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### The first wave impact of the COVID-19 pandemic on the Nasdaq Helsinki stock exchange: Weak signal detection with managerial implications

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# The first wave impact of the COVID-19 pandemic on the Nasdaq Helsinki stock exchange: Weak signal detection with managerial implications

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**ABSTRACT** The global pandemic caused by the coronavirus disease (COVID-19) came mostly as a surprise and had a major effect on the global economy. This type of major events that can bring societies to nearly a total standstill are difficult to predict but have a significant impact on business activities. Nevertheless, weak signals might be possible to detect beforehand to enable preparation for the impact, both globally and locally. This study analyses the impact of the first wave of the COVID-19 pandemic on the Nasdaq Helsinki stock exchange by utilising large-scale media analytics. This entails gaining data through media monitoring over the entire duration of the pandemic by applying black-box algorithms and advanced analytics on real cases. The data analysis is carried out to understand the impact of a such global event in general, while aiming to learn from the potential weak signals to enable future market intelligence to prepare for similar events. A social media firestorm scale, similar to the Richter scale for earthquakes or Sapphir-Simpson scale for hurricanes, is utilised to support the analysis and assist in explaining the phenomenon. The results indicate that pandemics and their impact on markets can be studied as a subset of a media firestorms that produce a shark-fin type of pattern in analytics. The findings indicate that early signals from such events are possible to detect by means of media monitoring, and that the stock exchange behaviour is affected. The implications include highlighting the importance of weak signal detection from abundant data to have the possibility to instigate preventive actions and prepare for such events to avoid maximum negative business impact. The early reaction to this type of events requires a very streamlined connection between market intelligence and different business activities.

**KEYWORDS** Covid-19, early signals, Nasdaq Helsinki, signal detection, social media

## 1. INTRODUCTION

The contagious coronavirus disease (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) first identified in Wuhan, China in December 2019 caused a large global outbreak and major public health issue (Lu et al., 2020). The World Health Organization (WHO) declared COVID-19 a pandemic on 11 March 2020 (Ferrer, 2020). These types of rare and unpredictable outlier events, which can have extreme

impacts, resemble the black swan events (Taleb, 2007): phenomena with almost zero beforehand predictivity and a large global influence.

Analysing the impacts of the pandemic can prove lucrative as the COVID-19 coronavirus pandemic resulted in global lockdowns, sharply curtailing economic activity, while representing a unique experiment with substantial impacts. In the northern Europe, in Finland, the Nasdaq Helsinki stock exchange companies were also hit by COVID-19, the

pandemic influencing the valuation of most listed companies. Studies covering the impact of the pandemic on the stock markets have started to emerge. However, the previous research is yet to present a more detailed timeline of the events and to cover and discover possible early warning signals of the event. Specifically, large-scale media analytics over the period have not been applied for the purpose.

This study analyses the impact of pandemic events on the Nasdaq Helsinki stock exchange (OMHX). The pandemic caused by the coronavirus disease and the course of events are analysed by the means of large-scale media analysis, covering the events from the very first stages for a period of more than a year and a half. The impact of COVID-19 is attempted to be understood in general, in terms of the media coverage and the simultaneous events in the stock exchange. The analysis consists of machine-learning based large-scale media analytics to cover a vast pool of media. Instead of a before-and-after approach on the impact on the stock exchange, a higher-level general event influence analysis is carried out. Specific focus is on the influence of the first wave of COVID-19 by dividing it to stages (Figure 1).

This paper is organised as follows: a brief literature survey is provided in section 2, followed by the detailed description of the research method in section 3, followed by the impact analysis of the corona pandemic in section 4. The discussion in section 5 further addresses the experienced phenomenon in the context of the study and discusses the relevant implications. Finally, the paper is concluded.

## 2. LITERATURE REVIEW

The coronavirus created a global, national, societal, regional, political, economic and commercial crisis, which can be characterised as a disruptive period of instability, uncertainty, and danger, but at the same time, a period of accelerated diffusion of digital technologies and initiatives (Karabag, 2020). This type of crisis influences risk management and decision-making under uncertainty (Aven, 2013). The impacts of the COVID-19 coronavirus pandemic include short-term decreases in emissions, consequences on the deployment of macroeconomic monetary and fiscal stimuli, investments in green deals, and possible further deglobalisation (Helm, 2020), impacts on travel and tourism (Li et al., 2020), and mandatory closures and reopening of businesses (Walmsley et al., 2021).

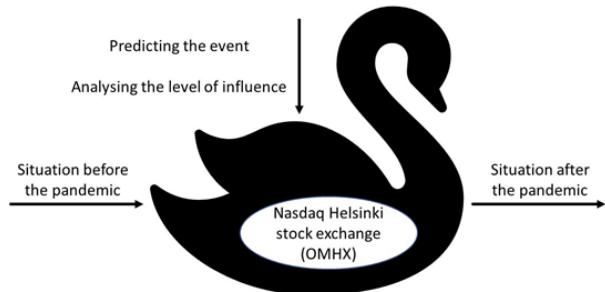


Figure 1 The research setting.

The influence of market reactions to unanticipated, catastrophic events, has been studied for example in the case of the 9/11 terrorist attacks in the USA (Carter & Simkins, 2004), and in the case of war (Schneider & Troeger, 2006). Generally, in case of any unexpected news, the markets tend to over-react and as more information becomes available and people understand the influences, the market seems to correct itself (Phan & Narayan, 2020). Concerning the stock markets, the consumer industry in the Chinese stock market was transitorily impacted by the pandemic in the first three trading days following the start of the pandemic (Yan & Qian, 2020). Significant negative effects on Chinese stock returns were observed across all companies (Al-Awadhi et al., 2020). Also, in Africa, stock markets reduced significantly during and after the start of the COVID-19 pandemic, usually between -2.7 % and -20 %, while the effects were restrictive (Takyi & Bentum-Ennin, 2021). In the USA, the initial impact on the stock market was in the same ballpark as the Great Crash of 1929, the Great Depression Crash of 1933, and the Black Monday Crash of 1987 (Contessi & De Pace, 2021). In Europe, the stock markets also showed volatility, some markets being more volatile than others (Aslam et al., 2021). The impact of pandemics on macroeconomic performance has aroused research attention, while many studies have attempted to explore the effect on the financial markets. These studies indicate the large economic cost of pandemics (Elnahas et al., 2018, Bloom et al., 2018). Table 1 lists further studies that have a focus on COVID-19 and the related impacts.

When starting to investigate the influence of any unanticipated significant crisis, explanations can be sought by looking at black swan events as defined by Taleb (2007), or other relevant concepts such as emerging risk. Emerging risk can be considered meaningful and complementary by relating it to known unknowns and black swans to unknown knowns, unknown unknowns, and a subset of

known knowns (Flage & Aven, 2015). The unknown unknowns that involve the lack of awareness, in practice or in principle, are also referred to as black swans by Taleb (2007) and have been linked to seeking for patterns to reveal risks (Leidner & Schilder, 2010). The research on Black Swan events in general can

be divided into three different stages – pre-black swan event, about the black swan event, and post-black swan event (Parameswar *et al.*, 2021). Social media monitoring, despite its challenges, provides means for the market intelligence function to discover similar events (Töllinen *et al.*, 2012).

*Table 1* Studies focusing on the impacts of COVID-19.

Focus	Methodology	Reference
March 2020 stock market crash triggered by COVID-19. S&P1500 evidence.	Event-study methodology	(Mazur <i>et al.</i> 2021)
COVID-19 generated negative shocks on the equity markets.	Event-study method	(Harjoto <i>et al.</i> , 2021)
The impact of the COVID-19 pandemic on the stock market crash risk in China.	Estimating conditional skewness	(Liu <i>et al.</i> , 2021)
How trust affects global stock market volatility during COVID-19.	Market volatility assessment	(Engelhardt <i>et al.</i> , 2021)
COVID-19 outbreak and stock market reactions in Australia & impact of a stimulus package.	Negative events assessment. Event-study methodology	(Rahman <i>et al.</i> , 2021)
COVID-19 pandemic and global stock market volatility.	EGARCH (1,1) model	(Uddin <i>et al.</i> , 2021)
The influence of government policy responses to the COVID-19 pandemic.	Estimation methods including a random-effects model	(Zaremba <i>et al.</i> 2021)
Collapses in the stock markets of 18 major countries during the first wave of the COVID-19 pandemic	Indices and mild explosiveness	(Contessi & De Pace, 2021)
The impact of COVID-19 on stock market volatility between the U.S. and China.	Quantile-on-quantile (QQ) method	(Gao <i>et al.</i> , 2021)
Time-frequency relationship between the recent COVID-19 pandemic and instabilities in oil price and the stock market.	Wavelet method	(Chien <i>et al.</i> , 2021)
The effect of the governments' responses to fighting the COVID-19 pandemic on the returns in the stock market index.	difference generalized method of moments (DGMM)	(Chang <i>et al.</i> , 2021)
Comparative assessment of the impacts of the COVID-19 pandemic on the US stock market.	multivariate GARCH, restricted correlation models, DCC and ADCC	(Yousfi <i>et al.</i> , 2021)
The impact of economic policy uncertainty (EPU) on the crash risk of the US stock market during the COVID-19 pandemic.	Gram–Charlier series expansion method	(Dai <i>et al.</i> , 2021)
Potential explanations for the unprecedented stock market reaction to the COVID-19 pandemic.	Text-based methods	(Baker <i>et al.</i> , 2020)
Stock price reactions to different stages in COVID-19's evolution.	Hypothesis	(Phan & Narayan, 2020)
Twitter affecting stock market decisions during the COVID-19 pandemic.	Financial sentiment analysis of influential Twitter accounts	(Valle-Cruz <i>et al.</i> , 2021)
The initial impact of COVID-19 sentiment on the US stock market.	Correlation between COVID-19 sentiment and 11 select sector indices of the United States (US) stock market	(Lee 2020)
The impact of the outbreak on Bitcoin.	VADER scoring	(Pano <i>et al.</i> , 2020)
Understanding the dynamics of public responses to events under uncertainty.	fusion of four deep learning	(Basiri <i>et al.</i> , 2021)
Analysis of tweets by President Donald Trump during the early spread of the Covid-19 pandemic across the United States.	WADER, a rule-based model	(Yaqub. 2020)
Shifting sentiments during the COVID-19 pandemic.	Machine learning classification on deep learning language models	(Zhang <i>et al.</i> , 2021)

The large data-set approach has been applied on emerging topics in the field of competitive/market intelligence that have discussed technological innovation focused for example on the competitive intelligence process (Casarotto *et al.*, 2021). However, the large-scale media analysis has not been, to a large extent, applied before to analyse the impact of pandemics, or to detect early warning signals to help in speeding up managerial actions in companies. Recent future studies claim that COVID-19 would not be a black swan, as a black swan event is defined as being unpredictable, a total surprise, and that the emergence of another coronavirus was predicted by many working in the emerging infectious diseases (EID) field (Inayatullah, 2020). Hence the argument in this case would be that if there is a weak signal, the phenomenon could not be called a black swan. This has an interesting link to the market intelligence function, and it can cause some debate on how to categorise different events. The identification of weak signals is considered a method to identify strategic surprises in a firm's environment, while implementing information technology in collection and treatment of the weak signals (Lescab, 2019).

Also, predictive analytics is discussed in the context of market intelligence. The predictive analytics enable informed decisions through a blend of data, analysis, and scientific reasoning (Nettleton, 2014). Attempts have been made to predict future behaviours by finding patterns in the data through various algorithms (Larson & Chang, 2016). The data processing, analytical technologies, business centric practices, and methods of business intelligence can also be applied on market intelligence (Shmueli & Koppius, 2011). Specifically, the predictive analytics and social media analysis provide an opportunity to gain first-hand market intelligence applicable to various areas (Jeble *et al.*, 2016). The analytics can involve descriptive analytics that entail activities of summarising historical performance to predictive analytics involving estimating potential future events and assessing possible actions to optimise business outcomes (Apte *et al.*, 2012). High impact applications are possible in market intelligence through social media monitoring and analytics via sentiment and effect analysis (Chen *et al.*, 2012). Nevertheless, regardless of the evident potential, ensuring the generation, dissemination, and responsiveness to modern

market intelligence remains an ongoing challenge, necessitating further research (Romero *et al.*, 2021). Advanced predictive analytics is necessary to find weak signals or early warnings of significant events.

### 3. RESEARCH METHOD

The approach used in this study applies media monitoring with black-box software, including machine learning-based opinion mining on a vast pool of media that covers billions of online documents, including editorial and social media (SoMe). The vast pool of media includes all the data from over 3 million SoMe, and over 100,000 news and other media sources. Both free access and subscription-based media are monitored by utilising computer software to collect data. The media coverage of the corona epidemic was monitored and analysed for a period of more than a year and a half on a keyword basis, starting from the very first stages of the appearance of COVID-19. The on-going keyword searches were applied to a large dataset available through a media monitoring software, mined by black-box algorithms. The keywords used included "corona virus" and "COVID-19".

The global searches were intentionally limited to Finland, and the Finnish language, to save computational resources due to the enormous number of relevant data points existing globally. The total number of identified relevant data points with the defined limitations through the computer assisted media monitoring were 569,997 at the time of extracting the data for the analysis. The data include all the pandemic related media coverage in Finland during the focus period. This first step of the research of collecting the data on the entire media coverage of COVID-19 in Finland was carried out with the help of a commercial black box media monitoring software M-Adaptive (Nuortimo, 2021).

The exact digital algorithms on how the software operates are not known to the researchers, but the data was collected reliably by the software making automated relevance judgements on the data points available through the pool of media accurately, the same way every time. Specific relevant events in the media were harvested based on the requirements by the researchers. These relevant events in the media formed the attention timeline for the pandemic. The magnitude of the media attention is revealed

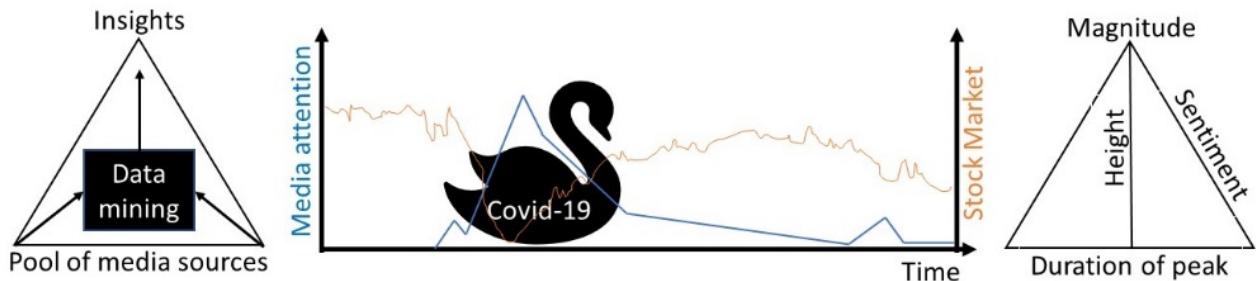


Figure 2 Research process.

both in SoMe and the published media. The computer-based media monitoring software used (M-Brain, 2015) has different lexicons (corpus) for several languages, including Finnish, which is the main language used in the data analysis in this study. The algorithms used by the software first calculated the local sentiments for each identified event by comparing the media event to the search terms, whereas the results were presented for the entire event by indicating the sentiment (neutral, negative, positive, mixed, or unknown sentiment). The sentiment classification accuracy was about 80% at most. Noteworthy is that human classification is not 100% accurate either and is dependent on the individuals carrying out the analysis. Human based classification is typically not fully consistent among different individuals and is limited to a small number of data points, limiting the possibilities of analysis.

The benefit of an algorithm-based analysis is that the computer does the analysis consistently, the same way each time, and can deal with a vast amount of data. The opinion mined sentiments are grouped and compared. The black box software approach has limitations by it providing limited benefits in terms of mainly detecting larger influences. Further application of the gained data was necessary. Hence a more thorough validation through comparison against findings with a similar software, or by human, might prove beneficial. The pandemic related media coverage was plotted on a timeline to reveal the magnitude of media attention during its course and reveal the main spikes in attention.

In the second step the data on the Nasdaq Helsinki stock exchange (OMHX) behaviour was obtained from Kauppalehti (Finnish multichannel news outlet focusing on economic phenomena and the money market) and the percent change was plotted on the same timeline as COVID-19 media attention to enable comparison and reveal how the stock exchange was being affected. The direct

causality was not tested but was assumed. Specifically, the spikes in media attention were compared to the changes in OMHX behaviour to analyse whether any weak signals appear through the media that might be beneficial for future market intelligence to enable learning and avoid the maximum impact of unexpected events of this nature.

In the third step, the magnitude of media attention on such unexpected events was put into context to enable estimating the significance of spikes in the media attention and the event classification was attempted. A SoMe firestorm scale (Nuortimo et al., 2020), similar to the Richter scale for earthquakes or Sapphir-Simpson scale for hurricanes, was utilised to analyse the spikes in the media attention, and assist in explaining the phenomenon, and possibly enable estimating the impacts of potential risks.

In the fourth step, selected media hits appearing during the times of early spikes of the media attention were investigated to further analyse the possibilities of recognising early signals of events leading to the realisation of major risks. Finally, the analysis results were used to distil implications for future market intelligence, and implications for managers dealing with risks that relate to several issues, such as crisis communication and stock market behaviour. The research process is illustrated in Figure 2.

#### 4. CORONA PANDEMIC IMPACT ANALYSIS

The impact of the coronavirus pandemic on the Nasdaq Helsinki stock exchange was analysed by plotting the media hits over an extended time period to visualise the development of the media attention on COVID-19. The development of the Nasdaq Helsinki stock exchange was plotted on the same timeline to enable the analyses. The analysis indicates that early stages of the COVID-19 pandemic, the first wave between 3/2020-6/2020 can be

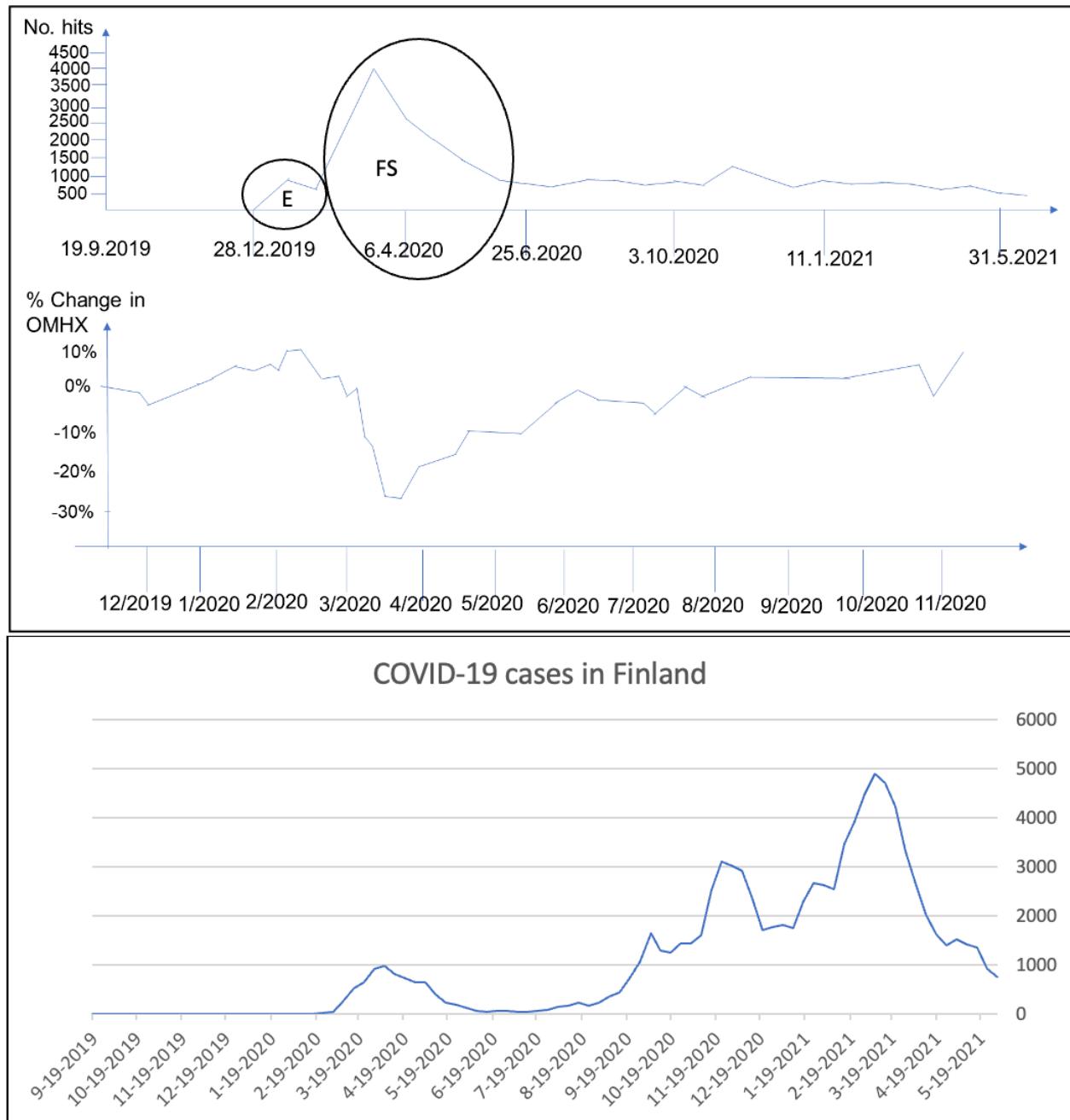


Figure 3 Finnish coronavirus related media hits/OMHX stock exchange behaviour and actual cases of COVID-19.

considered a media firestorm due to its shark-fin shape in the media analysis and the type of strong influence (Figure 2). However, when comparing to a traditional scandal-based media firestorm, COVID-19 and the related media communication are not focused on a single person or company. Instead, it has a large fundamental influence of a black swan type of phenomenon with crisis type effects (Figure 3). The actual Covid-19 cases are included in the illustration to enable comparison to the real situation.

The main spike of the COVID-19 related media hits (marked FS in Figure 3) and the linkage to the change in the Finnish stock index is clear. This period of high media

attention fits the time-period when the OMHX stock index collapsed approximately 30%. The media spike is almost exactly in line with the stock index development during the largest peak. The stock exchange recovery began almost immediately after the initial hit. The deepest drop in share prices occurred between 17.2-10.3.2020, while weak signalling from the coronavirus situation in China to the Finnish market started to evolve earlier in the beginning of the year. Noteworthy is that the first true Finnish case of COVID-19 was discovered on January 27<sup>th</sup>, 2020, and the daily cases started appearing from February 10<sup>th</sup> onwards. This link to the reality in Finland may have affected the stock exchange drop.

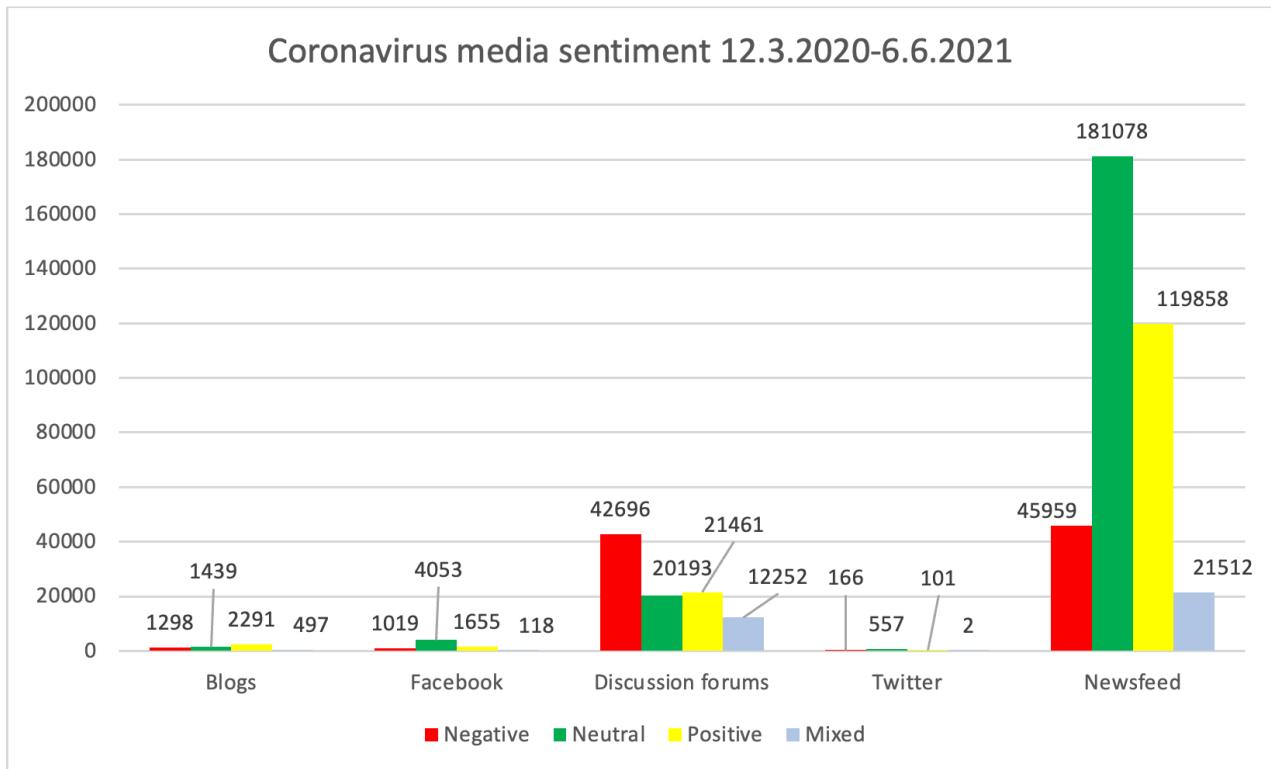


Figure 4 Media sentiment related to COVID-19 pandemic.

Concerning the market intelligence function in companies, the small media spike (marked E in Figure 3) in 28.12.2019-1/2020 can be considered an early warning or weak signal to the Finnish stock exchange that could have been derived from the news about China's situation. The same signal can be present also in different types of media firestorms, for example those involving SoMe and scandals (Nuortimo, 2020). The early warning signals are studied for example in the competitive intelligence literature (Lescab, 2019). However, the negative news seemed not to be yet influencing stock-exchange, or the general situation in Finland at the time.

Figure 4 presents the media sentiments classified by media type during the first wave of the pandemic.

The findings indicate that the media sentiment has been mainly negative in discussion forums, opposed to the editorial newsfeed, which is larger, and mainly neutral and positive. The editorial newsfeed includes more editorial style communication, also with risk-reducing elements and multiple views. The discussion forums have mainly been a channel for spreading concern about the COVID-19 pandemic. In general, the corona-related negative hits were mainly concentrated to discussion forums, which is logical due to more general sentiments, including the content of SoMe.

In order to analyse the impact of the early-stage media-spike, the Nuortimo *et al.* (2020) scale for SoMe firestorms was applied as a basis for estimating the general influence. Even though the original scale was developed for analysing media scandals, it seems to be valid also for this type of an incident. Although the situation differs from a typical single-incident based firestorm, such as a personal scandal, which is typically a more intense and visible as a negative burst targeted towards a single person or entity, this case seems to form a similar effect, which in this case was a global large scale media firestorm. The pandemic and its effect on media visibility in this case can be considered to resemble a SoMe firestorm.

A level 3 firestorm on a scale from 1 to 3, as in the Nuortimo model, is considered to have a large global influence: the COVID-19 pandemic presents a viable example of an event with global influence. When estimating the impact of the corona media-spike in the Finnish language, both the editorial and SoMe sources included the following variables to be addressed: the length of the media spike/days, the height of the spike (media hits SoMe/editorial) and the percentage of negative media hits. By multiplying these variables, a figure that indicates the magnitude of the media attention on the scale 1 to 3 is determined. The magnitude equals the length of the media spike/days, multiplied by the

height of the spike (media hits SoMe/editorial), multiplied by the % of negative media hits. The result in case this case would be = approximately 90 days \* 4000 media hits \* 0,2(20%) negative media hits resulting in the figure of 72,000, in the Finnish language context only. This would mean the magnitude of the media attention on the global scale would reach the value 3 (1-3 scale) in the Nuortimo model based on the Finnish hits only. The figure would be much larger with the total global hits, which makes it a rather large figure considering that this is based on the Finnish hits only. Gaining global media coverage, the global media hits are limited by the available computational power. Also, despite the unusually low percentage of negative hits related to the media firestorm, the length and intensity contribute to the influence. Hence, the measured influence in general can be seen as global and very large, with influence on all companies at all levels.

After the initial analysis of the large pool of media sources to reveal the magnitude and trend of media attention, specific focus was given on the potential early warning spikes on the timeline of media attention. The COVID-19 media hits falling within the potential early warning signalling period in different media were analysed (Table 2).

By the end of January 2020, a logical weak/predictive signal chain from different media was in place to possibly enable predicting the main spike of the COVID-19 related media hits (the FS event in Figure 3). With the help of the predictive signal, it might have been possible to partly estimate the drastic effect of the events on the Finnish stock exchange starting on February 17<sup>th</sup>, 2020. The

specific level of action taken by individuals and corporations during the time are outside of the scope of this paper. Nevertheless, this paper indicates that a weak signal of the upcoming Corona pandemic existed, and Finnish corporations could have used the signal to react to the event beforehand. The case of COVID-19 and the timeline of related media attention presents an example of 1) a real-life weak signal, and 2) the capabilities to detect significant events via modern media-analytics.

The major question in the managerial reaction would be whether the early warning signal from Chinese virus spread could have possibly been better utilised by the Finnish companies. In the early warning signal analysis, it was eventually clear that this type of virus could cause a global pandemic. Hence, early indications of major threats might be possible to link to early actions with logical reasoning in corporate management. In this case some of the preventive measures that were eventually started in March-April 2020 could have been initiated already in the beginning of the year. However, whether the companies have spotted this signal in their media monitoring and market intelligence function remains open in this analysis.

In general, if comparing the COVID-19 media firestorm to the earlier studied SoMe firestorm scale 2 incident (Nuortimo *et al.*, 2020), where the lossing of corporate reputation caused by a wrong wording was a general reason for corporate actions, this firestorm did not seem to clearly influence the corporate image or reputation. Predicting upcoming media firestorms and being able to link them to logical reasoning might benefit the future corporate market intelligence function.

Table 2 Samples of main topics appearing in the media during the potential COVID-19 early warning signalling period.

Source	Date	Topic	Indications
News/Finnish institute for health and welfare	16.12.2019	What is coronavirus	Start of discussion
Local news, "Aamuset" (city media for Turku)	9.1.2020	Pneumonia cases in China possibly originated from coronavirus	First signals of coronavirus in China
Local news	30.1.2020	WHO announces coronavirus as a global threat	Virus is spreading from China, WHO global threat classification
Facebook	30.1.2020	Coronavirus is more lethal than seasonal influenza, spreads more slowly for now	First popular estimates of threat severity
News/ "Lentoposti" (Aviation news)	30.1.2020	KLM cancels Chinese flights	First corporate actions
"Yle" News (the Finnish Broadcasting Company)	31.1.2020	Coronavirus death toll now over 210 persons, keeps spreading in China	More implications of threat severity
Yle Areena	31.1.2020	Chinese tourist had coronavirus in Rovaniemi, Finland	First signs of virus spreading to Finland

## 5. DISCUSSION

This study highlights the possibilities of estimating and measuring the impact of large-scale media appearance (COVID-19 pandemic in this case) on stock-listed companies (Nasdaq Helsinki in this case) via algorithmic media monitoring by targeting a vast pool of media through suitable algorithms. The presented approach consists of a large dataset media sentiment analytics via a black-box software, applied on COVID-19 over an extended time-period, initially appearing as a media firestorm, and comparing the timeline of events to stock market behaviour. The magnitude of the media firestorm is assessed and implications for company analytics considered.

The main results are as follows:

- 1) The impact analysis of COVID-19 based on a large dataset and media firestorm scaling can indicate an influence at a general level, such as the immediate impact on stock exchange performance. The sentiment and visibility in different media, including the social media and editorial sources, can reveal some general issues related to the impact, i.e., how negative has the sentiment been, and how much media coverage is in question.
- 2) The early warning signal could be spotted in this case to provide insights for preventive action, should this type of analysis be utilised in corporations.
- 3) The managerial actions could be initiated more proactively in case they need to react to early warning signals.
- 4) Theoretical debate remains, whether the event can be considered a black swan due to both global and local weak signalling received from the event. This provides basis for some general scientific counter-argumentation.

The main managerial contribution includes the possibilities for faster indication of negative future events that may come with early warning signals before the firestorm of large-scale media attention. Being able to link this type of modern analytics to the imminent risks by the means of logical reasoning may benefit the future corporate market intelligence function and enable earlier corporate reaction or risk management. Hence, managerial actions could also be planned faster

and more accurately. In this case, if the actions could have started already in time of the early warning signal with allocation to different functions of the company, obvious functions would have been crisis communication, financial planning, and health, safety and environment in HR-function.

The scientific research method development aspect is beneficial compared to interviews and questionnaires. This type of an approach is a relatively fast way to get the main event influence from a large dataset. To get to the detailed topic level, a hybrid approach (Nuortimo, 2021), could be applied.

The novelty of this research lies in the innovative combination of data, methodology, and modern analytics. The findings support earlier studies on predictive analytics that aim for informed decisions through finding patterns in data and combining the data with logical reasoning. When comparing to the literature, the debate of classification of the COVID-19 coronavirus pandemic remains, whether the event is a black swan and if it has some early warning signalling. Globally, there has been previous signs of earlier pandemics (EIDs) before (Inayatullah, 2020), and locally the warnings have been received also in Finland. In case of measuring the event, this article tests the SoMe firestorm scale (Nuortimo *et al.*, 2020) level 3 and has implications. Even though level 3 of the scale can contain multiple types of events with a global influence, the scale seems to be applicable for measuring the general event magnitude also in this case. As a scientific contribution, this paper proposes two possible event classifications:

1. Black swan with both global and local early warning signaling
2. Social media/media LVL 3 firestorm with:
  - a) Features that relate to global pandemics
  - b) Some level of early warning signaling, usually related also to scandals
  - c) Lower level of measured negative sentiment in general newsfeed compared to a regular scandal
  - d) Large diverse global influence on multiple sectors
  - e) No clearly visible influence on corporate image or reputation

One major limitation of this paper, however, involves the fact that the inaccuracies related to the algorithmic analytics prevents reaching a 100% research validity while utilising a black-box software. Utilising a second software in parallel could have increased the validity. Nevertheless, in this case, 100% validity may not even be necessary, because the goal is to measure the general level of influence, not the details related to, for example, corporations. To get to the detailed level, a hybrid approach (Nuortimo, 2021) is suggested, while leaving some room for further studies related to the COVID-19 coronavirus pandemic influence. Also, this study does not carry out correlation analysis. Future research concerning media firestorms is required to further validate the scale to assess the magnitude of different types of events, while the general scaling level seems appropriate for assessing this type of events with a large impact as well.

## 6. CONCLUSION

Better integration of the market intelligence function, namely media monitoring through the utilisation of new tools, may enable linking the early warning signals of significant future events to necessary corporate actions or risk management earlier than currently possible. The findings of this article agree with Inayatullah (2020) in that COVID-19 was not a total black swan and could have been partially anticipated.

The magnitude of events might be possible to assess by means of media firestorm scaling to provide input to company processes to have grounds for reacting to different events spurring from the business environment. These events also include black swan type media firestorms that have a very large impact and low predictivity. In the case of the coronavirus pandemic, the early warning signal was available from China's situation to the Finnish market before the market reacted. The type of approach suggested in this paper can be useful for planning preventive actions in similar situations, even if not all future events are the same.

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