Impact of COVID-19 Pandemic Announcement on the Market Value of Companies in the German Stock Index DAX30

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Abstract

While the literature in the range of Covid-19 related topics has started to examine the market impact of the pandemic, little evidence exists regarding the effect on the German stock index DAX30. This paper fills in the gap by analysing the impact of the COVID-19 pandemic announcements in March 2020 on the German Stock Index DAX30. Using an event study, we investigate how certain industries and specific companies in the index responded to the news, by using three event windows of different length. It mirrors the expectations and trust of the investors in the performance and valuation of certain industries. It was found that the impact of the event differs significantly among the 30 companies in 13 different industries. Some industries and their companies were strongly negatively affected, such as Real Estate, Utilities, Communication, Industrials and Financial Services. While three industries in our sample, Basic Materials, Online Food Ordering and Automobile, were found to be positively affected. Furthermore, possible reasons for those reactions for each of the companies are presented.

Keywords: Covid-19 pandemic, event study, German stock market, DAX30

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1. Introduction

After the global financial crisis of 2008, the stock markets across the world witnessed an unprecedented decade of growth. Big players like Apple, Microsoft, Amazon and similar pushed the US market from their 2009 lows to new all-time highs in early 2020. Out of a sudden, the world was shocked by the unprecedented outbreak of the novel coronavirus, a disease which was first detected in December 2019 in the Chinese city of Wuhan and rapidly spread around the world causing a pandemic. The authorities imposed strict quarantines and travel restrictions on their citizens and ordered shutdowns on many business activities. Consequently, the outbreak did not only bring the entire world's health system to its knees, but also shocked the global financial markets. A critical announcement was made by the Director-General of the World Health Organization (WHO) on March 11, 2020, when he declared the novel coronavirus outbreak a Public Health Emergency of International Concern (PHEIC), WHO's highest level of alarm (WHO Director-General, 02.05.2020). For example, one of the main US stock indices, the Dow Jones experienced major historic losses on two consecutive Mondays (March 9, March 16) and the Thursday in between (March 12 - a day after the pandemic declaration). It was reflecting the public's fear from news that arrived during the weekends, and from WHO's pandemic announcement (see Table 1 below).

Table 1: Dow Jones Industrial Average Close Black Monday I, Black Thursday & Black Monday II

Name	**Date**	**Change**	**% Change**	**Close**
Black Monday I	March 9, 2020	-2,013.76	-7.79%	23,851.02
Black Thursday	March 12, 2020	-2,352.60	-9.99%	21,200.62
Black Monday II	March 16, 2020	-2,997.10	-12.93%	20,188.52

Source: Created by the authors using the data retrieved from Statista (2021)

This paper aims to contribute to the existing literature on COVID-19's economic impacts, through the study of European markets' reactions to the COVID-19 announcements. More specifically, one of the strongest economies in the E.U. - Germany - has been chosen to be analysed through their major Index DAX30. The DAX30 is the Abbreviation for the German term "Deutscher Aktienindex," being the most important German Index. It currently measures the performance of the 30 largest and (in terms of free float market capitalization) most liquid companies on the German stock market. Therefore, it represents around 80 percent of the market capitalization of listed stock corporations in Germany. In this paper, the impact of the COVID-19 pandemic declaration is investigated through the event study methodology (ESM) how certain industries responded to the news, by choosing the companies with the biggest index weighting from each industry.

Previous research found negative effects of several Covid-related events, such as the WHO announcement of the pandemic (Mazur, Dang & Vega, 2020) specific lockdown announcements or central banks stimuli (Harjoto, Rossi & Paglia, 2020). In these studies,

authors either focused on analysing specifically chosen countries, for instance China (He et al., 2020) or the US (Chowdhury & Abedin (2020)), on indices (Mazur et al., 2020), and industries (Mittal & Sharma 2020; Polemis & Soursou 2020). Others made comparisons between different indices (Bash 2020; Liu et al. 2020), sectors (He et al., 2020), industries and reactions (Narayan & Phan 2020). Based on the analyzed literature an area that has been under-explored is the reaction of Europe's major markets unlike the Asian and American markets, which are discussed thoroughly in the existing literature. Therefore, contributing to the present research, this paper aims to analyze one of Europe's major averages - DAX30 - and the reaction of important companies based on their industry during the event period through the event study methodology.

The paper continues as follows: in part 2, we review related literature on the effect of events related to the pandemic. The third part describes the research methodology, explaining the study's theoretical framework, the development of the hypotheses, and the empirical procedure of the event study methodology. The fourth part presents and discusses the results. Finally, the paper concludes highlighting its implications and pointing out areas of future work.

2. Literature Review

2.1. Event Studies on the Economic Impact of Covid

In one of the early papers on the topic, He et al. (2020) investigated the COVID–19's impact on stock prices across different sectors in the Chinese stock market. Using the event study method, they found that in certain industries the virus outbreak had a strong positive impact, while in other industries a severe negative impact. Another third group of industries, COVID-19 had less or insignificant impact (positive or negative).

Mazur, Dang, and Vega (2020) on the other hand focused in their paper on the reaction of S&P 500-listed companies, analysing their reaction in March 2020. For this purpose, they also utilized the event study method. Similarly, they found diverse results for the US-based companies; for example, the food, healthcare, and software industries were positively affected, while entertainment and hospitality were negatively affected – as expected. A very interesting finding was the strong negative correlation between negative stock returns and "extreme asymmetric volatility" (p.1). However, when looking at some of the companies' reactions, they noticed surprising results, such as approved cash bonuses in some cases or even salary increases.

Mittal and Sharma (2020) examined the impact of COVID-19 on stock returns of the Indian economy focusing on the Healthcare and Pharmaceutical sector. They found that during the event day all sectors and their respective indices experienced significant negative returns. In the post-event window, investors took note of the increasing demand of companies in the Healthcare and Pharmaceutical sector to supply the necessary medicine and equipment during the outbreak, by bulk buying their stocks to profit from their future high revenues. The post-event period for these two sectors gave optimistic returns of as high as 18%.

Chowdhury and Abedin (2020) analysed the impact of the COVID-19 pandemic on the major US stock indices by using three different statistical methods. Firstly, they applied the Generalized Autoregressive Conditional Heteroskedasticity (GARCH), secondly the Vector Autoregressive (VAR), and finally the Event study Method (ESM) models. They found that

there was a negative reaction of the US stock market with an increasing number of death cases, however, a significant positive correlation towards stock market volatility was also observed.

Bash (2020) performed a very broad international analysis by calculating the CARS for 30 different countries and stock market indices. For each of the events, they chose to use the day of the first officially registered virus case. Furthermore, they apply two models, the mean-adjusted returns and the market model method as well as a broad selection of event window lengths. Finally, they prove that the international stock market returns reaction is significantly negative.

By examining the reaction of 77 countries (three categories: developed, developing, and undeveloped) and their major indices, Liu et al. (2020) firstly noticed that the pandemic announcement shocked the markets, and secondly that countries with a higher GDP per capita recovered more rapidly than ones with a lower one. To conclude, the authors observed not only a relationship between GDP capita and market reaction but also that more stringent restrictions imposed by governments can alleviate investors' fears.

Harjoto, Rossi, and Paglia (2020) examined two relevant events: not only the WHO announcement regarding the pandemic on the 11th of March 2020 but also the Federal Reserve Bank announcement on the 9th of April 2020. Those two events represent first the shock and then the stimulus on the market. The authors found that COVID-19 caused a negative effect on the global stock markets, in particular on emerging markets and small firms. On the other side, the Fed stimulus resulted in higher positive abnormal returns on the US stock market, compared to other developed countries and emerging markets. Furthermore, the stimulus´s positive abnormal returns impacted the US large companies instead of the smaller ones.

Alali (2020) used the event study methodology analysing the effect of the WHO declaring COVID-19 as a global pandemic on the stock market returns of the five largest Asian stock markets. Two models, the Mean-adjusted Return Model as well as the Market Model were used for three different event window lengths ((-5,5), (-15,15), and (-30,30)). In line with other literature, Alali also found significant negative effects of the WHO announcement on stock market returns of the major Asian stock markets.

To prevent the spread of COVID-19, countries responded differently, by locking down economic activity and people's movement, with travel bans, and stimulus packages to cushion the extreme slowdown in economic activity and loss of jobs. Narayan and Phan (2020) analysed how the stock prices reacted to different steps during the COVID-19's evolution. The authors also examined the top-25 most affected countries' stocks' returns during the days the countries recorded virus cases and virus deaths (1st, 100th, 1000th, etc.) As expected, markets initially overreacted to the news of the virus outbreak but over time and with more information becoming available, governments became more comfortable dealing with the crisis, and the markets corrected.

Polemis and Soursou (2020) examined the impact of the pandemic on the stock returns of listed Greek companies in the energy sector specifically. Their findings show negative abnormal returns for most of the firms during the study period, however, divergence from the event day diffuses these effects.

2.2. Other Studies on Economic Impact of Covid

Not only event studies are used to analyse the effect of the pandemic in the current literature. One insightful paper is “The impact of COVID-19 on emerging stock markets" by Topcua and Gulalb (2020). The authors chose to use the Ordinary Least Square (OLS) regression method with robust standard errors, examining the emerging stock markets between March 10 and April 30, 2020. They found a diminishing negative impact of the pandemic with time and then tapering off during April. Furthermore, they compared different regions, finding the highest impact of outbreaks in Asian emerging markets, while lowest in European ones. Another important finding is that the “official response time” (p1.) and the strictness of the measures set by the governments were significant factors.

On a similar note, Khan et. Al (2020) investigated the impact the coronavirus had on the stock market of 16 countries. To do so, they divided the entire period of the study into four periods; a normal, a pre-event, a short-event window, and a longer-event window period and presented their results in three models. Here, the authors concluded that all markets underperformed during the short-event window (20th of January 2020 - 3rd of February 2020) showing a statistically significant difference in daily average returns. Noticeably, markets behaved the same during the later phase period (20/1/2020-3/4/2020) except for Shanghai’s Composite Index who even though was severely affected during the short-event window period showed signs of recovery and stabilization during the longer-event. The improvement could be attributed to the drastic measures taken by the Chinese government that regained investors' confidence.

Saad et al. (2020) published the same findings in their event study “Relationship between Share Price and COVID cases among all sectors in main market of Bursa Malaysia”, where using a multiple regression approach they detected a negative market reaction to more than half of the industries and a significant relationship between share price and the number of COVID cases.

Table 2 below gives a summary of the literature review used for this paper and provides each paper’s information such as author(s), observation and event period, research question, key findings, and other variables.

Table 2: Summary of Relevant Literature Review

No	Authors	Size	Obs.-Period & Event	Event Window length	Data Source	Research question	Key Findings	Journal
1	He, Sun, Zhang & Li	2,895 chinese companies	closure of Wuhan on January 23, 2020	(−30, 0) …. (0, 0) …. (0, +30)	not mentioned	market performance and response trends of Chinese industries to the COVID-19 pandemic	1. Negative CARs: transportation, mining, electricity & heating, and environment industries. 2. Positive CARs: Sports & Entertainment, information technology, education and health-care industries	Emerging Markets Finance and Trade
2	Mazur, Dang Vega	Standard and Poor's (S&P) 1,500 firms	2020 March 9th Merch 12th March 16th	(0,0)	Thomson Reuters Eikon	US stock market performance during the crash of March 2020 triggered by COVID-19	1. Positive returns: natural gas, food, healthcare & software 2. Negative returns: petroleum, real estate, entertainment, and hospitality sectors 3. Loser stocks exhibit extreme asymmetric volatility that correlates negatively with stock returns 4. Firms react in a variety of different ways to the COVID-19. The analysis of poorest performers reveals departures of senior executives, remuneration cuts & newly approved cash bonuses and salary increases	Finance Research Letters
3	Chowd-hury & Abedin	S&P500 & Dow Jones	1.01.2020-30.04.2020 Event: 20.01.2020	(0,0)	Yahoo finance	Impact of COVID-19 pandemic on the US stock market.	US stock market reacts negatively toward confirmed and death cases due to COVID-19, while death cases have a significant impact on stock market volatility	Accounting, Auditing & Accountability Journal

4	Bash	30 stock market indices	First registered case in each country	[–1, 1], [–3, 3], [–5, 5], [–10, 10], [–10, 15], [–10, 20]	European Centre for Disease Prevention	effect of the first registered case of COVID-19 for 30 stock market indices	Highly significant negative effects of COVID-19 on all index returns	International Journal of Economics and Financial Issues
5	Harjoto, Rossi, Paglia	MXWO, MXWOU, MXUS, MXEF, MXUSLC, MXUSSC	11 March 2020 9 April 2020 (FED)	Each (−10, +10)	Bloomberg	Effects of 2 events (Covid-19 and FED announcement) on different markets	1. COVID-19 caused a negative shock to the global stock markets, especially in emerging markets and for small firms 2. US stock market experienced positive CARs from the Fed stimulus compared to other developed countries and emerging markets	Applied Economics Letters
6	Rebucci, Hartley, Jiménez	sovereign bond yields & percent changes in exchange rates (appr. 1000 bs)	Dates of 30 Central Banks QE announcements (March and April 2020)	(0,0) (0,-1) (0,-2)	Bloomberg	Effect of 30 quantitative easings (QE) announcements made by 21 central banks on daily government bond yields and bilateral US dollar exchange rates	QE is effective in advanced economies and its international transmission is consistent with the working of long-run uncovered interest rate parity.	NBER WORKING PAPER SERIES
7	Polemis, Soursou	11 energy companies listed in ASE	Observation period: 2/12/19 - 2/7/20 Event: 23/3/20	(-10, +10) (-20, +20) (-50, +50)	Athens Stock Exchange, daily stock price information	How the pandemic influenced the returns of the majority of listed energy firms in the ASE after the Greek Prime Minister's general lockdown announcement (23/03/2020).	The pandemic negatively influenced the stock price returns	Energy Research Letters

8	AlAli, Musaed Sulaiman.	Shanghai SE, Nikkei 225, Bombay SE, Hang Seng Index, and South Korea KOSPI Composite Index	Observation period: 4/3/19 - 22/4/20 Event: 11/3/20	(-30, +30) (-15, +15) (-5, +5)	MSCI, Yahoo Finance	The Effect of WHO COVID-19 Announcement on Asian Stock Markets Returns: An Event Study Analysis.	Results obtained from this research show that the WHO announcement had a significant negative effect on stock market returns on all major Asian stock markets.	Journal of Economics and Business
9	Dinh Hoang Bach Phan & Paresh Kumar Narayan	25 countries and their indices	Multiple dates for each country examined	1.WHO declares it a pandemic 2.Lockdown measures 3.Stimulus package 4.Travel bans	Not Mentioned	How the stock price reacted in different stages of the COVID-19 evolution (day of 1st, 100th, 1000, 10000 cases were observed)	Results show lockdown measures were the most effective and countries that quickly took measures and applied a travel ban as well, were less severely negatively affected in comparison to other countries.	Emerging Markets Finance and Trade

Source: Created by the authors.

3. Empirical Procedure

3.1. Theoretical Framework - Efficient Market Hypothesis

> "*A market in which prices always fully reflect available information is called efficient*."
> - Fama E.F. (1970, p. 383)

The theoretical foundation describing the calculation of return changes of the stock price for a company´s evaluation is the efficient market hypothesis (EMH) (Fama, 1970). Since the real cost of the pandemics' influence are hard to assess, the market value of a company is often used to detect the resulting loss after an event. For the event study methodology, which will be described in detail later, the Efficient Market Hypothesis was found by Fama (1970) as the underlying theory.

As per this hypothesis, in efficient markets, investors evaluate a company as Vt, signifying the discounted value of its predicted future cash flow at time t. This implies that companies' value are mainly grounded on the investors' anticipation of future abnormal returns (ARs). Their anticipation is based on their given information, thus new information would alter their evaluation correspondingly. Subsequently, stock prices mirror available public information (Fama, 1970). Therefore, during a time t+1, the worth of a company is Vt+1 (Yayla & Hu, 2011). The difference between Vt and Vt+1 is ΔV, which shows the change of the company's value, resulting of new information. This means the stockholder´s negative or positive assessment of such information is supposed to be revealed in ΔV respectively. As a result, the examination of the financial market is representing the investors' anticipations on the future stability and value of a company (Yayla & Hu, 2011; Fama E. F., 1970).

In the case of a negatively perceived event, such as a lockdown, the EMH could hint at a negative ΔV following the announcement - following an assumption that investors would judge the lockdown as a likely hazard to the company's future cash flow.

Fama (1970) formulated three forms of market efficiency: the strong, semi-strong, and weak form. According to the strong form, any information, private and public, is shown in market prices. It is based on the premise that neither information asymmetry nor transaction costs exist, and that all depositors agree on a price (ibid.1970). Therefore, it would not be possible to outperform the market. Nevertheless, this form of efficiency hardly exists. As per the semi-strong form of market efficiency, all publicly available information (but not private) is displayed by the stock price. Accordingly, the availability of public information decides the price (ibid., 1970). Outperforming the market is merely doable with insider information. Fama (1970) proved the existence of this market form. However, the weak form of market efficiency is the most known one. It says that future prices incorporate only information of historical prices. If the past is the sole factor to predict future prices, consequently, it is unrealistic to outperform the market. Only if more variables impact the stock price, the market could be outperformed (ibid., 1970).

This analysis is based on the assumption of a semi-strong market. Firstly, it cannot be strongly efficient, due to lacking private information, the existence of transaction costs, and information asymmetries. Secondly, it is not weakly efficient, as the stock prices do not exclusively contain historical prices, but the expectations of future prices based on the lockdown announcement as

well. Since prices change after new public information, this analysis presupposes a semi-strong market.

3.2. Research Hypotheses

According to the literature, there were negative consequences worldwide connected to lockdown announcements, which had a negative influence on investors' valuation of a company's expected short term and long-term profits.

Accordingly, the first hypothesis is:

H1: The pandemic announcement had a negative effect on the German Index DAX30, as identified by negative cumulative abnormal returns on its stocks.

Since there is a difference between the business activities of specific companies and industries, it is assumed that they react in a different way to the pandemic declaration. Some could be affected more severely than others. Maybe some companies or industries even profit from the events. Therefore, this question should be analysed with the second hypothesis:

H2: The different industries of DAX30 are affected differently by the pandemic announcement.

3.3. Applying the Event Study Methodology

As described by the Efficient Market Hypothesis, the stock price should mirror a company's value, which ultimately depends on all public information (Fama, 1970). Therefore, price changes due to an event should expose the economic impact quite precisely, as they are relatively free of insider manipulation (Yayla & Hu, 2011). Other methods, for instance, studies based on accounting data are used less often, because managers can select accounting processes, making those figures less trustworthy (McWilliams & Siegel, 1997; Fama, 1970).

Consequently, the event study methodology is utilized commonly in finance or management and applied in various research areas such as mergers and acquisitions, stock splits, strategic alliances, or miscellaneous investment decisions (Yayla & Hu, 2011). Furthermore, event studies are common to assess the impact of a company's newly created CIO positions, IT investments, or web traffic announcements (Konchitchki & O'Leary, 2011).

Three central assumptions are the fundament of the event study methodology: Firstly, in line with Fama's EMH-theory the analysed market is semi-strongly efficient. Secondly, the specific events of interest must occur unforeseen by the market, so that they cannot affect the investors' actions before the event is happening. Thirdly, as described by MacKinlay (1997), it is postulated that there is no event clustering. That means, no other events are occurring in close time before or after the event of interest. Only that enables us to calculate the variance of the cumulative average abnormal returns without considering covariances between the events, so these are set to zero (MacKinlay, 1997).

MacKinlay's (1997) approach is considered best practice for event studies. This is why, it is being used in this thesis as well. His recommended steps are (1) definition of the event of interest and choice of firms analysed in the study; (2) identification of the event window; (3) estimation of a normal return being expected in the event window, if the event would not occur;

(4) calculation of the cumulative abnormal return during the event window; (5) testing for statistical significance (ibid., 1997).

In the first stage, the study sample is selected. In this study the event of interest is the COVID-19 pandemic announcement in March 2020. On Wednesday March 11, 2020, the WHO declared the rapidly spreading coronavirus outbreak a pandemic, acknowledging what seemed clear at the time; the virus will likely spread all over the world. The reason for choosing this day as the event of interest is its relevance - it is an international event of an international independent organization (WHO).

There have been a few moments and announcements, but none of such relevance. On January 27, 2020, the first case in Germany became known in the federal state of Bavaria. Slowly the number of cases was growing. One month later, on February 27th, facing a total of 26 confirmed cases, the German government established an "inter-ministerial national crisis management group" (Wieler et al, 2020). Followingly, all incoming travelers from high-risk areas had to provide information about their potential exposures and contact details. Furthermore, travel and mass gatherings were increasingly restricted. On March 10, Germany forbade mass gatherings with more than 1,000 persons one day before the WHO pandemic announcement. After that, in mid-March the federal states began to shut-down schools (Wieler et al, 2020). On March 18, non-EU citizens were barred from entering the EU for 30 days. On March 22, Chancellor Angela Merkel announced a light lockdown: implementation of a "contact ban," limiting public gatherings to two people, requiring physical distance of at least 1.5 meters, and closing many businesses (ibid., 2020).

In the next step the sample is chosen. We selected the market data of the companies traded in the index DAX30. The DAX is the most important German stock index. It measures the performance of the 30 largest and most liquid companies on the German stock market and represents around 80 percent of the market capitalization of listed stock corporations in Germany. The source of the financial data used is Yahoo!Finance. Table 3 below lists the 30 companies included in the DAX30 index as at March 2020 - indicating the industry of each company as per the classification by the Prime Standard[2] of the Frankfurt Stock Exchange Deutsche Börse AG, 2019).

Table 3: 30 companies listed in DAX30, their Ticker and Industry

Instrument	**Ticker**	**Industry**
BMW	BMW.DE	Automobile
Volkswagen Group	VOW3.DE	Automobile
Daimler	DAI.DE	Automobile
Continental	CON.DE	Automotive
Heidelberg Cement	HEI.DE	Basic Materials
Covestro	1COV.DE	Basic Materials
BASF	BAS.DE	Basic Materials
Linde	LIN.DE	Basic Materials
Deutsche Telekom	DTE.DE	Communication Services
Beiersdorf	BEI.DE	Consumer Goods
Henkel	HEN3.DE	Consumer Goods

[2] The Prime Standard relates to sectors and industries of the Frankfurt Stock Exchange, that list companies complying with a higher standard of reporting and disclosure than required by German law. Companies in Germany's DAX index have to meet Prime Standard requirements (Deutsche Börse AG, 2019).

Deutsche Bank	DBK.DE	Financial Services
Deutsche Borse	DB1.DE	Financial Services
Munich Re	MUV2.DE	Financial Services
Allianz	ALV.DE	Financial Services
Adidas	ADS.DE	Footwear
Fresenius Medical Care	FME.DE	Healthcare
Merck	MRK.DE	Healthcare
Fresenius	FRE.DE	Healthcare
Bayer	BAYN.DE	Healthcare
MTU Aero Engines	MTX.DE	Industrials
Deutsche Post	DPW.DE	Industrials
Siemens	SIE.DE	Industrials
Delivery Hero	DHER.DE	Online Food Ordering
Deutsche Wohnen	DWNI.DE	Real Estate
Vonovia	VNA.DE	Real Estate
Infineon Technologies	IFX.DE	Technology
SAP	SAP.DE	Technology
RWE	RWE.DE	Utilities
E.ON	EOAN.DE	Utilities

Source: Created by the authors.

We next consider the event window.

It is assumed that investors do not instantly react to the event, because information is needed before a potential reaction can follow (MacKinlay, 1997). Consequently, the event window must be longer than the specific event of interest - in this case, the announcement of the government. Therefore, the day before the lockdown announcement (due to potential information leak) and the day after (due to uncertainty or closed market), are normally integrated into the event window.

Classically, the event of interest itself is defined by day-0, whereas [-x,+y] shows the event window. Here -x signifies the number of days before the event and +y the number of days afterwards (Konchitchki & O'Leary, 2011).

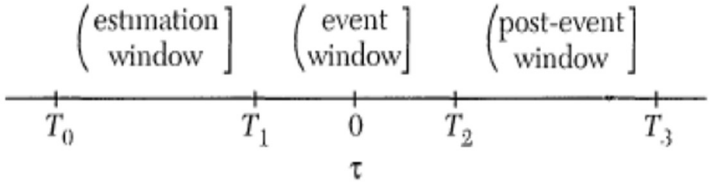
However, different studies have chosen other window lengths, as there is no scientific way to determine an “ideal” length. Still, the event window should be kept shorter, to diminish the risk of containing unrelated variables, which impact the stock price (MacKinlay, 1997). Another point is that a long event window can reduce the power of the test statistic. Furthermore, the length of the event window must be the same for all observations and not overlapping with the estimation window, which was used to estimate normal returns (ibid., 1997).

For this study, three event windows for the event are utilized to have a better overview and make a comparison of possible variations if needed. A longer window contains information leading towards the day of the event such as an increasing number of cases. A shorter window narrows the focus on the exact days around the event. The event windows are [-5;+5], [-10;+10], [-14;+14].

We next proceed to the estimation of a normal return.

The impact of the market response during the event window will be compared with an estimation period. Normally it is a substantial time window before the event window (MacKinlay, 1997).

Figure 1: Timeline of an event study.



Source: MacKinlay, 1997, p. 20

The event time is indicated by τ, where $\tau 0$ is the event date, T1 to T2 is the event window, T0 to T1 is the estimation window, and T2 to T3 the post-event window. Usually, there is a gap between the first two periods, to avoid overlap. The gap´s length needs to be determined carefully since a short gap decreases the possibility of differing company betas due to investments, leverage, or strategy changes. However, if it is too short, the estimation period could already include bias by the event, in case of information leak (ibid., 1997).

For this study, the estimation window length is set to 197 trading days. Therefore, beginning at day -233 and ending at day -33. It ends 33 days before the COVID-19 Pandemic announcement, one day before the first Covid case in Germany on the 27th of January.

The next stage is the calculation of the normal return. For that, the established models can be used, for instance, the market model or the Fama-French-three-factor model (Brown & Warner, 1985). As per Brown and Warner (1985), while single factor models show less variance, they give very similar results as more complex multifactor models. Those might reduce the ARs to some extent since they explain more volatility within the normal returns. However, according to the author, the marginal explanatory power of additional factors is small, meaning that the complex model has just limited advantages (ibid., 1985).

For that reason, in this study, the market model is used, which is commonly applied in practice and belongs to the category of single-factor models. The market model supposes a linear relationship between the market portfolio return (R_{mt}) and the return of security (R_{it}) (MacKinlay, 1997):

$$E[R_{it}] = \alpha_i + \beta_i * R_{mt} + e_{it}$$

$$E[\varepsilon_{it}] = 0 \qquad var[\varepsilon_{it}] = \sigma_{ej}^2$$

where $Rm\tau$ and $Ri\tau$ are the returns of the market portfolio and the security i, respectively. $E[Ri\tau]$ is the expected return of the security i. Further, a_i, β_i and $\sigma^2_{\varepsilon j}$ are the parameters of the model, e_{it} is the zero mean disturbance term (ibid., 1997).

After the estimation of the normal return, the abnormal return is computed, by deducting the normal from the de facto measured return. Thus, the abnormal return means the difference between the normal return (theoretically without any event) and the actual return (with the event):

$$AR_{it} = R_{it} - (\alpha_i + \beta_i * R_{mt})$$

where $ARit$ is a firm's abnormal return on the announcement day t=0. Rit is the actually measured return of a day in the event window (ibid., 1997).

Having determined a company's ARs of a given day, the ARs of all days in the event window (t1 to t2) are accumulated after that to calculate the cumulative abnormal returns (CARs) (ibid., 1997):

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it}$$

where $CARi$ embodies the cumulative abnormal return for the event i.

With a growing length of the event window, the $CARi$'s variance change (MacKinlay, 1997):

$$\sigma_i^2(t_1, t_2) = (t_2 - t_1 + 1)\sigma_{e_i}^2$$

To evaluate the average impact of one or more events on the sample, all cumulative abnormal returns of the companies are summed up and then divided by the number of the companies, in our case 30:

$$CAAR = \frac{1}{n}\sum_{i=1}^{n} CAR_i$$

where $CAAR$ is the cumulative average abnormal return of the event in the full sample (ibid. 1997).

For the validation of the event study's results, the t-test is used. It is applied to test the null hypothesis, that the cumulative average abnormal returns are not significantly different from zero.

The t-test the basic parametric test, consistently assuming a standard normal distribution of the calculated ARs. For event studies the t-test, which was developed by Brown and Warner (1985) and was calculated as follows:

$$t = \frac{CAAR_{[t_1,t_2]}}{\sigma_{CAAR_{[t_1,t_2]}}}$$

Where the standard deviation is defined as:

$$\sigma_{CAAR_{[t_1,t_2]}} = \frac{1}{n-d}\sum_{i=1}^{n}(CAR_{i(t_1,t_2)} - CAAR_{i(t_1,t_2)})^2$$

4. Discussion of Results

Tables 4 and 5 show the impact of the COVID-19 pandemic declaration on the DAX30 index. Looking at the total of DAX30 (see tables 4 and 5) one can notice that the index had negative returns in all three event windows. Table 4 summarizes the direct comparison of DAX30 returns between the estimation period and event windows. While the DAX30 returns in the estimation period were positive (14.03%) for all three event windows the returns were strongly negative, between -22.71% to -30,39%. Therefore, the first hypothesis cannot be rejected, which was:

H1: The pandemic announcement had a negative effect on the German Index DAX30, as identified by negative cumulative abnormal returns on its stocks.

Table 4: Comparison of estimation and event window % of Change on returns of DAX30 Index

% Change on DAX30 returns during different periods			
Estimation Period (-230,-33)	**(-5,+5)**	**(-10,+10)**	**(-14,+14)**
14.03%	-30.39%	-22.71%	-27.28%

In the following, the effects on each of the industries will be explained to answer the second Hypotheses:

H2: The different industries of DAX30 are affected differently by the pandemic announcement.

Table 5 shows the impact of the COVID-19 pandemic declaration on the market value of the 13 industries in Germany's index DAX.

Table 5: CAR & t-test on the different industry traded on Dax during Covid-19 pandemic announcement based on different event windows.

CAR (%) t-test	**Event Window**				
Industry		[-5, +5]	[-10, +10]	[-14, +14]	**Average**
Automobile	CAR	**-0.0600 *****	**0.05851 *****	0.00765	**0.204%**
	t-test	**-6.238**	**6.079**	0.796	
Automotive	CAR	**-0.0849 *****	**-0.0531 *****	**-0.0448 *****	**-6.098%**
	t-test	**-5.825**	**-3.642**	**-3.071**	
Basic Materials	CAR	**0.10449 *****	**0.02688 *****	**0.04768 *****	**5.969%**
	t-test	**10.393**	**2.674**	**4.743**	
Communication Services	CAR	**-0.1544 *****	**-0.1505 *****	**-0.1299 *****	**-14.500%**
	t-test	**-24.056**	**-23.453**	**-20.236**	
Consumer Goods	CAR	-0.0011	**-0.0906 *****	**-0.0551 *****	**-4.898%**
	t-test	-0.115	**-8.805**	**-5.355**	
Financial	CAR	**-0.1186 *****	**-0.0465 *****	**-0.0850 *****	**-8.340%**

Services					
	t-test	**-16.243**	**-6.379**	**-11.644**	
Footwear	CAR	**-0.0489 *****	**0.02940 ****	**-0.0313 ****	**-1.694%**
	t-test	**-3.559**	**2.140**	**-2.279**	
Healthcare	CAR	-0.0053	**-0.0515 *****	-0.0195	**-2.546%**
	t-test	-0.451	**-4.352**	-1.649	
Industrials	CAR	**-0.1328 *****	**-0.0882 *****	**-0.0757 *****	**-9.894%**
	t-test	**-14.611**	**-9.701**	**-8.333**	
Online Food Ordering	CAR	**0.09446 *****	**0.17482 *****	0.03141	**10.023%**
	t-test	**3.852**	**7.128**	1.281	
Real Estate	CAR	**-0.2306 *****	**-0.1054 *****	**-0.1391 *****	**-15.840%**
	t-test	**-15.981**	**-7.306**	**-9.643**	
Technology	CAR	**0.13058 *****	**0.11270 *****	**0.13923 *****	**3.008%**
	t-test	**9.014**	**7.780**	**9.611**	
Utilities	CAR	**-0.1617 *****	**-0.1685 *****	**-0.1953 *****	**-17.521%**
	t-test	**-13.596**	**-14.172**	**-16.425**	
Average		**-7.396%**	**-2.710%**	**-4.231%**	

*CAR stands for cumulative abnormal return. The abscissa represents the event window and the ordinate represents the industry. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.*

It can be seen in Table 5 that, in the short event periods [-5;5], the value of companies of the industries Automobile, Footwear, Automotive, Communication Services, Financial Services, Industrials, Real Estate, Utilities all significantly declined.

In contrary fashion, the industries of Basic Materials, Online Food Ordering and Technology experienced positive returns and continued to rise, even though in the longer window Online Food Ordering industry returns are not significant. Consumer Goods and Healthcare were not significantly affected in the shorter window, but both industries experienced negative returns during the [-10;10] period. Finally, Healthcare was not affected during the longer window while Consumer Goods was still in the negative returns.

As the event windows become longer, certain industries seem to deviate from their shorter event window returns. For instance, the Automobile industry was significantly hit in the shorter event period when the pandemic broke out but rebounded in the subsequent event window and became insignificant in the longer event window. Another example is the Footwear industry, which went, from the negative returns of the shorter window, to significant positive returns in the subsequent and longer event ones.

To discuss in more detail the impact of COVID-19 on various industries, Figures 1-3 below show the CARs across the industries during the three event windows. More detailed information on the performance of all the companies is provided in Tables A1-A6 in Appendix A.

Overall, most of the industries suffered strong negative impacts. Among them, Communication Services, Real Estate and Utilities were the ones most severely affected. When the COVID-19 pandemic intensified globally, most of the industries took precautions. Thereby some industry's active core businesses were more affected than those of others.

Figure 2:CAR & t-test on the different industry traded on Dax during Covid-19 pandemic announcement based on different event windows.

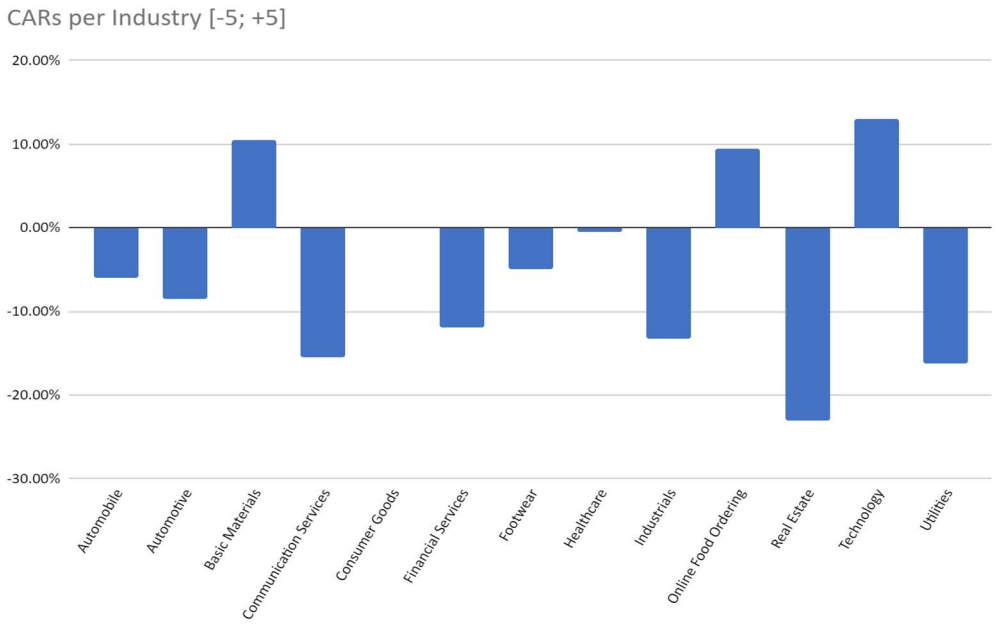


Figure 3: Cumulative Abnormal Return per Industry for the event window [-10;10]

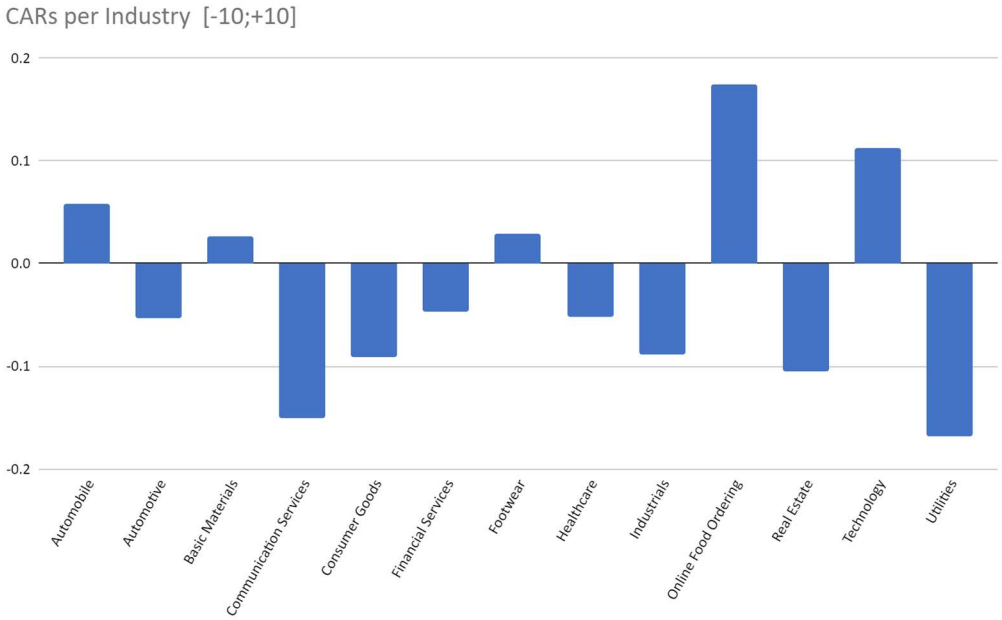
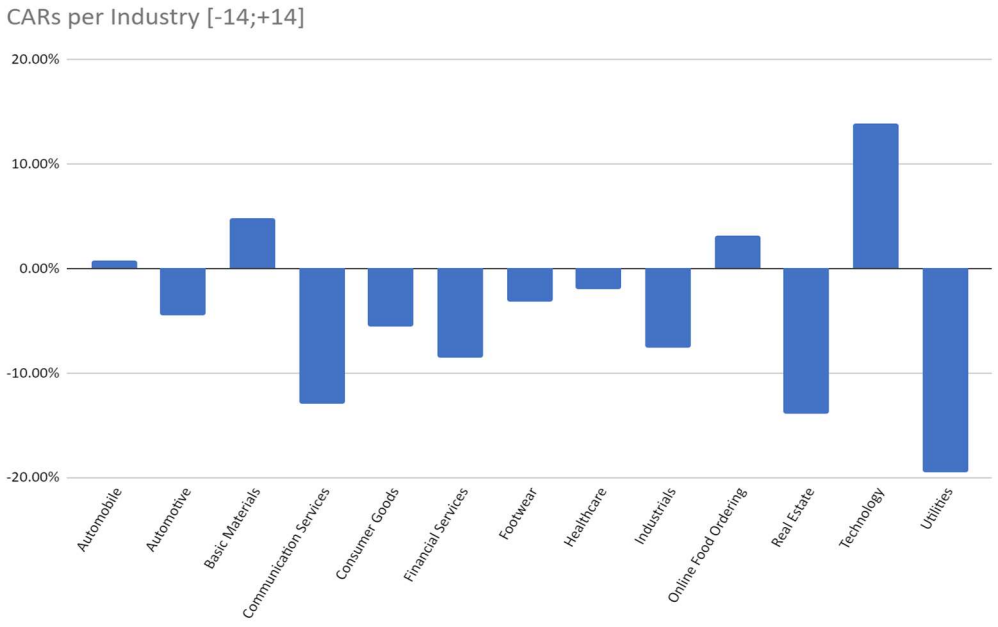


Figure 4: Cumulative Abnormal Return per Industry for the event window [-14;14]



One instance is the *Automotive* industry, which is represented solely in DAX30 by the company Continental, the second biggest Automotive supplier in the world. The company was negatively affected by the pandemic declaration with a strong significance over all three event windows, with CARs between -4.5% to -8.5%. Even though the company already suffered under decreasing market value since a peak in 2018, the impact of the declaration announcement affected the value of the company even more. This can be explained firstly, with a slowing down of their manufacturing activities and secondly, with supply chain bottlenecks for certain components. In Manufacturing many electronic parts are coming from China, where the pandemic broke out earlier, leading to production stops and break down of the supply (Reuters, 2020).

The *Real Estate* industry was severely affected by the pandemic declaration, and the significance was strong in all three event windows, having an average CAR of appr. -15.84% (Table 5). The two companies forming this industry and listed on the DAX30 are Vonovia and Deutsche Wohnen - companies that are renting out both office space and even more apartments. During the COVID-19 outbreak some companies reacted quickly with relocating their businesses in a work-from-home environment before the official lockdown started. The bigger customer group of Vonovia and Deutsche Wohnen is the civil population - people moving into new apartments, as well as people migrating to Germany. The demand for more living space was rising extremely in the past years. The sudden outbreak of the pandemic, leading to economic crisis and rising unemployment caused investor's fears of a dropping demand in living space and more importantly of rent defaults. This led to underperformance of those two Real Estate companies and the industry in general (Evertz, 2020).

The *Utilities* industry was severely negatively affected in all three event windows, with an average CAR of appr. -17.52% (Table 5). Starting with the first COVID-19 cases in Germany and continuing through several lockdowns, Utilities were one of the industries that were immediately and strongly negatively affected. Supply chains and general operations were disrupted due to the physical distancing and on-site restrictions imposed by the government (Booth et al. 2020). One important burden for the Utilities industry was the sudden drop of

demand. Since a big part of Germany's industries and factories narrowed down their business activities, less use of energy was needed (ibid. 2020). Consequently, two of the biggest Energy supply companies RWE and E.ON (DAX 30 listed) suffered significant losses.

Another negatively affected industry, in all three event windows, was the *Financial Services* - being represented in DAX30 by Deutsche Bank (Bank), Deutsche Börse (Securities Market), Munich Re and Allianz (Insurance Companies). The financial sector generally took a big hit due to the shock of the macroeconomic supply and demand (Strietzel et al., 2020). The uncertainty of the outcome of this pandemic affected this industry for many reasons such as banks having to lower interest rates, a fear of increasing number of insolvencies spotted and higher loan loss provisions (ibid., 2020). Similarly, the insurance companies included in this industry, Munich Re and Allianz, had significantly lower revenues. One possible explanation would be investors fearing high insurance policy fees caused by financial problems of insurance's clients.

Communication services industry, represented by the company Telekom, was negatively affected with strong significance. This was explained by the company itself with "impact on sales" (Fuchs, 2020), due to the closure of shops, lower roaming sales and the postponement or elimination of IT projects in companies. These reasons, alongside investors' fear could have caused a major sell-off of the company's shares.

Regarding the *Footwear* industry consisting only of one company - Adidas - the coronavirus disease caused a standstill on the majority of the company's business (Herzogenaurach, 2020). More than 70% of the company's global store base was forced to close, affecting revenues in all regions that Adidas operates, especially in the Asian markets. Most of Adidas supply chain structure depends on these markets and the impact was big. However, e-commerce channels partially offset the declines in revenue caused by the company's physical channels by experiencing huge growth during the early stages of 2020. In two out of the three windows examined, Adidas' reaction was negative with strong significance. Overall, the impact of the pandemic on the Footwear industry can also be seen in other similar Retail businesses.

A big portion of the GDP in Germany comes from their export-oriented economy. *Industrials* was one of the industries that suffered the most losses. This is merely due to the fact that one of the industrial companies MTU Aero Engines, lost approximately 40% of its market capitalization. The company is one important player in the production and maintenance of engines in the civil as well as military industry. In fact, these losses of MTU Aero Engines were the most severe among all companies traded on DAX30 (Knieps, 2020). Reasons can be the lower performance in the aviation sector - which had to slow down activities, pause their orders and therefore led to less demand in Aero Engines.

The industry *Consumer Goods*, containing the companies Henkel and Beiersdorf, was negatively affected as well, having average CARs of approximately -5%. Compared to other industries it was affected less severely. However, the decline can be explained by investors assuming a slightly lower decline for consumer goods, due to several reasons. For instance, according to Henkels half-year performance report on one hand one main customer group of Henkel are hair and beauty salons, which reduced their demand of beauty products (Bloomberg, 2020). On the other hand, end consumers continued to purchase the products or even increased their demand (ibid.,2020).

On the other hand, the Pandemic announcement also had positive effects on certain industries and companies of the DAX30. The fact that people were advised to stay home and/or minimize social gatherings is possibly one of the reasons that the *Online Food Ordering* industry reached new highs and was one of the few industries that benefited positively (average CAR of 10%). The industry is represented in DAX30 by only one company - Delivery Hero, that managed to increase their orders and revenues during this time which consequently led to a rise in their stock price. In fact, the Berlin-based company revenue was 2.9 billion euros ($3.39 billion) in 2020, up 95% year-on-year and at the upper end of its own forecast of 2.7-2.8 billion euros. (Reuter Staff, 2020).

The *Basic Material* industry was significantly positively affected by the event. The industry contains four companies: Heidelberg Cement, BASF, Covestro and Linde. The high positive impact is mainly due to Covestro, one of the world's leading manufacturers of high-tech polymer materials for all key industries. What may have triggered the overperformance of Basic materials such as cement, chemicals, and gases, is the perception as a 'safe haven' for investors to turn to, when the rest of the market is uncertain.

The *Technology* industry is perhaps one that was more suited for and ready to absorb the shock created by the pandemic declaration. Out of all the industries, it showed the greatest positive reaction, mainly because there was a higher demand for their high-performance technological resources for COVID-19 related research to be utilized (Evans, 2020). Companies like SAP had no problems continuing business as usual even with most people working from home, in contrast with other less technologically advanced companies. Just by enabling people to continue their daily regular tasks remotely, whether talking about working, shopping or learning, the technology industry has allowed the preservation of some semblance of a normal lifestyle (ibid. 2020).

After seeing companies being affected strongly negative or positive, two industries did not show clear results, Automotive and Healthcare.

The *Automobile* industry had contradictory results for different event windows: the shorter event window showed slightly negative but significant CARs of -0.06, while the middle-length window showed slightly positive significant CARs of 0.06 and the longest event window was insignificant. Consequently, no strong conclusions can be drawn from these CARs.

The results for *Healthcare* were slightly negative CARs (appr. -2.55%), even though insignificant for two out of three event windows. However, the results are surprising because they are not meeting the expectations of the literature. All four companies in the industry - Merck, Fresenius, Fresenius Medical Care, Bayer – did not overreact. One possible explanation could be that news of positive developments through the pandemic probably came at a later stage after the event windows. During the event window, the market did not show a clear, significant reaction, neither negative nor positive. Therefore, no solid explanations for the CARs can be given.

After examining each industry, all in all, the second hypothesis cannot be rejected and therefore supports the assumption that industries were affected in a different way by the pandemic declaration.

5. Conclusions and Future Research

This research paper aimed to identify and analyse the impact of the COVID-19 outbreak, specifically the pandemic announcement on March 11, 2020, on companies listed on the German DAX30 index, by using the event study methodology for three different event windows. What can be observed is that the German market reacted negatively on the news regarding the novel coronavirus in all three event windows under examination.

Furthermore, the results show different reactions based on the underlying industries that are examined. It was mirroring the investors' expectations that certain companies would perform either negatively or positively as a result of the current news. For example, certain traditional industries were heavily affected on the negative side due to a loss of investor´s trust in the companies (Utilities, Real Estate etc.). While others that were seen as more prepared for virtual working and in line with demand shifts, performed much better, even showing positive returns (Technology, Basic Materials, etc.). These results indicate that potential investors trusting to invest in certain industries during the first stages of the outbreak, as opposed to other specific industries that merely depend on the Asian markets supply chain or that faced less demand of their products (i.e. Automotive, Industrials).

Since this paper focuses on the very short-term effects on the Covid-19 pandemic declaration, the long-term effects could be examined in future research. In a few years, the event will be looked at and compared with the following developments of the different industries. Some might lose in the longer-term, others might even profit from the Virus outbreak, in addition to the possible 'new status quo' it has created. Possible trends can increase remote work, decreasing in this way business and vocational traveling, which can also lead to a global shift in demand. The paper had its focus on analysing the German stock market. The approach can be applied to other countries or markets as well, comparing the performance between different industries or companies.

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Appendix A: Details of Cumulative Abnormal Returns (CARs) Calculations for DAX30 Companies and Industry for Three Different Event Windows.

Table A 1:Cumulative Abnormal Return per Company for the event window [-5,5]

Company	Industry	CAR	t-test	Significance	Reaction
BMW	Automobile	-0.84%	-1.032490884	-	Negative
Volkswagen Group	Automobile	-15.44%	-15.3433197	***	Negative
Daimler	Automobile	-1.73%	-1.623396177	-	Negative
Continental	Automotive	-8.50%	-5.825290832	***	Negative
Heidelberg Cement	Basic Materials	-13.24%	-12.45881891	***	Negative
Covestro	Basic Materials	27.17%	22.02385192	***	Positive
BASF	Basic Materials	13.49%	16.34915596	***	Positive
Linde	Basic Materials	14.38%	15.01871002	***	Positive
Deutsche Telekom	Communication Services	-15.45%	-24.05622147	***	Negative
Beiersdorf	Consumer Goods	3.30%	3.539646945	***	Positive
Henkel	Consumer Goods	-3.53%	-3.132309106	***	Negative
Deutsche Bank	Financial Services	17.80%	10.2051623	***	Positive
Deutsche Borse	Financial Services	-20.73%	-19.32086225	***	Negative
Munich Re	Financial Services	-26.04%	-43.50170226	***	Negative
Allianz	Financial Services	-18.47%	-35.57882666	***	Negative
Adidas	Footwear	-4.89%	-3.559301815	***	Negative
Fresenius Medical Care	Healthcare	12.84%	10.29961779	***	Positive
Merck	Healthcare	-15.49%	-14.96818241	***	Negative
Fresenius	Healthcare	-11.62%	-10.19833613	***	Negative
Bayer	Healthcare	12.14%	8.818032445	***	Positive
MTU Aero Engines	Industrials	-42.62%	-35.14168679	***	Negative
Deutsche Post	Industrials	3.93%	5.575189844	***	Positive
Siemens	Industrials	-1.16%	-1.434651822	-	Negative
Delivery Hero	Online Food Ordering	9.45%	3.851855323	***	Positive
Deutsche Wohnen	Real Estate	-22.27%	-13.7311679	***	Negative
Vonovia	Real Estate	-23.85%	-18.86582526	***	Negative
Infineon Technologies	Technology	2.63%	1.607060977	-	Positive
SAP	Technology	23.49%	18.6279532	***	Positive
RWE	Utilities	-22.42%	-15.94719741	***	Negative
E.ON	Utilities	-9.93%	-10.19913597	***	Negative

Table A 2: Cumulative Abnormal Return per Industry for the event window [-5,5]

Industry	CAR	t-test	Significance	Reaction
Automobile	-6.01%	-6.238304391	***	Negative
Automotive	-8.50%	-5.825290832	***	Negative
Basic Materials	10.45%	10.39276104	***	Positive
Communication Services	-15.45%	-24.05622147	***	Negative
Consumer Goods	-0.12%	-0.1154767878	-	Negative
Financial Services	-11.86%	-16.24347324	***	Negative
Footwear	-4.89%	-3.559301815	***	Negative
Healthcare	-0.53%	-0.4505446478	-	Negative
Industrials	-13.28%	-14.61090406	***	Negative
Online Food Ordering	9.45%	3.851855323	***	Positive
Real Estate	-23.06%	-15.98053677	***	Negative
Technology	13.06%	9.014300054	***	Positive
Utilities	-16.17%	-13.59567429	***	Negative

Table A 3: Cumulative Abnormal Return per Company for the event window [-10,10]

Company	Industry	CAR	t-test	Significance	Reaction
BMW	Automobile	3.38%	4.148639255	***	Positive
Volkswagen Group	Automobile	1.19%	1.183569246	-	Positive
Daimler	Automobile	12.98%	12.17135919	***	Positive
Continental	Automotive	-5.31%	-3.642033958	***	Negative
Heidelberg Cement	Basic Materials	-17.31%	-16.28717034	***	Negative
Covestro	Basic Materials	16.51%	13.38269942	***	Positive
BASF	Basic Materials	4.15%	5.025963274	***	Positive
Linde	Basic Materials	7.41%	7.73907325	***	Positive
Deutsche Telekom	Communication Services	-15.06%	-23.4534796	***	Negative
Beiersdorf	Consumer Goods	2.13%	2.286129629	**	Positive
Henkel	Consumer Goods	-6.42%	-5.690478951	***	Negative
Deutsche Bank	Financial Services	9.42%	5.404701563	***	Positive
Deutsche Borse	Financial Services	-8.30%	-7.73781077	***	Negative
Munich Re	Financial Services	-13.34%	-22.28162314	***	Negative
Allianz	Financial Services	-6.42%	-12.3586991	***	Negative
Adidas	Footwear	2.94%	2.139855009	**	Positive
Fresenius Medical Care	Healthcare	-3.58%	-2.869857124	***	Negative
Merck	Healthcare	-9.93%	-9.598799304	***	Negative
Fresenius	Healthcare	-6.34%	-5.559825126	***	Negative
Bayer	Healthcare	-0.75%	-0.5484154582	-	Negative
MTU Aero Engines	Industrials	-34.18%	-28.18446172	***	Negative
Deutsche Post	Industrials	3.96%	5.623114524	***	Positive
Siemens	Industrials	3.76%	4.637746835	***	Positive
Delivery Hero	Online Food Ordering	17.48%	7.128160903	***	Positive
Deutsche Wohnen	Real Estate	-6.52%	-4.019422845	***	Negative
Vonovia	Real Estate	-14.57%	-11.52259755	***	Negative
Infineon Technologies	Technology	7.87%	4.809483689	***	Positive
SAP	Technology	14.67%	11.63576533	***	Positive
RWE	Utilities	-20.76%	-14.77059158	***	Negative
E.ON	Utilities	-12.95%	-13.30781994	***	Negative

Table A 4: Cumulative Abnormal Return per Industry for the event window [-10,10]

Industry	CAR	t-test	Significance	Reaction
Automobile	0.05851806058	6.078742074	***	Positive
Automotive	-0.05314214182	-3.642033958	***	Negative
Basic Materials	0.02688616591	2.674132539	***	Positive
Communication Services	-0.1505941392	-23.4534796	***	Negative
Consumer Goods	-0.09063501796	-8.804507016	***	Negative
Financial Services	-0.04657710052	-6.37878614	***	Negative
Footwear	0.0294085801	2.139855009	**	Positive
Healthcare	-0.05151303664	-4.351725481	***	Negative
Industrials	-0.08820143191	-9.701071414	***	Negative
Online Food Ordering	0.1748235995	7.128160903	***	Positive
Real Estate	-0.1054398163	-7.306381737	***	Negative
Technology	0.1127096253	7.780179906	***	Positive
Utilities	-0.1685638883	-14.17217394	***	Negative

Table A 5: Cumulative Abnormal Return per Company for the event window [-14,14]

Company	Industry	CAR	t-test	Significance	Reaction
BMW	Automobile	4.94%	6.062852509	***	Positive
Volkswagen Group	Automobile	-7.47%	-7.418641997	***	Negative
Daimler	Automobile	7.67%	7.189347132	***	Positive
Continental	Automotive	-4.48%	-3.071217046	***	Negative
Heidelberg Cement	Basic Materials	-7.45%	-7.01126198	***	Negative
Covestro	Basic Materials	19.18%	15.54940747	***	Positive
BASF	Basic Materials	8.27%	10.02996338	***	Positive
Linde	Basic Materials	11.34%	11.84142702	***	Positive
Deutsche Telekom	Communication Services	-12.99%	-20.23550568	***	Negative
Beiersdorf	Consumer Goods	-5.60%	-6.016951631	***	Negative
Henkel	Consumer Goods	-5.42%	-4.809271478	***	Negative
Deutsche Bank	Financial Services	0.50%	0.2892330635	-	Positive
Deutsche Borse	Financial Services	-5.96%	-5.551178857	***	Negative
Munich Re	Financial Services	-20.64%	-34.47354682	***	Negative
Allianz	Financial Services	-6.42%	-12.3586991	***	Negative
Adidas	Footwear	-3.13%	-2.278837589	**	Negative
Fresenius Medical Care	Healthcare	6.84%	5.484761516	***	Positive
Merck	Healthcare	-13.98%	-13.50318934	***	Negative
Fresenius	Healthcare	-1.99%	-1.749904094	*	Negative
Bayer	Healthcare	1.32%	0.9599598724	-	Positive
MTU Aero Engines	Industrials	-43.43%	-35.81225417	***	Negative
Deutsche Post	Industrials	6.89%	5.682887174	***	Positive
Siemens	Industrials	5.60%	6.910243922	***	Positive
Delivery Hero	Online Food Ordering	3.14%	1.280749193	-	Positive
Deutsche Wohnen	Real Estate	-7.73%	-4.763800829	***	Negative
Vonovia	Real Estate	-16.54%	-13.08095433	***	Negative
Infineon Technologies	Technology	8.31%	5.080546028	***	Positive
SAP	Technology	19.53%	15.49206592	***	Positive
RWE	Utilities	-22.40%	-15.93870934	***	Negative
E.ON	Utilities	-9.32%	-9.574455808	***	Negative

Table A 6: Cumulative Abnormal Return per Industry for the event window [-14,14]

Industry	CAR	t-test	Significance	Reaction
Automobile	0.77%	0.7956334332	-	Positive
Automotive	-4.48%	-3.071217046	***	Negative
Basic Materials	4.77%	4.742861968	***	Positive
Communication Services	-12.99%	-20.23550568	***	Negative
Consumer Goods	-5.51%	-5.355343497	***	Negative
Financial Services	-8.50%	-11.64429849	***	Negative
Footwear	-3.13%	-2.278837589	**	Negative
Healthcare	-1.95%	-1.64922775	-	Negative
Industrials	-7.58%	-8.333475262	***	Negative
Online Food Ordering	3.14%	1.280749193	-	Positive
Real Estate	-13.92%	-9.642513311	***	Negative
Technology	13.92%	9.611484595	***	Positive
Utilities	-19.54%	-16.42546631	***	Negative