indicate that no such information was available earlier and that the market started adjustments after the event day. Similarly, the Asia and Pacific markets have no or least information. The American markets are seen to been least impacted by the declaration of the WHO. The most affected market seems to be the Asian market where the CAARs for all 30 days in the post-event period are significant.

The analysis of the shorter event windows reveals that different markets have reacted differently. While the cluster of emerging markets, shows evidence of significant CAARs around the event day for 15 days and 3 days event window, Europe, Middle-East & African, and the Pacific markets show evidence of significant CAARs around the event day only for 7 days and 3 days event window respectively. The developed and the American markets have no significant CAARs during any of the event windows while the Asian markets show evidence of significant CAARs around the event day for all the three event windows. Once again, the Asian markets seem to have been impacted the most while the American markets have been least impacted by the declaration of an international health emergency.

4.4. Impacts of the lockdown/restrictions imposed

Table 11 incorporates the results of the paired *t*-test applied to the daily log-returns of the 25 economies (12 developed and 13 emerging). The data implicate that the mean returns for all the 15 days before the imposition of the lockdown are negative for all the economies while for the period post imposition experienced positive mean returns for 23 economies. The analysis of pre and post means reveals that some nations have tremendously recovered its losses. However, the post imposition means returns although negative for Italy and Qatar, show an improvement over the previous mean return. The WHO declared the 2019-nCoV outbreak as a global pandemic on March 11, 2020 which almost matches the imposition dates for both these economies. The market reaction of this news might have affected the returns of the few days after such a declaration. An improved mean post imposition of lockdown/restrictions infer that the expectation of the market that such imposition will curb the spread of the novel coronavirus and in the long run the market will yield better results.

The stock indices of almost all the economies are seen recovering the crashes that hit them in the early stage of the epidemic. To check the statistical significance of the means, the t-values are compared with the critical t-values, which depicts that the difference between the mean returns of the stock indices of 7 developed markets (Spain, Germany, France, Belgium, Israel, Norway, and Australia) and 5 emerging markets (China, Poland, Czech Republic, Colombia, and India) are significant at 95% confidence level. Positive and significant returns infer that the early lockdown/restrictions have helped contain the spread of the novel coronavirus in these nations which in turn has boosted the confidence of the stock market.

Fig. 2 depicts the graphical presentation of the AARs (calculated as per eq. (04) with event dates being the lockdown/restrictions, estimation period of 45 days from t_{-60} to t_{-16} and event window of 31 days from t_{-15} to t_{+15}) of the 25 economies for the pre and post lockdown/restrictions. It is noticed that the AARs are negative on 12 days in the pre-lockdown period while only 5 negative AARs in the post lockdown period. The polynomial trend line could be seen crossing the x-axis towards the positive quadrant from the day lockdown/restrictions are imposed. This indicates that the lockdown/restrictions have boosted confidence in the stock markets anticipating the avoidance of much adversity to the economy with the expectation of the novel coronavirus being contained.

Fig. 3 is the graphical presentation of the trend in daily new cases after the imposition of lockdown/restrictions in the sample nations. The trend of daily new cases post lockdown/restrictions follows an upward trend in France, UK, Denmark, Poland, Saudi Arabia, Qatar,

Fig. 3. Trend of daily new 2019-nCoV cases in various nations after imposition of lockdown/restrictions.
Source: Based on data available on www.worldometers.info

Table 12
Correlation between cumulative abnormal returns to total cases and total deaths.

Country	Total Cases (World)	Total Deaths (World)	Total cases (Country)	Total Deaths (Country)	-ve/ +ve	*3-day's CAR (t to t+2*	7-day's CAR (t to t+6)	Total Death/ Total Cases
USA	0.93	0.91	0.93	0.92	+ve	1.48	3.42	2.92
Italy	−0.93	−0.9	−0.93	−0.92	-ve	−0.66	−3.65	3.16
Spain	−0.96	−0.94	−0.92	−0.89	-ve	0.14	−2.69	2.73
Germany	−0.90	−0.88	−0.82	−0.67	-ve	0.69	−0.71	0.23
France	−0.90	−0.85	−0.87	−0.83	-ve	0.08	0.48	7.14
UK	−0.95	−0.92	−0.95	−0.92	-ve	−1.14	−5.22	3.56
Belgium	−0.91	−0.93	−0.8	−0.51	-ve	−3.69	6.49	1.64
Switzerland	−0.78	−0.80	−0.67	−0.60	-ve	0.14	−3.58	0.81
Netherlands	−0.9	−0.9	−0.79	−0.78	-ve	−4.70	2.65	2.52
Canada	−0.94	−0.91	−0.97	−0.91	-ve	−8.40	−14.74	1.24
Portugal	−0.95	−0.93	−0.90	NSD	-ve	3.19	7.05	1.44
Austria	−0.99	−0.97	−0.94	−0.58	-ve	−10.35	−1.63	0.47
Sweden	−0.76	−0.74	−0.62	−0.33	-ve	−0.99	11.97	0.98
Ireland	−0.62	−0.57	−0.51	−0.26	-ve	−0.97	−1.26	0.44
Norway	−0.93	−0.89	−0.87	−0.43	-ve	2.03	9.58	0.38
Australia	−0.97	−0.98	−0.94	−0.92	-ve	−6.78	−9.19	0.37
Denmark	−0.59	−0.63	−0.59	NSD	-ve	8.90	6.33	1.97
Japan	−0.97	−0.97	−0.96	−0.96	-ve	−1.63	−2.00	0.62
Finland	−0.63	−0.5	−0.65	−0.49	-ve	−0.98	−0.66	1.94
Singapore	−0.96	−0.91	−0.96	NSD	-ve	0.35	−3.80	0.30
Hong Kong	−0.01	0	0.03	−0.12	NS	2.00	2.54	1.79
New Zealand	−0.72	−0.77	−0.5	NSD	-ve	2.70	3.77	0.09
Israel	−0.96	−0.91	−0.94	NSD	-ve	−0.15	−1.50	0.37
China	0.64	0.59	0.44	0.58	+ve	−0.40	−2.02	2.98
Turkey	−0.87	−0.91	NSD	NSD	NSD	−2.52	−3.00	2.07
Brazil	−0.83	−0.79	−0.7	NSD	-ve	−2.53	0.80	2.58
South Korea	−0.73	−0.84	−0.73	−0.75	-ve	−3.41	−2.78	0.65
Russia	−0.97	−0.96	−0.90	NSD	-ve	9.68	6.28	0.49
India	−0.97	−0.96	−0.93	−0.66	-ve	−3.77	−6.56	2.00
Chile	0.90	0.90	0.79	NSD	-ve	−3.00	6.59	0.53
Poland	−0.94	−0.94	−0.92	−0.66	-ve	6.14	20.94	1.07
Czech Republic	−0.96	−0.98	−0.88	NSD	-ve	3.32	−1.37	1.09
Peru	−0.72	−0.68	−0.87	NSD	-ve	0.08	−9.63	2.53
Pakistan	−0.86	−0.90	−0.83	NSD	-ve	−2.44	−17.57	1.22
Malaysia	−0.88	−0.87	−0.85	NSD	-ve	−3.77	1.61	1.13
Philippines	−0.93	−0.93	−0.88	−0.81	-ve	1.25	2.41	NSD
Mexico	0.71	0.74	0.79	NSD	-ve	−3.16	−11.92	2.01
Indonesia	−0.92	−0.94	−0.83	−0.62	-ve	−2.48	−15.55	8.67
Colombia	−0.94	−0.87	−0.88	NSD	-ve	18.21	11.21	1.64
Greece	−0.95	−0.95	−0.91	−0.41	-ve	−11.68	4.13	2.45
South Africa	−0.61	−0.66	−0.36	NSD	-ve	1.07	0.94	0.36
Argentina	0.92	0.95	0.83	0.73	+ve	−1.35	−7.72	2.06
Thailand	−0.92	−0.94	−0.94	−0.64	-ve	0.55	−1.87	1.69
Saudi Arabia	−0.92	−0.87	−0.91	NSD	-ve	−0.09	5.75	1.11
UAE	−0.96	−0.92	−0.94	NSD	-ve	−1.42	−0.10	0.90
Qatar	−0.89	−0.85	−0.51	NSD	-ve	−2.83	3.47	0.29
Egypt	−0.96	−0.93	−0.78	−0.76	-ve	−7.14	−21.29	2.86
Hungary	−0.88	−0.88	−0.86	NSD	-ve	−6.96	0.55	4.42
Taiwan	0.20	0.27	0.42	NSD	+ve	−0.89	3.47	3.13

**NSD=Sufficient Data Not Available **NS=Not Significant.*

UAE, India, South Africa, and Russia through the stock market returns have recovered fast and are significant for France and Poland. However, an upward trend is not necessarily bad. The rate of spread after the lockdowns is continuously declining in these nations. The trend in daily new cases in Italy, Spain, Germany, Belgium, Israel, Norway, New Zealand, China, Czech Republic, Colombia, and Ireland is upward in the beginning but later on, follows a downward trend although the stock market returns for Italy, Ireland and New Zealand are not significant but has recovered to some extent as indicated by the mean returns.

The trend of daily new cases in Australia has been downward since the lockdown and seems the most successful nation in containing the spread of the pandemic. The stock market returns of Australia are also seen to have significantly recovered.

The trend in Malaysia, Argentina, and Hungary is somewhat constant; however, the stock market of these economies has recovered themselves. Correia et al. (2020) find that the cities which implemented the non-pharmaceutical interventions such as social distancing, etc. during the Spanish Flu, 1918 had suffered no economic adversities in the medium term. Similarly, this study evidences that the developed, as well as emerging nations, have been successful in containing the spread of the novel coronavirus by imposing early lockdowns/restrictions and this has led to reinstating the confidence in the market participants ultimately leading to a sharp reversal of the market returns. Hence, supporting the views of Correia et al. (2020).

4.5. Association between cumulative abnormal returns, total cases, and total deaths

The stock market reactions to the 2019-nCoV outbreak as well as the lockdowns/restrictions imposed have been analyzed in the previous sections. This section is dedicated to find if there exists any relation between the cumulative abnormal returns of different nations and the total number of cases and deaths in the world as well as those in the particular nation. The numbers of cases and the deaths have been collected for the study period t_{-30} to t_{+30} from the website "https://www.worldometers.info/coronavirus/". The data of the cumulative cases and deaths have been compared with the cumulative abnormal returns on that particular day with the help of a simple correlation using the data analysis function of the MS-excel. The results of the analysis have been presented in Table 12.

The correlation coefficients of all the nations, except USA, China, Hong Kong, Argentina, and Taiwan, indicates that there exists a high and moderate negative correlation between the data of total cases and the CARs as well as the total deaths and the CARs; that too, for both the data of the whole world as well as the country-wise figures. Sufficient data in respect of few nations was not available as there were deaths in those nations during the period of study. No new cases were available in Turkey. The high and moderate negative correlation reflects that the increasing number of cases and deaths in the nations as well as the world has led to the falling CARs of the indices of these nations by significantly impacting the investor's sentiments and anticipation for the future.

Further, we also calculate the 3-day's (t to t_{+2}) and 7-day's CARs (t to t_{+6}) for each nation as per the standard event study methodology with the event day being the date of first death due to the novel coronavirus in the sample nations and the estimation window of 90 days. The 3-day's and 7-day's CAR of each nation have been presented in Table 12. The analysis reveals that the 3-day's CARs of 30 nations and the 7-day's CARs of 26 nations have been negative. However, the 3-day's or 7-day's CARs of 37 nations have been negative. The CARs have been positive for 7 developed markets, i.e., the USA, France, Portugal, Norway, Denmark, Hong Kong, and New Zealand; and, for 5 emerging markets, i.e., Russia, Poland, Philippines, Colombia, and South Africa.

The increasing numbers of cases and deaths have impacted the market sentiments, mostly the emerging markets. The ratio of total deaths to total cases on the t_{+7} day has also been presented in Table 12. Although the increasing number of cases and deaths are correlated with the CARs, they do not indicate poor health systems in the nations because the CARs have been negative even for those nations which have low mortality rate and they have been positive for a few nations which have high mortality rate. It's all about how the information of rising cases and deaths are perceived by different markets. Both developed and emerging markets behaved differently to these numbers. The results, however, infer that the stock market reactions may be linked to the cross-country variation in the evolution of cases and fatality rates.

5. Conclusions

The 2019-nCov outbreak has negatively impacted the global stock markets. The statistical results infer that the developed markets have been hit hard in the long window as compared to the emerging markets. In the shorter window period, the impacts on the developed markets are not significant. The region-wise analysis concludes that while the Asian stock markets have been significantly impacted by the outbreak, the impacts on the American stock markets are not significant both in the long window as well as the shorter window. Previous studies have supported that macroeconomic news and firm-specific news do impact the stock market returns. This study provides evidence for global stock market reactions to epidemics. However, it is summarised that the impact of the 2019-nCoV outbreak was negative and significant on the global stock markets. It is also evident from the trend of AARs around lockdown/restrictions that early lockdowns/restrictions imposed by the nations have yielded positive results in containing the spread of the novel coronavirus, thus, rebuilding the investor's confidence and sharp reversal in the stock market returns. The statistical results indicate a high and moderate negative correlation between the CARs and the cumulative figures of the cases and deaths both country-wise and that of the world. The rising numbers of cases and deaths have impacted the market sentiments leading such stock market reactions; though different reactions for different markets.

6. Implications and limitations of the study

The event study literature lacks any such study on the impacts of epidemics on the global stock market. This study anticipates adding to the literature of the event study methodologies. Moreover, this study also provides an insight into the potential benefits of implementing early lockdown/restrictions to curb the spread of a global pandemic. The study may possess some limitations related to the results of the test statistics due to the non-normality of data. However, we have incorporated both parametric and non-parametric tests to conclude the significance of the abnormal returns. Further, we could not do an event study on the impacts of the lockdown/restrictions due to the lack of sufficient data. Hence, future research may be initiated to study the stock market reactions to the early interventions by the nations to curb the spread of the pandemic. Moreover, the information in respect of the lockdown/restrictions for all the nations could not be made available limiting the study of the impacts of such interventions on only 25 economies. With the passage of time, a comprehensive study on all the developed and emerging nations may be conducted.

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