COVID-19 and the Freefall of the Stock Market

by

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Thesis Summary

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Key Words	COVID-19, Stock Market Returns, OLS Regression, Lasso Regression
Purpose	The aim is to study the impact of COVID-19 and respective government interventions on the stock market returns of: China, Sweden, the United Kingdom, and the United States.
Methodology	The empirical approach uses stock market returns and COVID-19 data. Conducted are both OLS and Lasso regressions for the four selected sample countries.
Theoretical Perspectives	This study is based on the basic OLS regression and the advanced Lasso regression, aiming to invest what COVID-19 related factors have a significant impact on the stock market of the sample countries.
Empirical Foundation	This paper uses data for the countries understudy, with a range of 209 to 222 observations per variable and country. The study period covered is from January 23, 2020, to December 04, 2020.
Conclusions	The results reveal that primarily the Stringency Index is of importance, highly impacting the stock market returns indirectly by the imposed government interventions, especially in China, the United Kingdom, and the United States. Only Sweden does not have any significant explanatory variables, for both the OLS and the Lasso regression, respectively.

Abstract

Background: The novel COVID-19 outbreak has been present for over a year and is a permanent companion impacting daily lives and hurting economics universal. Since the presence of the coronavirus has been directly impacting stock markets and its returns worldwide, an analysis of the impact on the COVID-19 outbreak is inevitable. Therefore, this paper examines the influence of the novel COVID-19 outbreak on four leading stock market indexes in affected countries including China, the United Kingdom, Sweden, and the United States. *Method:* Linear regression models are used to evaluate the interconnection between stock market returns and exogenous variables including Governmental Interventions, New Cases, New Deaths, and others. To obtain a ranking of those exogenous variables by importance, the p-value of individual tests, the adjusted coefficients of determination R^2_{adj} and Lasso paths including their Trace Plots of Coefficients fit. *Results:* The results highlight that the global stock markets were impacted by the COVID-19 outbreak instantly and stock market returns dropped rapidly for them for a certain period. For describing the impact of the coronavirus outbreak on stock market returns, the Stringency Index and the Economic Support Index are exogenous variables of importance while New Cases and New Deaths demonstrate rather low importance. *Conclusion:* Our empirical results have important policy implications, primary through demonstrating that Governmental Interventions along with other exogenous variables have both positive and negative impact on stock market returns around the world.

Keywords: COVID-19, Stock Market Returns, OLS Regression, Lasso Regression

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List of Abbreviations

BPG	Breusch-Pagan-Godfrey Test
CAR	Cumulative Abnormal Return
CARES Act	Coronavirus Aid, Relief, and Economic Security Act
CDC	Centers for Disease Control and Prevention
COVID-19	Coronavirus Disease of 2019
DW	Durbin-Watson Test
FTSE 100	Financial Times Stock Exchange Index
JB	Jarque-Bera Test
LASSO	Least Absolute Shrinkage and Selection Operator
MERS	Middle East Respiratory Syndrome
OxCGRT	Oxford COVID-19 Government Response Tracker
SARS	Severe Acute Respiratory Syndrome
VIF	Variance Inflation Factor
WHO	World Health Organization

1. Introduction

The world will continue to fall prey to new epidemics, pandemics and new diseases that not only cause the dramatic loss of millions of lives, but also cripple and disrupt economics and leading to a decline in global economic growth (Madai, 2021). Research into novel viruses therefore is desirable as they continue to pose new risks (Salisu, Sikiru & Vo, 2020). On December 31, 2019, the World Health Organization (WHO) reported the first case of the so-called novel coronavirus – COVID-19 and moreover known as SARS-CoV-2 in Wuhan, China (WHO, 2021). This marked the beginning of the stock market crash in 2020 and is also the first deadly pandemic after the Spanish flu in 1918 (Liu et al., 2020).

The economic reaction of the novel pandemic has brought to the fore a need for improved awareness of novel diseases and their influence on economic actions along with the stock market changed to the cutting edge. As highlighted by Ibrahim, Kamaludin and Sundarasen (2020) the limited knowledge of the impact of a shock caused by a novel disease on the stock market motivates researchers to obtain a deep understanding of movements in the financial market in the event of the pandemic. Thus, previous studies have investigated the possible relation between stock market response and diseases. However, most previous studies about the novel pandemic focus solely on the Asian stock market and its industries respectively (He et al., 2020; Gu et al., 2020; Salisu & Sikiru, 2020; Yin, Lu & Pan 2020). Moreover, as pointed out by Xu (2021) only limited research has been conducted on the topic of the novel pandemic and the stock market returns with respect to the influence of governmental interventions among different impacted countries.

As a result, this thesis aims to investigate the stock market's reaction to the novel pandemic outbreak and different government policies with a focus on four different countries. Including China – where the first corona case was reported, Sweden and the United Kingdom – where herd immunity is sought but with different approaches and levels of government interventions, and the United States, as it has a different healthcare system and the S&P 500 as a very strong stock market that is important all over the world. By using the Least Absolute shrinking and Selection Operator (LASSO) approach and basic statistical tests, this study examines and compares the relationship between stock market returns, New Cases, New Deaths, and the related governmental interventions of the countries, respectively.

Therefore, our hypotheses are as following:

Governmental interventions have an impact on stock market returns during the COVID-19 pandemic.

The stock market reaction during the COVID-19 pandemic depends on the industry composition of the country.

To the best of our awareness, this master thesis is the first provisional empirical study on stock market returns which investigates into the impact on specific countries with different regulations including different healthcare systems during the novel coronavirus pandemic using the LASSO methodology. Investigating into the joint trends of these countries will conclusively bring suggestions to what extend a relationship between stock market return and the novel pandemic exists. The contribution of this study to the already existing literature on the COVID-19 pandemic is diploid: firstly, this paper is unlike most previously conducted papers country specific and hence will draw more concrete conclusions on the relation between the novel pandemic and the stock market return on different countries. Secondly, it frames the relation between to what extend the stock market returns vary in terms of the novel pandemic news with a focus on country specific governmental interventions. Ultimately, this research aids to contribute to strengthen the knowledge of the influence of the novel pandemic and the reciprocal political responses to the stock market return of China, Sweden, United Kingdom and United States, respectively.

This study reports the following findings. Firstly, the COVID-19 outbreak has a positive and negative impact on the stock markets understudy. Secondly, all four countries show different impacts of the Indexes depending on the degree of government interventions. Thirdly, the results reveal that the Stringency Index had the most importance to answer our hypothesis, being statistically significant for China, the United Kingdom, and the United States. Lastly, the study observes that Sweden, having the loosest restrictions, does not have any significant exogenous variables to explain the hypothesis.

The rest of this thesis is structured as follows. Section 2 covers a literature review on the current state of knowledge. Section 3 discusses the development of the hypothesis. Section 4, covers the methods and research approaches used. Section 5 analyzes the data and their descriptive statistics and examines key points. Section 6 outlines and highlights the empirical results of this research. Section 7 discusses the overall findings. The final section 8 summarizes our general observations and key findings.

2. Literature Review and Theoretical Framework

2.1. Government Interventions

There are different implications of government interventions on stock markets in previous literature. Examples of policies are lockdowns, business closings, limitation of residential movements, cancellations of public events, social isolation, school closings, virus testing and contact tracing (Ibrahim, Kamaludin & Sundarasen, 2020; Shanaev, Shuraeva & Ghimire, 2020; Zaremba et al., 2020; Yang & Deng, 2021). These interventions are imposed to help to limit the spread of infections, but also have an impact on the economy.

Zaremba et al. (2020) uses a panel regression looking at two different channels for how government policy responses may affect stock market volatility. On the one hand, they are investigating the "rational" channel which is related to portfolio restructuring that may result in higher volatility meaning a higher risk and therefore probably lower market returns. The second "irrational" channel is more of behavioral nature and leads to an increased volatility. The regression uses stock data from 67 countries from January 2020 to April 2020 and seven different types of government actions. They conclude that government interventions are associated with higher stock market volatility. Especially government information campaigns and cancellations of public events seem to be perceived by financial investors as a negative signal for further intervention and can therefore be interpreted as a precursor of economic and financial instabilities. If investors anticipate more stringent economic interventions in the future, volatility remains at a higher level. Another intervention introduced by many European countries is a restriction on short selling, which may also influence stock market volatility but is outside the scope of this thesis.

Furthermore, Ibrahim, Kamaludin and Sundarasen (2020) investigates government response measures and stock market volatilities for 11 developed and developing economies within the Asia-Pacific region from February to May 2020. They discovered that government measures in most sample countries significantly reduced market volatility in the domestic equity markets, which is in contrast to Zaremba et al. (2020) findings. According to Ibrahim , Kamaludin and Sundarasen (2020), the uncertainty and potential economic losses from the pandemic are one primary source of market volatility. Infection peaks and the local case growth seem to affect stock market volatilities and global financial markets volatilities appear to increase once the number of cases of COVID-19 started rising outside its epicenter China.

Resultingly, government responses mainly reduce market volatility, while the increasing number of COVID-19 cases induce market volatility.

Yang and Deng, (2021) support the result of a negative reaction of stock market returns to the increase in the number of confirmed cases and therefore a higher volatility. They assume that governmental interventions such as closing schools and restricting entry to control the spread increase investor confidence to get a positive market response and a possible reduction of the downside economic effects caused by COVID-19. They investigate stock market returns data of 20 OECD countries from February to October 2020 using a panel regression and discussing four comprehensive indicators – Government Response Index, Containment and Health Index, Economic Support Index and Stringency Index. An increase in the number of confirmed cases leads to a gradual increase of government interventions to attempt to lower the negative impact that the number of cases have on the stock returns.

Impact on China

The first COVID-19 case was identified in China in Wuhan city in December 2019 and has then rapidly spread throughout China. The Chinese government started implementing policies to slow down the spread of the virus. In Wuhan, the quarantine measures were implemented on January 23, 2020. Public places like schools, restaurants, and shopping centers were closed and all residents were restricted to stay at home in self-quarantine. Additionally, many train and bus stations were closed, and passengers' temperature was tested when entering and leaving stations. Necessities of life were distributed from community or neighborhood committees to avoid every unnecessary contact. Furthermore, traffic restrictions were imposed on all non-emergency vehicles (Liu, Yue & Tchounwou, 2020; Wang & Su, 2020). To support the control measures, big data and communication technologies were used, which brings up the question whether human rights and personal privacy were violated but in return, those measures were helpful in identifying confirmed cases and contacts in an effective manner and control the spread of COVID-19 in China (Liu, Yue & Tchounwou, 2020).

The economic activity and energy consumption significantly declined with the start of the pandemic. Mostly due to the reduction in industrial activities and urban transportation while people were in quarantine. China's GDP decreased by 5.3% in the first quarter of 2020 compared to the same period in 2019. The major industries' operating level was much lower than normal during the quarantine period and especially the coal consumption decreased a lot. This can be partly explained by a production stop of many enterprises (Wang & Su, 2020). The limitation of transportation, personnel quarantine and other restrictions interrupted the supply chain of a lot of enterprises and slowed down many business activities leading, especially small and medium-sized enterprises, to difficulties.

Government policies were implemented to support affected enterprises. Banks could reduce the loan threshold of enterprises; loan amounts could be increased, and loan interest rates are reduced for the period of the pandemic. Additionally, multiple tax reliefs were an option for seriously affected enterprises and special funds were set up to provide subsidy support for worst-hit industries (Liu, Yue & Tchounwou, 2020). Due to the supply shock in China in February 2020, which occurred because of the shutdown policies, a global demand shock was triggered (Njindan Iyke, 2020).

Impact on Sweden

Comparing the approach of Sweden to flatten the curve of infections and limiting the number of people that are infected at the same time with the other countries we focus our thesis on, Sweden has the least strict approach. Since the Swedish Infectious Diseases Act can restrict individuals, but does not allow for a general lockdown, many COVID-19 measures have been recommendations instead of restrictions (Ludvigsson, 2020). Therefore, the government's response to the pandemic differs mostly in terms of the degree rather than its content, while the recommendations are more binding than the word may suggest (Hensvik & Skans, 2020).

Sweden's GDP declined in the second quarter of 2020, with a decline in export rather than private consumption and investment. Even if the manufacturing sector has not been directly impacted by domestic social distancing and containment measures, it has been so by the external environment (Bricco, Misch & Solovyeva, 2020). A huge advantage for families in Sweden is, that in contrast to most other countries, schools, and childcare facilities did not close. This made it easier for parents to keep working and travel for work if needed and, since work from home was recommended, to remain productive (Bricco, Misch & Solovyeva, 2020; Hensvik & Skans, 2020; Yan et al., 2020). Regardless the mild nature of COVID-19 restrictions, the impact on the labor market was still quite high and started around the time of the announcement of the restrictions.

Additionally, new vacancies dropped by almost one third. This partly explains, why entrants are more affected than established workers in the labor market. Another reason is that especially the hotel, restaurant and retail sectors were strongly impacted, but they also provide many entry-level jobs (Hensvik & Skans, 2020). Looking at the cases, especially in the beginning of the pandemic, the death toll was higher for elderly people, affecting mostly nursing homes. Furthermore, there is a heavy concentration of deaths in the Stockholm region (Bricco, Misch & Solovyeva, 2020).

Impact on United Kingdom

The first lockdown in the United Kingdom was announced on March 23, 2020 and had, as in other countries, a significant economic impact (Mayhew & Anand, 2020). According to Keogh-Brown et al. (2020), it is likely to be dominated by the public prevention measures rather than the direct health costs of the disease. Measures against the spread of the COVID-19 virus are school closures, business closures, social distancing measures, wearing of masks, but also a home quarantine for 14 days when an individual within a household is suspected of an infection. This, however led to an increase in the duration of work absence. Additionally, it can be difficult for parents to keep working efficiently since workers are encouraged to work from home (Keogh-Brown et al., 2020).

To support the economy, the United Kingdom government enacted the so-called Job Retention Scheme. The aim is to keep temporarily stopping workers attached to their employers by supporting the employers with a certain 80% of the wages up to a certain limit (Mayhew & Anand, 2020; Keogh-Brown et al., 2020). Especially for young people that are either about to enter the labor market or just entered it, it is especially hard and unemployment rates have risen significantly since the start of the pandemic. The main stock index in the United Kingdom, the FTSE 100 (Financial Times Stock Exchange Index), fell by 14.3% over the year, but it has already significantly recovered since the start of the pandemic (Read, 2020).

Impact on United States

The United States confirmed its first COVID-19 case on January 21, 2020. It then quickly increased and had times with more than 100,000 new cases per day and high death tolls along with no effective treatments (Patton, 2020). Looking at the initial impact on the US economy, it was geographically widespread and people across all age groups and all states were affected, while the initial mortality impact targeted mostly older people (Udalova, 2021). On March 27, 2020, the Congress passed the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) aiming to provide financial relief to families and businesses impacted by the pandemic (Amadeo, 2021). The initial stimulus of this act of the Federal government and the Federal

Reserve was highly effective in avoiding a more catastrophic economic result (Patton, 2020). Another aim to support the US economy was to lower the target range for the fed funds rate by a full point on March 15, 2020, from a range between 1.00% and 1.25% to a range between 0% to 0.25%. Additionally, the reserve requirement was reduced to zero, enabling banks to lend their deposits without keeping any in reserve. The benchmark rate will be kept at zero until 2023, as the Fed announced on September 16, 2020, implying that banks, and consumers can be assured of low-interest rates for the time being of the pandemic (Amadeo, 2021).

A good indicator to show the economic impact is the decline in the employment-to-population ratio, which was significant in April 2020. Instead of the predicted 61.3% ratio, only a ratio of 51.5% was observed (Udalova, 2021). The week ending March 21, 2020, 3.3 million Americans had filed for unemployment insurance, followed a week later by almost 6.9 million more individuals. Reasons for the high unemployment are mostly shutdowns of businesses and that individuals across various industries were let go (Amadeo, 2021). Additionally, the labor market already changed before the pandemic to more technology replacing workers. This trend intensified further as companies seek to maximize profits. This in return, including the fact that many people are working from home due to the pandemic, reduced demand on commercial real estate and could cause a decline in commercial real estate prices and lease rates (Patton, 2020). Around 43% of business had temporarily closed in early April with industries that do not rely on an on-site location to stay in business doing better. After the unemployment rate peaked at 14.8% in April 2020, it gradually improved and dropped below 10% in August 2020 (Amadeo, 2021).

Before the COVID-19 pandemic started, the US economy was doing very well with an inflation that was below the Fed’s target of 2.0%. The “real” GDP growth fell during the second quarter of the year by a shocking 31.4% leading into a pandemic created recession. This is, inter alia, due to the US economy being primarily driven by consumer spending and the high unemployment because of the pandemic. After a peak in US stocks mid-February, they fell very quick in March until they rose substantially and peaked again in early September. Especially the declaration of a national emergency led to the stock market crash in March, while a reason for the upward trend later in the year came partly from the vaccine announcement from Moderna, that it is almost 95% effective (Amadeo, 2021; Patton, 2020).

2.2. Previous Pandemics and the Relation with the Stock Market

The impact on stock markets, and how their returns respond to epidemics, pandemics and deadly diseases have varied depending on the country's specific and global policies. The stock performance moreover depends on the individual components of the stock markets and their core business areas. For example, a stock in the travel industry was found to have dropped dramatically during the outbreak of a virus, while the performance of a stock in the pharmaceutical industry along with companies in the communications and online segments announced an increase in their stock during the virus outbreak due to certain restrictions in the economy taken (Liu et al., 2020).

In addition, stock markets have been found to be intertwined and co-dependent, with previous studies indicating the close cross-market correlations during pandemics and economic crisis. A previous study showed that along with a pandemic in one country, stock markets and their returns became more interdependent on a global scale. Time would carry over to another close country, resultingly in growing correlated changes in the stock markets (Morales & Andreosso-O' Callaghan, 2012). As a result, epidemics, pandemics, and fatal diseases can also negatively change the investment decision-making behavior in various sectors of individuals, ultimately affecting stock market returns.

To better understand the impact of virus outbreaks, Table 1 below provides details on the fatality rate and infection rate of previous viruses, including COVID-19. This Table emphasizes that not all previous pandemics, epidemics and diseases affect the health of people and individual countries with the same intensity and thus also affect the stock market differently in relation to different governmental interventions, health systems and country's industries.

Table 1 Infection Rates of Viruses as of 2020

Viruses	Fatality Rate (%)	Infection Rate
Ebola	50%	1.5-2.5
MERS	34.3%	0.42-0.92
SARS	10%	3
COVID-19	3.4%	1.5-3.5
Seasonal Flu	0.05%	1.3
Spanish Flu	>2.5%	

Note: Table 1 presents the Fatality Rates and Infection Rates of Viruses of 2020. *Data Source: Statista (2020)*

The Spanish Flu 1918-1919

The well-known pandemic of 1918 killed over 50 million people worldwide. The massive loss of people could be due to poor levels of healthcare and medical assistance back in 1918, along with almost no technology available at the time of the outbreak. Knowledge of novel viruses was still questionable for the large number of doctors, and antibiotics were not yet discovered at this early stage. Barro, Ursúa and Weng (2020) found evidence that the Spanish flu had a significant negative impact on short-term government bonds in the United States. Another study on the Spanish flu found that the virus outbreak continued to have a negative impact on Swedish capital income along with an incline in the poverty of Sweden after 1919. In addition, it was found that the stock market rose again about 50% for nearly nine months after February 1919. It cannot be said with certainty that this stock market distortion occurred due to the end of the Spanish flu in February 1919 or the end of World War I. However, the virus appears to be acting as a major disruptor, as noted in the United Kingdom and Sweden. As mentioned earlier, the novel coronavirus pandemic is having a global impact like that of the Spanish flu of 1918 (Barro, Ursúa & Weng 2020; Karlsson, Nilsson & Pichler, 2014; Taylor, 2020).

Severe Acute Respiratory Syndrome 2002-2004

The discovered Severe Acute Respiratory Syndrome which was caused by the severe acute respiratory syndrome coronavirus (SARS) known short as SARS-CoV-1 first broke out in 2002 in China, when the Chinese health authorities reported the first case of the virus. SARS was identified as a new coronavirus and is on the authority of the World Health Organization a virus with a high infection rate. As displayed in Table 1 the disease has an infection rate of 3. Even though the diseases got discovered firstly in Mainland China, the virus spilled over 30 territories worldwide. The outbreak of the virus led to a global pandemic and caused social instability, including a drop in GDP and domestic consumption in the affected territories (Koo & Fu, 2003; Chen et al., 2009). Previous studies which investigated into the outbreak of SARS and the stock market returns discovered that the SARS outbreak only hit until March one year later, indicating that the stock market was impacted by the outbreak not instantly. Moreover, it was found that the SARS outbreak resulted in an overall loss of three trillion-dollar value in GDP along with a two trillion-dollar value in financial market equity (Liu et al., 2020). A study of the impact of SARS-CoV-1 on stock markets in eight countries found that the only countries negatively affected by the outbreak were China and Vietnam, while the other six countries examined were Canada, Hong Kong, Indonesia, the Philippines and Singapore, and Thailand did not become negative influenced. On the contrary, two other studies found that Hong Kong also had a negative impact on the effects of SARS-CoV-1. The SARS literature generally concluded that the virus outbreak had no long-term effects worldwide. Panic among people quickly subsided once the virus was under government control of the affected areas, and then economies and stock markets quickly recovered to their normal states (Koo & Fu, 2003; Min, 2005; Nippani & Washer, 2004; Yi et al., 2003). Lastly, another previous research investigating in the SARS-CoV-1 outbreak with four different Asian stock markets found that the outbreak of the SARS-CoV-1 has weakened the long-term relation of China with the four individual stock markets. As already mentioned above, also for the SARS-CoV-1 the relevant previous literature confirms the overall conclusions, that individual investors might feel pessimistic about investment prospects in each stock market and resultingly selling off their individual market stocks in the event of a pandemic outbreak (Liu et al., 2020).

Middle East Respiratory Syndrome 2012-2015

The Middle East Respiratory Syndrome – short MERS – first broke out in Saudi Arabia in 2012 and spread to various countries including Korea, the United States, and the United Kingdom. Jung and Sung (2017) investigate the MERS outbreak in Korea in their study, where the largest outbreak of the virus occurred, as it is claimed by the Centers for Disease Control and Prevention (CDC). They examined the impact of the virus outbreak on online and offline markets in view of Korean government interventions such as quarantine and healthcare systems. Their research found that the Korean government advised Koreans to keep engaging in social activities, as the Korean government did not view the outbreak as a pandemic and found that the hospitals where the infected people were cured were not for the public open. While the MERS outbreak was dire in Korea, only two patients tested positive for the Middle East Respiratory Syndrome in the United States, with both cases were identified at health establishments operating Saudi Arabia and returning to the States with the virus (CDC, 2019). As mentioned above, since the MERS outbreak did not have a major impact on the United States, even when the first ever case was recognized in 2012, it did not have a large influence on the US stock market. According to Rooney (2012) the US stocks sold less on June 13th, 2012, lower amid concerns about falling oil prices and the European debt crisis. In addition, it was found that even on May 2nd, 2014, when the first MERS case was reported in the United States, the stock market declining overall that week, but still rose steadily, and moreover normalized again the following week.

Ebola 2014-2016

The first case of the Ebola virus case was reported in Zaire in 1976. This is one of the major viral infections in people with a 50% death rate. In 2014, a new Ebola disease announced by the World Health Organization as EVD hit West Africa in particular, but it also affected other countries. Previous studies for instance, analyzed the outbreak of the epidemic and people's mood. The studies found that humans in a rather depressed state due to the epidemic and uncertainties have a rather low willingness to engage themselves in riskier situations. In a more recent study, Ichev and Marinč (2018) based on the WHO's announcements to investigate the impact of stock market returns and the pandemic. Their study uses CARs which surrounded the event day of the outbreak of Ebola, where their study found, that negative CARs on the Ebola event day and a reversal effect the day after. They argue that these results may arise from the fact, that individuals act irrational to the announcement of any Ebola outbreak news, while the day after the event, they start to stabilize their behavior again. Moreover, they found, that the announcement of the outbreak was more relevant for financial markets close to the outbreak country than any other less effected country or any other industry sectors in the stock market index. Lastly, previous literature including this study, conclude that market return is insistent and indicate on the event day statistical significance incline in volatility.

3. Hypothesis Development

This paper posits that the government interventions have both direct and indirect effects on stock market returns in the sample countries. On the one hand, we posit that lockdown measures may have a direct negative reaction to the stock market by adversely affecting economic activity. Quarantine policies and health packages, on the other hand, will most likely generate positive responses by improving investors' behavior towards the stock market and reducing the adverse effect on the economic impact.

The indirect intervention effects are channeled by the prevention of the disease outbreak. Though government interventions, like aggressive testing, lockdown policies and healthcare support, can help in reducing the number of newly reported cases. Building on the existing literature on COVID-19, indicating that global stock markets responded with adverse returns, from this we hypothesize that in the scenario that governmental interventions during the pandemic can reduce the number of new cases, they subsequently depress the adverse market response (Ashraf, 2020; Liu et al., 2020; Madai, 2021).

Additionally, we hypothesize that the density of the impact of the COVID-19 outbreak varies across industries. For instance, we expect that the outbreak of the pandemic hit the industrial industry, including manufacturing to a greater extent than the information technology industry. Taking into consideration that through the number of government activities like lockdowns, manufactures have cut down productions or even shut down the entire business during the pandemic, whereas industries like information technology could remain operational through working from home.

Resultingly, we test the following hypotheses:

H1: *Governmental interventions have an impact on stock market returns during the COVID-19 pandemic.*

H2: *The stock market reaction during the COVID-19 pandemic depends on the industry composition of the country.*

These hypotheses are tested by regressions using stock market returns as the dependent variable and various COVID-19 data variables as explanatory variables on the RHS. Given the fact, that countries reacted very differently to the pandemic with varying degrees of government intervention, and that the countries have very different industry compositions it is interesting to analyze which country appears to be most effective in responding to the pandemic in terms of the stock market. The guidelines were similar in all countries but vary from recommendations in Sweden to measures like strict policies for staying-at-home in China.

4. Methodology

4.1. Research Approach

The main objective of this paper is to analyze and describe the relation between COVID-19 and the corresponding government interventions in China, Sweden, the United Kingdom, and the United States, hereinafter indicated to as endogenous variable y_i, through numerous exogenous variables referred to as x_{it}. Because government interventions create uncertainties about their influence for example, lockdowns are in place to reduce the number of potential new COVID-19 cases while harming the business community by downsizing and thereby impacting people's incomes. One can question explanatory variables such as bans, quarantines, and government enforced cancellations of social gatherings that can impact and reduce the number of New Cases or New Deaths. While there might be a connection between exogenous and endogenous variables, it can be challenging to quantify.

To establish a connection between endogenous and exogenous variables, statistical methods are therefore considered, which brings this master's thesis into the theory of regression analysis. Therefore, this study examined the expected impact by analyzing the response of the stock markets in China, the United Kingdom, Sweden, and the United States to government action. Specifically, this paper examines the stock markets' response to four Indexes, namely Stringency Index, Government Response Index, Containment and Health Index, and Economic Support Index. Hence this thesis starts with a simple linear regression model and will further dive into the Lasso regression which will aid to select the most appropriate parameters to answer the hypotheses.

The null hypothesis for this study is given by government interventions that adversely affect stock market returns during the COVID-19 pandemic. We will examine whether the OLS as well as the Lasso regression are statistically significant, and which above mentioned variables have the greatest influence on the stock market returns. We reject the null hypothesis if the coefficients of the significant variables are not statistically significant on a 10% significance level, regardless of a negative or a positive value of the coefficient.

4.2. OLS Regression

We are using the following OLS regression model that will be adapted accordingly to the results for each country and especially in case of violations of the basic OLS assumptions:

$$
\begin{aligned}
Stock\ market\ return_t \\
&= \alpha + \beta_1 \times \Delta NewCases_t + \beta_2 \times \Delta NewDeaths_t \\
&+ \beta_3 \times \Delta StringencyIndex_t + \beta_4 \times \Delta GovernmentResponseIndex_t \\
&+ \beta_5 \times \Delta ContainmentHealthIndex_t + \beta_6 \times \Delta EconomicSupportIndex_t \\
&+ u_t
\end{aligned}
$$

Equation 1 OLS Regression – Stock Market Returns

To perform the OLS regression, certain assumptions need to be fulfilled for the OLS estimator to be the best linear unbiased estimator (BLUE). The assumptions are as follows:

Table 2 Basic OLS Assumptions

Notation	Interpretation
$E(u_i) = 0$	The errors have zero mean.
$Var(y_i) = \sigma^2$	The variance of the errors is constant and finite over all values of x_i.
$Cov(u_i,u_j) = 0$	The errors are statistically independent of one another.
$Cov(u_i,x_i) = 0$	The errors are uncorrelated with the explanatory variables.

Note: Table 2 presents the basic OLS assumptions and the respective interpretation.

Statistically significant implies rejecting the null hypothesis for a standard regression F-test that all the coefficients except the intercept equal zero. Therefore, there is a statistically certain effect of the explanatory variables on the explained one, which is in this case the stock market return of the respective country.

We perform the Breusch-Pagan-Godfrey (BPG) test to test for homoscedasticity. In case of a rejection of the null hypothesis, meaning that the variables are heteroscedastic, we adjust the standard errors using the Newey-West robust standard errors. Even if we expect non-normality, since we are testing stock market returns, we check by performing the Jarque-Bera (JB) test. The Durbin-Watson (DW) test is used to detect autocorrelation, meaning having a pattern in the residuals.

In the case of highly correlated explanatory variables, multicollinearity occurs which can have several negative consequences and makes reliable inference impossible. It can be detected by setting up a correlation matrix between the independent variables. As a threshold for severe multicollinearity, we use a value above 0.9. Additionally, the Variance Inflation Factor (VIF) can be used to detect multicollinearity. As a remedy, we decide to remove the respective variables (Brooks, 2014).

4.3. OLS Regression Results

Testing for heteroscedasticity, we do not reject the null hypothesis of homoscedasticity for the United Kingdom, but clearly for the other three countries. Therefore, we adjust the standard errors using the Newey-West robust standard errors by using the hac command in Matlab resulting in the OLS estimators still being the best linear unbiased estimator.

It is known that stock market returns are not normally distributed but have fat tails. This can be supported by the JB test that we performed for all four countries. We clearly reject the null hypothesis of normality for all of them.

For all four chosen countries, we do not have any autocorrelation when checking using the DW test. We get DW statistics close to 2, resulting in a non-rejection of the null hypothesis of no autocorrelation.

Testing for multicollinearity, we can observe for China and the United Kingdom, the correlation between the Government Response Index and the Stringency Index is above the threshold of 0.9. This is also the case for the Containment and Health Index and the Stringency Index, as well as the Government Response Index. Since the Stringency Index has the lowest VIF compared to the other two indexes, we decide to remove the Government Response Index and the Containment and Health Index. Table 16 and Table 17 in the Appendix show the respective correlation matrix and VIF values for China, Table 18 and 19 for the United Kingdom. Looking at Sweden, only the correlation between the Containment and Health Index with the Government Response Index is above the threshold of 0.9. Since the VIF of the Government Response Index is higher, we decide to remove it from the regression. The details are shown in the Appendix in Table 20 and Table 21. Checking the variables for the United States, we suggest removing the Containment and Health Index, since the correlation between the Containment and Health Index and the Stringency Index, as well as the Government Response Index is above the threshold of 0.9. Table 22 and 23 in the Appendix indicate the exact values for each of the explanatory variables.

4.4. LASSO Regression

To check if our model explains the upcoming stock market returns well, we are using a Lasso regression. LASSO once more stands for Least Absolute Shrinkage and Selection Operator. This method goes beyond shrinking parameters and sets some equal to zero. The parameters are given by:

$$\beta_\lambda^L = argmin \sum_{i=1}^{n} (y_i - \beta_0 - \sum_{j=1}^{p} \beta_j x_{ij})^2 + \lambda \sum_{p=1}^{p} |\beta_j| = RSS + \lambda \sum_{p=1}^{p} |\beta_j|$$

Equation 2 Lasso Regression Model

Having the constraint $|\beta_j|$ will geometrically be a diamond in two dimensions, a so-called polyhedron 3D. The aim is to pick the lambda λ, a regularization parameter, that minimizes the forecast error out of sample in the validation sample to avoid overfitting (James et al., 2013). We will use K-Fold Cross Validation with K = 10. Furthermore, additionally to a Lasso regression with the original six explanatory variables, we run another one using a Design Matrix converted from the variables for the regression analysis, using “quadratic” as the model to receive constant, linear, interaction and squared terms.

The Trace Plot of Coefficients fit by Lasso can be used to observe how much shrinkage the model applies, and which explanatory variables are set to zero for the optimal lambda value. On the right side of the graph, we get something like OLS and on the left side, we are only keeping the constant in the model. Increasing the lambda value to the left, lets the coefficients shrink towards zero. The degrees of freedom show when an explanatory variable is set equal to zero when setting all to zero when going more to the left. The green dashed line in the trace plot indicates the optimal lambda model, which usually gets rid of a lot of explanatory variables since it is commonly far to the left. Moreover, the trace plot presents how much regularization is being done to the regression. Resultingly, one will be able to indicate whether OLS is the regression to pursue with or Lasso is the more appropriate regression to use, depending on where in the plot the optimal line lies.

The Cross-Validated Deviance Plot of the Lasso Fit generally presents two main data points in the plot. Firstly, it indicates the deviance of the Lasso. Which can be interpreted into kind of the forecast error. The goal is to get the smallest deviance as possible. Validated or out of sample deviance which is calculated for a range of Lasso lambdas. In the plot, the green circle indicates hence the minimized lambda. The optimal lambda one wants to achieve. This lambda lies normally between 10^0 and 10^{-4}. The second parameter indicated by the Lasso plot is the standard deviation lambda, which is normally presented in the plot as a blue circle. From here if one would have a standard deviation of the lambda to the right and the left, one would receive something like a confidence interval for the lambdas (Brooks, 2014).

5. Data

For this paper, we essentially gathered data from two primary data sources for four different countries namely, China, the United Kingdom, Sweden, and the United States, respectively. Thomson Reuters Eikon was used to compile the daily stock market data which we transformed into returns as the main endogenous variable in this study. To maintain consistency, we only chose to collect the major stock index from the four selected sample countries. These Indexes are SSEC, FTSE 100, OMX Stockholm 30 and, S&P 500, which is presented in Table 3 below respectively. For the collected Indexes we always used the closing prices for the specific days to be consistent and be able to generate useful results later when using the machine learning approach. Moreover, we collected the in Section 4 mentioned exogenous variables which are described in brief below.

Table 3 Indexes by Sample Countries

No	Code	Country	Stock Index
1	CHN	China	SSEC
2	GBR	United Kingdom	FTSE 100
3	SWE	Sweden	OMXS 30
4	USA	United States	S&P 500

Note: Table 3 presents the different Indexes by sample Countries, respectively.

As a next step, we downloaded the repository from GitHub along with the governmental responses from the Oxford COVID-19 Government Response Tracker (OxCGRT). We chose a sample period from January 23rd, 2020, to December 4th, 2020. We chose this sample period because we are excluding the start of the introduction of the vaccinations. All Indexes have a scale from 0 to 100, where 100 is the strictest. The Stringency Index contains nine response indicators, such as school closures, workplace closures, and travel bans. The Government Response Index contains 16 indicators, wherefrom seven more are added additionally to the Stringency Index, i.e., income support and testing policies. The Containment and Health Index adds five new indicators to the Stringency Index, making a sum of 14 indicators which include for example facial coverings and vaccination policies. The last Index, the Economic Support Index only takes into consideration two indicators, income support and debt relief.

Endogenous Variable

For both the OLS and the Lasso regression the dependent variable we want to describe is the stock market returns in reaction to SARS-CoV-2 variables in China, the United Kingdom, Sweden, and the United States.

Exogenous Variables

Once again, for both regression models also the independent variables will stay the same. Hereby the aim is to indicate independent variables which are significant for both regression models and can explain the dependent variable, namely the stock market returns. Therefore, various possible impacts on the stock market returns are represented in form of independent variables. The independent variables used in both models are as follows:

- New COVID-19 Cases: this variable indicates how many people are newly infected by the coronavirus compared to the last observation day. The more humans who are newly infected, the greater will be the probability of possible new governmental interventions and spillover of the virus.

- New Death Cases: following the newly identified corona cases, the new death variable presents how many people passed away from the prior observation day due to being infected by the virus. This further can be interpreted in means of how deadly the virus is.

- OxCGRT: To obtain a general impression of governmental interventions in the sample countries, four Indexes are used which are Stringency Index, Government Response Index, Containment and Health Index, and Economic Support Index, respectively. The Oxford COVID-19 Government Response Tracker – OxCGRT determines a cross-temporal and cross-national measurement which tracks government interventions across a standardized sequence of indicators, presented in Table 4 and furthermore, forms a collection of composites Indexes to indicate the vast of the individual government responses.

Table 4 OxCGRT Indicators

Indicator	Name	Type	Targeted
Containment and Closure			
C1	School Closing	Ordinal	Geographic
C2	Workplace Closing	Ordinal	Geographic
C3	Cancel Public Events	Ordinal	Geographic
C4	Restrictions on Gathering Size	Ordinal	Geographic
C5	Close Public Transport	Ordinal	Geographic
C6	Stay at Home Requirements	Ordinal	Geographic
C7	Restrictions on Internal Movement	Ordinal	Geographic
C8	Restrictions on Internal Travel	Ordinal	No
Economic Response			
E1	Income Support	Ordinal	Sectoral
E2	Debt/Contract Relief for Households	Ordinal	No
E3	Fiscal Measures	Numeric	No
E4	Giving International Support	Numeric	No
Health Systems			
H1	Public Information Campaign	Ordinal	Geographic
H2	Testing Policy	Ordinal	No
H3	Contact Tracing	Ordinal	No
H4	Emergency Investment in Healthcare	Numeric	No
H5	Investment in COVID-19 Vaccines	Numeric	No
H6	Facial Coverings	Ordinal	Geographic
H7	Vaccination Policy	Ordinal	Cost
H8	Protection of Elderly People	Ordinal	Geographic

Note: Table 4 presents the OxCGRT indicators with its respective name, type ad target.

The indicators presented above and used for this study are of two types namely ordinal and numeric. Where ordinal indicates that the specific indicators are measured and reported every single day, a policy took place, while numeric means that the above-presented indicators are of a specific number and are only reported on days where they are announced. These numeric type indicators are usually valued in USD. The above-mentioned four policy Indexes which are once again: Government Response Index, Stringency Index, Containment and Health Index, and the Economic Support Index are composed of a set of individual policy response indicators. It is worth mentioning, that each Index may not be defined as a judgment of the effectiveness of government responses.

These government activity Indexes are averages of 19 component indicators which is presented in Table 4 above and calculated as given in Equation 3 below:

$$index = \frac{1}{i}\sum_{j=1}^{i} I_j$$

Equation 3 Index Calculation

Where

i is the number of component indicators in an individual Index presented in Table 5 below

I_j is the subindex score for an individual indicator, derived from an additional equation

The indicators for each individual Index are as follows:

Table 5 OxCGRT Indexes with Components

Indicator	Government Response Index	Stringency Index	Containment & Health Index	Economic Support Index
Containment and Closure				
C1	x	x	x	
C2	x	x	x	
C3	x	x	x	
C4	x	x	x	
C5	x	x	x	
C6	x	x	x	
C7	x	x	x	
C8	x	x	x	
Economic Response				
E1	x			x
E2	x			x
E3				
E4				
Health Systems				
H1	x	x	x	
H2	x	x		
H3	x	x		
H4				
H5				
H6	x	x		
H7	x	x		
H8	x	x		
Total	16	14	9	2

Note: Table 5 presents the four Indexes used with their comprised indicators respectively for the chosen sample countries. The x indicates that an indicator is a component of the respective Index.

Lastly to better analyze the impact on the chosen Indexes respectively, we investigated the different sectors in the Indexes and their corresponding weights in the Indexes. Figure 1 below gives a brief overview of the Indexes and their sector weightings.

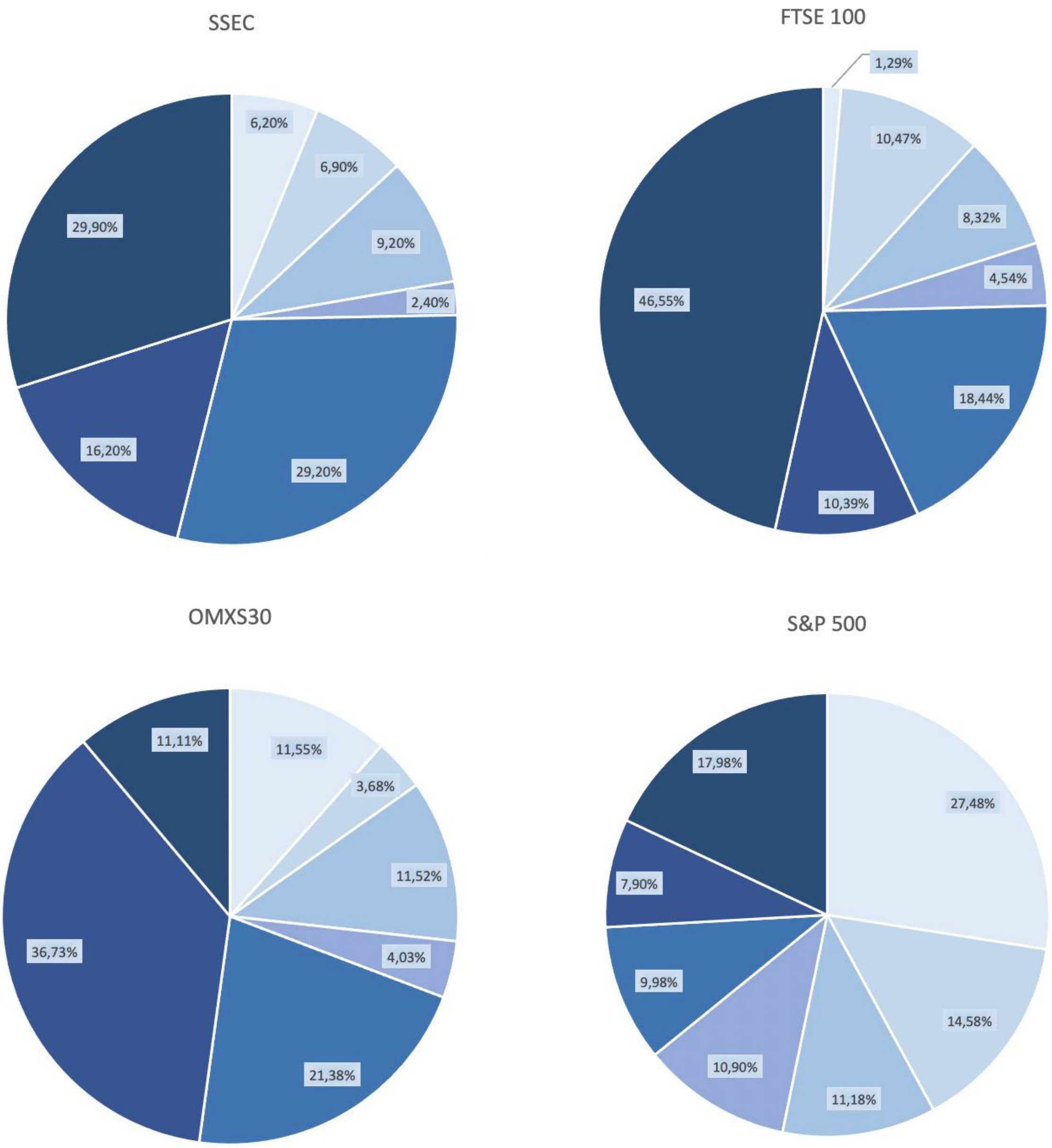

Figure 1 Index Sector Weightings by Sample Country

Note: The upper left figure in Figure 1 represents the SSE Composite Index breakdown by Sector. Information Technology: 6.2%, Health Care: 6.9%, Consumer Discretionarily: 9.2%, Communication Services: 2.4%, Financials: 29.2%, Industrials: 16.2%, Others: 29.9%. Where Others include Energy, Materials, Consumer Staples & Utilities. The upper right figure represents the FTSE 100 Index breakdown by Sector. Information Technology: 1.29%, Health Care: 10,47%, Consumer Discretionarily: 8.32%, Communication Services: 4.54%, Financials: 18.44%, Industrials: 10.39%, Others: 46.55%. Where Others include Energy, Materials, Consumer Staples & Utilities. The lower left figure represents the OMXS 30 Index breakdown by Sector. Information Technology: 11.55%, Health Care: 3.68%, Consumer Discretionarily: 11.52%, Communication Services: 4.03%, Financials: 21.38%, Industrials: 36.73%, Others: 11.11%. Where Others include Energy, Materials, Consumer Staples & Utilities. The lower right figure represents the S&P 500 Index breakdown by Sector. Information Technology: 27.48%, Health Care: 14.58%, Consumer Discretionarily: 11.18%, Communication Services: 10.9%, Financials: 9.98%, Industrials: 7.9%, Others: 17.98%. Where Others include Energy, Materials, Consumer Staples & Utilities.

5.1. Descriptive Statistics

To give a brief overview of the analysis of the series with a range of 209 to 222 observations, it is helpful to describe the main characteristics of individual sample countries through the implementation of various summarizing measures. Therefore, this section describes the descriptive statistics, which are the quantities mainly used to further describe the hypotheses and additional economic series.

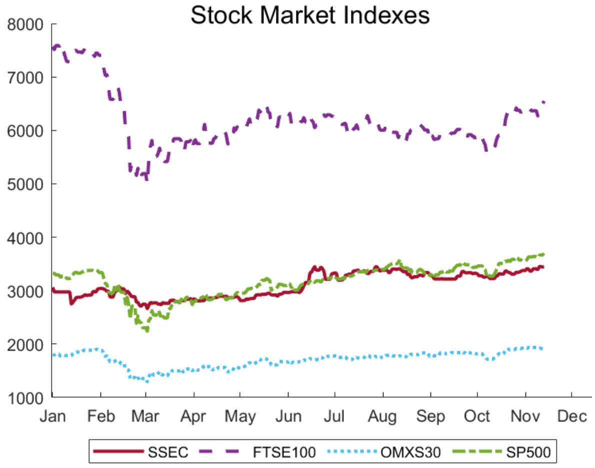

Figure 2 Stock Market Indexes Plot

Note: Figure 2 shows the four stock market indexes, namely, (1) SSEC (2) FTSE 100 (3) OMXS 30 and (4) S&P 500 for the four chosen countries, CHN, GBR, SWE, USA, respectively over the time period from Jan 23 to Dec 04, 2020. The colors are as follows: Red: CHN; Purple: GBR; Blue: SWE; Green: USA.

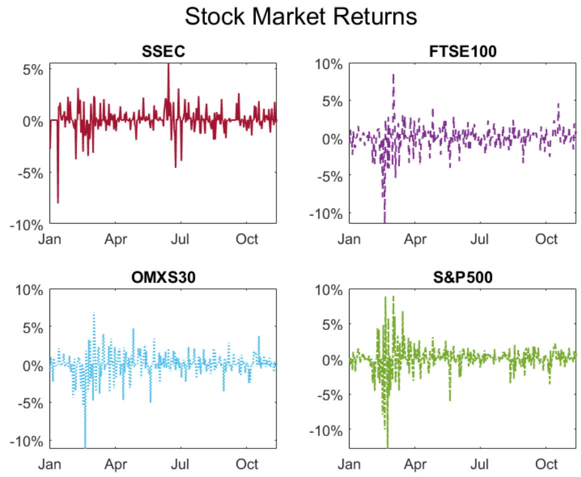

Figure 3 Stock Market Returns Plot

Note: Figure 3 shows each stock market return of the four indexes, namely (1) SSEC (2) FTSE 100 (3) OMXS 30 and (4) S&P 500 for the four chosen countries, CHN, GBR, SWE, USA, respectively over the time from Jan 23 to Dec 04, 2020. The Colors are as follows: Red: CHN; Purple: GBR; Blue: SWE; Green: USA.

In addition to stock market returns, we show the four OxCGRT Indexes in Figure 4 below. Each subplot represents an Index. One can clearly observe that in China regarding government restrictions (Stringency Index and Government Response Index in the upper fields) the government hit harder and, above all, began to impose restrictions earlier. This is expected given that the pandemic started in China. All other countries later responded to the pandemic around March 2020, addressing both government-related and support and health measures. In Sweden with the lightest restrictions, the Indexes rose more slowly than in the other three countries and remained at a lower level. Only for the Economic Support Index China appears to have the lowest Index, while the United Kingdom climbed to an Index of 100 almost instantly when the first lockdown was introduced in March.

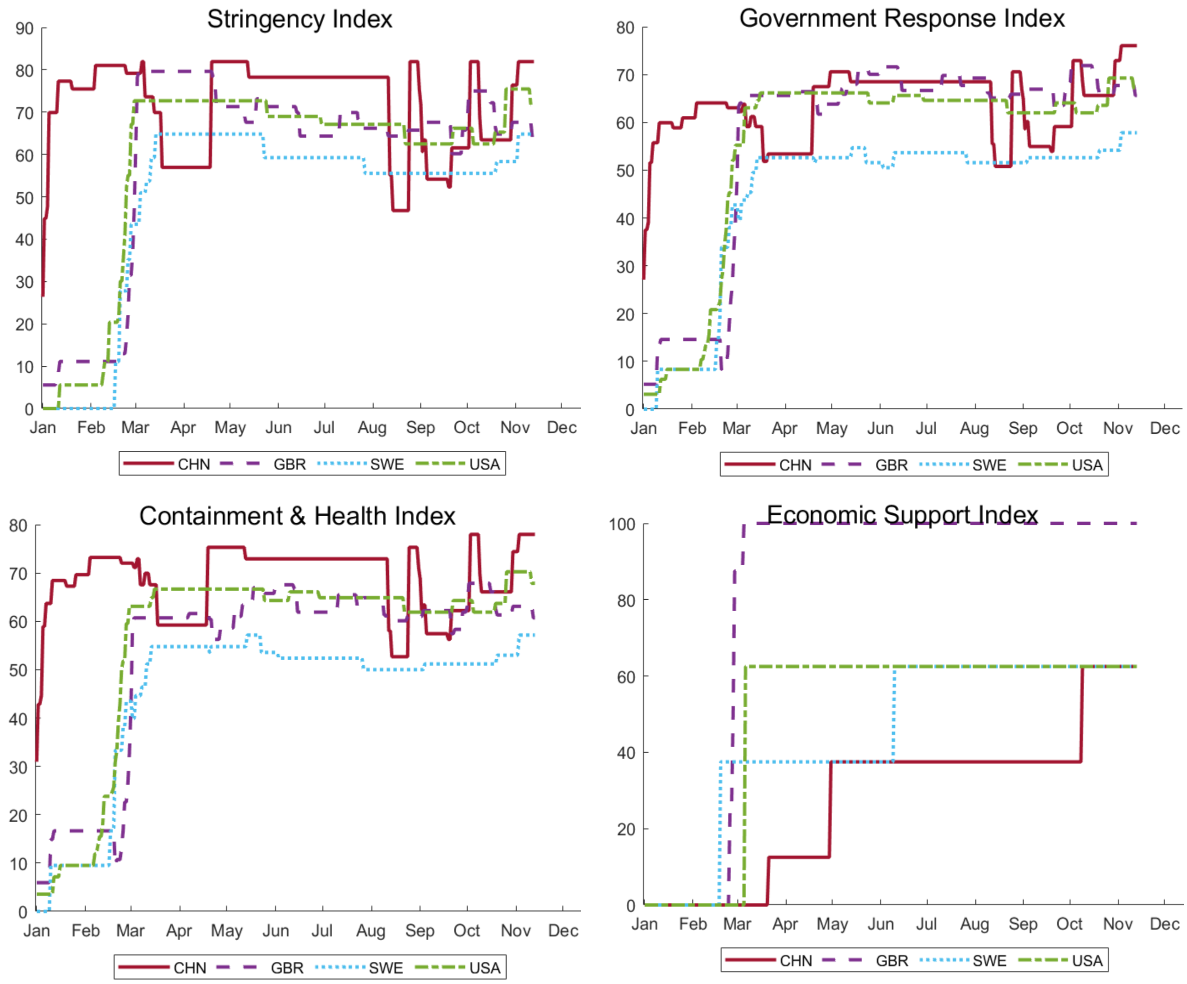

Figure 2 OxCGRT Indexes Overview by Sample Countries

Note: Figure 4 shows the four OxCGRT Indexes for the four chosen countries, namely: CHN, GBR, SWE, and USA, over the period from Jan 23rd to Dec 04th 2020. The upper left plot shows the Stringency Index, the upper right plot the Government Response Index, the lower left plot the Containment & Health Index and the upper right plot shows the Economic Support Index. The colors are as follows: Red: CHN; Purple: GBR; Blue: SWE; Green: USA.

Furthermore, Figures 5 and 6 below demonstrate both the daily new COVID-19 cases and the daily New Deaths during the period from the 23rd of January to the 4th of December 2020. One can clearly observe that the number of cases in the United States exceeds the other countries by several million cases in total, which makes the below graph distorted. In general, it can be said, that the pandemic likely hit the countries in several waves. Governmental actions like lockdowns seem to have a positive influence on the cases, which implies a slowdown of the virus spread. Since Sweden partly reported the number of New Cases only once a week, there is a respective pattern in Figure 5. The negative peak in March for Sweden is a correction of new reported deaths cases and might also be partially through new death case definitions.

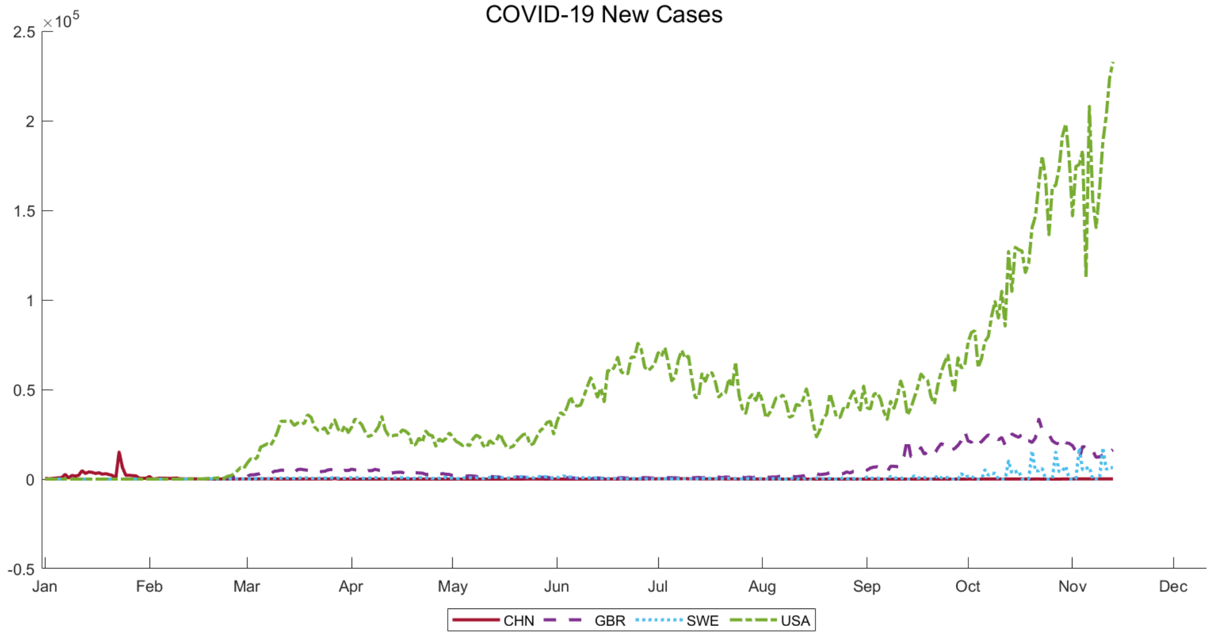

Figure 3 New COVID-19 Cases

Note: Figure 5 shows the daily new COVID-19 cases for the four countries over the period from Jan 23rd to Dec 04th 2020. Red: CHN; Purple: GBR; Blue: SWE; Green: USA.

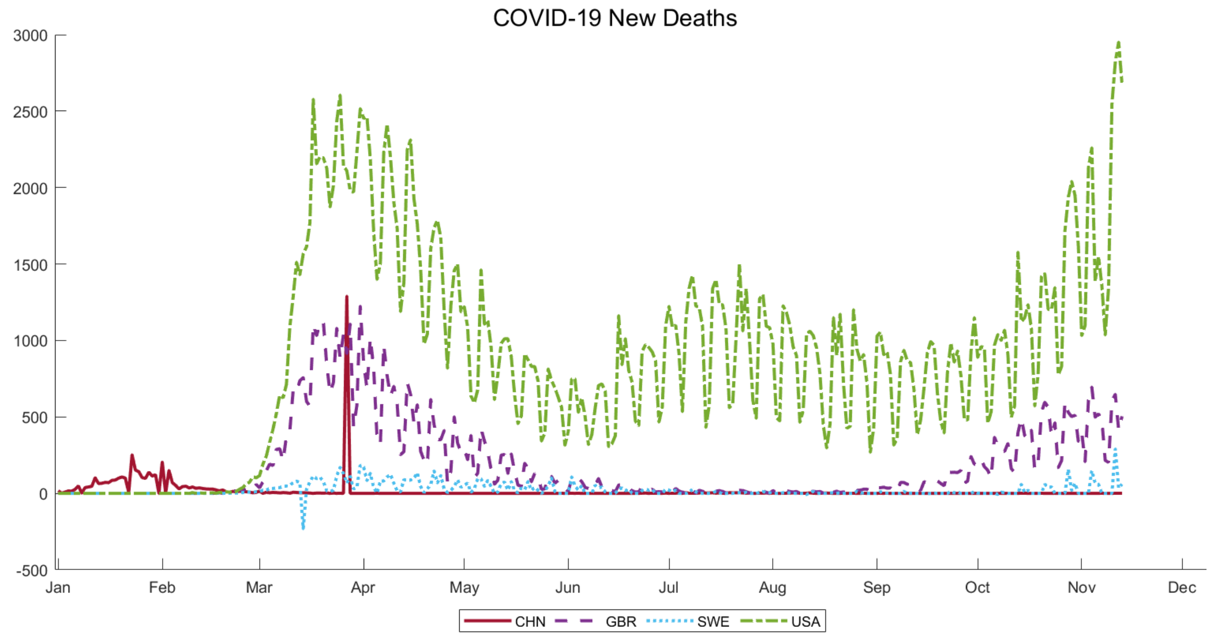

Figure 4 New COVID-19 Deaths

Note: Figure 6 shows the daily new COVID-19 deaths for the four countries over the time from Jan 23rd to Dec 04th 2020. Red: CHN; Purple: GBR; Blue: SWE; Green: USA.

Table 6 DS – Stock Market Indexes

Stock Market Index	CHN – SSEC	GBR – FTSE 100	SWE – OMXS 30	USA – S&P 500
Min	2 660.17	4 993.89	1 292.27	2 237.40
Max	3 451.94	7 585.98	1 938.14	3 699.12
Mean	3 098.06	6 159.15	1 707.82	3 172.96
Median	3 039.67	6 034.43	1 750.24	3 246.41
Std	228.99	535.11	149.22	306.40
Kurtosis	1.44	4.25	2.66	3.11
Skewness	-0.03	1.16	-0.68	-0.78

Note: Table 6 presents the results of the descriptive statistic for the Stock Market Indexes. The variables are as followed: (1) CHN – SSEC, Shanghai Stock Exchange Index – China (2) GBR – FTSE 100, Financial Times Stock Exchange Index 100 – United Kingdom (3) SWE – OMXS 30, OMX Stockholm 30 Index – Sweden (4) USA – S&P 500, Standard and Poor's 500 Index – United States.

Table 7 DS – Stock Market Returns

Stock Market Return	CHN – SSEC	GBR – FTSE 100	SWE – OMXS 30	USA – S&P 500
Min	-0.0804	-0.1151	-0.1117	-0.1277
Max	0.0555	0.0867	0.0685	0.0897
Mean	0.0004	-0.0005	0.0002	0.0003
Median	0.0000	0.0000	0.0000	0.0000
Std	0.0112	0.0165	0.0159	0.0195
Kurtosis	14.5424	14.0183	12.6323	14.5536
Skewness	-1.1877	-1.1666	-1.2154	-0.9406

Note: Table 7 presents the results of the descriptive statistic for the Stock Market Returns. The variables are as followed: (1) CHN – SSEC, Shanghai Stock Exchange Index – China (2) GBR – FTSE 100, Financial Times Stock Exchange Index 100 – United Kingdom (3) SWE – OMXS 30, OMX Stockholm 30 Index – Sweden (4) USA – S&P 500, Standard and Poor's 500 Index – United States.

Since the study uses the stock market returns at a later point as the dependent variable, we exclude the days from the explanatory variables that we do not have stock data on, to be consistent and be able to explain the immediate impact of the variables. We do not want to impose inconsistencies because of not displaying the right returns, for example using the last value given for the day that we do not have stock market returns. Table 6 and 7 above display the respective descriptive statistics for the stock market index and the respective returns.

To emphasize once more, to stay consistent and additionally to collect all basic data needed to pursue in this study, we show the descriptive statistics broken down by country in the presented Tables 12, 13, 14, and 15 in the Appendix, respectively. Each separate country-specific descriptive statistic uses the same endogenous along with the same exogenous variables, which were previously discussed in Section 4 above.

One can see for instance, when looking at the individual descriptive statistics by country that the United States has the highest maximum number of new corona cases, whereas China has the highest maximum Stringency Index in contrast to the other three sample countries. Lastly, it can be observed that the maximum of the Economic Support Index is the same for China, Sweden, and the United States with a value of 63 respectively whereas the maximum of this Index is at a value of 100 for the United Kingdom. These results can be interpreted as means that the government activity in the Economic Support Index is higher than in the other three observed sample countries.

6. Empirical Results

6.1. OLS Regression

China

Running the basic OLS regression for 209 observations, excluding the variables Government Response Index and Containment and Health Index because of the high correlation, results in an adjusted R squared value of 0.0224. Only the Stringency Index has a significant p-value at the 1% significance level significant with a value of 0.096. The intercept and the variable New Deaths have positive but non-significant coefficients, while the variables New Cases, the Stringency Index, and the Economic Support Index have negative coefficients and therefore a negative impact on the stock market return. Furthermore, the overall F-statistic of 2.19 and p-value of 0.0715 mean that the regression is statistically significant at the 10% level. The exact value results are shown in Table 8.

Table 8 OLS Regression Results – CHN

Dependent variable: SSEC (in Returns, daily)		
# of Observations: 209	Adjusted R Squared: 0.0224	F-Stat: 2.19
Parameter	Coefficient	P-Value
α (Intercept)	0.0009 *(0.0010 / 0.009)*	0.3646
ΔNew Cases	-3.7892e-07 *(7.7591e-07 / 5.6847e-07)*	0.6258
ΔNew Deaths	4.7284e-06 *(1.0459e-05 / 1.9176e-06)*	0.6517
ΔStringency Index	-0.0005 *(0.0002 / 4.3517e-04)*	0.0096***
ΔEconomic Support Index	-0.0006 *(0.0004 / 2.2445e-04)*	0.1325

Note: Table 8 displays the results of the OLS regression for China using the daily Stock Market Return as the dependent variable. The return is a function of daily values of: (1) Intercept (2) New Cases (3) New Deaths (4) Stringency Index (5) Economic Support Index. Table 2 and Table 3 explain what every variable stands for in detail. Below each coefficient, standard errors on the left and the respective robust standard errors on the right are presented in *(Italic)*. For every parameter coefficient exists a p-value. *, **, *** is assigned based on the statistical significance level (Brooks, 2014), showing *** for a 1%-significance level, ** for a 5%-significance level and * for a 10%-significance level, respectively.

United Kingdom

For the United Kingdom, we run the basic OLS regression for 222 observations, excluding the variables Government Response Index and Containment and Health Index because of the high correlation. It results in an adjusted R squared value of 0.0293 The Stringency Index and the Economic Support Index have significant p-values at the 5% significance level. While the intercept and the Stringency Index have negative coefficients and therefore a negative impact on the stock market return, the variables New Cases, New Deaths, and the Economic Support Index have a positive impact. Furthermore, the overall F-statistic of 2.67 and p-value of 0.0332 mean that the regression is statistically significant at the 5% level. The exact value results are shown in Table 9.

Table 9 OLS Regression Results – GBR

Dependent variable: FTSE 100 (in Returns, daily)		
# of Observations: 222	Adjusted R Squared: 0.0293	F-Stat: 2.67
Parameter	Coefficient	P-Value
α (Intercept)	-0.0028 *(0.0018)*	0.1097
∆New Cases	1.4193e -08 *(1.8545e-07)*	0.4449
∆New Deaths	6.405e-06 *(5.041e-06)*	0.2052
∆Stringency Index	-0.0009 *(0.0004)*	0.0398**
∆Economic Support Index	0.0008 *(0.0004)*	0.0443**

Note: Table 9 displays the results of the OLS regression for the United Kingdom using the daily Stock Market Return as the dependent variable. The return is a function of daily values of: (1) Intercept (2) New Cases (3) New Deaths (4) Stringency Index (5) Economic Support Index. Table 2 and Table 3 explain what every variable stands for in detail. Below each coefficient, standard errors are presented in *(Italic)*. For every parameter coefficient exists a p-value. *, **, *** is assigned based on the statistical significance level (Brooks, 2014), showing *** for a 1%-significance level, ** for a 5%-significance level and * for a 10%-significance level, respectively.

Sweden

Using the same procedure, we run the basic OLS regression for 222 observations, using five explanatory variables since we exclude the Government Response Index because of the high correlation with the Containment and Health Index. The regression results in an adjusted R squared value of 0.0573. None of the variables have a significant p-value. The Stringency Index, the Containment and Health Index, and the Economic Support Index have negative coefficients and therefore a negative impact on the stock market return, while the intercept and the variables New Cases and New Deaths have a positive impact. Furthermore, the overall F-statistic of 2.63 and p-value of 0.0249 mean that the regression is statistically significant at the 5% significance level. The exact value results are shown in Table 10.

Table 10 OLS Regression Results – SWE

Dependent variable: OMXS 30 (in Returns, daily)		
# of Observations: 222	Adjusted R Squared: 0.0573	F-Stat: 2.63
Parameter	Coefficient	P-Value
α (Intercept)	0.0004 *(0.0002 / 0.0014)*	0.7993
ΔNew Cases	3.3954-07 *(4.9317e-07 / 3.0904e-07)*	0.4919
ΔNew Deaths	7.7846e-06 *(2.8338e-05 / 2.9230e-05)*	0.7838
ΔStringency Index	-0.0005 *(0.0014 / 0.0024)*	0.7044
ΔContainment & Health Index	-0.0022 *(00016 / 0.0028)*	0.1735
ΔEconomic Support Index	-0.0002 *(0.0004 / 1.8863e-04)*	0.6199

Note: Table 10 displays the results of the OLS regression for Sweden using the daily Stock Market Return as the dependent variable. The return is a function of daily values of: (1) Intercept (2) New Cases (3) New Deaths (4) Stringency Index (5) Containment & Health Index (6) Economic Support Index. Table 2 and Table 3 explain what every variable stands for in detail. Below each coefficient, standard errors on the left and the respective robust standard errors on the right are presented in *(Italic)*. For every parameter coefficient exists a p-Value. *, **, *** is assigned based on the statistical significance level (Brooks, 2014), showing *** for a 1%-significance level, ** for a 5%-significance level and * for a 10%-significance level, respectively.

United States

Running the basic OLS regression for 221 observations, excluding the Containment and Health Index because of the high correlation with other variables, results in an adjusted R squared value of 0.142. All three Indexes have significant p-values at the 1% significance level. The intercept, as well as the Stringency Index and the Economic Support Index have negative coefficients and therefore a negative impact on the stock market return, while New Cases, New Deaths and the Government Response Index have a positive impact. Furthermore, the overall F-statistic of 8.31 and p-value of 3.36e-07 mean that the regression is statistically significant at the 1% significance level. The exact value results are shown in Table 11.

Table 11 OLS Regression Results – USA

Dependent variable: S&P 500 (in Returns, daily)		
# of Observations: 221	Adjusted R Squared: 0.142	F-Stat: 8.31
Parameter	Coefficient	P-Value
α (Intercept)	-0.0018 *(0.0027 / 0.0032)*	0.5098
ΔNew Cases	1.8752e-08 *(3.5155e-08 / 2.7721e-08)*	0.5943
ΔNew Deaths	1.8645e-06 *(2.4368e-06 / 2.4500e-06)*	0.4450
ΔStringency Index	-0.0109 *(0.0024 / 0.0039)*	8.7591e-06***
ΔGovernment Response Index	0.0127 *(0.0039 / 0.0064)*	0.0011***
ΔEconomic Support Index	-0.0021 *(0.0006 / 0.0008)*	0.0004***

Note: Table 11 displays the results of the OLS regression for the United States using the daily Stock Market Return as the dependent variable. The return is a function of daily values of: (1) Intercept (2) New Cases (3) New Deaths (4) Stringency Index (5) Government Response Index (6) Economic Support Index. Table 2 and Table 3 explain what every variable stands for in detail. Below each coefficient, standard errors are presented in *(Italic)*. For every parameter coefficient exists a p-Value. *, **, *** is assigned based on the statistical significance level (Brooks, 2014), showing *** for a 1%-significance level, ** for a 5%-significance level and * for a 10%-significance level, respectively.

6.2. LASSO Regression

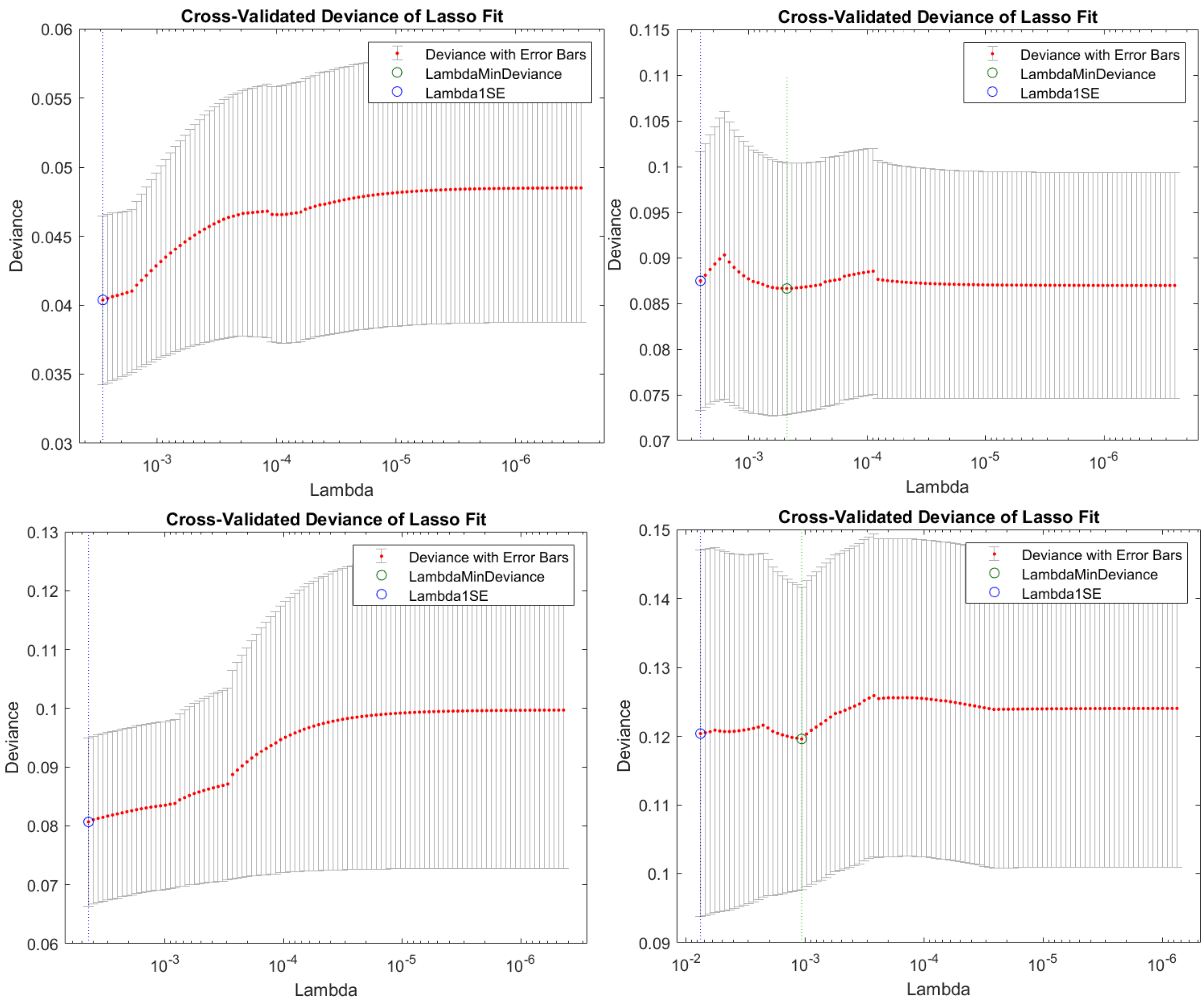

Figure 5 Cross-Validated Deviance of Lasso Fit by Country

Note: Figure 7 of Cross-Validated Deviance of Lasso Fit by country. Upper Left Panel shows: China. Upper Right Panel shows: United Kingdom. Lower Left Panel shows: Sweden. Lower Right Panel shows: United States. The vertical axis for all plots is the deviance of each individual plot, horizontal axis is the deviance of each model per country, respectively. Center red line of the curves represents the deviance for 10-fold cross validation, along with the grey lined areas indicate the error bars of the deviances. Vertical dotted lines indicate the optimum models selected by minimum Lambda with 1 standard error (blue circle with vertical line) and the minimum deviance of the lambda from the model (green circle with vertical line).

China

The Cross-Validated Deviance plot of the Lasso Fit for China presented above Figure 7 shows that the optimal lambda with the minimum deviance lies between 10^{-2} and 10^{-3}, indicating the minimum cross-validation error presented with a green circle in the upper left panel plot. This indicated minimum cross-validation error lambda plus one standard error results in the blue circle which is closer to 10^{-3}. Given that the confidence interval of China's optimal lambda given by the Lasso fit can be interpreted as the above-mentioned optimal minimum cross-validation error ±1 SE.

From the Trace Plot of Coefficients fit by Lasso using the original explanatory variables in Figure 8 one can observe that the model applies a lot of shrinkages and sets all explanatory variables to zero. The optimal lambda, meaning the lambda with the minimum deviance, has a value of 0.0028 and the respective Index is 100. The variables with the slowest shrinkage are the Government Response Index and the Economic Support Index. Running a regression with only these two variables on the RHS results in a positive Intercept estimate and for both variables in negative coefficients meaning that they have a negative impact on the stock market return. Additionally, the Government Response Index has a significant p-value at the 1% significance level of 0.0025. The F-statistic is 5.4 with a p-value of 0.0052, meaning that the regression is statistically significant at the 1% significance level.

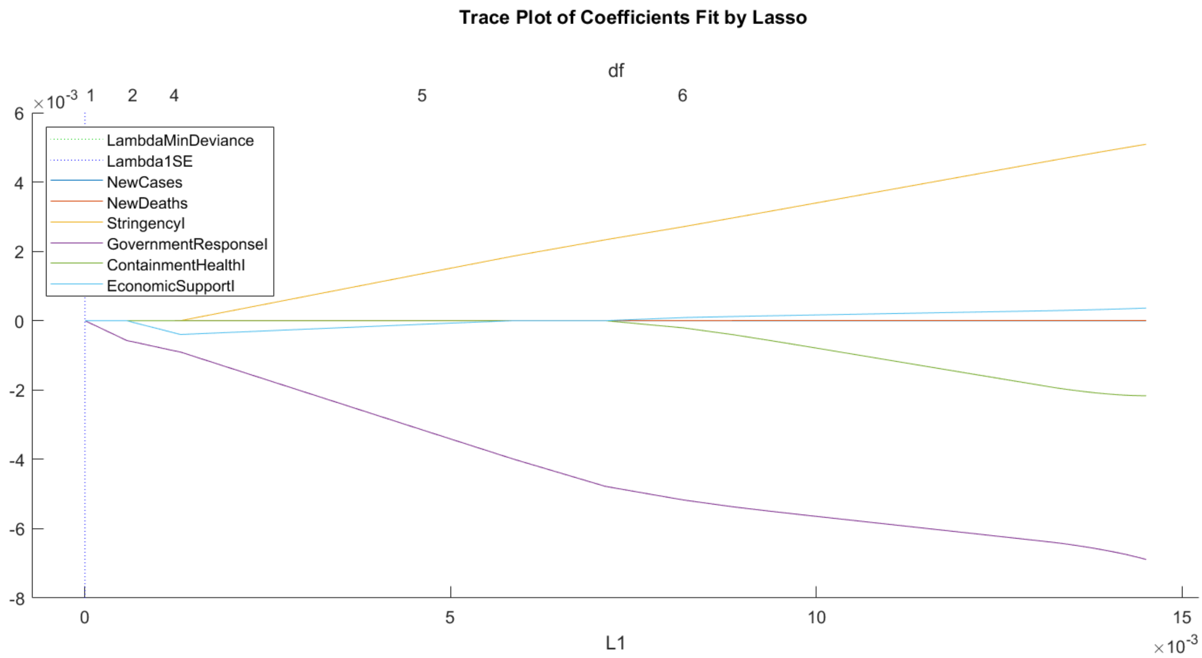

Figure 6 Trace Plot of Coefficients Fit by Lasso – Original Variables – CHN

Note: Trace Plot of Coefficients Fit by Lasso for the sample country China. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country China. The maximum permissible value L1 can take ranging from 0 to $15x10^{-3}$. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -8 to $6x10^{-3}$. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containment & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

Using the Design Matrix, including squared and interaction terms results in a lambda value for minimum deviance of 0.0003 with a respective Index of 70. The variables New Deaths and the Economic Support Index and six of the interaction terms are not set to zero by the Lasso regression. This can also be observed in Figure 9. Using those two variables on the RHS in a normal regression gives positive coefficient estimates for the intercept and the variables New Deaths, while the coefficient of the Economic Support Index is negative, all with non-significant p-values. The F-statistic has a value of 0.735 with a non-significant p-value of 0.481.

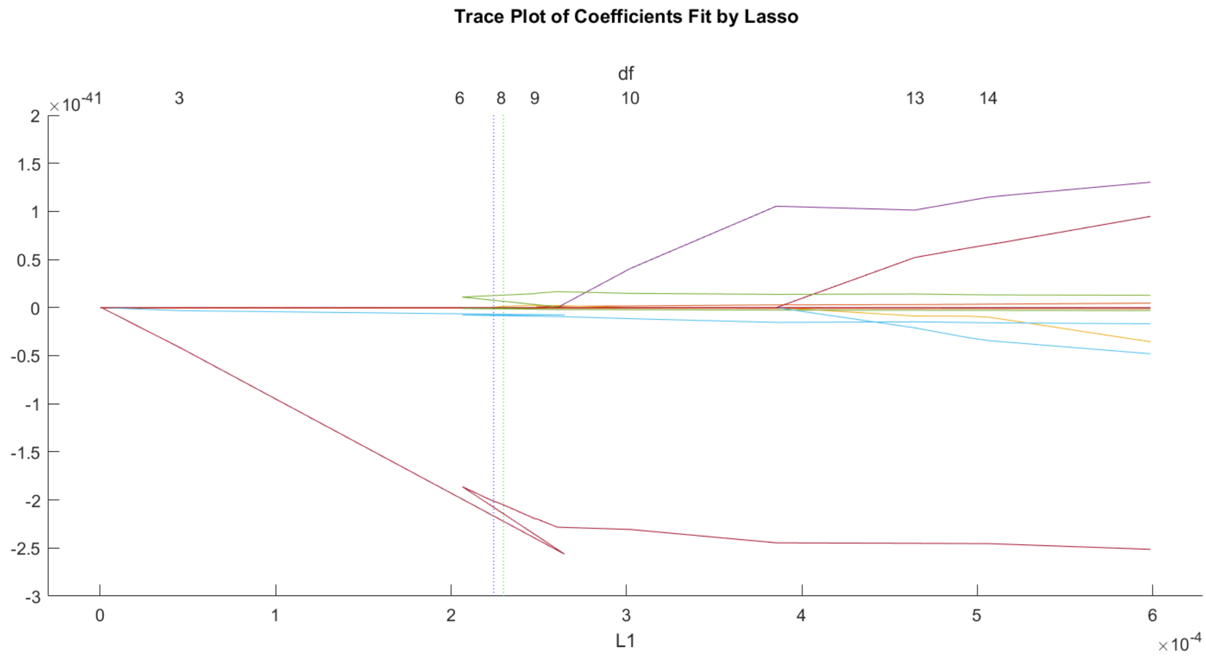

Figure 7 Trace Plot of Coefficients Fit by Lasso – Design Matrix – CHN

Note: Trace Plot of Coefficients Fit by Lasso for the sample country China. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country China. The maximum permissible value L1 can take ranging from 0 to 6x10^{-4}. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -3 to 2x10^{-4}. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containment & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

United Kingdom

The Cross-Validated Deviance plot of the Lasso Fit for the United Kingdom shows that the optimal lambda with the minimum deviance lies between 10^{-3} and 10^{-4}, indicating the minimum cross-validation error presented with a green circle in the upper right panel plot. This indicated minimum cross-validation error lambda plus one standard error results in the blue circle which is closer to 10^{-2}. Given that the confidence interval of the United Kingdom's optimal lambda given by the Lasso fit can be interpreted as the above-mentioned optimal minimum cross-validation error ±1 SE.

From the Trace Plot of Coefficients fit by Lasso using the original explanatory variables in Figure 10, the model applies only a little shrinkage and sets the Government Response Index to zero. The optimal lambda, meaning the lambda with the minimum deviance, has a value of

0.0005 and the respective Index is 82. Running a regression excluding the Government Response Index on the RHS, results in negative coefficients for the Intercept, the Stringency Index, and the Economic Support Index and in positive coefficients, meaning a positive impact on the stock market return, for the variables New Cases, New Deaths and the Containment and Health Index. Additionally, the p-value of the Stringency Index and the Containment and Health Index are statistically significant at the 1% significance level, while the p-value of the intercept is significant at the 10% significance level. The overall F-statistic of 5.8 with a p-value of 0.000048, mean that the regression is statistically significant at the 1% significance level.

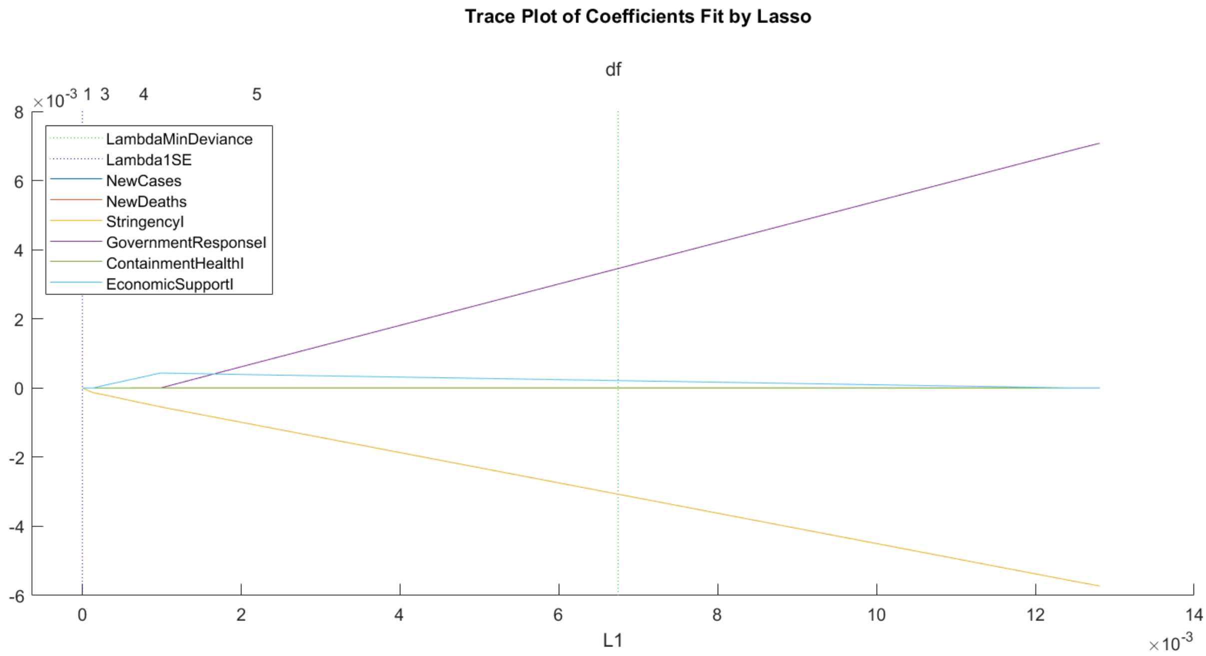

Figure 8 Trace Plot of Coefficients Fit by Lasso – Original Variables – GBR

Note: Trace Plot of Coefficients Fit by Lasso for the sample country United Kingdom. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country United Kingdom. The maximum permissible value L1 can take ranging from 0 to $14x10^{-3}$. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -6 to $8x10^{-3}$. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containment & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

Using the Design Matrix, see Figure 11 below, including squared and interaction terms results in a lambda value for minimum deviance of 0.0029 with a respective Index of 100 and a Lambda plus 1 standard error Index of 100. The Lasso regression sets all explanatory variables to zero. The variables New Deaths, the Stringency Index, and the Economic Support Index are shrinking the slowest. Using those three variables on the RHS in a normal regression gives very small but positive coefficient estimates for the variables New Deaths and the

Economic Support Index and negative coefficients for the intercept and the Stringency Index. The indexes both have significant p-values at the 5% significance level. The F-statistic results in a value of 3.37 with a p-value of 0.0194, meaning that the regression is significant at the 5% significance level.

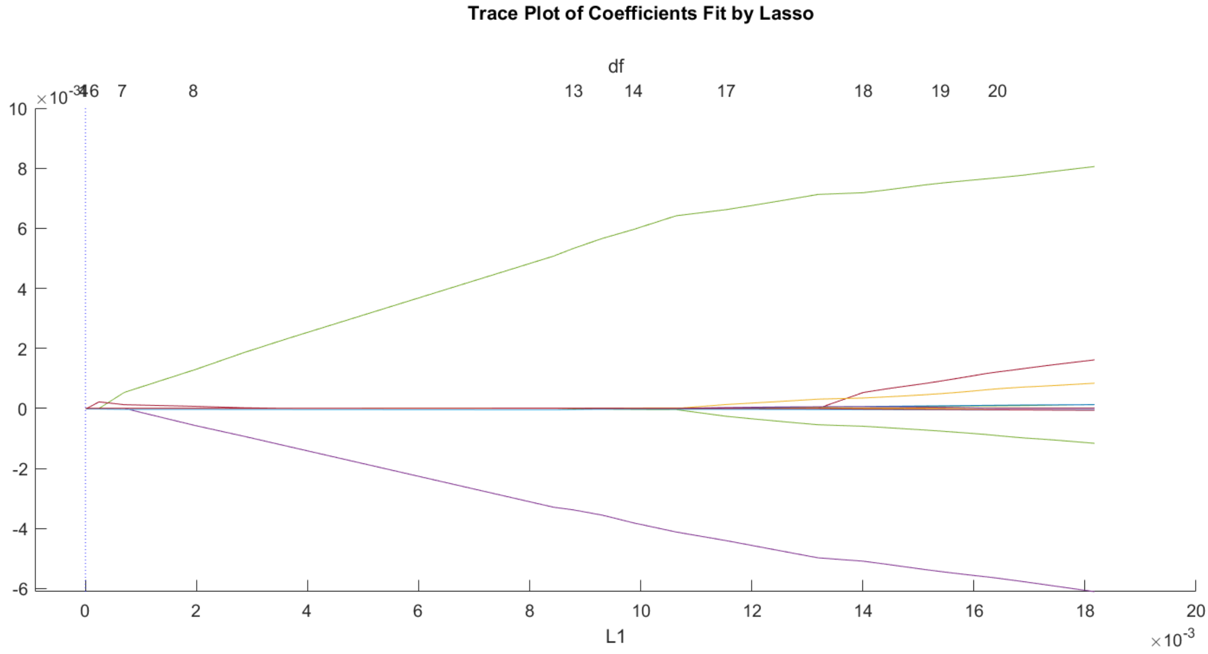

Figure 9 Trace Plot of Coefficients Fit by Lasso – Design Matrix – GBR

Note: Trace Plot of Coefficients Fit by Lasso for the sample country United Kingdom. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country United Kingdom. The maximum permissible value L1 can take ranging from 0 to $20x10^{-3}$. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -6 to $10x10^{-3}$. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containment & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

Sweden

The Cross-Validated Deviance plot of the Lasso Fit for Sweden presented previously shows that the optimal lambda with the minimum deviance lies around 10^{-3}, indicating the minimum cross-validation error presented with a green circle in the lower-left panel plot. This indicated minimum cross-validation error lambda plus one standard error results in the blue circle which is closer to 10^{-2}. Given that the confidence interval of Sweden's optimal lambda given by the Lasso fit can be interpreted as the above-mentioned optimal minimum cross-validation error ±1 SE.

From the Trace Plot of Coefficients fit by Lasso using the original explanatory variables in Figure 12 the model applies a lot of shrinkage and sets all explanatory variables to zero. The optimal lambda, meaning the lambda with the minimum deviance, has a value of 0.0044 and the respective Index is 100. The variables that shrink the slowest are the variables New Deaths and the Stringency Index. Running a regression with only these two variables on the RHS, results in a negative estimate for the Stringency Index and in positive coefficients for the Intercept and variable New Deaths. The Stringency Index is statistically significant at the 1% significance level with a p-value of 0.0017. The F-statistic is of 5.22 with a p-value of 0.006. It is therefore statistically significant at the 1% significance level.

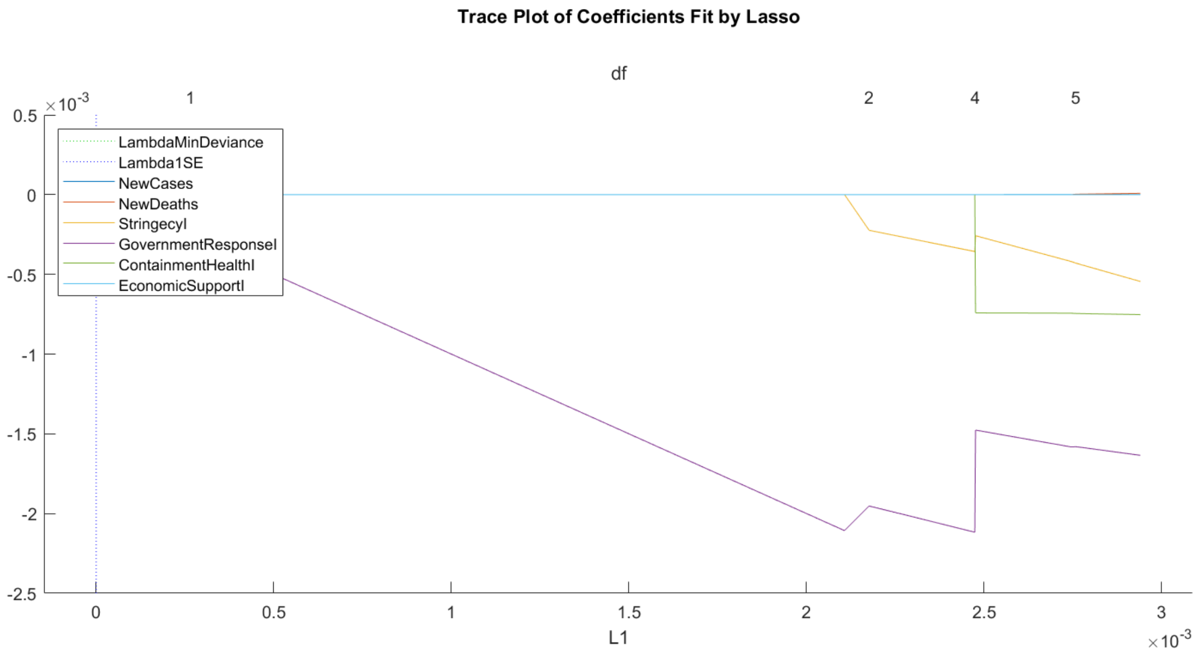

Figure 10 Trace Plot of Coefficients Fit by Lasso – Original Variables – SWE

Note: Trace Plot of Coefficients Fit by Lasso for the sample country Sweden. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country Sweden5. The maximum permissible value L1 can take ranging from 0 to 3x10^{-3}. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -2.5 to 0.5x10^{-3}. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containment & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

Using the Design Matrix, see Figure 9 below, including squared and interaction terms results in a lambda value for minimum deviance of 0.0073 with a respective Index of 100 and a Lambda plus 1 standard error Index of 100. The Lasso regression sets all explanatory variables to zero. The Government Response Index is shrinking the lowest, see Figure 13. Using this variable on the RHS in a normal regression gives a positive, non-significant Intercept and a negative estimate for the Government Response Index with a p-value of 0.0005, therefore significant at the 1% significance level. The F-statistic presents similar results as in the regression above, 12.4 with a p-value of 0.0005, indicating that it is very significant.

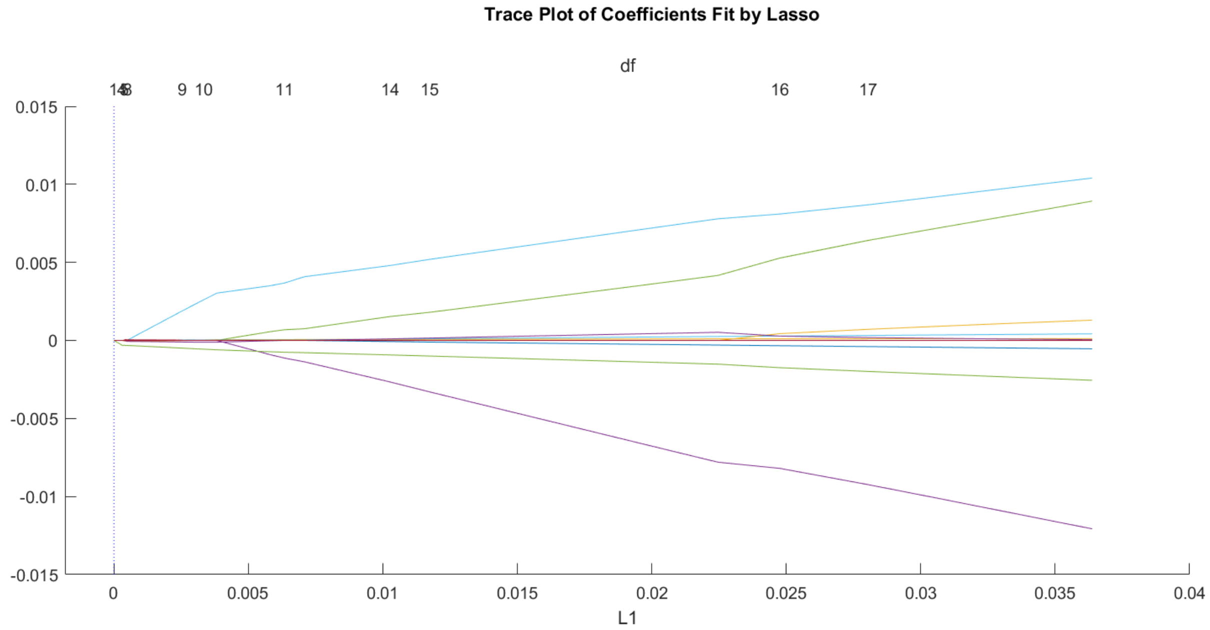

Figure 11 Trace Plot of Coefficients Fit by Lasso – Design Matrix – SWE

Note: Trace Plot of Coefficients Fit by Lasso for the sample country Sweden. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country Sweden. The maximum permissible value L1 can take ranging from 0 to 0.04. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -0.015 to 0.015. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containments & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

United States

The Cross-Validated Deviance plot of the Lasso Fit for the United States presented previously shows that the optimal lambda with the minimum deviance lies between 10^{-2} and 10^{-3}, indicating the minimum cross-validation error presented with a green circle in the lower right panel plot. This indicated minimum cross-validation error lambda plus one standard error results in the blue circle which is closer to 10^{-2}. Given that the confidence interval of the United States' optimal lambda given by the Lasso fit can be interpreted as the above-mentioned optimal minimum cross-validation error ±1 SE.

From the Trace Plot of Coefficients fit by Lasso using the original explanatory variables in Figure 14 one can observe that the model applies some shrinkage and sets three explanatory variables to zero. The ones not set to zero are the variables New Deaths, the Stringency Index, and the Economic Support Index. The optimal lambda, meaning the lambda with the minimum deviance, has a value of 0.0011 and the respective Index is 79. The variables with the slowest shrinkage are New Deaths and the Government Response Index and the Economic Support Index. Running a regression with only these three variables on the RHS results in a negative estimate for the Intercept, the Stringency Index, and the Economic Support Index, only the Stringency Index has a significant p-value of 2.5054e-06, it is significant at the 1% significance level. The variable New Deaths has a positive, non-significant estimate. The regression has a F-statistic of 9.79, with a p-value of 4.37e-06, meaning it is very significant at the 1% significance level.

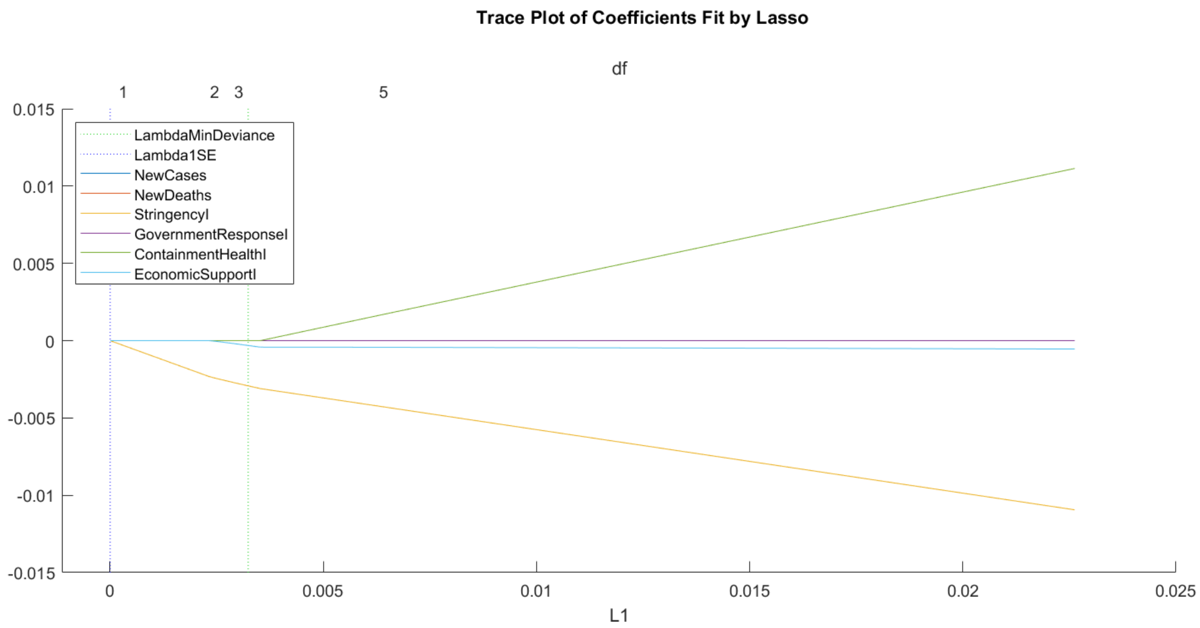

Figure 12 Trace Plot of Coefficients Fit by Lasso – Original Variables – USA

Note: Trace Plot of Coefficients Fit by Lasso for the sample country United States. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country United States. The maximum permissible value L1 can take ranging from 0 to 0.025. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -0.015 to 0.015. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containments & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

Using the Design Matrix including squared and interaction terms results in a lambda value for minimum deviance of 0.0010 with a respective Index of 77 and a Lambda plus 1 standard error Index of 100. The Lasso regression most of the variables to zero, which can also be observed in Figure 15. Apart from the variables New Deaths and the Stringency Index, three of the interaction terms are also not set to zero. Using the two variables on the RHS in a normal regression gives negative coefficient estimates for the Intercept and the Stringency Index and a positive, non-significant estimate for the New Deaths variable. Only the Stringency Index has a significant p-value at the 1% significance level with a value of 0.0001. The F-statistic has a value of 9.59 with a p-value of 0.0001, so significant at the 1% significance level.

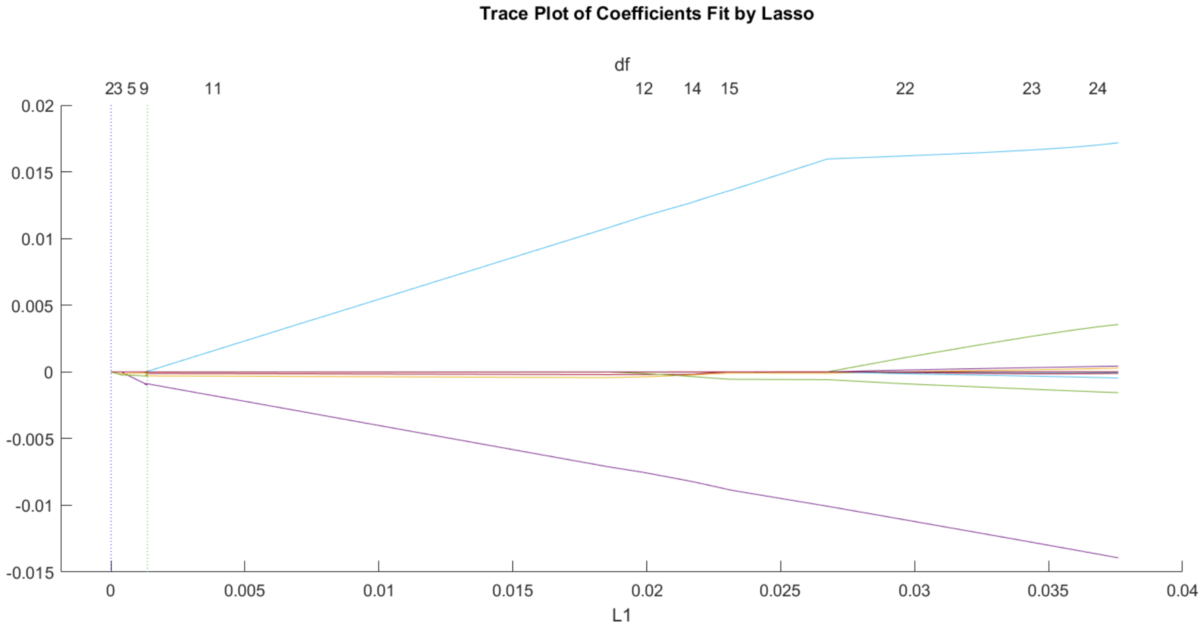

Figure 13 Trace Plot of Coefficients Fit by Lasso – Design Matrix – USA

Note: Trace Plot of Coefficients Fit by Lasso for the sample country United States. Lower horizontal line (x-axis) represents L1, the regularization term of Lasso for the sample country United States. The maximum permissible value L1 can take ranging from 0 to 0.04. Upper horizontal line (x-axis) indicates the degrees of freedom from the Lasso Trace Plot. Vertical line (y-axis) indicates the coefficients ranging from -0.015 to 0.02. Model parameters are as follows, dark blue: New Cases, orange: New Deaths, yellow: Stringency Index, purple: Government Response Index, green: Containments & Health Index and light blue: Economic Support Index. The dashed green line represents the minimum deviance lambda with the blue dashed line representing the minimum deviance lambda plus 1 standard error.

7. Analysis and Discussion

China

As previously described, China is the country where the novel SARS-CoV-2 known as COVID-19 pandemic first broke out as reported by the World Health Organization (WHO, 2021) and afterward spread rapidly across the globe and affecting all sample countries in this study. In end-January when the number of new cases started to increase in China, the Chinese stock market experienced its first visible fall to an Index of 2 746, which is previously presented through the SSEC plot in Figure 2. Even though the number of new infected COVID-19 cases increased in China from this point on and hit its peak with the highest number of infected cases analyzed and presented through the new cases data in mid-February, the stock markets increased in this period again which is clearly demonstrated in Figure 5.

At the timing China firstly introduced its lockdown regulation, the number of newly infected cases reported declined rapidly along with a questionable decline in the Shanghai Composite Index. Although our data analysis and results indicate that through the implementation by the government of a lockdown and public closings in China, including school closings, shop closings, social distancing and cancelations of public events, the Chinese stock market still experienced a noticeable decline. This fall in the SSEC can be interpreted as a decline through a reduction in economic activities along with investors and private peoples' behavior towards the stock market and the uncertainty the pandemic brings with it. This is the timing when China saw the serious issue in the outbreak and hence this initial panic influenced inversely the stock market. However, even with the continuation of the lockdown in China, the stock market declined with the lowest Index of 2 660 at the beginning of March despite the decline in new reported COVID-19 cases, which clearly depicts that there must be additional factors along with new reported cases affecting the Index of the stock market. At the end of March, when China started to loosen the lockdown regulations, the stock market index started to increase and slowly recovered again. This leads us to an observation, that the Chinese stock market index was more impacted during the period of the lockdown than when the number of new reported COVID-19 cases increased considering the above-mentioned Index fluctuations, respectively. Moreover, by analyzing the reported number of new deaths in China, one can see, that the number of new reported deaths has no significant influence on the stock market returns. Hence, we come to the first overall conclusion, that the reduction in economic activities through activities such as lockdowns, cancelations of social gatherings, shop closings etc.

represented by the Government Response Index had a greater negative impact on the stock market returns than the number of new reported COVID-19 cases.

To strengthen our above-mentioned conviction, the results of the linear regression model for the sample country China indicates a significant p-value for the Stringency Index. Due to the high number of error degrees of freedom of 204 resulting out of 209 observations respectively, we can be certain that the regression results are accurate and trustworthy. Along with that, the p-value of 0.0715 and the F-statistic of 2.19 are indicating statistical significance. Considering the estimates of coefficients from the explanatory variables it can be said that New Cases, Stringency Index and Economic Support Index are the only coefficients with a negative estimate. All other explanatory variables namely New Deaths tend to have no negative impact on the explained variable the stock market index of China. These findings support the above-mentioned result, that economic activities in China have a rather negative influence on the stock market returns than other explanatory variables measured. Once again, it should be noted and taken into consideration, that the Government Response Index along with the Containment and Health Index were taken out of the regression due to high correlations, which can be found in Table 16 in the Appendix below.

Looking at the Lasso regression, it can be noted, that for the regression the Government Response Index and the Economic Support Index appear to have the most influential impact on the stock market returns since these two variables are the ones shrinking the slowest. Additionally, after running the regression only with those two explanatory variables it can be said that both explanatory variables have a negative impact on the stock market returns of the SSEC. The observed results of the new regression furthermore indicate a significant p-value for the Government Response Index and a significant F-statistic at a 1% level. This moreover is in line with our observations regarding governmental influence. The Lasso Design Matrix indicates that New Deaths and the Economic Support Index have significant impact on the stock market returns. Through running a new regression only with the two explanatory variables respectively, the variables which are not set to zero by Lasso and hence are rather influential to the explained stock market returns, we observe that in this new regression, the Economic Support Index has a negative impact while the New Deaths coefficients of the new regression tend to have a positive impact on the stock market return.

In terms of the weighting of the Index, the Health Sector has its highest peak during the lockdown period when government interventions took place, as well as the

Telecommunications and Information Technology Sectors, as people have confidence in Health care companies and Telecommunications and Information Technology Sectors as components of a fairly safe TMT Sector. Controversially, Finance, Consumer Discretionary, Raw Materials, Industrial and Energy Sectors may have seen a rather decline during the period of stringent interventions such as lockdowns and public closings in China during the outbreak of the COVID-19 pandemic. These conclusions are consistent with the overall negative impact on the SSEC. Since the weighting shown in Figure 1 above for the Shanghai Stock Exchange Composite Index is 84.5% of the Sectors negatively impacted by the pandemic outbreak and only 15.5% of the Sectors more positively impacted during the pandemic.

To reiterate, China was the first country to be hit by the deadly disease and was the first to see the novel virus as a serious problem to conclude that this initial panic reversed the Chinese stock market influenced. As seen above, stock market returns rose sharply again after a while in June after the government eased regulations and no more lockdowns in China. This supports our general understanding that government intervention is having an impact on Chinese stock market returns.

United Kingdom

The stock market in the United Kingdom reacted to the new pandemic with a negative trend even before having any COVID-19 cases. This supports the idea that stock markets not only react to events happening in their country of origin but to events from all over the world (Morales & Andreosso-O-Callaghan, 2012). Already the news of the pandemic outbreak in China and the impact on the stock market in the country, as well as other countries led to more careful actions of investors since people were skeptical about the development of the virus.

The lowest stock market index was recorded on March 23 with an Index of 4 993.89, when the number of new cases started to increase faster, already summing up to more than 12 000 cases in total in the United Kingdom. Figure 1 shows the graph of the stock market index during the chosen period, within the Index fell by 34% until its low, overall, it fell by 13.5%. This trend can also be observed in Figure 3 which shows the stock market returns and clear negative values, especially in March 2020. After this low point, the stock market recovered slowly, regardless of high numbers of new infections. The first lockdown was announced the same day as the Index hit the low (Mayhew & Anan, 2020). It can therefore be seen as a supporting factor in the recovery of the Index, while it was also slowing down the economy and preventing a faster spread of the virus.

Regarding the OLS regression, the Stringency Index along with the Economic Support Index have significant p-values at the 5% significance level, while the other chosen explanatory variables are not statistically significant to explain the stock market. It is worth mentioning that besides the intercept also the Stringency Index was also observed with a negative coefficient, while the remaining explanatory variables have a positive coefficient and hence a positive impact on the stock market returns which strengthens our hypothesis of a positive influence. Since we observed a high correlation between the exogenous variables, especially of the Government Response Index and the Containment and Health Index, we excluded them in the regression. From the Stringency Index, we can conclude, that especially lockdown measures like school and workplace closings, as well as stay at home requirements, movement restrictions and restrictions on gatherings or the cancelation of public events were important factors in the United Kingdom. This supports the findings in the literature review that measures like school and business closures, as well as social distancing measures were used to slow down the spread of the virus (Keogh-Brown et al., 2020). However, the Index has a negative impact on the stock market. The other significant variable, the Economic Support Index has a positive impact on the stock market. It includes the indicators of income support and debt relief for households. The positive impact might indicate a higher trust in the market and a better financial situation of individuals.

Comparing these results with the Lasso regression, only the Government Response Index is set to zero. This goes along with excluding this variable in the OLS regression because of its high correlation with other explanatory variables. Contrary to the first regression, running a new one only excluding the variables set to zero results in negative coefficients for not only the Stringency Index but additionally for the Economic Support Index, opposing our statement from before, that individuals are in a better financial state and regain trust in the market. Surprisingly, the variables New Cases, New Deaths, and the Containment and Health Index have a positive impact. Since only the Index is statistically significant, the number of the actual COVID-19 cases does not seem to have a great impact on the stock market. The Containment and Health Index includes fewer indicators than the Stringency Index, leading to the assumption that the indicators excluded in the Containment and Health Index are the ones with a negative impact. They are testing policies, contact tracing, facial coverings, vaccination policies and protection of elderly people. It seems that those indicators make the investors and individuals less trustworthy, which might be due to the strong intervention in their daily lives.

A positive impact on the Containment and Health Index is, besides helping to reduce the spread of the virus, also supporting the stock market, and improving investors' trust.

Considering the sector weightings of the FTSE 100 Index, the Consumer Related Sectors increased, supporting the statement from the OLS regression, that individuals are in a better financial situation due to debt reliefs from the Government. Additionally, since a lot of people are working from home, their consumption increases as well. This also explains the rise in the Information Technologies Sector of the FTSE 100, since people got to know and especially use more during lockdowns having to work from home and homeschool their children. Surprisingly, after a rise in the Health Care Sector until the middle of the year, it had a decreasing trend in the second half of the year, resulting in a value of 10.47% in December 2020, which is even below the December 2019 weight of 10.98%.

Concluding, since the Indexes consist of different indicators and partially overlap, the example of the United Kingdom clearly demonstrates that some individual indicators along with the individual weightings of sectors in the Index are more likely to have a negative impact on the respective stock market understudy than the entire Index.

Sweden

Looking at the OMXS 30 Index, Sweden, like the rest of the world, saw the Index decline earlier in the year, particularly in the months February and March when the news of the new pandemic and its impact spread to come countries around the world coincides with the rise of COVID-19. The stock market hit its lowest point on March 23rd with a value of 1 292.74. The trend that the imposed restrictions in Sweden were, compared to the other three countries, very light, explains that none of the explanatory variables is statistically significant in the OLS regression. Nevertheless, it is interesting to observe that all Indexes in the regression have a negative impact on the stock market, while the variables New Cases and New Deaths have a very slight positive one. It can therefore be concluded that the loose recommendations did not have a major impact on investors' behavior and more likely a negative one as they may have felt confused and lost confident in the market following the recommendations.

The Lasso regression supports these findings by setting all explanatory variables to zero. Even if the Stringency Index is not significant before, it is one of the variables that shrink the slowest and therefore one of the more important explanatory variables. Regression results indicate once more a negative coefficient. Since the restrictions in Sweden are more like recommendations, and for example, schools have not closed, not all the indicators in the Index can be used to explain this negative effects. Furthermore, restrictions on internal travel or stay-at-home requirements are likewise recommendations and no strict rules that must be followed. These light policies explain why the test results are not significant. It is more likely that the stock market reacted to the global situation and news than reacting strongly to internal recommendations.

It is evident to say, that the OMXS 30 Index has a higher weighting towards multinational industrials than Consumer, Health Care and Technology Sectors. Hence, one can argue that stocks in the Industrial Sector of the Index have depressed the overall OMXS 30. Moreover, the Industrials represent over one-third of the entire OMXS 30 Index with 36.73% respectively. Due to the reasoning, that governmental interventions were not as present in Sweden as in the other sample countries such as hard lockdowns, public closings, school closings or fully business closures, most companies could remain open and continue their businesses and productions to a much larger degree than most other countries.

United States

The US stock markets experienced through this novel coronavirus one of their weakest quarters in 2020, nevertheless it is evident to point out that the COVID-19 pandemic not only had severely affected the US stock markets but as already discussed above markets globally, which has created market fluctuation and increases uncertainty, speculations, and adverse investor behavior towards stock markets, especially in the Unites States. At the timing COVID-19 influenced and spread across the United States, the bull market experienced the first downturn in a long period. The first-ever case was reported on January 21st in the United States. As seen in Figure 2 above, the S&P 500 encountered after the announcement of the first cases a dramatic downturn in February and fell to an Index of 2 954.22, respectively. This can be considered as the dark quarter of the S&P 500 in a long period. While the number of new reported cases increased from March onwards, the stock market experienced at the same timing its lowest point. It hit its lowest point on March 23rd with an Index of 2 237.4. Afterwards the stock market started to slowly increase again, with a V-shaped recovery. Our results present, that the S&P 500 was firstly negatively impacted through the increasing number of New Cases. Moreover, it can be noted that the massive downturn in the stock market happened at the timing the government in the United States announced state-wise the stay-at-home policy, starting with California on March 19th all the way to the beginning of lockdown regulations on April

7th in South Carolina. Therefore, we came to the first observation, that the announcement of lockdowns and hence the restriction of economic activities by the government and uncertainty coming along with the pandemic had a first negative impact on the US stock market returns. Nevertheless, as described above, the stock market recovered after the massive downfall rather quickly indicating, that the governmental interventions in the United States taken by the public including school closings, home office, social distancing and others had a rather positive influence on the recovery of the stock market returns after it witnessed the dramatic downturn at the starting of the COVID-19 pandemic. This can also be seen as a first shock to the pandemic and the analyzed period afterwards indicates how the governmental interventions have impacted the stock market after the initial shock.

The results of the OLS regression for the sample country the United States moreover consolidate our cardinal results, that governmental interventions in the United States have an impact on the stock market returns of the S&P 500 Index. The results in Table 11 indicate that the Stringency Index and the Economic Support Index both have a negative influence on the stock market returns and further are significant at a 1% level. Additionally, also the Government Response Index results to be statistically significant on a 1% level, nevertheless this Index has a positive impact on the S&P 500.

Also, the results of the Lasso regression indicate, that both the Economic Support Index and the Stringency Index in addition with New Death have an impact on the US stock market since these variables were shrinking the slowest by the Lasso regression. Furthermore, the additional regression with the above-mentioned three variables concludes that only the Stringency Index has a statistical significance at a 1% level. Moreover, also the Design Matrix of Lasso gave evidence of a statistical significance of the Stringency Index variable again with a negative impact on the stock market. These results are reasonable since the Stringency Index does not include variables of the Economic Support Index, and hence is the only Index with negative impact. This can be interpreted that for the S&P 500 the Containment and Closure Indicators have a rather negative impact on the returns than a positive one.

Considering the S&P 500 sector-wise, on the one hand, the sectors which fared the best were the Health Care and Consumer Staples one, where the Consumer Staple Sector includes necessaries like groceries. On the other hand, the Sectors which fared the worst during the COVID-19 pandemic are the Financial, Energy and Industrial Sectors. Especially the Energy Sector experienced one of the hardest hits since the shutdowns during the pandemic pushed the demand of oil prices and resultingly also pushed down oil companies stock prices. The strongest recoveries during the pandemic have been in the Information Technology Sector which makes up 27.48 % almost one-third of the entire S&P 500 Index. Some companies in this Sector specifically such as Amazon benefitted from the COVID-19 pandemic.

Discovery in previous Diseases, Epidemics and Pandemics and COVID-19

From the literature to date, as well as our results and discussions presented above, it appears that negative events such as epidemics, pandemics, and diseases negatively affect the returns of individual stock markets by influencing the behavior and decisions of the individuals in relation to the markets and in a direct way it guides the overall movement in the stock markets. Our results clearly show that there is a positive association between the novel COVID-19 pandemic and the earlier epidemics, pandemics, and diseases briefly described above.

After careful review of the existing research and our findings, it can be concluded that the SARS-CoV-2 pandemic is showing a pattern trend like the 2002 SARS outbreak in terms of its impact on global stock market returns. Nonetheless, the COVID-19 pandemic hit the Chinese stock market immediately after the outbreak of the pandemic and immediately after the stock market on a global scale, while the SARS pandemic only affected the stock markets until March 2003, as previously described. Therefore, it can be said that while both pandemics had a negative impact on global stock markets, they differed in terms of duration. In addition, it can be said that both previous pandemics and the COVID-19 pandemic have been spread around the world, suggesting that stock markets are interconnected. Since, as noted above, the COVID-19 outbreak is spreading to other countries faster than previous diseases, it shows that stock markets are more interconnected today than they were years ago. From now on, a shock in one stock market has an indirect effect on another stock market. Stock market movements of different stocks would therefore move in the same direction and therefore these movements would be more closely correlated with one another.

Finally, it should be noted that various methods have been used in the past to prevent the pandemics, such as frequent cleaning and crowd avoidance, but with limited technological advances. The novel COVID-19 pandemic on the contrary, is mainly being addressed through aggressive government interventions, including full country closures, quarantines, travel restrictions, public closings, etc. These methods have been implemented in a country-specific manner, and most countries have used these government interventions differently. In addition, it can be stated that many countries are still using these government interventions a year later after the SARS-CoV-2 pandemic broke out, as it is still a societal issue and has not yet been completely prevented. Additionally, from our results above, we can say that the most popular intervention indicators used by individual countries to combat the pandemics are quarantines, bans, travel bans and weekly COVID-19 tests.

Overall COVID-19 effect on stock markets

All four sample countries have approached the novel COVID-19 pandemic in slightly different ways in terms of government intervention. For example, while China was more aggressive with its government interventions during the outbreak of the pandemic, the United Kingdom used a gentler and more open method to address the start of the pandemic outbreak, which has affected differently across the country's economies and their stock market Indexes, FTSE 100, S&P 500, OMXS 30, and SSEC, which were each examined.

For example, although the Swedish domestic economy outperformed that of the United States, the OMXS 30 Index, which represents Sweden on the stock exchange, did not outperform the corresponding S&P 500 Index, which represents the United States on the stock exchange. The main reason for this lies in the sector weighting of the Indexes examined. As mentioned shortly before, the Swedish Index consists more of multinational industrial companies, while the US Index is weighted more heavily against the health care and technology sectors. With this heavier domestic Swedish economy, the financial sector in the OMXS 30 is also expected to suffer significantly fewer credit losses than the S&P 500 Index due to the main reasons for including companies like Visa and American Express in the US stock market. It can be said that not all Indexes and their individual sectors performed equally well and were affected by the pandemic in the same manner. The impending vaccination policy and the lifting of country-specific restrictions are likely to help all sectors in the Indexes understudy to fully recover and return to individual pre-COVID-19 levels.

This study indicates that government interventions during the outbreak of the pandemic had a universal impact and affected individual countries directly. In China, the United Kingdom and the United States, government intervention during the COVID-19 pandemic is clearly having an impact on the stock market in both positive and negative ways. While in Sweden, where the government has not imposed aggressive policies, the interventions did not affect the Swedish stock market in the same way as the other sample countries examined.

Depending on the composition of the industry, our example country China where there are many manufacturing and fewer service companies is more heavily affected by the expansion of government interventions such as workplace closures and lockdowns. In conclusion, it should be emphasized that this study shows that governments never ordered a complete lockdown of all industries for the countries under study and therefore essential sectors such as consumer discretionary and pharmaceuticals along with other useful sectors remain operational. Countries with a focus on the service and technology sector are therefore better positioned in the market to maintain their business operations than countries with a primary focus on the industrial industry. This leads to the full answer of the hypotheses that firstly, all four countries studied, namely China, the United Kingdom, Sweden, and the United States respectively, were affected by the COVID-19 pandemic to different degrees, according to the density of measures taken by governments in the respective countries. Secondly, as a result, the stock market reactions depend to an extensive amount of the industry composition in the country concerned.

8. Conclusion

Summing up, especially the Stringency Index seems to be an important explanatory variable with a high influence on stock markets. Apart from Sweden where no explanatory variables were significant, the Stringency Index has a negative coefficient with a significant p-value for all other countries. Once again, the Stringency Index contains mostly Containment and Closure indicators and Health Systems related indicators like school and workplace closings, stay-at-home requirements, travel restrictions, information campaigns, testing policies, facial coverings, and lastly vaccination policies. All these measures can be observed in the four sample countries in different degrees. The significance of the other Indexes and their impact changes depending on the country but were mainly negative.

Leading to the conclusion that the implemented interventions had mostly a negative impact on the stock market, since they slowed down the economy and led to a lower trust of investors and individuals in the stock market, nevertheless they had a positive impact on decreasing the spillover effect of the virus. This pattern is clearly observable for the countries China, the United Kingdom, and the United States, whereas for Sweden where the government did not impose hard lockdowns and where rather looser actions were taken in respect to closures, social distancing, etc., it is reasonable that the explanatory variables under study showed all non-statistical importance.

We acknowledge that this study is only for a sample period ranging from January 23rd, 2020, to December 4th, 2020, with solely four chosen sample countries which are China, United Kingdom, Sweden, and the United States, respectively. Where the previously presented findings are only for the above-specified time of the COVID-19 pandemic. Since the novel coronavirus is still an ongoing pandemic and is going to keep unfolding and affecting the global stock market returns there is a vast amount of uncertainty on future decisions taken worldwide. Moreover, since we decided to keep our sample period only until December 4th, we clearly exclude the introduction of the vaccination announcement to prevent the spread of the global pandemic. Finally, given the scope of this study we only touched on the impact of the COVID-19 outbreak on stock markets sector-specific.

Given that the COVID-19 pandemic is ongoing and uncertain, we recommend conducting further investigations into the pandemic. We would suggest that this investigation may include the vaccination announcement and the continued evolution of stock market returns after December 4^{th}. In addition, a wider scope could be considered to assess the impact of the pandemic, for example by considering a larger sample of countries studied. This could lead to a better perspective of the pandemic effect on a global scale. Lastly, this study only touches on the sector weightings of individual stock markets, we would suggest that further research would investigate more into the impact of the novel coronavirus outbreak and their sectoral weightings.

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Appendix

Appendix A – Descriptive Statistics

Table 12 DS – CHN

CHN	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
Min	-1.00	0.00	-23.15	-13.02	-14.88	0.00
Max	15 136.00	1 290.00	35.18	22.40	25.59	25.00
Mean	289.61	16.81	0.27	0.23	0.23	0.30
Median	34.00	0.00	0.00	0.00	0.00	0.00
Std	1 269.01	93.97	5.05	3.01	3.46	2.58
Kurtosis	94.35	163.04	27.07	30.07	29.56	83.23
Skewness	8.72	12.12	3.23	3.79	3.68	8.94

Note: Table 12 presents the results of the descriptive statistic for the sample country China. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index

Table 13 DS – GBR

GBR	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
Min	0.00	0.00	-7.40	-6.25	-7.15	0.00
Max	33517.00	1224.00	41.20	29.43	33.63	37.50
Mean	5484.74	201.06	0.26	0.27	0.25	0.45
Median	1697.50	58.00	0.00	0.00	0.00	0.00
Std	7555.50	278.18	3.20	2.40	2.65	3.54
Kurtosis	4.25	4.99	123.11	100.97	116.38	76.28
Skewness	1.58	1.64	9.57	8.36	9.14	8.41

Note: Table 13 presents the results of the descriptive statistic for the sample country United Kingdom. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Table 14 DS – SWE

SWE	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
Min	0.00	-8.00	-5.55	-3.13	-3.57	0.00
Max	17 629.00	291.00	16.67	14.58	16.66	37.50
Mean	1 172.99	29.19	0.29	0.26	0.26	0.28
Median	419.00	7.00	0.00	0.00	0.00	0.00
Std	2 564.34	44.44	1.81	1.46	1.62	3.02
Kurtosis	24.85	9.05	41.99	49.36	55.91	125.49
Skewness	4.40	2.16	5.49	5.84	6.31	10.99

Note: Table 14 presents the results of the descriptive statistic for the sample country Sweden. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Table 15 DS – USA

USA	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
Min	0.00	0.00	-4.63	-2.60	-2.98	0.00
Max	232 785.00	2 951.00	22.22	14.58	16.67	62.50
Mean	47 677.36	971.49	0.32	0.29	0.29	0.28
Median	35 941.00	955.00	0.00	0.00	0.00	0.00
Std	48 222.02	705.94	2.20	1.47	1.57	4.20
Kurtosis	6.27	2.84	53.20	48.40	59.10	219.00
Skewness	1.83	0.52	6.19	5.83	6.40	14.76

Note: Table 15 presents the results of the descriptive statistic for the sample country United States. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Appendix B – Correlation

Table 16 Correlation Matrix – CHN

CHN	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
ΔNew Cases	1	0.2685	0.0618	0.0736	0.0756	-0.0236
ΔNew Deaths	0.2685	1	0.0124	0.0146	0.0167	-0.0203
ΔStringency Index	0.0618	0.0124	1	0.9869*	0.9933*	-0.1256
ΔGovernment Response Index	0.0736	0.0146	0.9869*	1	0.9943*	-0.0132
ΔContainment Health Index	0.0756	0.0167	0.9933*	0.9943*	1	-0.1196
ΔEconomic Support Index	-0.0236	-0.0203	-0.1256	-0.0132	-0.1196	1

Note: Table 16 shows the results of the correlation matrix for China. The threshold for a severe correlation is a value above 0.9, marked with a star *. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Table 17 VIF – CHN

CHN	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
VIF	1	1	87	1 949 737	1 987 164	22 447

Note: Table 17 shows the respective VIF values for China for the six explanatory variables, namely (1) New Cases, (2) New Deaths, (3) Stringency Index, (4) Government Response Index, (5) Containment Health Index, (6) Economic Support Index.

Table 18 Correlation Matrix – GBR

GBR	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
ΔNew Cases	1	0.3565	-0.0452	-0.0566	-0.0451	-0.0705
ΔNew Deaths	0.3565	1	-0.0639	-0.0594	-0.0483	-0.0692
ΔStringency Index	-0.0452	-0.0639	1	0.9376*	0.9467*	0.1284
ΔGovernment Response Index	-0.0566	-0.0594	0.9376*	1	0.9830*	0.2769
ΔContainment Health Index	-0.0451	-0.0483	0.9467*	0.9830*	1	0.0959
ΔEconomic Support Index	-0.0705	-0.0692	0.1284	0.2769	0.0959	1

Note: Table 18 shows the results of the correlation matrix for the United Kingdom. The threshold for a severe correlation is a value above 0.9, marked with a star *. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Table 19 VIF – GBR

GBR	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
VIF	1	1	10	947 556	882 574	32 187

Note: Table 19 shows the respective VIF values for the United Kingdom for the six explanatory variables, namely (1) New Cases, (2) New Deaths, (3) Stringency Index, (4) Government Response Index, (5) Containment Health Index, (6) Economic Support Index.

Table 20 Correlation Matrix – SWE

SWE	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
ΔNew Cases	1	0.0843	0.0869	0.0366	0.0453	-0.0286
ΔNew Deaths	0.0843	1	-0.0380	-0.0595	-0.0533	-0.0303
ΔStringency Index	0.0869	-0.0380	1	0.8445	0.8748	-0.0151
ΔGovernment Response Index	0.0366	-0.0595	0.8445	1	0.9661*	0.2439
ΔContainment Health Index	0.0453	-0.0533	0.8748	0.9661*	1	-0.0149
ΔEconomic Support Index	-0.0286	-0.0303	-0.0151	0.2439	-0.0149	1

Note: Table 20 shows the results of the correlation matrix for Sweden. The threshold for a severe correlation is a value above 0.9, marked with a star *. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Table 21 VIF – SWE

SWE	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
VIF	1	1	4	1 114 641	1 048 759	74 362

Note: Table 21 shows the respective VIF values for Sweden for the six explanatory variables, namely (1) New Cases, (2) New Deaths, (3) Stringency Index, (4) Government Response Index, (5) Containment Health Index, (6) Economic Support Index.

Table 22 Correlation Matrix – USA

USA	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
ΔNew Cases	1	0.5080	-0.1038	-0.1390	-0.1326	-0.0406
ΔNew Deaths	0.5080	1	-0.2059	-0.2274	-0.2259	-0.0430
ΔStringency Index	-0.1038	-0.2059	1	0.8979	0.9611*	-0.0100
ΔGovernment Response Index	-0.1390	-0.2274	0.8979	1	0.9336*	0.3466
ΔContainment Health Index	-0.1326	-0.2259	0.9611*	0.9336*	1	-0.0125
ΔEconomic Support Index	-0.0406	-0.0430	-0.0100	0.3466	-0.0125	1

Note: Table 22 shows the results of the correlation matrix for USA. The threshold for a severe correlation is a value above 0.9, marked with a star *. The variables are as followed: (1) New Cases (2) New Deaths (3) Stringency Index (4) Government Response Index (5) Containment Health Index (6) Economic Support Index.

Table 23 VIF – USA

CHN	ΔNew Cases	ΔNew Deaths	ΔStringency Index	ΔGovernment Response Index	ΔContainment Health Index	ΔEconomic Support Index
VIF	1	1	14	574 705	507 294	73 785

Note: Table 23 shows the respective VIF values for China for the six explanatory variables, namely (1) New Cases, (2) New Deaths, (3) Stringency Index, (4) Government Response Index, (5) Containment Health Index, (6) Economic Support Index.