WORLD AND NATIONAL STOCK MARKET REACTIONS TO COVID-19

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Abstract

COVID-19—the world's most recent pandemic, has caused economic and financial crises globally. The situation is continually evolving overtime in a series of events, and stock markets must respond immediately to these evolving events with updates of expected cash flows and the real and perceived risks. This study asks how and how early the world and national markets react, and to which event or events in the series. Using the event-study method, based on returns on the world, French, German, Italian, Spanish, U.K., U.S., Chinese, Philippine, and Thai stocks, the study found significant, negative reactions to the disease. The reactions were to COVID-19's extensive media coverage and pandemic declaration, not to the evolving events and situations when they actually occur.

Keywords: event study; infectious disease; return behavior

1. INTRODUCTION

COVID-19 is an infectious, respiratory disease caused by severe acute respiratory syndrome coronavirus 2 (Lai, Shih, Ko, Tang, & Hsueh, 2020), and has led to the world's most recent pandemic. Since it was first detected in Wuhan, China, on November 17, 2019 (Miller, Bhattacharyya, & Miller, 2020), COVID-19 has spread to 210 countries and territories. By April 23, 2020, there were already a total of 2,638,909 cases, with 184,249 deaths worldwide (Worldometers, 2020). In addition to this health disaster, COVID-19 has induced economic and financial crises globally. In an economic-impact study, McKibbin and Fernando (2020) estimated that in 2020, losses from baseline values in GDP could be as high as 6.2% for China and 8.4% for the United States in certain scenarios. For the rest of the world, the GDP losses could be up to 5.9%. As the spread of the disease continues, and the number of

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infections and deaths increases, the future of health related and economic problems remains uncertain. Forecast losses and uncertain futures translate into low expected cash flows, rising real and perceived risks, and, as a result, falling stock prices (Harvey, 1989).

Stock price reactions have been conducted for other infectious diseases before COVID-19. For example, Chen, Jang, and Kim (2007) and Chen, Chen, Tang, and Huang (2009) studied the effects of severe acute respiratory syndrome (SARS) in Taiwan, while Nippani and Washer (2004) studied the effects of SARS in Canada, China, Hong Kong, Indonesia, the Philippines, Singapore, Thailand, and Vietnam. Funck and Gutierrez (2019), and Ichev and Marinc (2018) studied the effects of Ebola on the United States, while Jiang et al. (2017) studied the effects of H7N9 influenza on China. Kim, Kim, Lee, and Tang (2020) tested the reactions in response to avian influenza, bovine spongiform encephalopathy, salmonella infection, and swine influenza in the United States; Yeung and Aman (2016) studied H1N1 influenza, ebola, and SARS in Canada and Pakistan; and Wang, Yang, and Chen (2013) studied dengue fever, enterovirus 71, H1N1 influenza, and SARS in Taiwan. Generally speaking they all reported significant negative reactions. However, for stocks in some industries, such as pharmaceutical and biotechnology industries, reactions could be positive due to the rising sales.

Al-Awadhi, Alsaifi, Al-Awadhi, and Alhammadi (2020), Pavlyshenko (2020), Yilmazkuday (2020), and Zeren and Hizarci (2020) studied COVID-19 using regression analyses. They found that COVID-19 variables have a significant relationship with stock returns. Other researchers applied event-study analyses to uncover the reactions. Aravind and Manojkrishnan (2020) reported negative reactions of pharmaceutical stocks in the Indian market during the crisis period from December 2019 to February 2020. Ramelli and Wagner (2020) found that, for the incubation phase from January 2, 2020 to January 17, 2020, the outbreak phase from January 20, 2020 to February 21, 2020, and the fever phase from February 24, 2020 to March 20, 2020, the U.S. market reacted significantly and negatively to COVID-19. Reactions grew with the sequential phases. Finally, Ru, Yang, and Zou (2020) compared the stock market reactions to SARS and COVID-19 in 65 countries. They found significant, negative reactions to the two diseases. Those countries with SARS experiences tended to have a greater and earlier response to COVID-19 than those without.

It is important to note that an infectious disease incubates over time before it spreads and becomes pandemic. Eventually, the disease is controlled by a cure, vaccination, or quarantine measures; it disappears. For event study analyses, a pandemic is therefore a series of events, not just a single event (Khanthavit, 2020).

Table 1
Timeline of COVID-19's Evolving Events

Occurrence Day	(Event Number) Description	Occurrence Day	(Event Number) Description
11/17/19[H]	(1) Earliest detected COVID-19 case in China	02/03/20[H]	(15) The Philippines' first COVID-19 death (first COVID-19 death outside China)
12/08/19[H]	(2) First official confirmed COVID-19 case in China	02/13/20	(16) Spain's first COVID-19 death
12/31/19[H]	(3) China informed the WHO of patients with mysterious pneumonia	02/14/20	(17) France's first COVID-19 death
01/11/20 [H]	(4) China and the world's first COVID-19 death	02/21/20	(18) Italy's first COVID-19 death
01/13/20	(5) Thailand's first COVID-19 case–first infection outside China	02/29/20[H]	(19) The United States' first COVID-19 death
01/20/20	(6) The United States' first COVID-19 case; (7) China publicly conceded human-to-human transmission of the COVID-19 virus; (8) The WHO issued its first situation report on COVID-19	03/01/20	(20) Thailand's first COVID-19 death
01/24/20	(9) France's first COVID-19 case	03/05/20	(21) The United Kingdom's first COVID-19 death
01/27/20	(10) Germany's first COVID-19 case	03/09/20	(22) Germany's first COVID-19 death
01/30/20	(11) Italy's first COVID-19 case; (12) The Philippines' first COVID-19 case; (13) The WHO declared a global public-health emergency on COVID-19	03/11/20	(23) The WHO declared COVID-19 a global pandemic
01/31/20	(14) Spain and the United Kingdom's first COVID-19 cases		

Note: [H] = holiday on which the stock market did not trade.

Table 1 shows the COVID-19 related events for France, Germany, Italy, Spain, the United Kingdom, and the United States, together with those for China, the Philippines, and Thailand. The former six countries are the most affected countries in terms of infections and deaths. The latter three

had first experiences. The virus was first detected in China, and China is the first country that experienced the first death due to COVID-19. Thailand and the Philippines reported the first infection and death, respectively, outside China. The respective COVID-19 related events are also included, stated according to the World Health Organization's (WHO) reports and announcements.

The fact that a pandemic is a series of events, motivates two important research questions—how early do markets react, and to which event or events in the series? Although previous studies on COVID-19 and other infectious diseases found that stock markets reacted to the pandemics and some markets reacted much earlier and more significantly than others, these two questions have never been addressed. The regression studies showed only correlation; the event studies considered certain events, but disregarded other evolving events in the series.

This study attempts to answer these two questions with regard to COVID-19 for both the world and national stock markets. COVID-19 is interesting and unique, as the disease is the most recent global pandemic, and it is not limited to low or middle-income countries. Additionally, the world in the time of COVID-19 is more integrated than in the time of preceding diseases, and it has caused simultaneous destruction of demand and supply, and induced crisis spillover throughout supply chains (Fernandes, 2020).

This study applies the event-study approach for hypothesis tests and follows Khanthavit (2020) to incorporate all events pertaining to the market during the event period. Significant abnormal returns (ARs) and their occurrence days indicate significant reactions and the times at which the markets reacted to news and events.

2. METHODOLOGY

2.1 The Model

Significant market reactions are measured by significant ARs, that is, the deviation of realized returns from expected returns (Fama, Fisher, Jensen, & Roll, 1969). r_t and ε_t are the realized return and AR respectively, on day t. This study fixes the expected return E(r) by the mean return μ, thereby constituting the mean-adjusted model for event studies in Equation (1).

$$\varepsilon_t = r_t - \mu. \qquad (1)$$

The study chooses the mean-adjusted model as it performs just as well as the alternatives (Brown & Warner, 1985). Additionally, other studies have chosen, for example, the capital–asset–pricing–model–adjusted model (Ramelli & Wagner, 2020) or the market-adjusted model (Ru et al., 2020). This study does not consider these models as they rely on common factors for identifying the expected return. However, COVID-19 is common to all markets and it is unlikely that the common-factor

models are able to identify COVID-19-induced ARs.

The study computes the average abnormal return (AAR) $\bar{\varepsilon}_{[t,t+n]}$ to measure the aggregate effect of COVID-19 for n days from day t to $t + n - 1$ by

$$\bar{\varepsilon}_{[t,t+n-1]} = \frac{\sum_{k=t}^{t+n-1} \varepsilon_k}{n}. \qquad (2)$$

Typically, day t is the first day of the pre-event days. The number n runs from 1 to the number of days in the window surrounding the event days with an increment of one. The study calculates the AARs for all the event days within the event period. The averages offer insights into the effects of specific events.

2.2 Model Estimation

The mean return μ is the normal level of returns expected to be observed if COVID-19 did not occur. The study estimates μ from the realized returns over days $[\tau^* - T, \tau^* - 1]$, totaling T days. Day τ^* is the first day of the pre-event-period window. The estimate for the mean return μ is the average return $\bar{r}$ in Equation (3).

$$\bar{r} = \frac{1}{T}\sum_{t=\tau^*-T}^{\tau^*-1} r_t. \qquad (3)$$

The estimation period must not immediately surround the event period because ε_t is influenced by COVID-19 (Peterson, 1989). To compute the average, this study must correctly and appropriately identify the event period whose first day is day t=0, the pre-event-period window for days $[\tau^*, -1]$, and the estimation window for days $[\tau^* - T, \tau^* - 1]$.

2.3 Identification of the Event Period

The COVID-19 pandemic involves a series of evolving events. Unlike most studies, for example Ru et al. (2020), in which a single event is specified, this study considers an event period covering all the COVID-19 events relevant to the sample market. The first event is the earliest detection of COVID-19 in China on Sunday, November 17, 2019, and the last event is the declaration of COVID-19 as a global pandemic by the WHO on Wednesday, March 11, 2020 (day t= +82). The event days are the corresponding occurrence days. If, however, the occurrence days are holidays on which the markets were closed, then the event days are the following trading days (Ahmed, 2017). The event period totals 83 days. Table 1 covers all COVID-19 events relevant to the sample markets.

2.4 Length of the Pre- and Post-event-Period Window

If the pre-event-period window is long, the AR ε_t will absorb the effects of other economic and noneconomic events that are not interesting to the study (Nazir, Younus, Kaleem, & Anwar, 2014). However, if it is too short, the study will not be able to analyze the effects of the first event.

This study chose a 20-day pre-event-period window because it is the shortest length for a window typically chosen in event studies (Peterson, 1989). As a result, day τ^* is $t = -20$. The post-event-period window is also 20 days long. This window runs from days +83 to +102. Altogether, the event window is 123 days.

The study computes the AAR for an 11-day window surrounding a specific event—five days before and after the event day and one day for the event day. Despite its short length, the 11-day window has been used in other studies, for example, by Ru et al. (2020). As some events lie close to each other, the 11-day window mitigates problems caused by having overlapping-windows.

2.5 Length of the Estimation Window

Peterson (1989) summarized that typical lengths of the estimation window are from 100 to 300 days. For accuracy of the $\bar{r}$ estimate, this study followed Salinger's (1992) recommendation to choose the longest window of 300 days. The estimation window starts Monday, August 27, 2018, and ends Friday, October 18, 2019.

2.6 Relevant COVID-19 Events

Previous studies specified events in different ways. For COVID-19 studies, Aravind and Manojkrishnan (2020) chose the earliest detection of the disease; Ramelli and Wagner (2020) were interested in China's first COVID-19 report to the WHO, China's report of human-to-human transmission of the virus, and Italy's announcement of the lockdown measure; while Kim et al. (2020) chose the first time the disease was known to the media. For the studies of other infectious diseases, Chen et al. (2007) and Chen et al. (2009) also chose the first time the diseases were known to the media. Yeung and Aman (2016) identified the event by the first time the WHO was alerted to the diseases. Contrastingly, Nippani and Washer (2004) used the first case of infection; whereas, Wang et al. (2013) used the first death.

In this study, the COVID-19 relevant events are identified in Table 1. Italy's lockdown measure is not considered because it was among many measures imposed by the governments of heavily-affected countries. Likewise, the first time COVID-19 was known to the media is not used as an event either. COVID-19 spread from China and reached other countries at different times. It is difficult to determine which incident first drew the media's attention.

The events in Table 1 can be classified into two groups—(i) the events that are common to all the markets and (ii) the events that are specific to each market. The events in the first group are events (1), (2), (3), (4), (5), (7), (8), (13), (15), and (23). The events in the second group are the first infections and deaths of the individual countries.

In addition to the reactions of national markets, the study analyzes the reactions of the world market. For

the world market, the events in the first group are the same as those for the sample markets. The events in the second group are China's first infection and COVID-19 related death. These are the first cases experienced by the world.

2.7 Hypothesis Tests

If stocks do not react to the COVID-19 events, the corresponding ARs and AARs must be zero. The study concludes significant reactions if ARs and AARs are significant. The market reacts to COVID-19 early if significant ARs and AARs are detected for early events in the event period.

Most financial market variables are not normally distributed. Neither are the sample returns shown in Table 2. For this reason, the study uses a bootstrap method for the hypothesis tests. Bootstrap tests do not require normality (Chou, 2004).

One hundred thousand scenarios were constructed from sampling with replacement of the ARs in the estimation window. The ARs and AARs were then tested against the constructed scenarios.

3. THE DATA

The sample markets are France, Germany, Italy, Spain, the United Kingdom, and the United States. These markets are important because they belong to the most affected countries in terms of infections and deaths. The study also analyzes China, the Philippines, and Thailand. China is the country in which COVID-19 was first detected. Moreover, it is the country that experienced the first death. The Philippines and Thailand are the first countries that reported death and infection outside of China, respectively.

Market reactions are measured by daily ARs on the market. The realized return is the logged return computed from the closing Morgan Stanley Capital International (MSCI) indexes, in terms of local currencies. The MSCI index for the world market is in U.S. dollars. The full sample begins Monday, August, 27, 2018 and ends Wednesday, April 8, 2020 (423 daily observations). The index values were retrieved from the MSCI database (www.msci.com/end-of-day-data-country).

Sub-tables 2.1 and 2.2 of Table 2, show the returns in the full and estimation samples respectively, and are negatively skewed and fat-tailed. The skewnesses and kurtoses for the sample markets in the full sample are much larger than those in the estimation sample. It is likely the larger sizes result from COVID-19. The Jarque-Bera statistics are very large and significant at the 99% confidence level. Return normality is rejected. Nonnormality supports the use of bootstrapping for hypothesis tests.

Table 2
Descriptive Statistics
Sub-table 2.1
Full Sample (August 27, 2018 to April 8, 2020)

Statistic	World	Most-Affected Countries						First-Experience Countries		
		France	Germany	Italy	Spain	The United Kingdom	The United States	China	Philippines	Thailand
Average	-2.21E-04	-4.83E-04	-5.70E-04	-4.76E-04	-7.30E-04	-7.12E-04	-1.09E-04	-8.95E-05	-8.16E-04	-8.64E-04
Standard Deviation	0.0139	0.0144	0.0144	0.0167	0.0149	0.0129	0.0169	0.0133	0.0157	0.0146
Skewness	-1.4687	-2.2627	-1.8086	-4.0541	-3.0633	-1.9402	-0.9929	-0.3355	-2.5271	-2.2679
Excess Kurtosis	18.6740	22.3502	25.1615	45.0362	33.2768	23.0062	16.3815	1.8096	23.5413	23.2728
First-Order Autocorrelation Coefficient	-0.1953***	0.0174	0.0385	-0.0875*	-0.0748	0.0054	-0.3054***	0.0528	-0.0395	-0.2010***
Jarque-Bera Statistic	6.30E+03***	9.17E+03***	1.14E+04***	3.69E+04***	2.02E+04***	9.59E+03***	4.80E+03***	65.6523***	1.02E+04***	9.91E+03***

Note: * and *** = Significance at the 90% and 99% confidence levels, respectively.

Sub-table 2.2
Estimation Sample (August 27, 2018 to October 18, 2019)

Statistic	World	Most-Affected Countries						First-Experience Countries		
		France	Germany	Italy	Spain	The United Kingdom	The United States	China	Philippines	Thailand
Average	6.96E-05	9.21E-05	-1.10E-04	2.35E-04	-3.09E-05	-2.13E-04	1.20E-04	-1.54E-04	6.64E-05	-2.71E-04
Standard Deviation	0.0078	0.0090	0.0094	0.0102	0.0086	0.0077	0.0100	0.0122	0.0102	0.0074
Skewness	-0.4312	-0.5105	-0.3362	-0.3464	-0.2875	-0.4508	-0.2913	-0.0492	0.2029	0.0677
Excess Kurtosis	1.8592	1.4361	1.2390	1.1281	0.6020	2.0473	3.2200	0.4396	0.5254	2.0637
First-Order Autocorrelation Coefficient	0.1552***	0.0582	0.0237	-0.0239	-0.0044	0.0516	0.0516	0.0287	-0.0044	-0.0678
Jarque-Bera Statistic	52.5087***	38.8078***	24.8408***	21.9065***	8.6618**	62.5560***	133.8435***	2.5363	5.5098**	53.4629***

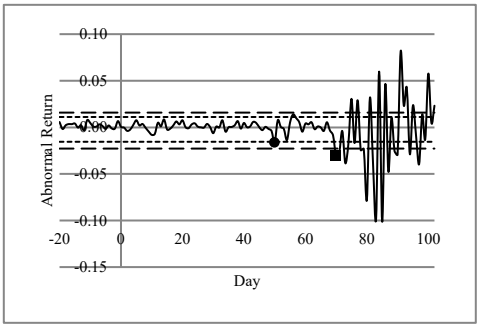
Note: ** and *** = Significance at the 95% and 99% confidence levels, respectively.

4. EMPIRICAL RESULTS

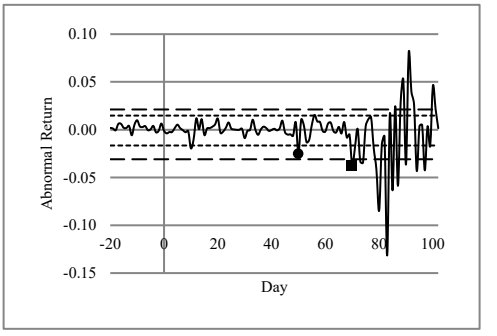
Sub-figures 1 to 10 of Figure 1 show the ARs of the world and sample national markets during the event window, while sub-tables 3.1 and 3.2 of Table 3 report the ARs and AARs, respectively. In the sub-figures, the vertical axes label the level of ARs, while the horizontal axes label the days of the event window. Day 0 is Monday, November 18, 2019—the trading day following the day on which COVID-19 was detected for the first time. The dotted and dashed lines fix the bootstrapped, 95% and 99% confidence bands respectively.

Figure 1
Abnormal Returns

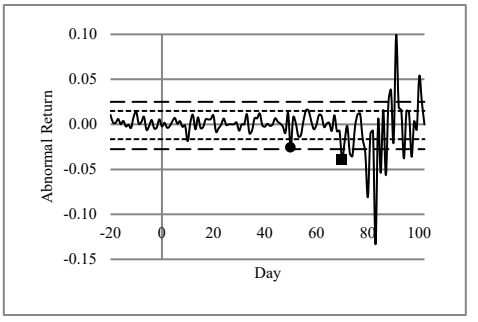
Sub-figure 1.1
The World



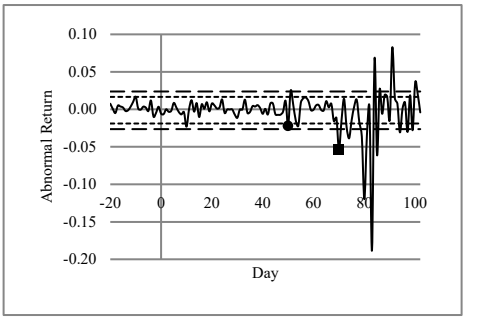
Sub-figure 1.2
France



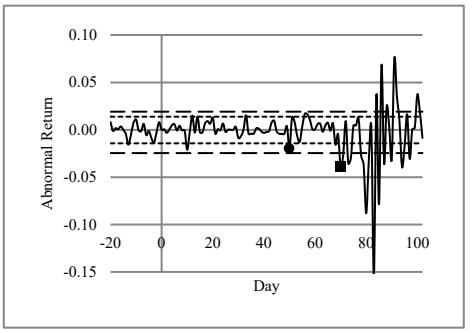
Sub-figure 1.3
Germany



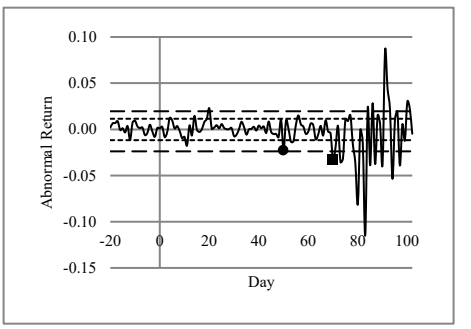
Sub-figure 1.4
Italy



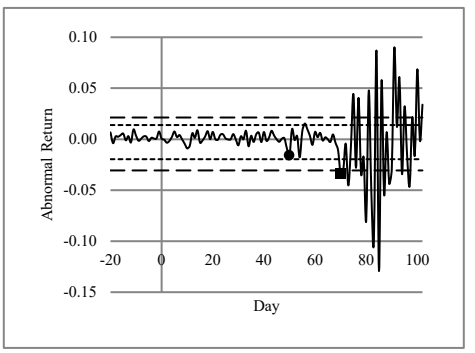
Sub-figure 1.5
Spain



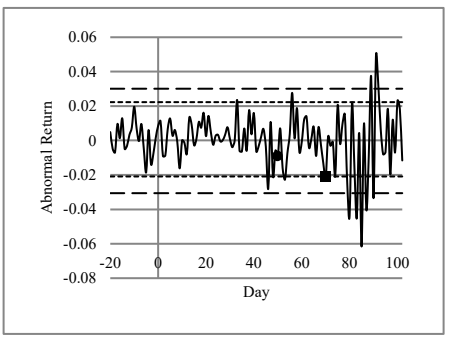
Sub-figure 1.6
The United Kingdom



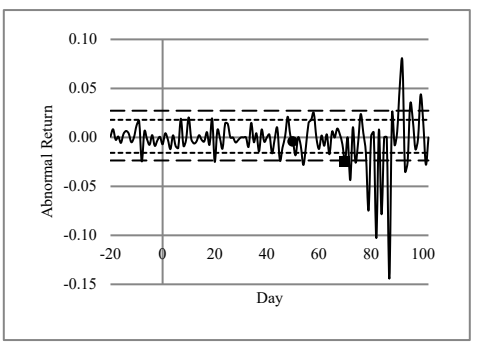
Sub-figure 1.7
The United States



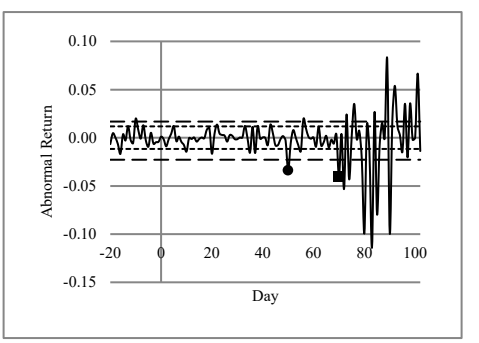
Sub-figure 1.8
China



Sub-figure 1.9
The Philippines



Sub-figure 1.10
Thailand



Note: Day 0 is Monday, November 18, 2019—the trading day following the day on which COVID-19 was detected for the first time. The dotted (dashed) lines fix the bootstrapped, 95% (99%) confidence band. • = Monday, January 27, 2020 and ▪ = Monday, February 24, 2020.

For the world market, the first significant negative AR was seen on Monday, January 27, 2020, as shown in sub-figure 1.1. The AR then became negative and significant again on Monday, February 24, 2020. These two days are represented by the round and square dots, respectively. The sizes and significance levels of the ARs are in rows 2 and 3, column 2 of sub-table 3.1. These days and surrounding days were checked for any COVID-19 related events but none were found. Further checking was made for other possible explanations and it was found that Monday, January 27, 2020 is the first time that COVID-19 had extensive media coverage around the world (Ru et al., 2020). The second extensive media coverage was on Monday, February 24, 2020 (Stewart & Molla, 2020). Similar AR reactions were found for all the sample countries, except for China and the Philippines. Their ARs for the first extensive media coverage were not significant.

Sub-table 3.2 reports the sizes and significance levels of the AARs. On the one hand, the AARs for the first media coverage became non-significant for the world, Germany, Italy, Spain, and the United States. On the other hand, they became significant for China. The AARs for the second media coverage are significant for the world and all the sample countries except for China. Combining the results for the ARs and AARs, the study concludes that the extensive media coverage influenced the world and national stock markets.

Sub-figures 1.2 to 1.6 and 1.10 show that, for France, Germany, Italy, Spain, the United Kingdom, and Thailand, the first significant, negative ARs were on Monday, December 2, 2020. What explains the significance is not a COVID-19 event or its corresponding media coverage, but the media coverage on the markets' concern with a delayed trade agreement between the United States and China (Nazareth & Hajric, 2019).

Sub-figure 1.8 shows China's first and second significant negative ARs, on Tuesday, January 21, 2020 (one day after the confirmed human-to-human transmission of the virus) and Thursday, January 23, 2020 (the day China locked down Wuhan), respectively. For the Philippines, shown in sub-figure 1.9, the first significant negative AR is on Wednesday, November 13, 2019, much earlier than the first detection of the virus. It is unlikely that this negative AR reflects the Philippines' reaction to information about COVID-19. Regarding common events, sub-table 3.1 shows that the world market reacted significantly only to the WHO declaration of the COVID-19 pandemic. The United Kingdom, United States, Philippines, and Thailand also reacted to the event. Another common event that the national markets showed a significant reaction to is the WHO declaration of a public-health emergency. These markets include the French, German, Italian, U.K., and Chinese markets. In addition, the Philippines had a significant negative AR for the

confirmed human-to-human transmission of the virus.

For country-specific events, Germany, Italy, Spain, and the United Kingdom had significant negative ARs for the days corresponding to their first infections; Germany and the United Kingdom had significant negative ARs corresponding to their first COVID-19 related deaths. The United States and China also had significant ARs corresponding to their first deaths. However, these ARs were positive. It is unlikely that the deaths explain the significance.

Sub-table 3.2 reports AARs for the common and market specific events. The AAR for the confirmation of human-to-human transmission is significant only for Thailand. In spite of the fact that the ARs for the WHO declaration of a public-health emergency are significant for some countries, no country had significant AARs. The emergency event took place three days after the first extensive media coverage. The shock may have peaked on the media-coverage day and tapered off on the following days, resulting in non-significant averages.

Significant AARs for the WHO declaration of the COVID-19 pandemic are found for the world and all the sample countries. The significance is attributed to the deteriorating situation surrounding the event day. Sub-figures 1.1 to 1.10 indicate that the markets were highly volatile in this period. The ARs became negative and significant. The virus continued spreading and, a few days prior to the declaration, Europe became the new center of the disease (World Health Organization, 2020).

Whereas the ARs for the first infections are significant for Germany, Italy, Spain, and the United Kingdom, the AARs are significant for neither the world nor the sample countries. Note that AR-significant countries had their first infection on or a few days after the first-media-coverage day. Hence, the significant ARs but nonsignificant AARs for these four countries should be interpreted as indicating significant reactions to the media coverage not to the first infections.

The AARs for the first deaths are negative and significant for Germany, Italy, the United Kingdom, the United States, and Thailand. The event days are close to the days of the second media coverage and pandemic declaration. The situation was deteriorating; the markets were extremely volatile. Moreover, the AR for the United States is positive and significant at the high, 99% confidence level. The significant, positive AR, together with significant negative AAR, suggests that the significant, positive AR for the United States' first death is due to price reversal.

The price-reversal explanation cannot be given for China. Its AAR is positive but non-significant. The significant, positive AR must be associated with good news in the market. Shidong and Iyer (2020) associated the price rise in the Chinese market on the day with the news of the government subsidies for the construction of a 5G network and the upcoming signing of the first phase

Table 3
Analyses of Stock Market Reactions to COVID-19
Sub-table 3.1
Abnormal Returns on Event Days

Event (Day)	World	Most-Affected Countries						First-Experience Countries		
		France	Germany	Italy	Spain	The United Kingdom	The United States	China	Philippines	Thailand
First Extensive Media Coverage (50)	-0.0164**	-0.0252**	-0.0259**	-0.0225**	-0.0198**	-0.0229**	-0.0158*	-0.0091	-0.0043	-0.0340***
Second Extensive Media Coverage (70)	-0.0310***	-0.0380***	-0.0397***	-0.0535***	-0.0391***	-0.0332***	-0.0342***	-0.0214**	-0.0254***	-0.0410***
First detected COVID-19 case in China (0)	5.00E-04	-0.0012	-0.0024	-0.0058	0.0000	9.00E-04	5.00E-04	0.0085	-0.0071	0.0011
First official confirmed COVID-19 case in China (15)	-0.0023	-0.0056	-0.0041	-0.0103	-0.0027	-4.00E-04	-0.0033	-0.0027	-0.0026	-0.0013
China informed the WHO of patients with mysterious pneumonia (31)	8.00E-04	-0.0012	1.00E-04	-2.00E-04	-0.0069	-0.0058	0.0029	-0.0039	-1.00E-04	3.00E-04
China and the World's first COVID-19 death; Thailand's first COVID-19 case–the first case outside China (40)	0.0047	-3.00E-04	-0.0026	-0.0060	-0.0033	0.0041	0.0071	0.0159*	-1.00E-04	4.00E-04
Confirmed human-to-human transmission of the COVID-19 virus; the WHO issued the first situation report on COVID-19 (45)	1.00E-04	-0.0027	0.0029	-0.0067	-0.0018	-0.0028	-1.00E-04	-0.0036	-0.0237***	-0.0079
The WHO declared a global public-health emergency on COVID-19 (53)	-0.0018	-0.0130*	-0.0135*	-0.0148*	-0.0063	-0.0134**	0.0031	-0.0227**	-0.0084	2.00E-04
The Philippines' first COVID-19 death–the first death outside China (55)	0.0051	0.0054	0.0041	0.0090	0.0036	0.0051	0.0078	0.0038	-0.0092	-0.0138**
The WHO declared COVID-19 a global pandemic (82)	-0.0381***	-0.0073	-0.0075	0.0021	0.0027	-0.0141**	-0.0507***	-0.0153	-0.1028***	-0.0152**
First Infection (Day)	5.00E-04 (0)	0.0078 (49)	-0.0259** (50)	-0.0148* (53)	-0.0128* (54)	-0.0129** (54)	-1.00E-04 (45)	0.0085 (0)	-0.0084 (53)	4.00E-04 (40)
First Death (Day)	0.0047 (40)	-0.0029 (64)	-0.0809*** (80)	-0.0113 (69)	-0.0021 (63)	-0.0162** (78)	0.0443*** (75)	0.0159* (40)	-0.0092 (55)	7.00E-04 (75)

Note: *, ** and *** = Significance at the 90%, 95%, and 99% confidence levels, respectively.

Sub-table 3.2
Average Abnormal Returns in Period Surrounding Event Days

Event (Day)	World	Most-Affected Countries (Day)						First-Experience Countries (Day)		
		France	Germany	Italy	Spain	The United Kingdom	The United States	China	Philippines	Thailand
First Extensive Media Coverage (50)	-0.0024	-0.0036*	-0.0031	-0.0029	-0.0022	-0.0041**	-0.0022	-0.0084**	-0.0071***	-0.0065***
Second Extensive Media Coverage (70)	-0.0089***	-0.0115***	-0.0129***	-0.0125***	-0.0113***	-0.0095***	-0.0083***	-0.0029	-0.0073***	-0.0110***
First detected COVID-19 case in China (0)	7.82E-04	4.00E-04	3.55E-04	-9.18E-04	-0.0010	6.00E-04	0.0012	-0.0010	-0.0037	-0.0012
First official confirmed COVID-19 case in China (15)	0.0013	0.0011	0.0014	5.55E-04	0.0029	0.0023	0.0012	0.0044	-3.82E-04	-0.0018
China informed the WHO of patients with mysterious pneumonia (31)	1.36E-04	-3.36E-04	-3.00E-04	-0.0010	-8.64E-04	-3.91E-04	3.18E-04	0.0024	-3.73E-04	5.73E-04
China and the World's first COVID-19 death; Thailand's first COVID-19 case–the first case outside China (40)	0.0022	6.36E-04	0.0021	7.64E-04	6.36E-05	5.91E-04	0.0026	0.0025	-0.0037	-5.45E-04
Confirmed human-to-human transmission of the COVID-19 virus; the WHO issued the first situation report on COVID-19 (45)	-7.55E-04	-0.0023	-0.0017	-0.0029	-0.0019	-0.0018	-6.45E-04	-0.0038	-0.0018	-0.0038**
The WHO declared a global public-health emergency on COVID-19 (53)	4.45E-04	4.91E-04	-9.09E-06	0.0028	0.0026	-0.0008	6.09E-04	-0.0021	0.0011	-0.0022
The Philippines' first COVID-19 death–the first death outside China (55)	9.00E-04	6.36E-05	-8.91E-04	0.0019	0.0028	-0.0016	0.0015	-0.0674	-0.0021	-0.0022
The WHO declared COVID-19 a global pandemic (82)	-0.0222***	-0.0335***	-0.0325***	-0.0322***	-0.0304***	-0.0248***	-0.0213***	-0.0155***	-0.0362***	-0.0252***
First Infection (Day)	7.82E-04 (0)	-0.0032 (49)	-0.0031 (50)	0.0028 (53)	0.0031 (54)	-4.55E-04 (54)	-0.0006 (45)	-0.0010 (0)	0.0011 (53)	-5.45E-04 (40)
First Death (Day)	0.0022 (40)	9.09E-06 (64)	-0.0281*** (80)	-0.0113*** (69)	0.0021 (63)	-0.0269*** (78)	-0.0181*** (75)	0.0025 (40)	-0.0021 (55)	-0.0172*** (75)

Note: *, ** and *** = Significance at the 90%, 95%, and 99% confidence levels, respectively.

of the trade deal between the United States and China.

5. DISCUSSION

5.1 Stock Market Reactions to COVID-19

The significant negative ARs and AARs for the various COVID-19 events and their extensive media coverage lead this study to conclude that the world and national stock markets reacted negatively to COVID-19. The reactions were significant. This finding is consistent with those of Al-Awadhi et al. (2020), Aravind and Manojkrishnan (2020), Ramelli and Wagner (2020), and Ru et al. (2020). Furthermore, it adds to the literature regarding how and how early markets react to disease.

COVID-19 was first detected on November 17, 2019. From that day onward, the situation has been deteriorating. The markets did not react to the disease, even though the WHO had been informed and had issued a situation report. Significant reactions came twice, much later, on Monday, January 27, 2020 and Monday, February 24, 2020 when there was extensive media coverage of the disease. This finding is the evidence of market reactions to old news, not new news (Huberman & Regev, 2001). Colas and Rabe's (2020) survey supports the old-news reactions. The survey was collected from Wednesday, February 19 to Saturday, February 22, 2020. In the survey, U.S. investment professionals believed COVID-19 would not cause a global economic recession. Only a third of the respondents recommended their clients to rebalance their portfolios. No new news arose on Sunday, February 23 and Monday, February 24, 2020 that was important enough to drive down the markets on Monday, February 24, 2020.

It can be argued that significant ARs and AARs for the WHO declaration of a COVID-19 pandemic indicate market reactions to the event. The event is news to the market. This argument cannot be correct. The declaration followed and resulted from the deteriorating COVID-19 situation. The deteriorating situation was readily known to the markets.

5.2 Market Over- and Under-reactions

In sub-figures 1.1 to 1.10, extreme price movements were detected following extensive media coverage. Chan (2003) reported for firms in the U.S. market that price reversal followed extreme price movements. The reversal was stronger for the movements unaccompanied by news. Price drift was also found. Strong drift was associated with bad news.

In this study, COVID-19 is bad news and price reactions are extreme. It is interesting to ask whether the markets over- or under-reacted to COVID-19. To answer this question, the study performed autocorrelation regressions at the first order of the ARs in periods from the first- and second-media-coverage days to the last day in the event window. A

significant positive first-order autocorrelation coefficient indicates price drift, while a significant negative first-order autocorrelation coefficient indicates price reversal. The results are reported in Table 4. Price reversal was found for the world, U.S., and Thai markets, whereas the remaining markets had neither drift nor reversal. The negative first-order autocorrelation coefficient for the U.S. market provides additional evidence to support the price-reversal explanation of the significant positive AR for the country's first death.

Table 4
Tests of Stock Market Over-reactions to COVID-19

Sub-table 4.1
Abnormal-Return Sample from the First Media Coverage to the Last Day of the Event Window

Country	First-Order Autocorrelation Coefficient	Country	First-Order Autocorrelation Coefficient
World	-0.3239**	France	-0.0244
Germany	0.0340	Italy	-0.1389
Spain	-0.1470	The United Kingdom	-0.0434
The United States	-0.4373***	China	-0.1318
Philippines	-0.0597	Thailand	-0.2530*

Note: *, ** and *** = Significance at the 90%, 95% and 99% confidence levels, respectively.

Sub-table 4.2
Abnormal-Return Sample from the Second Media Coverage to the Last Day of the Event Window

Country	First-Order Autocorrelation Coefficient	Country	First-Order Autocorrelation Coefficient
World	-0.3481*	France	-0.0468
Germany	0.0145	Italy	-0.1785
Spain	-0.1903	The United Kingdom	-0.0567
The United States	-0.4575***	China	-0.1871
Philippines	-0.0898	Thailand	-0.2600

Note: * and *** = Significance at the 90% and 99% confidence levels, respectively.

6. CONCLUSION

The COVID-19 pandemic has brought severe economic damage to all countries worldwide. This study tests whether and how the damages translate into stock price movements. Based on event study analyses of the world and national stock returns, the study found significant negative reactions, of the markets to the disease. More importantly, it reveals insight that the reactions were not to evolving events or situations, but to extensive media coverage of the disease.

The study has at least two limitations. First, only nine national

markets and the world market were included in the sample. The reactions of these markets may not necessarily represent those of other markets. Second, each country imposed different measures against COVID-19 and has a different interpretation of the seriousness of the situation. This fact in turn translates into different messages the country communicates with the market, probably resulting in a different speed and degree of the market's reaction to the situation. However, the study did not bring these differences into the analysis.

At the time of writing, the COVID-19 pandemic is ongoing. It is not clear how the markets will react in the future to news such as the discovery of a medical cure or a preventive vaccine. The markets may react to new news once the discovery appears in a medical journal; or they may react to old news in the media in the way they did in the past (Huberman & Regev, 2001). This important question is proposed for future research.

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