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The economic impact of anti-contagion policies on different industries

Author : Jingjing WANG

Thesis Director : Jean-François MAYSTADT

Thesis Reader : Jean-François MAYSTADT

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Université catholique de Louvain - Economics School of Louvain - Place Montesquieu 3, 1348 Louvain-La-Neuve
Université de Namur – Economics School of Namur – Rempart de la Vierge 8, 5000 Namur

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1. Introduction

The outbreak of COVID-19 is a public health emergency that occurred at the beginning of 2020 and has not been eliminated until now. Anti-contagion policies have been adopted worldwide to prevent the spread of this pandemic, which also has a non-negligible impact on the economy.

The studies on the impact of the anti-contagion policies have been conducted through the following perspectives, the impact on the growth rate of infections, the impact on the growth rate of deaths, and the impact on the economic development of distinct countries. HSIANG, ALLEN, ANNAN-PHAN, et al. (2020) measure the effect of large-scale anti-contagion policies on the growth rate of economics by applying the reduced-form econometric methods, to empirically evaluate the effect that these anti-contagion policies have had on the growth rate of infections. DERGIADES, MILAS, MOSSIALOS, PANAGIOTIDIS (2020) assess the impact of government interventions policies on the deaths related to the COVID-19 outbreak by using daily death data of 32 countries and the stringency indices of the conducted policies. ASAHI, UNDURRAGA, VALDES, and WAGNER (2021) measure the reduction in local economic activity from lockdowns by using econometric methods, in which the economic activity is measured by tax collection at the municipality level.

The economic impact of anti-contagion policies on distinct industries is analyzed in this study. The impact on different industries is expected to be different. Industries, where distancing work is impossible, are affected most, such as manufacturing. Industries, where working from home can be guaranteed, are affected less, such as IT services. The communication services sector is even promoted due to the boosted demand during the pandemic of online streaming. Understanding such a differentiated impact is important not only to assess the economic consequences of the pandemic but also to potentially identify subsequent structural changes in the economy.

Little research has been done on the economic impact of the COVID-19 anti-contagion policies on different industries. However, there are established literature seeking to analyze the economic impact of shocks. For instance, GUIDOLIN and LA FERRARA (2007) study the relationship between civil war and the value of firms. More recently, ACEMOGLU, HASSAN, and TAHOUN (2018) investigate the stock market reaction of three groups in Egypt during the Arab Spring. Both of them use the standard event-study methodology. The variation of the cumulative abnormal return (CAR) from the stock market at the event window is analyzed in their method to quantify the economic impact of an unexpected event. GUIDOLIN and LA FERRARA (2010) propose an alternative method, the so-called 'dummy regression approach' to analyze the economic effects of the violent conflict. However, the COVID-19 pandemic and the implementation of corresponding anti-contagion policies have been lasting for more than one year since the beginning of 2020. The stringency of the anti-contagion policies also varies as the pandemic situation varies. The event-study methodology can show that the return affected by an event changes over the event window, but cannot be used in our analysis to analyze the correlation between the anti-contagion policies and the economic performance of industries since the anti-contagion policy is continuously implemented and changed instead of occurring at a certain moment like an event.

MACKINLAY (1997) proposes a market model, which is a statistical model by correlating the return of any given security to the return of the market portfolio. DRACA, GARRED, STICKLAND, and WARRINNIER (2019) propose an interaction model, which estimates the impact of international sanction policy on the stock return of different political groups. Both methods could be adapted to quantify the impact of anti-contagion policies on the economic performance of distinct industries.

In this study, the Containment and Health (CH) policy index from Oxford COVID-19 Government Response Tracker (THOMAS, WEBSTER, PETHERICK, PHILLIPS, and KIRA, 2020) is used to quantify the anti-contagion stringency policies of different countries. The equity returns of all firms in the analyzed

industry are used to quantify their economic performance. Both the market model and interaction model are adapted to analyze the impact of containment and health policies on the equity returns of the analyzed industry. The market model is used as the main method, while the interaction model is used as the alternative method for verification.

Statistically close results are obtained from both methods. The result suggests that stringent containment and health policies are conducive to the development of the IT sector, health care sector, communication service sector, and consumer discretionary sector. As for the Industrial sector and financial sector, the degree of the stringency of containment and health policies doesn't affect them.

This dissertation is organized as follows. The dataset of containment and health policies and stock market used for analysis is described in detail in chapter 2. The analysis methodology as well as its limitations are presented in chapter 3. The analysis based on the results is discussed in chapter 4. And, the dissertation is concluded in chapter 5.

2. Data

Stock market data of six core sectors of the US, UK, and Germany from 2nd January 2020 to 31st December 2020 have been collected from Bloomberg, while the C&H policy index of corresponding date and country is collected from the Oxford COVID-19 Government Response Tracker.

2.1. Data of stock returns

6 top sectors with the largest stock market share, which are information technology, health care, consumer discretionary, communication services, financials, and Industrials as shown in Figure 1, are selected from Bloomberg (2022) for analysis. These 6 sectors represent 83.6% of the stock market share as shown in Table 1. The classification of the sectors and industries used by Bloomberg is based on the Bloomberg Industry Classification Systems (BICS), which is an industry classification similar to the Global Industry Classification Standard (GICS, 2020). Among all the stock market indices available in Bloomberg, S&P 500 (US), FTSE 100 (UK), and DAX (Germany) follow the classification of BICS and include more than 2 firms in each selected sector, thus they are selected for the analysis.

The equity returns of all the firms that belong to the 6 selected sectors in S&P 500, FTSE 100, and DAX are collected. As shown in Table 1, the equity indices of 450 firms are collected in total, which includes 80 firms in the sector of Information Technology, 93 firms in the sector of Industrials, 70 firms in the sector of health care, 88 firms in the sector of financials, 34 firms in the sector of communication services, and 85 firms in the sector of consumer discretionary.

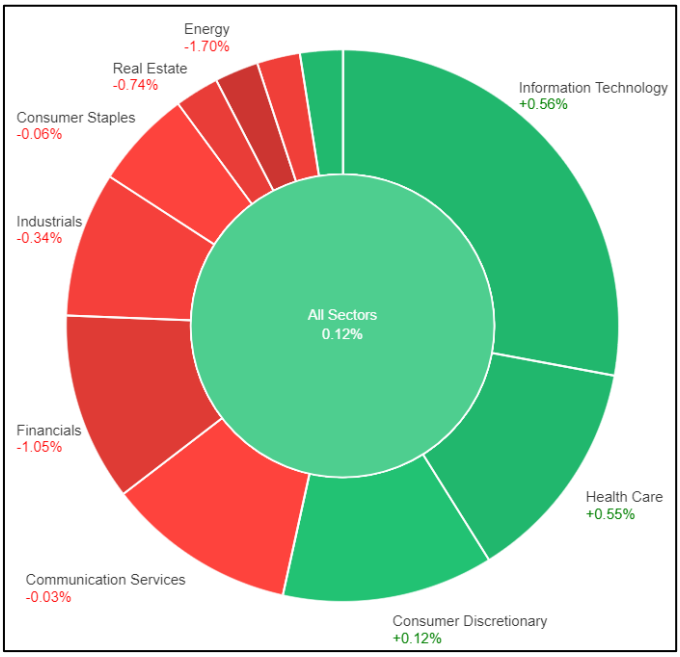

Figure 1. Stock market share of different sectors (Bloomberg, 2021)

Table 1. The selected six top sectors with the largest market share

Sectors name	**Share**	**Number of firms**	**Industries included**
Information Technology	27.4%	80	Including software, hardware, and etc.
Health Care	13.1%	70	Including pharmaceuticals, biotechnology, and etc.
Consumer Discretionary	12.4%	85	Including automobile, retailing, and etc.
Financials	11.2%	88	Including banks, insurance, and etc.
Communication Services	11.1%	34	Including media, movie, entertainment, and etc.
Industrials	8.4%	93	Including transportation, capital goods, and etc.
In total	**83.6%**	**450**	N/A

2.2. Data of the containment and health index

The Containment and Health (CH) index of the country in which the equity indices are analyzed is collected from the Oxford COVID-19 Government Response Tracker. The CH index, which ranges from 0 to 100, is developed to quantify the stringency of the anti-contagion policies of the corresponding country. The higher the CH index, the more stringent the country's containment and health policy.

The variation of the CH indices of the 3 analyzed countries US, UK, and DE in the year 2020 is illustrated in Figure 2. The implementation of the CH policies of the 3 countries was started at the end of January. In mid-March, the CH indices of the 3 countries were all risen from less than 20 to more than 60 to prevent the rapid spread of the pandemic. The CH indices were kept at the same level from March till the end of 2020.

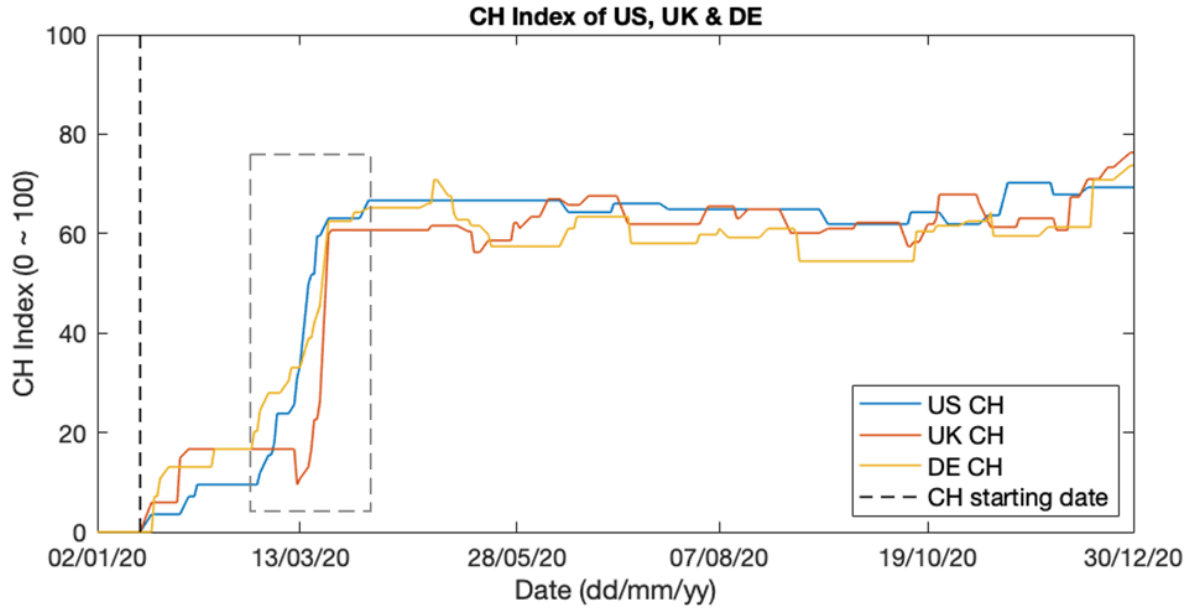

Figure 2. The CH indices variation of US, UK, and DE in the year 2020

The CH index is derived by a simple average of all sub-indices of individual CH component policies as shown in Equation (1)

$$CH\ index = \frac{1}{k}\sum_{j=1}^{k} I_j \tag{1}$$

where k is the total number of CH component policies, subscript j is the number of each policy, I_j is the sub-index of each policy. The derivation of the sub-index of each CH policy is shown in Equation (2)

$$I_j = 100\frac{v_j - 0.5(1 - f_j)}{N_j} \tag{2}$$

where v_j is the recorded ordinal value of each CH policy, N_j is the maximum ordinal value of each policy, and f_j indicates whether this policy is general (f_j = 1) or targeted (f_j = 0), which is treated as a half-step between ordinal values. More detailed derivations of the CH index can be found in the work done by Thomas, Webster, Petherick, Phillips, and Kira (2020).

The CH policies that are considered in the study are listed in Figure 3 below. The stringency of each policy is quantified in the ordinal values from 0 to a maximum value. The implementation scope of the policy is quantified by a binary value, 1 as general and 0 as targeted.

ID	Name	Type	Value	General (1) / Targeted (0)
Containment and closure				
C1	School closing	Ordinal	0, 1, 2, 3	1 / 0
C2	Workplace closing	Ordinal	0, 1, 2, 3	1 / 0
C3	Cancel public events	Ordinal	0, 1, 2	1 / 0
C4	Restrictions on gathering size	Ordinal	0, 1, 2, 3, 4	1 / 0
C5	Close public transport	Ordinal	0, 1, 2	1 / 0
C6	Stay at home requirements	Ordinal	0, 1, 2, 3	1 / 0
C7	Restrictions on internal movement	Ordinal	0, 1, 2	1 / 0
C8	Restrictions on international travel	Ordinal	0, 1, 2, 3, 4	0
Health systems				
H1	Public information campaign	Ordinal	0, 1, 2	1 / 0
H2	Testing policy	Ordinal	0, 1, 2, 3	0
H3	Contact tracing	Ordinal	0, 1, 2	0
H4	Emergency investment in healthcare	Numeric	N/A	0
H5	Investment in Covid-19 vaccines	Numeric	N/A	0
H6	Facial coverings	Ordinal	0, 1, 2, 3, 4	1 / 0
H7	Vaccination Policy	Ordinal	0, 1, 2, 3, 4, 5	1 / 0
H8	protection of elderly people	Ordinal	0, 1, 2, 3	1 / 0

Figure 3. The containment and health policies

3. Methodology

3.1. Empirical analysis

3.1.1. Market model

The method used to analyze the impact of containment and health policy on distinct industries is based on the market model, which is introduced by MACKINLAY (1997). The fixed effects of country, sector, and date are added in the analysis

$$R_{ecst} = \alpha_c + \alpha_s + \alpha_t + \beta_1 i_{CHt} + \beta_2 R_{mt} + \varepsilon_{ecst} \quad (3)$$

where R_{ecst} is the daily return of the equity *e* in the analyzed sector *s* of country *c* during the event window t (02/01/2020 – 31/12/2020), R_{mt} is the daily return of the stock market index during event window *t*, which is the index of S&P 500, FTSE 100, and DAX in the analysis, i_{CHt} represents the time-series data of the CH index, which indicates the stringency of the anti-contagion policies of the corresponding country *c*, and α_c, α_s and α_t represent the fixed effects of country, sector, and date, respectively.

The addition of fixed effects seeks to eliminate the biases of the unobserved-but-fixed variables which lead to unobserved heterogeneity. In our case R_{ecst} includes the variation caused by country, sector and date. Fixed effects α_c, α_s and α_t are introduced to increase consistency by reducing the risk the error term is correlated with the variable of interest.

β_1 and β_2 are the coefficients of the market model estimated by linear regression. β_1 estimates the average effect of the CH index on the equity return quoted in that country, while β_2 estimates the relationship between the equity return and the stock market index of the same country, and ε_{ecst} is the error term.

Standard errors are clustered at the country. The standard errors are clustered at the country level in the analysis. The standard error directly affects the significance and confidence interval of the significant coefficient in statistical inference, and ultimately affects the conclusion of the hypothesis test. Therefore, the correct estimation of standard errors is particularly important in the process of empirical analysis. When there is a correlation between the error terms, the standard errors estimated by ordinary-least-squares are not correct and likely too low, so the standard error needs to be adjusted. In order to avoid the occurrence of the problem, the "clustered standard errors" method (ABADIE, ATHEY, IMBENS, and WOOLDRIDGE, 2017) is adopted and the standard errors are clustered at the country level.

3.1.2. Alternative method: Interaction model

An alternative approach is to introduce sector-specific interaction terms in the pooled sample. The analysis model would the take the following form

$$R_{ecst} = \alpha_e + \eta R_{mt} + \emptyset CH_t + \sum_s (\theta_s \cdot Sector_e \cdot CH_t) + \mu_{ecst} \quad (4)$$

where R_{ecst} is the dependent variable for equity e of sector s in the country c during the event window t, R_{mt} represents the stock market index, $Sector_e$ is an indicator vector for different sectors, the containment and health index CH_t is the regressor of interest, η, $\emptyset$ and θ_s are the coefficients of the model estimated by the linear regression, index s represents different sectors, and μ_{ecst} is the error term. The indicators correspoding to the analyzed sector in $Sector_e$ are equal to 1， while the others are 0.

As shown in Equation (4), $\emptyset$ estimates the average effect of CH_t across all sectors while omitting the effect of CH_t on each sector, and θ_s estimates the effect of CH_t on a sepecific sector *s* while omitting its effect on other sectors. The overall average effect of CH_t on one sector s is thus equal to $\emptyset + \theta_s$. And the overall average effect of CH_t across all sectors is $\emptyset + \sum_s \mu_s \theta_s$, where μ_s is the stock market share of sector *s* in all analyzed sectors.

3.2. Limitations of the methods

The changing of the stock market returns in various industries may be affected by multiple factors, and some factors are difficult to be analyzed quantitatively. Although three fixed effects have been added to the analysis model, there are still other variables that are omitted. For instance, the direct impact of COVID-19 on the economics without the implementation of containment and health policies is omitted, meanwhile, the impact of fiscal stimulus packages of different countries on the economics during the event window is also not considered. These omitted variables will be controlled in later work.

There's no comparison between the treatment group and the comparison group in this study. The treatment group represents the country where the CH policy is implemented after the outbreak of the pandemic, while the comparison group represents the country where no CH policy is implemented after the outbreak. It would be better to add a comparison group in the study, but it's difficult to find a country with exhaustive stock market data but without CH policies.

Moreover, ANGRIST and PISCHKE (2009) point out that the estimators used for fixed effects typically remove both good and bad variations. In other words, these transformations may reduce some of the omitted-variables bias, and they also remove much of the useful information in the variable of interest. Therefore, deviations could be expected between the estimated results we got from the market model and the actual results.

Finally, there have been recent developments warning against the bias of two-way fixed effect model with staggered treatment induced by the existence of heterogeneous treatment effects.

4. Results

4.1. Average effect across all sectors based on the market model

In the analysis of the average effect of the CH index across all sectors, all the equity data of 450 firms are pooled together. The country, sector and date are considered as the categorical variables which are absorbed as fixed effects.

The linear regression results of the market model presented in Equation (3) are shown in Table 2, where our dependent variable is the daily return of equities R_{est}, independent variables are the stock market index R_{mt} and the containment and health policy index i_{CHt}.

The estimated coefficient β_1 is 0.1462 as presented in Table 2, which indicates a positive average effect of the CH index on the equity return across all sectors. The increase of the CH index (0 ~ 100) by 1 would result in the increase of 0.146 dollar return per equity across all sectors in average. In other words, on the whole, stringent containment and health policies are relatively conducive to the development of various industries. That may seem surprising but it may hide large variation across sectors.

Table 2. Linear regression results of the market model

Average effects across all sectors	
VARIABLES	Recst
β_2	0.0190
	(0.0147)
β_1	0.1462*
	(0.0444)
Constant	49.7316
	(64.3531)
Observations	109 942
R-squared	0.054
Robust standard errors in parentheses. Standard errors are clustered at the country level.	
*** p<0.01, ** p<0.05, * p<0.1	

4.1.1. Impact of time lag

Financial markets may not respond to the containment and health policies in a timely manner. There might be a time lag between the implementation of the CH policies and their actual impact on the stock market. To verify whether the time lag should be considered, the CH indices with different time lags are added to the market model as independent variables.

The market model including the impact of time lag is shown in equation (5). CH index with the time lag of *n* days is represented by $i_{CH(t-n)}$, and β_n is its estimated coefficient. Time lag *n* is set to 1 day, 5 days, 10 days, 15 days, and 20 days in the analysis. A time interval of 5 days is chosen because there's five-day stock market data per week.

$$R_{ecst} = \alpha_c + \alpha_s + \alpha_t + \beta_1 i_{CHt} + \beta_2 R_{mt} + \beta_n i_{CH(t-n)} + \varepsilon_{ecst} \quad (5)$$

Table 3. Linear regression results including different time lag

		t-1	t-5	t-10	t-15	t-20
VARIABLES	Recst	Recst	Recst	Recst	Recst	Recst
β_2	0.0191	0.0191	0.0192	0.0191	0.0193	0.0196
	(0.0147)	(0.0147)	(0.0147)	(0.0146)	(0.0146)	(0.0148)
β_1	0.1462*	0.1468*	0.1541*	0.1644*	0.1633*	0.1715*
	(0.0444)	(0.0445)	(0.0438)	(0.0424)	(0.0428)	(0.0431)
CH_Lag1		-0.0009	0.0072*	0.0147**	0.0159**	0.0178*
		(0.0006)	(0.0021)	(0.0022)	(0.0029)	(0.0043)
CH_Lag2			-0.0016	0.0076**	0.0147**	0.0135**
			(0.0029)	(0.0017)	(0.0016)	(0.0017)
CH_Lag3				-0.0018	0.0050	0.0143*
				(0.0013)	(0.0023)	(0.0041)
CH_Lag4					-0.0074***	0.0008
					(0.0005)	(0.0013)
CH_Lag5						0.0019
						(0.0024)
Constant	49.6580	49.5196	48.3437	47.1942	46.2110	43.1403
	(64.3877)	(64.4458)	(64.6286)	(64.1230)	(64.4126)	(65.7420)
Observations	109 942	109 496	107 707	105 469	103 229	100 991
R-squared	0.054	0.054	0.054	0.054	0.054	0.054

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2. Effects on distinct sectors based on the market model

To analyze the average effect of the CH index on the equity return of a specific sector. Market mode in the format of Equation (6) is adopted. Compared with Equation (3), which is the market model used to evaluate the average effect of CH index across all sectors, R_{ecst} is replaced by R_{ect}, which is the daily return of the equity *e* in the analyzed sector, and the fixed effect of sector α_s is omitted.

$$R_{ect} = \alpha_c + \alpha_t + \beta_1 i_{CHt} + \beta_2 R_{mt} + \varepsilon_{ecst} \quad (6)$$

The linear regression results of the market model of Equation (6) for distinct sectors are listed in Table 4. The standard errors are also clustered at the country level.

Among all the 6 sectors analyzed, there are 4 sectors positively affected by the containment and health policies. They are IT, health care, communication services and consumer discretionary. β_1 of these 4 sectors is positive and greater than 0.146, which is the estimated coefficient of the average effect of CH index across all sectors.

The other 2 sectors, Industrials and Financials, are negatively affected by the CH policies. The estimated coefficient β_1 of these two sectors is negative. However, the p-values of these two estimations are relative high, which indicate the estimation is not significant. Detailed analysis will be done later on these two sections and the alternative method will be utilized to verify the estimated coefficient β_1.

Table 4. Linear regression results of the market model

Sector Name	Industrials	IT	Health Care	Financials	Communication Services	Consumer Discretionary
VARIABLES	Recst	Recst	Recst	Recst	Recst	Recst
β_2	0.0152	0.0263	0.0188	0.0095	0.0185	0.0263
	(0.0123)	(0.0184)	(0.0165)	(0.0069)	(0.0177)	(0.0210)
β_1	**-0.0723**	**0.2561****	**0.2970****	**-0.0768**	**0.2755****	**0.3121***
	(0.0801)	(0.0282)	(0.0299)	(0.0667)	(0.0453)	(0.0737)
Constant	49.3889	21.0039	81.5757	46.9777	58.1183	57.2024
	(51.1931)	(69.1342)	(69.1169)	(29.0936)	(82.1306)	(103.6030)
Observations	22 498	19 600	17 150	21 560	8 330	20 804
R-squared	0.130	0.096	0.074	0.157	0.056	0.026

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4.2.1. IT

In the analysis focusing on the Information Technology sector, equities returns of 80 firms in the US, UK, and Germany are included. As shown in IT column of Table 4, the estimated coefficient of the CH indices is equal to 0.256, which is greater than the average effect of 0.146 and significantly different from zero. It indicates that the increase of the CH index (0 ~ 100) by 1 would result in the increase of 0.256 dollar return per equity in the IT sector. It shows that stringent containment and health policies are conducive to the development of the information technology sector. This sector is more adaptable to the containment and health policies, compared with the average of all the sectors.

This result is consistent with expectations. According to Figure 3, we can see that the containment policies include 'Workplace closing', 'School closing', etc., which are aimed to reduce the crowd gathering so as to contain the spread of the virus. However, these policies do not affect the normal operation of the IT industry, while on the contrary, it has been promoting the development of the IT industry in some way. For example, office software that facilitates remote cooperation and management, such as Microsoft Azure and Teams, Cisco VPN and SAP, has become indispensable thanks to the measure of working from home and attending courses online. At the same time, the demand for telecommunication and social media platforms, such as Zoom, Microsoft Teams and WhatsApp, has been increased dramatically by the policy of staying at home. All these telecommunication tools help the people who have to stay at home to keep in touch with their family members and to have conference meetings with their colleagues.

During the Covid-19 period, the importance of the Internet and technology was valued because it helps people stay safe while keeping in contact with the outside world. Therefore, the IT industry is expected to benefit from the containment policies and in fact it is indeed the case.

4.2.2. Health Care

In the analysis focusing on the Health Care sector, equities returns of 70 firms in the US, UK, and Germany are included. As shown in the Health Care column of Table 4, the estimated coefficient of the CH indices is equal to 0.297, which is more than double the average effect of 0.146 and is significant according to its p-value. It means when the CH index (0 ~ 100) is increased by 1, the return per equity of the health care sector would increase by 0.297. It also indicates that stringent containment and health policies are substantially conducive to the sustainable development of the health care sector, compared with the average of all the sectors.

Although many industries are facing unprecedented disruption by the unexpected pandemic, healthcare is uniquely affected given the nature of this crisis. Countries all over the world invest plenty of manpower and resources into their own medical undertakings. As shown in Figure 3, the health policy includes 'Emergency investment in healthcare', 'Investment in Covid-19 vaccines', 'Testing and Vaccination Policy', and so on. These policies are intended to make the healthcare industry developing steadily and rapidly as much as possible to ensure saving more lives, to promote vaccine research and development, and ultimately to eliminate the coronavirus.

There is no doubt that the stringent containment and health policies are substantially conducive to the orderly progress of the sector of health care.

4.2.3. Communication Services

In the analysis focusing on the Communication Services sector, equities returns of 34 firms in the US, UK, and Germany are included. As shown in Table 4, the estimated coefficient of the effect of CH on the communication services sector is equal to 0.275, which is greater than the average effect of 0.146 and is significant as well according to the p-value. That is to say, the increase of the CH index (0 ~ 100) by 1 would result in the increase of 0.275 dollar return per equity in the communication services sector. It shows that the stringent containment and health policies promote the development of the Communication Services sector. The results are in line with the expectations.

The communication service sector includes the firms that engage in media, movies, entertainment, etc.. The containment policies force the movie theaters and amusement parks to be temporarily closed, and millions of people stay at home, but most people who have to stay at home can still consume video entertainment. Powerful online entertainment has become one of the mainstream entertainment manners in 2020. Netflix claimed that it hit a record of 37 million subscribers in 2020,

and its total number of subscribers exceeds 200 million. (The Wall Street Journal, 2021) During the pandemic, a lot of new streaming video services emerged from such prominent companies as Disney, Universal, and Warner Bros, which started to join the competition with Netflix and Amazon.

Therefore, the communication services sector is promoted by the containment policies.

4.2.4. Consumer discretionary

In the analysis focusing on the sector of Consumer discretionary, equities returns of 85 firms in the US, UK, and Germany are included. As shown in Table 4, the estimated coefficient of the effect of CH policies on the consumer discretionary sector is equal to 0.312, which is more than twice the average effect of 0.146 and greater than the effect of CH on any other analyzed sector. The estimation is significant according to the p-value. The estimated coefficient indicates that the increase of the CH index (0 ~ 100) by 1 would result in the increase of 0.312 dollar return per equity in the consumer discretionary sector.

This result seems to be inconsistent with expectations. The consumption of consumer discretionary is typically more elastic than that of the consumer staples, which means that the consumer demand for the consumer discretionary products is directly limited by their income. The pandemic has severely impacted the income and purchasing power of residents in different countries. Therefore, the consumer discretionary industry would be affected negatively by the CH policies in the expectation.

However, large online retail platforms like Amazon, eBay, Etsy, etc., all belong to this sector. The outbreak of the pandemic has provided them great opportunities for development. It is shown that the equity price of Amazon, the largest firm in the sector, rose from $1907.70 on April 1, 2020 to $3450.96 on August 31, 2020. (Bloomberg, 2020)

Lots of traditional retailing and catering firms, like Nike, McDonald's, STARBUCKS, etc., after experiencing the early lockdown at the beginning of the pandemic, started to develop their online business, while closing some of their brick-and-mortar chain stores. These traditional firms changed their marketing structure and strategy during the pandemic to be adaptive in the new norm.

Besides that, there are lots of emerging and booming E-commerce firms in the sector, like Takeaway, and Delivery Hero, etc. After the implementation of the containment policies such as ‘stay at home requirements’ and ‘Restrictions on gathering size’, online shopping and takeaway have become much more popular thanks to the convenience they brought to our daily life.

Therefore, the stringent containment policies are conducive to the consumer discretionary sector, and the results are consistent with expectations.

4.2.5. Industrials

In the analysis focusing on the sector of Industrials, equities returns of 93 firms in the US, UK, and Germany are included. As listed in Table 4, the estimated coefficient of the effect of CH policies on the industrials sector is equal to -0.0709, which is not statistically different from zero considered with the size of the effect. It seems that the stringent degree of containment and health policies doesn’t affect the development of the industrials sector too much.

Most firms in industrials experienced a difficult phase at the beginning of the implementation of CH policies such as 'workplace closing' and 'stay at home requirements'. Many firms faced challenges of production stoppages due to supply chain disruption, cost escalation and labor shortage. However, the majority of firms in the industrial sector adjust then their operation mode to be adaptive to the ‘new-

norm'. Besides, all the analyzed countries have implemented economic stimulus packages on the infrastructure construction, which promote the development of the industrials sector.

However, this estimation is not significant according to the p-value. We cannot conclude that there is no impact of CH policy on the industrial sector. This estimation will be verified by the interaction model in 4.3.

4.2.6. Financials

In the analysis focusing on the sector of Financials, equities returns of 88 firms in the US, UK, and Germany are included. In the estimated results in Table 4, the estimated coefficient of the effect of CH policies on the financial sector is equal to -0.0768, which is not statistically different from zero considered with the size of the effect. It indicates that the stringency degree of containment and health policy does not affect the development of the financial sector.

The coefficient of the financial sector in Table 4 is not significant according to the p-value. As discussed in 3.3, the estimation coefficient would be affected by the economic policies of their own countries, which is not considered in the analysis model. And financial sector is particularly affected due to its nature. Therefore, we cannot conclude the impact of CH policy on the financial sector accurately. This estimation will be verified by the interaction method in 4.3.

4.3. Average effect analysis based on interaction model

The interaction model with the format of Equation (4) is adopted in this section to assess the average effect estimated by the market model. The dataset used in the interaction model is the same as that in the market model. All the data of 450 firms are pooled together. The standard errors are clustered at the country level. The linear regression results of the interaction model of Equation (4) for distinct sectors are listed in Table 5 on the next page.

As discussed in the 3.1.2, the overall average effect of CH policies on a specific sector is equal to the estimated $\emptyset+\theta_e$, and the average effect of CH policies across all sectors is captured by $\emptyset + \sum_s \mu_s \theta_s$. Based on the linear regression results in Table 5, the overall average effect of CH policies on a specific sector and across all sectors are summarized in Table 6 on the next page.

Table 5. The coefficients results of the interaction method

VARIABLES	Recst	Recst	Recst	Recst	Recst	Recst
$R_{mt}\ \eta$	0.0190	0.0190	0.0189	0.0188	0.0188	0.0188
	(0.0147)	(0.0147)	(0.0147)	(0.0147)	(0.0147)	(0.0147)
CH Ø	**0.2060****	**0.1951***	**0.1547**	**0.3318****	**0.3330****	**0.3330****
	(0.0374)	(0.0465)	(0.0653)	(0.0456)	(0.0509)	(0.0509)
Industrial θ_1	**-0.2957****	**-0.2848****	**-0.2448*****	**-0.4221*****	**-0.4233*****	**-0.4233*****
	(0.0425)	(0.0329)	(0.0130)	(0.0325)	(0.0271)	(0.0271)
IT θ_2		0.0477	0.0879	-0.0892	-0.0904	-0.0904
		(0.0376)	(0.0571)	(0.0380)	(0.0428)	(0.0428)
Health Care θ_3			0.1567	-0.0204	-0.0216	-0.0216
			(0.0568)	(0.0372)	(0.0426)	(0.0426)
Financials θ_4				**-0.4158****	**-0.4170****	**-0.4170****
				(0.0537)	(0.0483)	(0.0483)
Communication Service θ_5					-0.0042	-0.0042
					(0.0219)	(0.0219)
Consumer Discretionary θ_6						-
Constant	49.9119	50.0386	50.4861	50.6606	50.6609	50.6609
	(64.3401)	(64.2713)	(64.1196)	(64.1133)	(64.1137)	(64.1137)
Observations	109,942	109,942	109,942	109,942	109,942	109,942
R-squared	0.054	0.054	0.054	0.055	0.055	0.055

Robust standard errors in parentheses. Standard errors are Clustered at the country level

*** p<0.01, ** p<0.05, * p<0.1

Table 6. The average effect of CH policies on a specific sector and across all sectors

Sector Name	Industrials	IT	Health Care	Financials	Communication Services	Consumer Discretionary	All 6 sectors
Stock market share of sector μ_s	0.2067	0.1778	0.1556	0.1956	0.0756	0.1889	1.00
Average effect of CH	-0.0897	0.2428	0.3114	-0.084	0.3288	0.333	0.1442

To quantify the estimated average effect of CH policies on distinct sectors, the estimated coefficients obtained by the market model and the interaction model are compared in Table 7. Among all the 6 sectors analyzed by the interaction model, only the effects for the industrials and financials sectors are significant according to reasonable levels of confidence, meanwhile the estimation of these two sectors is not significant when using the market model. However, the coefficients estimated by using

the market model are statistically close to those by using the interaction model, which verifies our estimation using the market model.

Table 7. Results comparison between two methods

	Industrials	IT	Health Care	Financials	Communication Services	Consumer Discretionary	All 6 sectors
Coefficients from market model	-0.0723	0.2561**	0.2970**	-0.0768	0.2755**	0.3121*	0.146
Coefficients from interaction model	-0.0897***	0.2428	0.3114	-0.084**	0.3288	0.333	0.1442

In the market model, the estimation of industrials and financials sectors is not significant, while the estimation of these two sectors is more efficient in the interaction model. The estimated coefficient for industrials is -0.0723 in the market model and -0.0897 in the interaction model, while the estimated coefficient for financials is -0.0768 in the market model and -0.0840 in the interaction model. These two coefficients estimated by two models are not different from zero statistically, which means there's no effect of containment and health policies on the industrials and financials sectors.

These two industries have been impacted severely at the beginning of the pandemic. However, all the three countries analyzed have implemented corresponding economic stimulus package, especially on the infrastructure construction and monetary policy, which would balance out the impact of CH policies on these two sectors. Economic stimulus policies will be considered into the analysis model in the future analysis.

The other concern is that there are 3 industry groups, 14 industries included in the industrial sector, and there are 3 industry groups, 7 industries included in the financial sector. It would be worthwhile to investigate the impact of CH policies at the industry group level and even at the industry level for these 2 sectors in later study.

5. Conclusions

In this study, the impact of the containment and health policies on the economic performance of distinct industries is analyzed by using two different methods, the market model method and the interaction model method. The containment and health policies are quantified using the containment and health policy index from Oxford COVID-19 Government Response Tracker, and the economic performance of distinct industries is quantified by using the equity returns of all firms in the analyzed sectors.

Statistically close results are obtained from both methods. The result indicates that stringent containment and health policies are conducive to the development of the IT sector, health care sector, communication service sector, and consumer discretionary sector. As for the Industrial sector and financial sector, the degree of the stringency of containment and health policies doesn't affect them.

This study not only helps to assess the differentiated economic consequences of the anti-contagion policies on distinct industries, but also identifies the subsequent structural changes in the economy as a consequence of the anti-contagion policies. The digitization of each industry has been promoted substantially by the anti-contagion policies, and the booming development of the e-commerce has gradually changed the traditional retail model.

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