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Vulnerability of Stock Returns and the effects of Covid-19: An Event Study from the Energy Sector of USA

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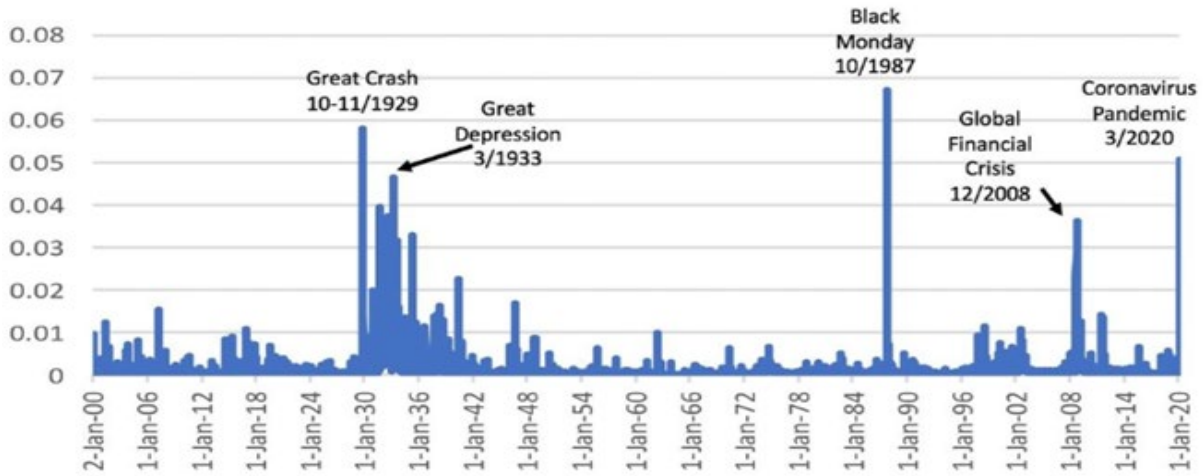
The outbreak of COVID-19 creates serious distress for the world economy due to an increasing economic, financial and health related response to the pandemic. The purpose of this paper is to examine the reaction of the energy sector in the USA toward the outbreak of COVID-19, which reportedly began on 20th January, 2020 (event day). This study uses a sample of 33 listed firms from the energy sector of USA during the period of January 2019 to March 2020, with daily observations. The reaction of the stock return is observed through event study methodology while calculating the cumulative average abnormal return (CAAR). The study findings show that out of 33 sampled firms, only five significantly reacted against the outbreak of COVID-19 on the event day, whereas for the first event window (-3,3) the stock return (CAAR) for the ten energy firms is found to be statistically significant (in normality assumption), providing that only 30.30% sample firms are reacting against this pandemic. The results of this research would be of reasonable support to industry experts, investors and other stakeholders while making some strategic decisions on the basis of disease outbreaks and trends in stocks return, specifically in the energy sector. As an extension to this research, expanding the regional boundaries, sample period, and adding those firm-related variables which may serve as risk mitigating factors against disease epidemics and stock return relationship would provide a good output.

Key words: *CAAR, Stock return, COVID-19. USA.*

Introduction

After the detection of very first case of COVID-19 in the country on January 20, 2020, the United States (USA) was found to become the epicentre, surpassing the confirmed cases of 466,299, across all the fifty states. It is believed that more than 16,700 people have died across the USA from this novel virus. In the global business hub of New York city, the COVID-19 cases continue increasing since its outbreak, while a maximum death total of 2212 was recorded over a single day on April 22 throughout the entire country (Guardian, 2020a). To cope with this issue, two memorandums were sent to the president Donald Trump and to the National Security Council (NSC), in which it is clearly mentioned that the lack of immune protection would leave Americans defenceless against its full spread. On March 27, 2020 the President signed a law covering a rescue bill of $2 trillion that was later passed by the senate on March 25, 2020 (Guardian, 2020a). Although the provision of such significant financial aid may help the overall economy and health system show a reasonable resilience, the market volatility nonetheless rocketed upward. In the last 120 years, the USA stock market's volatility over the ten trading days is observed as somewhat uneven, due to the great crash of 1929, the Great Depression of 1933, black Monday 1987, the global financial crisis in 2008 and COVID-19 now in 2020 (Kellogg Insight, 2020) (Figure 1). However, the recent epidemic is observed with unprecedented outcomes. Experts believe that since 1985, no other infectious disease has had more than a tiny influence on USA stock market volatility.

Figure 1. USA Stock Market Volatility in 10-Day trading periods.



Source: Kellogg Insight (2020)

In addition, the global impact of COVID-19 on the world energy sector reveals a dramatic decline in both demand and oil prices. However, this dropdown has opened several opportunities for the renewable energy sector. Before the pandemic, both the oil and gas sector worldwide were feeling negative shocks in their operations. One of the leading law firms, McCarthy Denning, has anticipated that demand will decrease in the first quarter of the

current year due to the outbreak of the pandemic, resulting in the suspension of projects by energy companies, shelved share buyback and slashed capex. This was later observed when a hydrocarbon exploration company named Diamondback Energy announced a reduction in their business activity on 09 March and thereafter: its share price declined over 50 % in the industry (ICLG, 2020). In addition, the New York Stock Exchange Energy Sector Index (NYNRGS) has reported an overall decline in the price return from January 1, 2020 to April 8, 2020 (i.e., 10037.30 to 5904.74) (Investing.com, 2020). This declining trend creates serious concern for the investors, financial analysts and industry experts. Therefore, the present study aims to explore the energy sector of the USA through the reaction in their stock returns, as observed during the outbreak of COVID-19. More specifically, our study aims (a) to collectively measure the impact of this epidemic outbreak on the sample firms' return pattern during January 2019 to March 2020; (b) to investigate the impact of this outbreak during different event windows, covering both before and after time slots; (c) to contribute to the body of knowledge regarding the impact of disease outbreak on the energy sector and provide recommendations for the industry experts, academics and market analysts to strategically understand the unprecedented market shocks for the development of proposed policies, accordingly.

Literature Review

The world economy is already facing almost all types of crises due to the outbreak of COVID-19. In this regard, the literature under discussion for the impact of this pandemic and its impact on the different economies and sectors is gradually increasing. However, literature support for investigating the relationship between population health and economic growth has been widely observed earlier by Bezruchka (2009), Bloom et al. (2010), Laporte (2004), Siddiqi and Hertzman (2001), Szreter (2003) and Tandon and Zhuang (2007). These studies have explored both the direct and indirect relationship between the population, diseases and economic dynamics. It is observed that the economic cost due to such disease outbreaks and resultant causalities are subject to the consequent burden on the economy in the form of loss of future income and increasing medical expenditures. Likewise, the influence of these outbreaks is examined by the researchers while observing different regions. For example, Thompson et al. (2002) inspect the economic costs of the foot and mouth disease (FMD) outbreak in the United Kingdom (UK) during 2001. It is claimed that an estimated loss to the economy due to this pandemic was £3.1 billion. Meanwhile, the loss to the agriculture sector was £355 million, and for the tourism industry, the estimated damage was between £2.7-3.2 billion. Furthermore, the authors claim that there is a net effect reduction of 0.2% in the gross domestic product of the UK. In the same period, Paarlberg, Lee and Seitzinger (2002) examine the potential impact of FMD in the USA during 2001. For determining the combined effect, factors such as quarantine, export bans, fear about the disease, and slaughter of the animals were observed. The results show that the largest impact by FMD was on farming

income, with the added reduction of domestic demand due to fear of such outbreaks, too. As a consequence, there was a total loss of $14 billion in farming income including the losses from each animal.

Lee and McKibbin (2004) provide a good assessment of the global impact of severe acute respiratory syndrome (SARS) on the world economy with a comprehensive approach for estimating the outcomes of such epidemics. The authors estimated the cost of the SARS outbreak by considering its influence on both investment and consumption behaviours. It is claimed that with the more economic interdependency that is prevalent in current times, such changing behaviour in investment and consumption factors may lead to more economic losses. Polgreen, Nelson, Neumann and Weinstein (2007) narrate that prediction markets can accurately forecast the results of a wide range of upcoming events. Such markets may also be useful to predict infectious disease like acute respiratory syndrome, avian influenza and many more. The pilot testing suggests that such markets can reasonably predict the spread of these seasonal influenza activity at least 2-4 weeks advance.

Park, Jin and Bessler (2008) review the Korean economy by checking the impact of animal disease on the meat market through an error correction and historical decomposition approach. They find that after approximately sixteen months of animal disease outbreak, the market was partially recovered whereas such outbreaks have differentiated impacts in terms of supply chain level and disease type. Rich and Wanyoike (2010) analyse Rift Valley fever (RVF) in the economy of Kenya during 2007 through rapid assessment of the livestock value chain in the northeast part of the country. Their findings conclude that there is a significant loss due to such epidemics for the downstream actors like livestock traders, slaughterhouses, butchers and labourers. Stocks, McNamee, Turner, Carder and Agius (2013) aim to determine whether the incidence of work-related short latency respiratory disease (SLRD) is attributed to workplace exposure limits (WELs). They conclude that the introduction of COSHH 2004 legislation in the UK causes a substantial drop in the reports of SLRD.

In addition, investors' perspective about infectious diseases and their relationship with market behaviour is also observed in the literature. Wang, Yang and Chen (2013) explain that an increasing number of infectious diseases affects the health of the people and causes stagnation in economic growth. Their study investigates the outbreak of ENTEROVRIOS 71, SARS, dengue fever and HINI and found a significantly abnormal return for the biotechnology industry of Taiwan. Jiang et al. (2017) discuss the correlation between the reported cases of H7N9 (daily basis) and stock price indices in the Chinese economy, based on a time duration of stock indices between February 19, 2013 to March 31, 2014 with the application of distributed lag non-linear model. It is believed that there is a significant correlation between the reported cases of H7N9 and closing prices of the stock and opening prices of the Shanghai Composite Index.

For COVID-19, Maital and Barzani (2020) provide their findings through summarising the recent reports on the global impact of this epidemic. It is claimed that a major impact of this pandemic is on the supply side of the world economy, while remedies are associated with the demand side. Due to this scenario, there is a likelihood for a new global recession. Ramelli and Wagner (2020) conducted a cross sectional stock price reaction while providing the investors reaction toward this outbreak. The authors term the time span of January as the "incubation phase", when some sophisticated investors started pricing. However, after the human-to-human transmission of COVID-19 (January 20), other stakeholders like managers, analysts and investors grew their concerns too. After this period, the "outbreak phase" was tracked as when the Chinese stock market and other international stocks were underperforming. However, from the last week of February, the "fever" phase started, which is when the aggregate market fell down, creating a whipsaw shape. Overall, it is claimed that health crises lead to economic and financial crisis. Lastly, McKibbin and Fernando (2020) demonstrate their concerns that COVID-19 disrupted the world economy and makes it hard for policymakers to develop a macroeconomic policy response. Their study examines seven different scenarios for both macroeconomic outcomes and financial markets considering the DSGE/CGE general equilibrium model. Their study findings reveal that even a contained epidemic could significantly impact the world economy over the short term.

Research Methods

Because of the unexpected event in the market, business firms react accordingly while demonstrating some abnormal patterns in their returns. For this purpose, the event study method helps to calculate such abnormality in the returns, either for the individual stock or for the portfolio or both. It is believed that the event study technique allows assessment of whether a given situation in the market has proved able to impact on the market value of the firm's stock as measured through stock prices. Additionally, there is the implication of event study, which may, in addition to observing for the common stocks, also observe for the other securities (i.e. bonds, credit default swaps), as reported by Andres, Betzer and Doumet (2016). For generating the abnormal return (AR), Equation 1 provides the general understanding.

$$AbR_{i,t} = R_{i,t} - E(R_{i,t}.I_t)$$ ……..Equation 1

The equation provides the description of AR through (actual returns) and indicates the expected return as based on the information I based on the time period t, which is primarily not related to the event. As explained in the study of Lee and McKibbin (2004), the application of the event study approach can be divided into several steps. Initially, there is a definition of the event window. Normally, the event window is explained as the period(s)

over which the event is assumed to influence the market returns of the securities of different firms. For this purpose, each event window comprises of over one or more days, including covering the event date itself. It is accepted as a common practice to include the days before and after the event, which covers both the pre-event and post event period, to analyse the market reactions. After the description of the event window(s), the next step considers the calculation of AR over a specific time for financial securities. For calculating the AR, it is quite necessary to compute the normal performance of the securities. However, this step covers the clear definition of the estimation window (the sample period before the event window). Different models are provided in the literature to estimate the value of a normal return. However, the most common approaches are the single index model and the historical mean model.

$$E(R_{i,t}, I_t) = \mu_i$$ ……..Equation 2

In the above Equation 2, the historical mean return for the securities over the estimation window demonstrates the expected normal performance undefined by the event. However, as per the single index model (Equation 3), it is believed that a normal return of the security(s) is/are estimated through the parameters like those observed in the estimation window of the study.

$$E(R_{i,t}, I_t) = \partial + \beta_i + R_{m,t}$$ ……..Equation 3

In addition, literature support is also available in order to improve the variance as reflected by the single index model while using the multi factor model, which is known as the three factor model, as provided by Fama (1993).

After the calculation of a normal return of the security(s), the next step is to calculate the AR. If the aim of the study is to examine the impact of the stated event on each of the securities, Equation 1 above is fairly helpful. However, sometimes a researcher is interested in examining the event impact over a multi-day time duration, therefore, a time series aggregation of the AbRs through obtaining the cumulative abnormal return (CAR) occurs through Equation 4.

$$CAR_i(t_1,t_2) = \sum_{t=t_1}^{t_2} AbR_{i,t}$$ ……..Equation 4

In addition, if the objective is to examine the event impact on the pool of firms, an overall aggregation (cross-sectional) becomes significant, hence the calculation of an average abnormal return is performed while using the following Equation 5, where the AbR indicates the abnormal return for the security and where, N indicates the overall population of the

securities. Also, if the objective of the study is to examine the average effect over multiple days, then the calculation of the cumulative average abnormal return becomes obvious while summing the AAbR, as presented in Equation 6.

$$AAbR = \frac{1}{N}\sum_{i=1}^{N} AbR_{i,t} \quad \text{.....Equation 5}$$

$$CAAR_t(t_1, t_2) = \sum_{t=t_1}^{t_2} AAbR_t \quad \text{.....Equation 6}$$

Our study has considered CAAR for examining the reaction to the outbreak of COVID-19 in the USA economy. For this purpose, different event windows are specified and the reaction of the stock returns as observed through CAAR was provided along with their statistical significance. Additionally, our study has employed the event study approach while using the STATA-15, where both upper and lower bounds are defined. In an individual analysis, six multiple event windows around the event day may be specified at one point in time. However, our study has developed the three step approach while examining the reaction of CAAR throughout the outbreak of COVID taking -3,3 as the first window only (Table 3), -3,3, -3,-1, and 0,3 as the next window pattern (Table 4), and lastly, 0,1, 0,2, 0,5, and 0,10 as the third pattern for the event windows. The post-window estimation period of 2, 5, and 10 shows the longer event periods.

Results

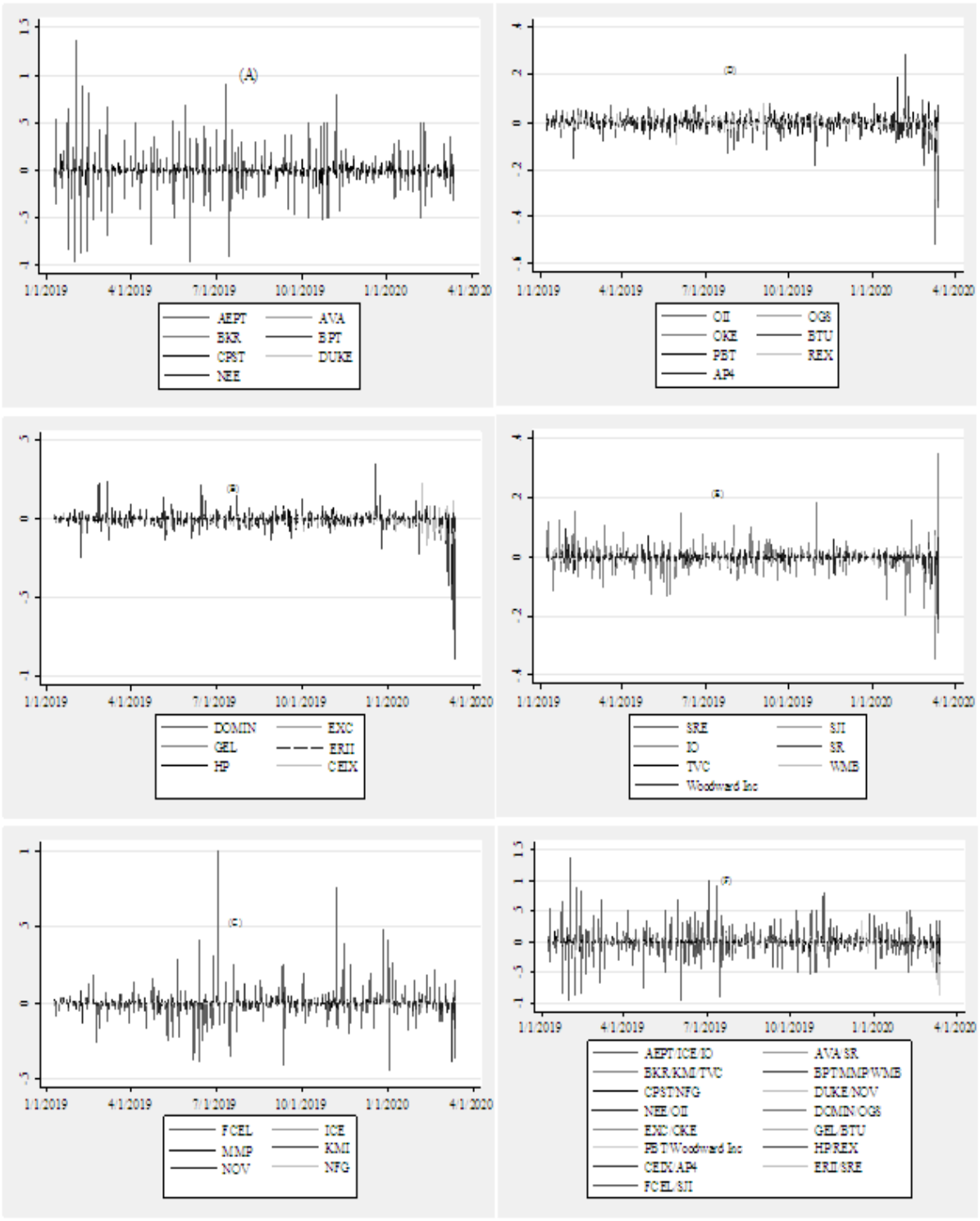
Table 1 reports the descriptive results of all the trends in the stock return for the selected companies, where mean scores are reported with the standard value of the dispersion. For measuring the normality assumption, both skewness and kurtosis, Jarque_Bera and probability scores are given. The largest mean score of the stock return is reported by NEE, followed by ICE and WWD. This would explain that from the sample firms, NextEra Energy, Inc. is found to be higher in terms of mean returns. The historical observation of the company record reveals that from March 04 to March 23, 2020, there is a significant decline in the stock price. However, before and after this period (over the last one year), NextEra Energy shows a positive return in the mean return (Yahoo Finance, 2020). This positive tendency in the stock prices are providing substantial evidence for observing a higher mean of NEE stock returns. Similarly, our findings for ICE reports the second highest mean among the stock returns of sample firms. This would justify the claim that ICE also observed positive returns in the stock prices during March 2019-2020. A similar situation is made for the WWD, DOMIN, AVA and ERII and TVC, where the study duration observes a positive return in the maximum period. However, the lowest mean in the stock return was -0.00806 as reflected by BTU. For standard deviation, the highest value is represented by AEPT, followed by FCEL and IO. These firms are observed with more dispersion in their mean score and a similar trend is reflected in standard deviation. The maximum value of stock return is reflected by

AEPT;1.37 % and FCEL; 1.01%. Lastly, the values of Jarque_Bera for each of the stock along with the probability values are also presented under Table 1, whereas Figure 1 provides the graph for the all the stocks during the study period (i.e each subgraph from A to E covers 6-7 stocks from sample firms, while sub graph F covers all the stocks collectively during 1st of January, 2019 to 15th of March, 2020).

Table 1: Descriptive Results

Sr. No.	Acronym	Obs	Mean	Std. Dev.	Min	Max	Jarque_Bera	Prob.
1.	NEE	297	0.000827	0.014826	-0.14238	0.059091	14000	0.00000
2.	ICE	297	0.000263	0.013869	-0.09267	0.040101	1430	0.00000
3.	WWD	297	0.000235	0.022241	-0.21215	0.098456	11000	0.00000
4.	DOMIN	297	0.000205	0.012289	-0.08673	0.062694	2050	0.00000
5.	AVA	297	0.000167	0.011117	-0.07165	0.046097	700.7	0.00000
6.	ERII	297	0.000126	0.024963	-0.12503	0.087861	112	0.00000
7.	TVC	297	5.14E-05	0.008707	-0.04469	0.028373	251	0.00000
8.	DUKE	297	-1.19E-06	0.011141	-0.08278	0.052188	2066	0.00000
9.	SRE	297	-2.80E-05	0.013015	-0.08911	0.028129	1558	0.00000
10.	OGS	297	-0.00013	0.012671	-0.09516	0.047877	1695	0.00000
11.	SR	297	-0.0003	0.014488	-0.09203	0.053569	960.6	0.00000
12.	KMI	297	-0.00036	0.015847	-0.10658	0.055399	1794	0.00000
13.	AP4	297	-0.00043	0.020196	-0.08135	0.188591	11000	0.00000
14.	SJI	297	-0.00045	0.014783	-0.07847	0.058262	345.5	0.00000
15.	EXC	297	-0.00072	0.013601	-0.11523	0.04283	4445	0.00000
16.	AEPT	297	-0.00097	0.298571	-0.97692	1.373716	95.66	0.00000
17.	NFG	297	-0.00123	0.014495	-0.06929	0.072505	201.1	0.00000
18.	MMP	297	-0.00142	0.016355	-0.17175	0.037011	27000	0.00000
19.	REX	297	-0.00159	0.023618	-0.14368	0.081087	358.1	0.00000
20.	WMB	297	-0.00179	0.019809	-0.20277	0.072257	16000	0.00000
21.	OKE	297	-0.00211	0.027005	-0.32549	0.048333	69000	0.00000
22.	BKR	297	-0.00221	0.026396	-0.2036	0.058748	2045	0.00000
23.	PBT	297	-0.00241	0.022829	-0.13129	0.085569	163.1	0.00000
24.	NOV	297	-0.00368	0.03837	-0.39859	0.132935	19000	0.00000
25.	HP	297	-0.00373	0.036285	-0.42444	0.08259	45000	0.00000
26.	IO	297	-0.0045	0.062421	-0.34545	0.353197	625	0.00000
27.	CPST	297	-0.00453	0.07303	-0.18232	0.180126	62.08	0.00000
28.	GEL	297	-0.0046	0.032054	-0.3233	0.071751	18000	0.00000
29.	OII	297	-0.00489	0.051975	-0.51875	0.096348	20000	0.00000
30.	FCEL	297	-0.00587	0.150153	-0.44787	1.011601	1330	0.00000
31.	BPT	297	-0.00588	0.044195	-0.25814	0.183082	365.9	0.00000
32.	CEIX	297	-0.00658	0.038778	-0.16843	0.229605	552.9	0.00000
33.	BTU	297	-0.00806	0.046918	-0.33372	0.29157	2648	0.00000

Figure 1 (A-F). Stock Return Patterns of Sample Firms



Note: Figure A-E covers 6-7 firms each, Figure F covers all

Our empirical results (Table 2) start with the discussion of the event day (0) and one event window which takes seven days (-3 to +3) from the event day, where the event date was considered as 20th January 2020 for the outbreak of COVID-19 in the USA. As stated earlier, the calculation of AR is based on the single index model which is set to be the default. For this purpose, market return has been used as an index list in our analysis procedure. By default, the estimation window of our results observe the first trading day to the 30th trading day before the event (-30). While demonstrating the results, column 1 (Table 2) shows the list of securities (i.e., listed energy firms), column 2 provides their acronyms, column three reports the CAAR for the event day and column four shows the CAAR for the first event window. The study findings show that during the event day, stock returns for CPST, KMI, NOV and IO show significant and negative reaction to the outbreak of COVID-19. This outcome demonstrates an adverse response of these firms on the event day. However, significant and positive reaction is observed from the stocks of EXC only. The remaining stocks of listed energy firms are showing no reaction during the event day. For the stated event window, the return pattern for the AVA is responding positively by 3.87% and this is a similar case with the DUKE and SRE, where the CAAR has responded positively and significantly by 4.91% and 4.54%. This means that the event of COVID-19 has caused a significant and positive impact on stock returns in four (4) out of 33 sample firms. However, the stock returns of BPT, CEIX, BTU, IO, WMB and WWD are showing a statistically significant and negative result of -20.06%, -15.08%, -29.24%, -5.54% and -7.89%, respectively. These findings confirm that out of 33 energy firms, six (6) are responding through negative movements in their returns against the outbreak of COVID-19 in the USA economy. However, most of the sample stocks are showing insignificant results, confirming no influence from such outbreak during observation time of first event window.

Table 2: Empirical Findings for Event Day and First Event Window

Firm Name	**Acronym**	**Event Day**	**CAAR[-3,3]**
American Energy Pattern	AEPT	-11.39%	-23.69%
Avista Corporation	AVA	1.20%	**3.87%***
Baker Hughes Company	BKR	0.77%	-5.23%
BP Prudhoe Bay Royalty Trust	BPT	0.79%	**-20.06%***
Capstone Turbine Corporation	CPST	**-0.35%*****	-6.29%
Duke Energy Corporation	DUKE	0.98%	**4.91%****
Next Era Energy, Inc.	NEE	0.57%	3.34%
Dominion Energy, Inc.	DOMIN	0.35%	2.03%
Exelon Corporation	EXC	**1.16%****	3.65%
Genesis Energy, L.P.	GEL	-0.14%	-5.11%
Helmerich & Payne	HP	-0.87%	-7.71%
Consol Energy	CEIX	-3.80%	**-15.08%****
Energy Recovery	ERII	-1.18%	3.46%

Fuel Cell Energy	FCEL	13.75%	-2.51%
ICON Energy Fund	ICE	0.75%	1.49%
ION Geophysical Corporation	IO	**-0.31%***	0.59%
Kinder Morgan	KMI	-0.42%	-0.38%
Magellan Midstream Partners	MMP	0.36%	-0.39%
National Fuel Gas Company	NFG	**-0.64%****	-3.53%
National Oilwell Varco	NOV	-2.37%	-9.18%
Oceaneering International	OII	-0.19%	2.61%
ONE Gas	OGS	0.59%	-1.84%
ONEOK, Inc	OKE	-2.32%	**-14.46%***
Peabody Energy	BTU	-0.89%	0.95%
Permian Basin Royalty Trust	PBT	-0.76%	-2.04%
REX American Resources	REX	0.13%	**11.70%*****
Riverstone Holdings	AP4	0.98%	4.54%*
Sempra Energy	SRE	-0.21%	0.88%
South Jersey Industries	SJI	**-2.37%*****	**-29.24%****
Spire Inc	SR	-0.03%	2.53%
Tennessee Valley Authority	TVC	0.61%	0.22%
The Williams Companies, Inc	WMB	-1.28%	**-5.54%***
Woodward, Inc.	WWD	-0.20%	**-7.89%****

Note: *** p-value < .01, ** p-value <.05, * p-value <.1

Table 3 shows the findings while expanding the event windows from -3, +3 to -3,-1 and 0,3 respectively. For checking the significance of the results, the Boehmer, Masumeci and Poulsen (1991) test is applied and the response of each stock return (CAAR) with their relative significance level is presented accordingly. The results demonstrate that BPT is responding significantly and negatively during the window period of -3,3 with a slight change in the CAR value (from 20.06 % to -20.54%). However, for the remaining two windows, the stock return of BPT are found to be statistically insignificant. This indicates a negative but no influence from COVID-19 during the event window of the first and fourth days before the event and three days after the event. Similarly, for CEIX, IO, BTU, WMP and WWD, it is observed that stock returns are showing different responses over different windows. More specifically, for the event window period of -3,3 under the Boehmer et al. (1991) test a minor change (from -15.08% to -15.51%) in the CAAR for CEIX is found. However, both of these stock returns are statistically significant, proving the adverse impact from COVID-19. In addition to this, the second event window (-3,-1, Table 3) is showing negative but insignificant findings but these are highly significant and negative in the third event window (-13.98%). This means that CEIX stocks are vulnerable towards this pandemic in U.S economy. For the stock return of OI, our study observes a highly negative and significant results when the Boehmer et al. (1991) was applied. This effect is -28.77%, which continues to the second event window (-17.57%, Table 3). However, our third window provides no

evidence for a significant reaction from CAAR of IO during the recent pandemic. Furthermore, WMP and WWD are showing their adverse returns for the first event window, providing enough evidence to justify an adverse reaction (-5.47% and -7.75%) due to COVID-19. However, from WMB and WWD, only the earlier window is supposed to be more vulnerable to the current pandemic, showing highly significant and negative response (0,3, -6.24%). For the third event window, our results claim that GEL and BTU are the only two firms whose returns' reactions are statistically significant in the third window (0,3), whereas no significant reaction is found during the first and second event window from their stocks. Table 3 concludes that only 24.24% significant reaction is recorded (eight stocks) in the first event window, 3.03% (one stock) in the second event window and 18.18% (six stocks) in the third event window. These results illustrate that stock returns of some of the energy firms were affected temporarily by COVID-19, implying that a majority of the key role players from energy sector in U.S are mainly driven by other economic and financial factors and related events. Furthermore, insignificant reaction from a majority of the firms would imply that the energy sector is relatively stable in the USA, hence observing little to no effect from the uneven shocks of an epidemic like COVID-19.

Table 3: Empirical Findings for 1-3 Event Windows

Firm Name	Acronym	CAAR[-3,3]	CAAR[-3,-1]	CAAR[0,3]
American Energy Pattern	AEPT	-21.98%	-10.98%	-11.01%
Avista Corporation	AVA	3.68%	1.54%	2.15%
Baker Hughes Company	BKR	-5.42%	-3.72%	-1.70%
BP Prudhoe Bay Royalty Trust	BPT	**-20.54%****	-10.72%	-9.82%
Capstone Turbine Corporation	CPST	-4.99%	0.26%	-5.25%
Duke Energy Corporation	DUKE	**4.85%****	1.87%	**2.97%***
Next Era Energy, Inc.	NEE	3.31%	1.97%	1.34%
Dominion Energy, Inc.	DOMIN	1.89%	1.69%	0.20%
Exelon Corporation	EXC	3.69%	1.57%	2.13%
Genesis Energy, L.P.	GEL	-5.39%	0.96%	**-6.35%***
Helmerich & Payne	HP	-7.91%	-2.22%	-5.69%
Consol Energy	CEIX	**-15.51%****	-1.52%	**-13.98%*****
Energy Recovery	ERII	3.25%	4.56%	-1.30%
Fuel Cell Energy	FCEL	-3.04%	12.91%	-15.95%
ICON Energy Fund	ICE	1.61%	0.37%	1.24%
ION Geophysical Corporation	IO	**-28.77%****	**-17.57%****	-11.20%
Kinder Morgan	KMI	0.58%	-1.38%	1.96%
Magellan Midstream Partners	MMP	-0.53%	-0.44%	-0.09%
National Fuel Gas Company	NFG	-0.34%	1.63%	-1.97%
National Oilwell Varco	NOV	-3.49%	-0.33%	-3.16%
Oceaneering International	OII	-9.38%	-4.79%	-4.60%
ONE Gas	OGS	2.57%	1.72%	0.85%

ONEOK, Inc	OKE	-1.74%	-0.04%	-1.70%
Peabody Energy	BTU	-14.33%	-2.41%	**-11.92%***
Permian Basin Royalty Trust	PBT	0.68%	1.94%	-1.26%
REX American Resources	REX	-1.55%	-3.56%	2.01%
Riverstone Holdings	AP4	**11.67%*****	0.13%	**11.54%*****
Sempra Energy	SRE	**4.52%***	2.14%	2.38%
South Jersey Industries	SJI	0.88%	0.11%	0.77%
Spire Inc	SR	2.47%	2.24%	0.23%
Tennessee Valley Authority	TVC	0.26%	-0.25%	0.51%
The Williams Companies, Inc	WMB	**-5.47%***	0.77%	**-6.24%*****
Woodward, Inc. `	WWD	**-7.75%***	-3.37%	-4.38%

Table 4 considers the additional four windows for examining the trends in the stock returns of selected firms as observed through COVID-19. Under the first window, there is significant positive impact of COVID-19 on DUKE, NEE and AP4, and significant negative on CEIX and WMB is observed, whereas the rest of the sample firms are found to be statistically insignificant in the first event window (Table 4). This means that from the day of the event to the subsequent first day (0,1), only 15.15% of sample stocks are showing their significant reaction, out of which 6.06% (02 stocks) are adversely reacting, whereas 9.09% are positively and significantly responding.

Those stocks which are exposed to COVID-19 under the first event window (Table 4) are showing similar reaction, plus GEL whose stock returns are also negatively significant at 10% under the second event window (0,2). However, both CEIX and WMP are showing a highly negative and significant outcome at 1%. The results under the third window (0,5) show that there is a negative reaction from the stock returns of GEL, CEIX and WMB, whereas significant and positive response is observed from DUKE, NEE and AP4. However, no significant reaction from the remaining stocks is found under the third window (Table 4). In the fourth event window (0,10), there is a significant and positive reaction of 5.36%, 5.03% and 13.29% for AVA, DUKE and AP4, respectively. Furthermore, there is significant and negative reaction of -15.65%, -25.69%, -6.62% and -8.29 % for GEL, CEIX, MMP and WMB. The percentage of the significant response from the overall sample firms under the event windows second and third is the same. However, overall 21.21% of the sample response is found for the last event under Table 4 of the present research.

Table 4: Empirical Findings for 1-4 Event Windows

Firm Name	Security	Caar[0,1]	Caar[0,2]	Caar[0,5]	Caar[0,10]
American Energy Pattern	AEPT	-11.41%	11.50%	-31.32%	-30.77%
Avista Corporation	AVA	1.90%	2.38%	2.65%	**5.36%***
Baker Hughes Company	BKR	-2.19%	-3.34%	-1.56%	-2.61%
BP Prudhoe Bay Royalty Trust	BPT	-5.26%	-4.38%	-9.69%	-2.23%
Capstone Turbine Corporation (CPST)	CPST	-0.14%	-5.14%	-8.32%	-0.39%
Duke Energy Corporation	DUKE	**1.98%***	**2.40%***	**3.84%***	**5.03%***
Next Era Energy, Inc.	NEE	**2.33%***	2.42%	**5.02%****	4.18%
Dominion Energy, Inc.	DOMIN	0.53%	-0.06%	-0.08%	2.59%
Exelon Corporation (EXC)	EXC	1.40%	1.87%	1.79%	3.68%
Genesis Energy, L.P.	GEL	-3.43%	**-4.92%***	**-7.62%***	**-15.65%*****
Helmerich & Payne	HP	-3.19%	-5.93%	-5.83%	-1.23%
Consol Energy	CEIX	**-9.17%*****	**-13.07%*****	**-17.99%*****	**-25.69%*****
Energy Recovery	ERII	-2.27%	-1.56%	0.32%	1.61%
Fuel Cell Energy	FCEL	-3.94%	-12.32%	-22.84%	-17.59%
ICON Energy Fund	ICE	0.56%	0.31%	3.10%	5.41%
ION Geophysical Corporation	KMI	-1.81%	0.49%	2.02%	0.11%
Kinder Morgan	MMP	0.21%	-0.82%	-1.40%	**-6.62%****
Magellan Midstream Partners	NFG	-1.59%	-2.52%	-3.88%	-3.64%
National Fuel Gas Company	NOV	-1.71%	-2.94%	-6.33%	-3.85%
National Oilwell Varco	OII	-4.32%	-4.03%	-9.98%	-7.09%
Oceaneering International	OGS	0.63%	0.55%	1.11%	1.52%
ONE Gas	OKE	-1.19%	-1.61%	-1.24%	-0.25%
ONEOK, Inc	BTU	-6.28%	-8.24%	-7.61%	-11.88%
Peabody Energy	PBT	0.70%	-1.45%	-2.32%	-2.79%
Permian Basin Royalty Trust	REX	-0.64%	-0.56%	4.86%	7.89%
REX American Resources	AP4	**3.35%***	**7.08%*****	**13.85%*****	**13.29%*****
Riverstone Holdings	SRE	1.54%	1.12%	2.23%	2.73%
Sempra Energy	SJI	-0.61%	-0.38%	3.03%	-0.30%
South Jersey Industries	IO	-6.21%	-7.29%	-10.39%	-6.31%
Spire Inc	SR	0.16%	-0.70%	1.56%	2.66%
Tennessee Valley Authority	TVC	0.97%	1.36%	1.27%	1.52%
The Williams Companies, Inc	WMB	**-3.99%****	**-5.72%*****	**-7.34%****	**-8.29%****
Woodward, Inc.	WWD	-0.81%	-4.09%	-5.19%	-3.99%

Note: *** p-value < .01, ** p-value <.05, * p-value <.1

Conclusion

The present study addresses the energy sector during the study period of January 2019 to March 2020, examining the outbreak of COVID-19 in the economy of the USA. Several event windows were specified and the reaction of the CAAR is examined and discussed accordingly. The stock return of sample firms confirms that only a limited number of the equity stocks from the selected sample are responding significantly both in positive and negative ways. However, a majority of the firms are showing no reaction because of such outbreaks, specifically on the event day. Our study enriches the body of knowledge while examining the epidemic of this novel virus through employing the event study method (ESM). The findings under different windows confirm that the energy sector in the USA is vulnerable to COVID-19 but in a limited context. Based on the study results, some conclusions emerge. Firstly, the impact of the COVID-19 outbreak for all the listed firms of the energy sector of US is not homogenous. This would support the claim that not all the

sample stocks of selected firms under this study are equally affected by this global pandemic. Those stocks which are found to be vulnerable against such epidemics are probably observed as having weak stability and poor capability against such risk factors. Secondly, some stocks are found to be positively reactive against such an outbreak, defending their unusual position in a similar market where very few are negatively responding. Thirdly, we do not find much evidence for a viewpoint that the energy sector of the USA is totally susceptible to such pandemics, hence limiting the generalisation of the findings. This may indicate that future studies should incorporate the other disease outbreaks in the same region for some other sectors too. Additionally, the government response against such outbreaks may also be considered as another event for further investigation in upcoming studies.

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