The Impact of COVID-19 on the Norwegian Stock Market

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Abstract

This paper studies the potential economic impact of the COVID-19 pandemic using Norwegian stock market data. We conduct event studies on three major events that are related to the evolution of the COVID-19 pandemic in Norway, namely the first confirmed COVID-19 case in Norway, the WHO's declaration of COVID-19 as a pandemic and the Norwegian government's new COVID-19 policies, and the press conference on the second wave. Our analysis suggests that the Norwegian stock market responded negatively to all three events, with its strongest reaction being to the second event. In addition, our multifactor regression analysis shows that profitability, firm size, and liquidity are the factors that potentially explain the variation in stock market reactions. We also find a large variation in market reaction between different sectors. Furthermore, we carry out a comparative analysis of stock market reactions in Norway, Denmark, and Sweden and find similar patterns among these countries. Finally, whereas most sectors experienced stock prices collapse and volatility jumps in early 2020, our analysis of shareholder returns suggests that many sectors show signs of recovery.

Keywords

COVID-19, Pandemic, Oslo Stock Exchange, Abnormal returns, Volatility, Event study

Introduction

The outbreak of the novel coronavirus (COVID-19) pandemic has led to an unprecedented disruption to the global economy. As researchers, we would like to know how the economy is affected and which sectors are more resilient. However, the exact economic impacts are not yet clear. This paper takes an investor perspective and examines the effect of the COVID-19 pandemic on stock market movements in Norway. As stock prices are usually considered forward-looking and reflect investors' expectation on future firm performance and economy, studying the stock market reaction thus provides new insights into the potential economic impacts of the COVID-19 pandemic.

We study Norway for two reasons. First, similar to other Nordic countries, Norway has been ranked high in overall health-care system performance by the World Health Organization in recent years. Second, like the rest of the world, the financial markets in Norway have responded to COVID-19 with dramatic movements. Stock volatility in March 2020 was close to that last seen in October 1987 and October 2008, and surpassed that in October 1998; stock returns also declined sharply (Figure 1). Investors' responses were triggered by fear and uncertainty about the crisis and the expected loss of future cashflow due to the shutdown of some business activities.
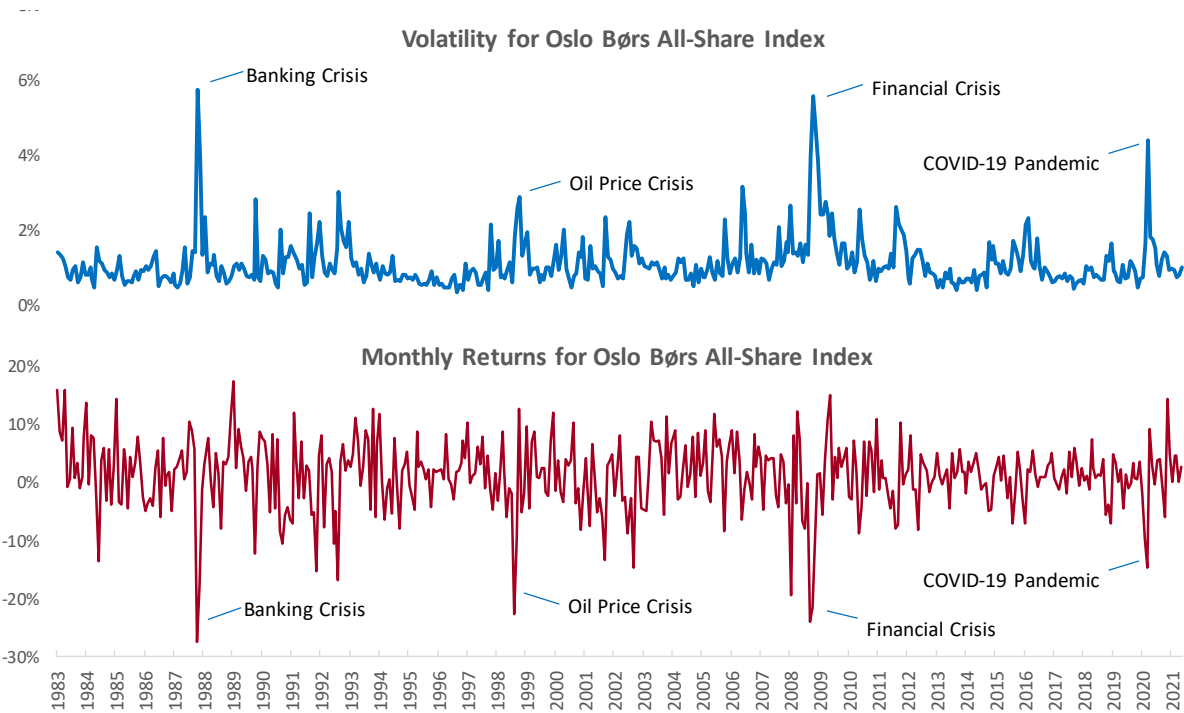
Figure 1: Monthly volatility and returns for Oslo Stock Exchange All-Share Index (OSEAX) for the period of January 1983 to May 2021.

To study the potential impact of COVID-19, we start with event study analysis, which is widely used to measure the effects of an economic event on the value of firms (MacKinlay, 1997). We focus on three major events in 2020 that mark the different stages of the COVID-19 situation in Norway. These include the first confirmed COVID-19 case in Norway on February

26, 2020, the WHO's declaration of COVID-19 as a pandemic on March 11, 2020, together with the Norwegian government's new COVID-19 policies (lockdown) the day after, and the Norwegian government's press conference regarding the second wave on October 23, 2020. Our analysis suggests that the Norwegian stock market responded negatively to all three major events, with the strongest reaction around March 11, 2020. Meanwhile, we observe a large variation in how investors reacted to the same event for different stocks. To investigate which factors drove the variations in stock market reaction, we run a multiple regression analysis using firm and stock characteristics. Liquidity, profitability, and firm size are shown to have some explanatory powers on the variation across market reactions.

In addition, we also carry out a comparative analysis of stock market reactions in Norway, Denmark, and Sweden. We ask whether the stock market reactions to the COVID-19 pandemic are unique to Norway, or if they represent more general patterns that can be found in other Nordic stock markets. To answer this question, we conducted similar event studies using the data from the stock markets in Denmark and Sweden, Norway's two neighboring countries. Specifically, we take a close look at what happened on March 11, 2020, when the WHO characterized COVID-19 as a pandemic and when Denmark announced a national lockdown, on March 12, 2020 when Norway announced a lockdown, and on March 13, 2020 when Sweden declared that stopping the spread of COVID-19 had entered a "new phase" which required "other efforts". We find that the stock markets in all three countries reacted in a very similar way – a large drop on the day when the government interventions of either national lockdowns (-12% for Norway and -9.9% for Denmark) or a "new phase" (-16.3% for Sweden) were announced, and a slight rebound the day after (5%, 1.8%, and 7.5%, respectively). This finding is very interesting, as these three neighboring countries applied different policies – Norway and Denmark imposed significant restrictions on social and economic activities that included the full or partial shutdown of many venues, whereas Swedish authorities considered lockdowns to be unnecessary and adopted limited restrictions on the activities of private businesses. Even though the policy interventions that aim to slow or contain the COVID-19 pandemic are different among these three countries, the stock markets reacted in a very similar way, which perhaps indicates that in March 2020 the stock markets were reacting mostly to the virus itself and to a lesser extent to the government social distancing/lockdown interventions.

Next we investigate what happened to stock market volatility. We compare the volatility levels in the Norwegian stock market before, during, and after March 2020 with those in the Danish and Swedish stock markets. Our results suggest that all three stock markets behaved similarly – the stock markets crashed in March 2020 with an extremely high monthly volatility, but this did not last long. The market volatility declined significantly and has been stabilizing since April 2020. Although the volatility peaked in March, the average annualized volatility for 2020 excluding March is only slightly higher than that of 2019. Besides, the volatility patterns for each sector are very similar. The highest volatility levels are seen in March 2020; thereafter, volatility drops significantly.

Whereas most sectors suffered from a large price drop, others were less affected by the pandemic. Our analysis on sectors shows that there is a large variation in market reactions among sectors. For example, when the first COVID-19 case was confirmed in Norway, the

health-care sector was the most badly hit by a large price drop. At the same time, the real-estate sector was not much affected by the news.

Finally, we look at shareholder returns over different periods to look for signs of potential recovery. Our analysis shows that some sectors had already rebounded by June 2020. By May 2021, stock prices in all the sectors except for the energy sector had bounced back to pre-pandemic levels, showing a good upward trend. At the moment, the pandemic is still ongoing. It is thus difficult to know whether the combination of the ongoing policy interventions and individual behavioral changes will ultimately heal the economic wounds. So far, we see some positive signs from an investor perspective that the stock market has stabilized. Yet, it is yet too early to predict the full recovery and evaluate the economic consequence of the COVID-19 pandemic.

This paper contributes to the literature in three ways. First, we consider COVID-19 as an exogenous shock which provides a cleaner setting to gain insights into drivers of firm value. Many studies on the fundamental drivers of firm value have explored events related to corporate financial decisions which are likely to be endogenous. To some extent, the COVID-19 pandemic serves as a natural experiment that allows us to quantify the firm-level impact of a real shock to the global economy. Second, our study is also related to the finance literature on rare disaster that investigates how investors price in the tail risk of future disaster events (e.g., Gabaix 2012; Wachter 2013). The analysis in this paper may shed a light on which firm characteristics are associated with the fragility to tail-risk events. Third, this study extends the emerging literature on COVID-19 and financial markets. The existing literature mainly looks at the first period of the pandemic around March 2020 (e.g. Akhtaruzzaman, Boubaker, and Sensoy, 2020; Baker, Bloom, Davis, Kost, Sammon, and Viratyosin, 2020; Størdal, Dinh, Haugom, and Lien, 2020; Alam, Wei, and Wahild, 2020; Zhang, Hu, and Ji, 2020). In comparison, we follow the development of the pandemic by examining three different events, where the third event took place in October 2020. Besides, most of the literature focuses on the immediate effect of COVID-19 on the stock market (e.g. Alam et al., 2020; Størdal et al., 2020; Mazur, Dang, Vega, 2021). Our study looks at a longer horizon and investigates the potential effects over various timespans. Furthermore, we also look for signs of recovery.

The paper is organized as follows. The methodology and data are described in the next section. The third section presents all the empirical results, and the last section concludes with some implications and discussions.

Methodology and Data

COVID-19 trends in Norway and three major events

In Norway, the National Institute of Public Health started testing for COVID-19 on January 23, 2020, and the first confirmed case was registered a month later, on February 26. On March 11, 2020, the World Health Organization (WHO) declared the COVID-19 outbreak a pandemic. A day later, a number of safety measures aiming to achieve physical distancing and hinder the COVID-19 outbreak were introduced. On the same day, the first death in Norway caused by

COVID-19 was reported. From mid-March onwards, the Norwegian government introduced a set of policies related to the economic impact of the COVID-19 pandemic, including a lower capital buffer requirement for banks, a work furlough scheme, and loan guarantees for businesses. The number of confirmed cases decreased, and kindergarten and schools reopened in late April the same year. The national border for travel also gradually opened from mid-June. However, after the summer the number of affected cases surged again. From September, the government began to warn about a potential second wave. On September 21, 2020, new economic measures were proposed to counteract the economic consequences of the pandemic. On October 23, 2020, the Norwegian government held a press conference regarding the second wave of COVID-19 and introduced new targeted measures and travel restrictions starting from October 26. In late December 2020 and early January 2021, further measures were introduced after the discovery of a new COVID-19 variant in the U.K. which was believed to be more transmissible. In March 2021, stricter local measures were introduced in those municipalities suffering most from outbreaks of the new strain of the virus, followed by national measures. From April 2021, Norway started its four-step plan to reopen and lift COVID-19 restrictions after seeing a stable infection rate and an increased vaccination rate.

In the event study, we focus on three major events in 2020 that mark the different stages of COVID-19 situation in Norway. The first event is the press release of the first confirmed COVID-19 case in Norway, on February 26, 2020 (Event 1). At the time, the virus had already hit most European countries, and Norwegians abroad had been infected. The news of the first confirmed case in Norway came in the evening of February 26. Hence, we expect the stock market to react on the next day. The second event is the day the WHO declared COVID-19 as a pandemic, on March 11, 2020 (Event 2). The press conference took place in the evening, and again we expect the stock market to react the day after. However, since March 12 was also the day when the Norwegian Government presented policies intended to limit and slow the COVID-19 outbreak, we are unable to distinguish whether the stock market reacted to the WHO's announcement the night before or to the new policies on March 12. Thus, we group these two events into one and use March 11 as the event day. The third event is October 23, 2020, the day of the press conference announcing the second wave of COVID-19 and subsequent stricter measures (Event 3). This press conference was held on a Friday, around noon. Therefore, the stock market had time to react on that same day.

Event study and multiple regression

To investigate the impact of COVID-19 on the stock market, we start with the event study analysis, which is widely used to measure the effects of an economic event on the value of firms (MacKinlay, 1997). This is an empirical method that uses financial market data to measure the stock market responses to economy-wide events. MacKinlay (1997) argues that, given rationality in the marketplace, the effects of an event will be reflected immediately in security prices. Thus, the economic impact of an event can be measured by the difference between the observed and the expected stock prices in a relatively short time period. As the COVID-19 pandemic is still ongoing and it will take some time before we can analyze the lasting impact

of this crisis, the event study methodology is therefore especially helpful to provide some early insights into the potential economic impacts of the COVID-19 pandemic at this stage.

In this method, appraisal of the event's impact is measured by the abnormal return (AR), which is the difference between the actual return of the security (R) and the estimated return had the event not taken place ($\bar{R}$).

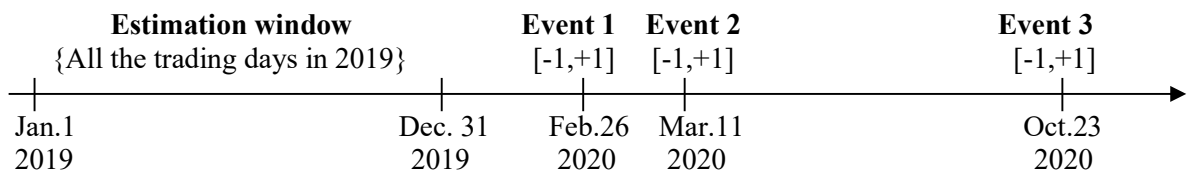$$AR_{i,t} = R_{i,t} - \bar{R}_i \text{ for stock } i \text{ at time } t \tag{1}$$

where the estimated return $\bar{R}$ is calculated using the average return over the estimation window (the constant mean return model). The daily return $R_{i,t}$ is calculated using the daily closing price $P_{i,t}$:

$$R_{i,t} = ln\left[\frac{P_{i,t}}{P_{i,t-1}}\right] * 100 \tag{2}$$

In addition to the abnormal return, we also examine the short window around the event to capture the price effects that occur after the stock market closes on the announcement day as well as potential information leakage before the announcement day. We then sum up all the abnormal returns within the event window for each stock, which is referred to as cumulative abnormal returns (or CAR):

$$CAR_{i,t} = \sum AR_{i,t} \tag{3}$$

For our main analysis, we use the three-day event window of one day before to one day after (denoted as [-1,+1]). For some analysis, we also show results for a two-day event window [0,+1], a five-day event window [-2,+2] and a seven-day event window [-3,+3]. To estimate an average expected return from "normal" times, we need to define an estimation period that is sufficiently long to be able to perform the estimations properly (Aktas et al., 2007). This is used to estimate an average expected return from "normal" times had the event not happened. The most common way is to use the 250 days prior to the event window (MacKinlay, 1997). We use daily log returns from all the trading days in 2019 (224 trading days) as the estimation window. We consider this estimation period long enough to generate reliable estimates; and it is a "normal" period in the sense that it precedes any news on the spread of the virus in China in early 2020. In addition, it is not immediately prior to the event day, as unrelated events might be present, which will interfere with the estimation (Aktas et al., 2007). The timeline below (Figure 2) summarizes our settings on the event study.

Estimation window		**Event 1**	**Event 2**		**Event 3**
{All the trading days in 2019}		[-1,+1]	[-1,+1]		[-1,+1]
Jan.1	Dec. 31	Feb.26	Mar.11		Oct.23
2019	2019	2020	2020		2020

Figure 2: The timeline of the event study.

We expect that the market would react to the same event in a somewhat different way for each individual stock. To investigate if there are any factors that drive the variations in the abnormal returns, we run the following multiple regressions on three major events:

$$AR_i \ (or \ CAR_i) = \beta_0 + \beta_1 Profitability_i + \beta_2 FirmSize_i + \beta_3 Liquidity_i + \beta_4 Growth_i$$

$$+\beta_5 Tangibility_i + \beta_6 Headquarter_i + \epsilon_i \qquad (4)$$

where i stands for stock/company, the dependent variable is the abnormal return AR or the three-day cumulative abnormal return CAR; independent variables are profitability, firm size, liquidity, growth, tangibility, and headquarter dummy by the end of 2019. We include profitability, firm size, liquidity, and growth because the literature suggests that these are priced factors that affect stock returns (e.g., Jaffe, Keim and Westerfield, 1989; Fama and French, 1992, 1993; Amihud, 2002; Pástor and Stambaugh, 2003; Fama and French, 2015). Research also suggests that more profitable companies are likely to survive when facing competition and challenges (Zingales, 1998; Fotopoulos and Louri, 2000; and Huynh, Petrunia, and Voia, 2010) and smaller companies are less resilient to recessions (Lai et al., 2016). In addition, we include tangibility as firms with a higher tangibility perform better in a crisis (Beltratti and Stulz, 2012). Finally, we include headquarter dummy, which equals one if the headquarter is in Norway and zero otherwise, since Størdal et al. (2020) suggest that companies headquartered in Norway recovered better in the period after the lockdown announcement.

Sample and Data

To study the general trend of stock return and volatility since the early 1980s (Figure 1), we collect daily data for the period of January 1, 1983 to May 31, 2021 from Oslo Stock Exchange All-Share Index (OSEAX) from Euronext/Oslo Børs, Eikon, and Bernt Arne Ødegaard's website (https://ba-odegaard.no/financial_data/index.html). We calculate monthly return and monthly volatility from the daily index price.

For our sector-level analysis, we collect all the sector indices available on Euronext/Oslo Børs. Specifically, we use the following sector indices: OBX Basic Materials GR (OBMG), OBX Consumer Discretionary GR (OCDG), OBX Consumer Staples GR (OCSG), OBX Energy GR (OENG), OBX Financials GR (OFING), OBX Health Care GR (OHCG), OBX Industrials GR (OING), OBX Real Estate GR (OREG), OBX Technology GR (OTECG), OBX Telecommunications GR (OTELG), OBX Utilities GR (OUTG).

For the event study and multiple regression analysis, we start with a sample of all the stocks listed on the Oslo Stock Exchange (OSEAX) on February 15, 2021. We exclude those stocks that have less than 150 trading days available during 2019 (out of 249 trading days in total) to ensure reliable estimations of normal returns, which is crucial for our methodology. We also exclude stocks that were listed only for part of the period between January 2019 and May 2021. The final sample consists of 157 stocks, covering all the 11 sectors (six in basic materials, 12 in consumer discretionary, 12 in consumer staples, 38 in energy, 17 in financials, 10 in health care, 39 in industrials, five in real estate, 15 in technology, two in

telecommunications, and one in utilities). We collect stock price, trading volume, sector, and other firm accounting data from Thomson Reuters Eikon. Table 1 shows summary statistics for variables used in our analyses.

Table 1: Summary statistics. This table reports the number of observations (N), mean, median, standard deviations (Std. Dev.), the 10th percentile, and the 90th percentile for all the variables used in our analyses.

	N	Mean	Median	Std. Dev.	10th Pctl.	90th Pctl.
Data for general trends on OSEAX, January 1983 – May 2021						
Monthly return	461	1.17%	1.73%	6.00%	-5.66%	7.95%
Monthly volatility	461	1.10%	0.94%	0.66%	0.58%	1.75%
Data for event study, individual stocks, 2019-2020						
Daily log return	68,665	5.47%	-2.3%	25.8%	-43.6%	20.1%
Data for multiple regression analysis						
Profitability	157	0.01	0.07	0.39	-0.04	0.20
Firm size	157	22.22	21.78	3.28	19.35	24.37
Trading volume	157	11.92	11.88	1.57	9.91	14.09
Growth opportunity	157	2.61	1.38	4.17	0.43	5.92
Tangibility	157	0.23	0.21	0.33	-0.09	0.63
Headquarter	157	0.18	0.00	0.39	0.00	1.00
Data for sector patterns, daily log return, January 1, 2020 – May 31, 2021						
OBX Basic Materials GR	358	0.12%	0.14%	1.78%	-1.91%	2.13%
OBX Consumer Discretionary GR	358	0.03%	0.12%	2.23%	-2.34%	2.26%
OBX Consumer Staples GR	358	0.02%	0.02%	1.59%	-1.88%	1.78%
OBX Energy GR	358	-0.03%	0.00%	2.53%	-2.76%	2.77%
OBX Financials GR	358	0.05%	0.09%	1.96%	-1.89%	1.97%
OBX Health Care GR	358	0.12%	0.31%	2.55%	-2.70%	2.73%
OBX Industrials GR	358	0.11%	0.18%	1.67%	-1.70%	1.88%
OBX Real Estate GR	358	0.05%	0.09%	1.73%	-1.29%	1.55%
OBX Technology GR	358	0.20%	0.17%	1.83%	-1.77%	2.29%
OBX Telecommunication GR	354	0.04%	0.05%	1.48%	-1.45%	1.50%

Regarding the independent variables in multiple regression analysis, profitability is measured as normalized EBITDA divided by total assets, where normalized EBITDA is the net income from continuing operations before interests, income taxes, depreciation and amortization, excluding non-recurring items and non-cash equity compensation expense. Firm size is the logarithm of the market value as of December 31, 2019. Liquidity is measured as the logarithm of the average trading volume for 2019. Growth is calculated as market value per share divided by book value per share. Tangibility is calculated as the tangible book value divided by total assets. Headquarter is a dummy variable that equals one if the country of headquarters is Norway and zero if the headquarter is abroad.

Empirical Results

How did the stock market react to the major news in COVID-19?

We conduct event studies on three major events in 2020, namely the first confirmed COVID-19 case in Norway on February 26, the WHO's declaration of COVID-19 a pandemic on March 11 and the Norwegian government's new COVID-19 policies the day after, and the press conference on the second wave on October 23. Table 2 summarizes the average cumulative abnormal returns (CAR) and the corresponding *t*-statistics for various event windows.

Table 2: Stock market reactions to three major events regarding the Covid-19 development in Norway. The average cumulative abnormal returns (CAR) for various event windows and the corresponding *t*-statistics are reported. ** denotes a statistical significance at 1% level.

Event Window	First case in Norway		WHO declare a pandemic		Second Covid-19 wave	
	CAR	t-stat	CAR	t-stat	CAR	t-stat
[0, +1]	-8.5%**	-9.70	-17.3%**	-17.71	-2.7%**	-4.97
[-1, +1]	-9.5%**	-8.32	-15.7%**	-10.68	-3.5%**	-4.03
[-2, +2]	-15.6%**	-7.90	-22.8%**	-7.74	-11.9%**	-4.82
[-3, +3]	-15.8%**	-6.22	-36.9%**	-9.17	-8.9%**	-2.80

Our analysis suggests that the Norwegian stock market responded negatively to all three major events. The average cumulative abnormal returns for all three events over all the event windows are negative and statistically significant at 1% level. Among these three events, the most negative market reaction occurred after the WHO declared COVID-19 as a pandemic and the Norwegian government introduced new COVID-19 policies, with a -15.7% cumulative abnormal return for the event window for the three-day event window and -17.3% for the event window [0, +1] (the abnormal returns for March 10, March 11 and March 12 are 1.6%, -5.3% and -12%, respectively). Since the news on the WHO's declaration of COVID-19 a pandemic came in the evening, it is not surprising to see that the biggest reaction came on March 12, the day after our event day. In addition, March 12 is also the day when strict countermeasures were introduced and the first death related to COVID-19 was reported.

The market reaction to the first confirmed COVID-19 case in Norway is also negative and significant with a -9.5% (or -8.5%) cumulative abnormal return for the event window [-1,+1] (or [0, +1]). The abnormal returns for February 25, February 26 and February 27 are -0.95%, -1.56% and -6.96%, respectively. This announcement came on the evening of February 26. Therefore, the biggest reaction on the stock market came the day after.

Relatively speaking, the market reaction to the press conference regarding "the second wave" is small, although still negative and statistically significant at the 1% level. This press conference was held around noon on October 23, which means that the market still had some time to react on that same day. The abnormal return for that day is 1.01% and for the Monday after is -3.7%. In total, then, the cumulative abnormal return for the three-day event window is -3.5% (or -2.69% for the event window [0, +1]), which is a much smaller scale compared with the other two events in February and March. This is not surprising, because the third event is

less shocking to the market as the number of COVID-19 cases were increasing steadily and the government had warned about the potential "second wave" and had been considering introducing new restrictions since September 10.

Table 3: Multiple regression analysis on what drives the difference in stock market reactions. The dependent variables are abnormal returns (AR) and cumulative abnormal returns over the event window of [-1, +1] for three major events related to the COVID-19 development in Norway. *t-statistics* are shown in parentheses. ** and * denote statistical significance at 1% and 5%, respectively.

Variables	First case in Norway		WHO: pandemic		Second wave	
	AR_1	CAR	AR_1	CAR	AR_0	CAR
Profitability	4.67^{**}	7.97^{**}	-0.08	-1.96	0.42	-0.48
	(3.64)	(4.07)	(-0.05)	(-0.75)	(0.63)	(-0.36)
Firm size	0.25	0.18	0.44^{*}	0.38	-0.04	0.16
	(1.56)	(0.74)	(2.17)	(1.20)	(-0.43)	(0.97)
Liquidity	-0.94^{**}	-0.42	-0.98^{*}	-1.96^{**}	0.41^{*}	0.25
	(-2.85)	(-0.83)	(-2.34)	(-2.93)	(2.39)	(0.72)
Growth	-0.08	-0.28	-0.05	-0.26	-0.09	-0.19
	(-0.69)	(-1.61)	(-0.36)	(-1.12)	(-1.44)	(-1.63)
Tangibility	-2.92	-4.28	0.50	0.77	-0.92	-0.77
	(-1.97)	(-1.89)	(0.27)	(0.25)	(-1.18)	(-0.50)
Headquarter	-0.96	-2.29	-0.30	-2.94	-0.68	0.41
	(-0.78)	(-1.22)	(-0.19)	(-1.18)	(-1.06)	(0.32)
Constant	-0.26	-6.46	-9.90	0.17	-2.58	-9.46^{*}
	(-0.06)	(-1.03)	(-1.89)	(0.02)	(-1.19)	(-2.20)
Observations	157	157	157	157	157	157
Adjusted R^2	0.15	0.12	0.02	0.04	0.03	0.00

Meanwhile, we observe that there is a large variation in how investors reacted to the same event for different stocks. To investigate if there are any factors that drove the variations in the stock market reaction, we run the multiple regression analysis using regression estimation equation (2) on three major events. Table 3 shows the coefficients and t-statistics of multiple regressions using abnormal returns (AR) and cumulative abnormal returns over the event window of [-1, +1] as the dependent variable. For the first two events, we use the abnormal return at Day 1 (AR_1) instead of Day 0 (AR_1) since the announcements came after the closure of the stock exchange.

As shown in Table 3, the only variable that turns out to be significant across all three events is liquidity, using trading volume in 2019 as a proxy. Trading volume is also a measure of the overall interest in the company before COVID-19. The negative coefficient suggests that firms with a high trading volume in 2019 experienced greater negative abnormal returns to the major events regarding COVID-19 in 2020. In addition, the coefficients of profitability are positive and significant, meaning that firms with higher profitability in 2019 were more likely to have more positive (or less negative) returns when the first COVID-19 case was confirmed in

Norway. For the second event, firm size also seems to matter for how investors react to the news. The coefficient for the firm size variable is positive and significant for the regression on abnormal returns, indicating that larger firms have more positive or less negative abnormal returns when the WHO declared the COVID-19 outbreak as a pandemic and the strict countermeasures were introduced. The remaining variables, such as growth, tangibility, and the headquarter dummy are not significant.

Comparison of stock market reactions in Norway, Denmark, and Sweden

One may wonder whether the stock market reactions to the COVID-19 pandemic were unique in Norway or whether they represented more general patterns that could be found in other stock markets. The health systems in Norway, Denmark, and Sweden are similar in the sense that they are all tax-based and locally managed, with universal coverage for all residents. However, Saunes et al. (2021) suggest that the epidemiological situation has varied across these countries, which may reflect different policy responses as well as institutional structures. Therefore, it is unclear *ex ante* whether the stock market movements (which ultimately reflected investors' expectation on the future economy) in Norway, Denmark, and Sweden would behave similarly.

Below we carry out similar event studies using the data from the stock markets in Denmark and Sweden, neighboring countries of Norway. We focus on the CARs of the second event, i.e. when the WHO characterized COVID-19 as a pandemic, because we do not consider the other two events (the first confirmed case in Norway and the announcement of the second wave in Norway) as directly relevant for the stock markets in Denmark and Sweden. The analysis of CARs regarding the stock market reactions to the WHO's declaration of COVID-19 as a pandemic are shown in Table 4.

Table 4: Comparisons of Norwegian, Danish, and Swedish stock market reactions to the WHO's declaration of COVID-19 as a pandemic. The average cumulative abnormal returns (CAR) for various event windows and the corresponding *t*-statistics are reported. ** denotes a statistical significance at 1% level.

	Norway		Denmark		Sweden	
Event Window	*CAR*	*t-stat*	*CAR*	*t-stat*	*CAR*	*t-stat*
[0, +1]	-17.3%**	-17.71	-12.3%**	-13.88	-3.1%**	-7.54
[-1, +1]	-15.7%**	-10.68	-12.9%**	-10.93	-4.2%**	-7.46
[-2, +2]	-22.8%**	-7.74	-17.1%**	-7.96	-21.5%**	-7.11
[-3, +3]	-36.9%**	-9.17	-23.5%**	-7.93	-15.0%**	-4.33

At the first glance, the table seems to indicate that the stock markets in Norway and Denmark reacted similarly to the WHO's pandemic declaration, whereas the stock market reaction in Sweden is somewhat different – the big drop came one or two days later. However, this may have to do with the fact that Denmark announced a lockdown on the same evening that the WHO declared the pandemic and Norway did the same the day after (their respective

stock markets both reacted on March 12); whereas Sweden only declared on March 13 that stopping the spread of COVID-19 had entered a "new phase" which required "other efforts"[1]. Therefore, we have zoomed in on the days around the major government interventions in March 2020, namely the national lockdown for Denmark on the evening of March 11 and for Norway on March 12, and the "new phase" for Sweden on March 13. Please note that here we took March 12 as the event day for both Denmark and Norway, but March 13 for Sweden, since the national lockdown was announced in Denmark on the evening of March 11, after the stock market had closed, while for Norway and Sweden the announcements came during the day when stock market was open. Table 5 summarizes the abnormal returns for Day -1, Day 0, and Day +1.

Table 5: Comparisons of Norwegian, Danish, and Swedish stock market reactions to the national lockdown and "new phase" (Sweden). The event day for Norway and Denmark is March 12, 2020 as the Norway announced a national lockdown during the day of March 12 and Denmark announced it the evening before after the stock market had closed. The event day for Sweden is March 13, 2020 as Sweden declared on that day that stopping the spread of COVID-19 had entered a "new phase" which required other efforts. The average abnormal returns (AR) for Day -1, 0, +1 and the corresponding *t*-statistics are reported. ** denotes a statistical significance at 1% level.

	Norway		Denmark		Sweden	
Event Day	*AR*	*t-stat*	*AR*	*t-stat*	*AR*	*t-stat*
-1	-5.3%**	-13.68	-2.4%**	-6.18	-0.9%**	-3.21
0	-12.0%**	-20.54	-9.9%**	-19.73	-16.3%**	-7.04
+1	5.0%**	7.71	1.8%**	3.13	7.5%**	24.42

The abnormal returns for Day 0 and Day +1 suggest that the stock market reactions are very similar in Norway, Denmark, and Sweden – a large drop on Day 0 (-12%, -9.9%, and -16.3%, respectively) and a slight rebound the day after (5%, 1.8%, and 7.5%, respectively). This finding is very interesting as these three neighboring countries with similar healthcare systems applied different policy interventions that aimed to slow or contain the COVID-19 pandemic. Norway and Denmark imposed significant restrictions on social and economic activities that included the full or partial shutdown of many venues such as restaurants, bars, cinemas, and personal care services. In contrast, Swedish authorities considered lockdowns to be unnecessary and adopted limited restrictions on the activities of private businesses. Nevertheless, the stock markets in all three countries reacted in a similar pattern – about a 10% abnormal return around the day when the government intervention of either national lockdown (Norway and Denmark) or the "new phase" (Sweden) was announced. This could perhaps indicate that in March 2020, when the national lockdown or the "new phase" was announced,

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[1] See "Ny fas kräver nya insatser mot covid-19" retrieved from the website of the Public Health Agency of Sweden https://www.folkhalsomyndigheten.se/nyheter-och-press/nyhetsarkiv/2020/mars/ny-fas-kraver-nya-insatser-mot-covid-19/

the stock market reacted most on the potential economic impact of virus itself and not so much on the government interventions of social distancing.

Together with results in Table 4, we find that the stock markets in Norway, Denmark, and Sweden seem to react less to the WHO's announcement of global pandemic and more to the national lockdown/"new phase". In other words, the WHO's announcement itself did not seem to directly affect investors' belief in these three countries. Rather, investors seemed to adjust their expectations of the future economy on the basis of the government's rapid response to the WHO's announcement, which confirmed the severity assessment of pandemic situation.

What happened to the stock market volatility?

From Figure 1 in the introduction, we observe that stock volatility on the Oslo Stock Exchange increased markedly in March 2020, approaching that last seen in the banking crisis of October 1987 and the financial crisis of October 2008. To take a closer look, we zoom in on the period January 2019 to May 2021 and show the daily stock market return and monthly volatility in Figure 3 below. The figures indicate that the stock market crashed in March 2020, showing several large negative daily returns and the highest monthly volatility in the stock market. Luckily, the trend did not last long and stock market volatility dropped significantly, remaining stable since April 2020.
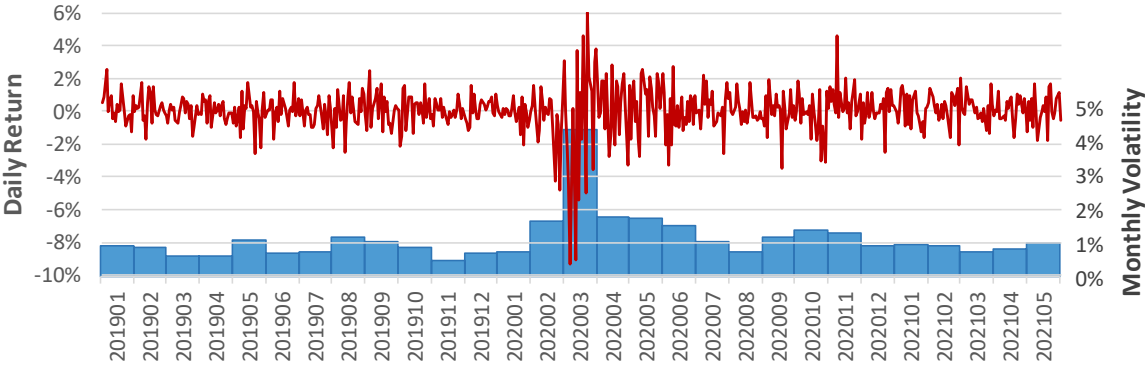

Figure 3: Monthly volatility (bars, axis on the right) and daily returns (line, axis on the left) for Oslo Stock Exchange All-Share Index (OSEAX) for the period of January 2019 to May 2021.

To formally test the difference between the volatility in 2020 and in "normal" times, we use 2019 as a reference point for what we would consider as a normal stock market volatility. In Table 6 below, we compare the stock market volatility in 2019 and 2020. All the values in volatility are annualized for the purpose of the comparison. Again, we compare the Norwegian stock market with the Danish and Swedish stock markets for the same period. The average annualized stock market volatility for March 2020 is 68% in Norway, 49% in Denmark, and 65% in Sweden, all being significantly higher than the volatility level in 2019 (13%, 12%, and 12%, respectively). The F test for two-sample means shows p-values of 0.00, indicating the

differences between the volatility levels in March 2020 and those in 2019 are statistically significant at the 1% level. The average annualized volatility levels for 2020 excluding March are 21%, 17%, and 22% for Norway, Denmark, and Sweden, respectively. The stock market volatility levels in the 11-month period in 2020 are still significantly higher than those in 2019, but are much lower than those in March 2020. In short, we find that the stock market volatility developed in the same way in Norway as in Denmark and Sweden. The stock market crashed in March 2020 with an extremely high monthly volatility, but the market volatility declined significantly in April 2020, though still remaining above the volatility in "normal" times.

Table 6 Comparison of stock market volatility in 2019 and 2020 for Norway, Denmark, and Sweden. All the volatility values are annualized. The difference between the two samples and the p-value for F test for two-sample variance are shown in the table. ** denotes a statistical significance at 1% level.

	Norway		Denmark		Sweden	
	Trading Days	Volatility	Trading Days	Volatility	Trading Days	Volatility
Benchmark 2019	249	13%	242	12%	246	12%
(1) 2020 March	22	68%	22	49%	22	65%
(2) 2020 excl March	228	21%	228	17%	229	22%
	Difference	P(F≤f)	Difference	P(F≤f)	Difference	P(F≤f)
(1) – Benchmark	54%**	0.00	37%**	0.00	53%**	0.00
(2) – Benchmark	7%**	0.00	5%**	0.00	9%**	0.00
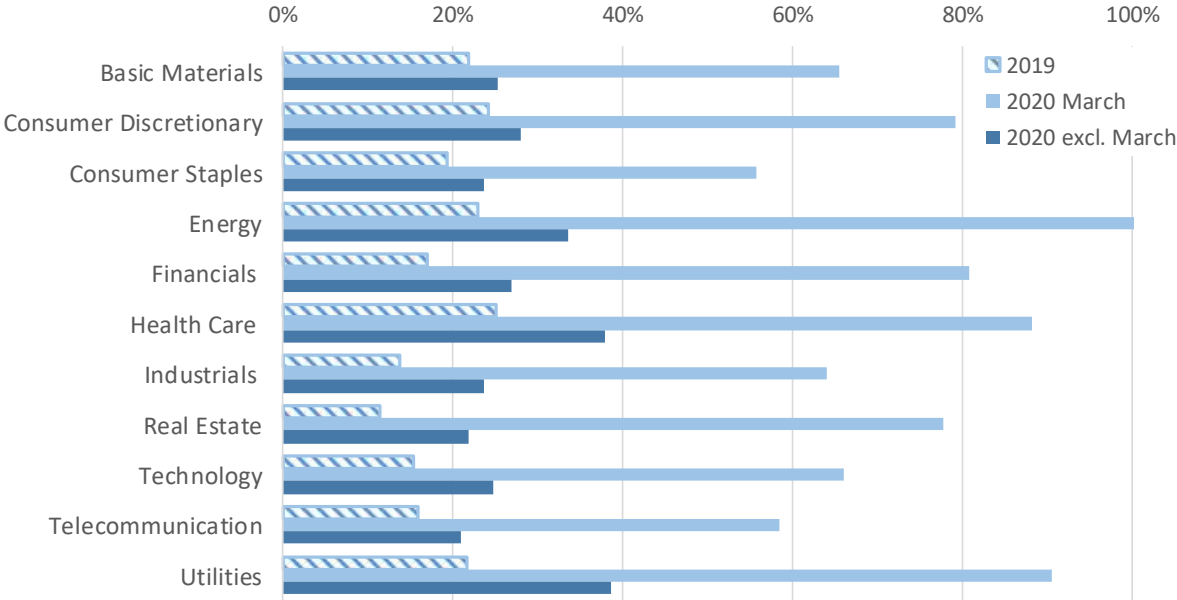
Figure 4: Volatility by sector, 2019 versus 2020. All the volatility values are annualized.

In addition, we compare volatility levels in 2019 and 2020 by sectors in Figure 4, using all the sector indices available on Euronext/Oslo Børs. Again, we use 2019 as a reference point, and split 2020 into March and all other months without March. All the values in volatility are annualized. The patterns for each sector are very similar to what are described above. The average annualized volatility level for March 2020 is extremely high, ranging from 56% in consumer staples to 105% in energy. They are all significantly different from the volatility levels in 2019. However, when excluding March, the volatility levels in 2020 are somewhat higher than those in 2019, but not statistically significant.

The extreme negative returns and excessive volatility in March 2020 reflect the vast uncertainty of the pandemic and investors' expectations at the time of huge economic losses. The drop in the volatility a month later seems to show that the government COVID-19 policies and the stimulus packages helped bring down uncertainty in the financial markets. In particular, on March 13, 2020 the Ministry of Finance lowered the countercyclical capital buffer from 2.5% to 1%, as Norges Bank indicated that the outbreak of the COVID-19 and the measures implemented to limit the spread would lead to a clear slowdown in growth in the Norwegian economy, and that tighter lending practices could intensify the economic downturn. That same day the government announced a stimulus package that would benefit individuals, Norwegian companies, workplaces and employees. For example, a 20-day furlough scheme was implemented on 20 March so that employers were only responsible for paying the first two days, with the remaining 18 days to be covered by the state. In addition, a shortened notification period to employees and a part-time furlough option also helped to limit unemployment and to compensate businesses that were shut down overnight. Furthermore, the Norwegian government offered loan guarantees of NOK 6 billion to the aviation industry on March 19. On March 20, the government introduced new guarantee and loan schemes to improve the liquidity of companies, including the postponement and relief of VAT, and deferred payment of employers' contributions and withholding tax for companies. The loan guarantees were implemented on March 27 for small and medium enterprises and later extended to all private firms on April 2. These stimulus packages, together with the decline in the number of confirmed COVID-19 cases, seem to have contributed to the lower volatility after March 2020.

Is there any difference in stock market reactions among sectors?

As we have discussed, we observe a large variation in stock market reactions to the same event for different stocks. In the previous section we conducted multiple regression analysis to investigate some firm characteristics factors that could potentially drive the difference in stock market reaction. In this section we will explore the variation in market reactions along the dimension of sectors. According to Narayan and Sharma (2011), the sectors are heterogeneous and can therefore react to market shocks in different ways. Figure 5 summarizes means and medians of three-day cumulative abnormal returns of the three major events as well as the corresponding 95% confidence intervals. The means of three-day cumulative abnormal returns are shown in the light-colored bars; medians are highlighted in dots. The corresponding 95% confidence intervals are exhibited in the horizontal error bars. We do not show confidence intervals for telecommunications and utilities because our event study sample contains only two

stocks in telecommunications and one in utilities stocks, which are too few observations to calculate the confidence intervals.
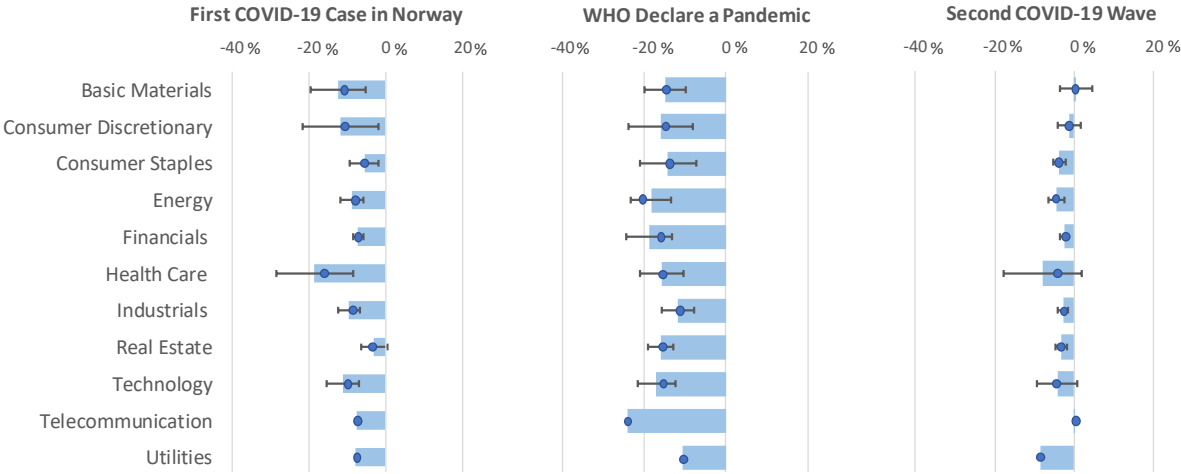
Figure 5: Three-day cumulative abnormal returns (means in light color bars; medians in dots) and the corresponding 95% confidence intervals (horizontal error bars) for three major events regarding the Covid-19 development in Norway

When the first COVID-19 case was confirmed in Norway, the health-care sector seems to be the one most badly hit, with a three-day cumulative return of -18.4%. The health-care sector is comprised of a broad range of companies that manufacture health-care equipment and supplies or that provide health-care-related services or research, development and production of pharmaceuticals and biotechnology products. The large negative number in the average cumulative abnormal returns in the health-care sector is mainly driven by two stocks: PCI Biotech (3-day CAR of -42%) and Nordic Nanovector (3-day CAR of 41%). Then come basic materials, consumer discretionary, and technology, with three-day cumulative returns of -12.2%, -11.7%, and -11.2%, respectively. As the consumer discretionary sector includes travel and leisure, it is not surprising that the market reaction was rather negative on the related stocks. In addition, according to Alam et al., (2020), many technology companies stopped doing business due to shipping delays to electronic goods. The same also affects the basic materials sector. Real estate seems not to have been hurt by the announcement, with a three-day cumulative return of -3% and not statistically significant from zero. All other sectors have significant negative market reactions, with -5.6% for consumer staples, -8.6% for energy, -7.1% for financials, and -9.5% for industrials.

When the WHO declared COVID-19 a pandemic and the new COVID-19 policies were introduced, investors in all sectors responded negatively, ranging from -10.6% in utilities to -24.2% in telecommunications. As mentioned before, we have too few observations in utilities and telecommunications to draw any statistical inference. Ramelli & Wagner (2020) find that the telecommunications sector performed well in early 2020 as the demand for services that promote work at home increased significantly. Apart from telecommunications, financials and energy have the largest significant negative market reactions, with -18.7% and -18.3%, respectively, for three-day cumulative returns. The financials sector consists of companies

engaged in savings, loans, security investment and related activities, such as mortgage/consumer/corporate financing, investment banking and brokerage, asset management and custody, insurance, and mortgage REITs. Three stocks contribute to the large negative average in the financials sector: Axactor, Aker, and B2Holding, with three-day CAR of -44%, -30%, and -30%, respectively. The energy sector covers both renewable and non-renewable energy companies that engage in energy extraction, process, and production activities. The largest negative CARs are found in Awilco Drilling (-62%) and Archer (-48%). Other sectors were also hit hard: technology (-16.9%), consumer discretionary (16.0%), real estate (-15.9%), health care (-15.7%), basic materials (-14.8%), consumer staples (14.2%), and industrials (-11.8%). All of these negative numbers are large and significant, indicating that the announcement on March 11 led to an overall crash in the Norwegian stock market, regardless of sector.

The press conference announcing the second wave of COVID-19 has a smaller effect on the stock market in general. Health care and utilities have about -8% three-day cumulative abnormal returns, though these are not statistically significant. Energy has a three-day cumulative abnormal return of -4.5% and is significant at the 0.1% level. This may be the consequence of the reduced need for oil and gas during the lockdown and the fact that OPEC agreed to a cut in oil production as a push for stability. Consumer staples has a CAR of -3.8%, followed by real estate (-3.3%), industrials (-2.9%), and financials (-2.5%). The remaining sectors have negative and insignificant cumulative abnormal returns. In general, the market reacted less negatively to the press conference about the second wave; even the most negative sector average CAR is still higher than the highest for Event 2.

Do we see any signs of recovery?

Having evaluated the impact of the COVID-19 on the Norwegian stock market using event study, we would like to know how all the listed firms are performing now (May 2021, at the time of this analysis) – about one year since the drama of March 2020 and a half-year since the press conference on the second wave. In this section, we look at the shareholder returns by sector over different periods which might reflect investors' beliefs about the future, a powerful indicator of what may lie ahead. Figure 6 exhibits annualized shareholder returns by sector since January 1, 2020, using all the sector indices available on Euronext/Oslo Børs. For the purpose of comparison, all the returns are annualized.

The first period, January 1 to March 31, 2020 (indicated by the white bars), spans over roughly the most dramatic period with historically large drop in prices across all sectors. Except for utilities, all the sectors saw large declines in shareholder returns, ranging from 81% in energy sector to 31% in telecommunication sector. This period represents the stage early on in the pandemic when the news was mostly negative, uncertainty was surging, and investors were expecting unpredictable economic losses.

The second time window covers the first half-year of 2020 (striped bar), representing an initial rebound stage. Towards the end of March, stock prices started to rebound after the new measures and stimulus package were introduced. In late April, the number of confirmed

COVID-19 cases was decreasing and kindergartens, schools, and some stores were reopened. In late May, the Norwegian government initiated a new policy phase to increase economic activity and help the unemployed return to work. On the basis of the shareholder returns shown in Figure 6, the stock prices in some sectors had already rebounded while others were still suffering. For example, the health-care sector saw a 26% of increase in the annualized shareholder return, overturning the large negative return in the first quarter. Similarly, the annualized shareholder return for the consumer discretionary sector jumped from -76% in the first quarter to 16% in the first half year, showing a clear sign of rebound. The annualized shareholder return for the utilities sector continued on the high end, reaching 72% for the first half-year. Meanwhile, the annualized shareholder return for the energy sector increased from -81% in the first quarter to -50% in the first half-year, remaining down significantly from its pre-pandemic peaks. Consumer staples, financials, real estate, and telecommunication sectors were also lagging on the stock price recovery.
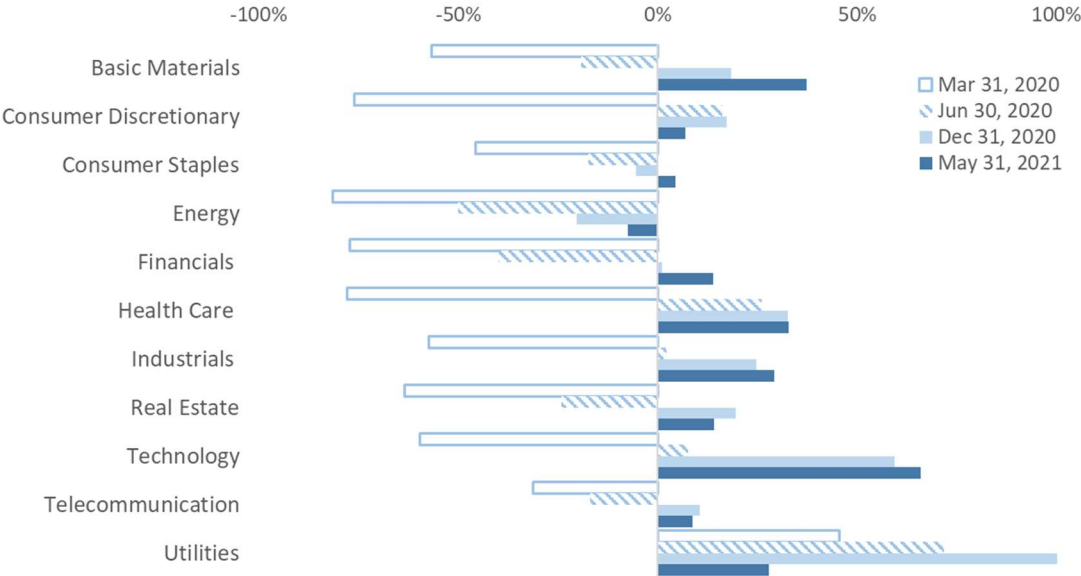
Figure 6: Annualized shareholder returns by sector since January 1, 2020

The third timespan covers the whole of 2020. In other words, we want to see how each sector was performing by the end of the year. The light-colored bars in Figure 6 suggest that nine months after the huge declines in the stock market, the majority of the sectors had fully regained their market losses, except for consumer staples (-5%) and energy sectors (-20%), which are still below the pre-pandemic level. Utilities and technology sectors are the biggest winners, with 102% and 60% annual shareholder returns, respectively. In general, the development in the economy in the second half of 2020 was more positive than expected during the summer, but was still sensitive to new outbreaks. The economic outlook was still uncertain. In addition to the stimulus package introduced in March/April, the government proposed new economic measures on September 21, aiming at industries that remained hard hit. These measures include employee benefits, business development in the districts, a support scheme to

stimulate activities in the culture, volunteering and sports sectors, and compensation schemes for public transport and tourism.

Finally, we expand the time window to today (May 31, 2021). Since the end of 2020, the news of imminent vaccines led to an anticipation of recovery. However, in early 2021, stricter measures were introduced after the discovery of new variants of COVID-19. In March 2021, kindergartens and schools were back to the "red" level for municipalities suffering most from outbreaks of the new variants. From April 2021, after seeing a stable infection rate and an increased vaccination rate, Norway started its four-step plan to lift COVID-19 restrictions. The dark-colored bars in Figure 6 show that all the sectors except for the energy sector had rebounded from the stock price drop in March 2020. Even the worst-hit energy sector had partially regained its market losses, with an annualized shareholder return of -7%. The best-performing sector is technology, standing 103% above the pre-pandemic level (66% annualized shareholder returns), followed by basic materials (37%), health care (33%), industrial (29%), and utilities (28%). In short, we see some signs of potential recovery in shareholder returns but have to wait and see if stock price development is sustained and backed by fundamentals.

Conclusion

This paper studies the potential economic impact of COVID-19 using event study methodology on stock market data. As stock price movements usually reflect investors' future expectations of economy and firm value, our study provides an alternative approach to gauge the impact of COVID-19 using forward-looking measures. In addition, we also carry out a comparative analysis of stock market reactions in Norway, Denmark, and Sweden and find similar patterns among these countries. Furthermore, this paper provides a first-hand description of the dramatic movement in the Norwegian stock market in response to the COVID-19 outbreak. We document one of the biggest stock market crashes in history, with the collapse of stock prices and the drastic jump of volatility in March 2020. According to our event study analysis, the Norwegian stock market dropped by 8.5% after the first COVID-19 case was confirmed in February 26, by 17.3% after the WHO declared COVID-19 outbreak a pandemic and new COVID-19 measures were introduced, and by 3.7% after the press conference on the second wave.

This dramatic movements in the Norwegian stock market reflect the vast uncertainty about the duration and consequences of the outbreak and a risk of a marked downturn in the economy. Yet, the stock price developments afterwards also offer hope and promise of new growth for the post COVID-19 era. While most sectors were heavily hit by the pandemic in March 2020, our analysis of shareholder returns suggests that stock prices in many sectors have already rebounded. By May 2021, stock prices in almost all the sectors have bounced back to pre-pandemic levels. Even the worst-hit sector has partially regained its market losses. However, it is yet too early to call it a recovery. The increase in stock prices can be purely the effect of the stimulus package and the liquidity injected into the market. We have to wait and see if the recovery trend is truly backed by company fundamentals. Investors should also keep an eye on a potential resurgence of COVID-19 or perhaps even disaster risks more generally.

Our findings on the comparative analysis of stock market reactions in Norway, Denmark, and Sweden are also interesting. First of all, we find that investors reacted more directly to the national policy intervention in March 2020 than to the WHO's declaration of COVID-19 as a global pandemic. Our findings suggest that the WHO's announcement itself did not directly affect investors' belief in these three countries. What changed investors' expectation of future economy was the government's response to the WHO's announcement (i.e. a national lockdown), perhaps because it confirmed the assessment of the severity of the pandemic situation. Second, even though Norway, Denmark, and Sweden applied different policy interventions in response to the COVID-19 pandemic, their stock markets reacted to the government interventions in a similar way. We find a large drop of about 10–15% on the day when a lockdown (in Norway and Denmark) or a "new phase" (in Sweden) was announced. This finding seems to suggest that the negative impact of the COVID-19 outbreak on capital markets and the future economy was inevitable no matter how strict the policy interventions were.

At the time of writing this paper, COVID-19 is still an ongoing pandemic. The full picture of the consequence and the impact of the pandemic is yet to unfold. Therefore, it is too early to conclude when the economy will recover fully. According to the government's revised national budget for 2021, NOK 135 billion was allocated in 2020 for measures related to COVID-19, with NOK 94 billion so far in 2021. We are fully aware that it is difficult to distinguish the impact of the pandemic from the impact of infection control measures and self-regulation between households. Nevertheless, our study provides the first insight on the Norwegian stock market's losses and potential recovery from COVID-19 pandemic. So far, it seems that from an investor perspective, the measures taken by the Norwegian government have helped to reduce uncertainty in the financial market. If we believe that the stock market is forward-looking, our analysis offers some promising signs for future recovery.

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