The impact of government response to COVID-19 on stock return predictability

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ผลกระทบของการตอบสนองต่อโควิด-19 ของรัฐบาลต่อความสามารถในการพยากรณ์ผลตอบแทนหุ้น

นายดิษยเดช แดงเดช

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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ในสภาวะเศรษฐกิจถดถอย ความสามารถในการพยากรณ์ผลตอบแทนหุ้นจะเพิ่มสูงขึ้น การแพร่ระบาดของโควิด-19 นั้น นอกจากจะทำให้ผู้คนล้มป่วยและเสียชีวิตแล้วยังทำให้เศรษฐกิจโลกเข้าสู่สภาวะถดถอยอีกด้วย รัฐบาลทั่วโลกจึงได้ออกมาสร้างมาตรการต่างๆเพื่อตอบสนองต่อภัยจากเชื้อไวรัสนี้ งานวิจัยนี้เริ่มต้นจากการหาค่าความสามารถในการพยากรณ์ผลตอบแทนหุ้นที่เพิ่มขึ้นจากการแพร่ระบาดของโควิด-19 โดยใช้ข้อมูลจาก 41 ประเทศและตัวแปรในการพยากรณ์ทางเศรษฐศาสตร์ต่างๆ นอกจากนั้นงานวิจัยนี้ยังแสดงผลให้ทราบว่าการตอบสนองของรัฐบาลต่อโควิด-19 สามารถแก้สภาวะเศรษฐกิจถดถอย และลดความสามารถในการพยากรณ์ผลตอบแทนหุ้นลงได้ โดยแต่ละมาตรการนั้นยังมีผลแตกต่างกันไปอีกด้วย อย่างไรก็ตามงานวิจัยนี้พบว่าการติดเชื้อและการตายจากโควิด-19 ซึ่งควรจะทำให้สภาวะเศรษฐกิจถดถอยรุนแรงขึ้นนั้นกลับไม่มีผลอย่างมีนัยสำคัญต่อความสามารถในการพยากรณ์ผลตอบแทนหุ้น

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Recession is known to cause an increase in stock return predictability. The COVID-19 pandemics had not only resulted in sickness and loss of life but also plunged global economy into recession prompting governments to come up with measures to combat the disease. This paper first confirms that return predictability increased due the spread of COVID-19 using data from 41 countries on variations of popular predictors. Furthermore, it shows that government responses to COVID-19 alleviated the pandemic, the recession and reduced the return predictability with varying impact for different government measures. However, cases and deaths from COVID-19 which should have intensified the recession were found to have an insignificant impact on the return predictability.

Field of Study:	Finance	Student's Signature	
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Disayadej Dangdej

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1. Introduction

In 2019, coronavirus (COVID-19) infected it first victim in Wuhan, China. Since then it has continued to spread further and culminate into a global pandemic around February 2020 with now millions of confirmed cases and deaths. As a result, the impacts of the virus went beyond the scope of public health into real economy and finance.

COVID-19 is known to cause significant decline in economic activities. On the income side, Corporations saw decline in their financial performance. People experienced lower income and poverty. While countries saw the rising unemployment rate. On the consumption side, household consumption had dropped and global trade were weakened as well. All these factors contributed to the reduction in Gross Domestic Product (GDP) of most countries around the world. The severity and length of the negative GDP growth were enough for the pandemic to trigger its own recession, the COVID-19 recession, as defined as 2 consecutive negative quarterly GDP growth, year on year.

The financial market also saw the impact of COVID-19. Particularly, the stock market saw a drop in stock price. Many researches showed that COVID-19 cases and deaths have a negative impact on stock return. The price of stock had dropped so much that it made stock markets around the world crashed at around February-march 2020 as well. From the discounted cash flow valuation, it is common to assume that COVID-19 decrease the cash flow of various business resulting in lower stock price. However, COVID-19 also affected stock price through the discount rate as well. The discount rate is a weighted average of cost of equity and cost of debt. This discount rate increases. As discount rate grows, cash flow gets heavily discounted resulting in less stock price.

The growing discount rate can be caused by the rising equity premium. It is known that equity premium tend to increase during recession. Campbell and Cochrane (1999) proposed a consumption-based model showing that people become more risk averse during economic recession when consumption and income levels are low. They will demand a higher equity risk premium near business-cycle troughs to be willing to take on the risk from holding stocks. This Countercyclical risk aversion suggests that the risk premium is countercyclical; Since equity premium is expected to increase in recession, it also becomes more predictable resulting in countercyclical return predictability.

Stock return predictability measures how well a variable from current period can predict the equity premium of the next period. With the rising trend in equity premium during recession, many researchers found the evidence that return predictability increased including in the recent COVID-19 recession. They detected the increase in return predictability which happened around February 2020 coinciding with the stock market crash.

Since COVID-19 caused damage to human life and economy, governments around the world had started implementing policies in response to COVID-19 aiming to alleviate the pandemic. The response can be categorized as closure and containment measure which include lockdown and travel ban. Economic measure which contain debt relief and income support policies and Health system measure which deal with countries' public health policies. The measures were successful at reducing the cases and deaths from the virus and many research papers documented the positive effects of the measures on stock return.

So far, researches focused on either the impact or COVID-19 and government response to COVID-19 on stock return or studying return predictability during COVID-19. This gap in literature leading to my research question: the impact of government response to COVID-19 on stock return predictability.

The main purpose of this paper is to measure what kind of impact government responses to COVID-19, which include containment and closure, economic and health system measures, have on stock return predictability across 41 countries around the world.

2. Literature review

COVID-19 and government responses impact on stock market and real economy

Literature on COVID-19 and finance concentrated around its effect on stock market return. Although some business sector experienced positive return during COVID-19, particularly healthcare and software stock, the stock market as a whole saw negative return resulting in price drop and stock market crash. loser stocks such as hospitality and entertainment had their equity value fell as much as 70% (Mazur et al., 2021). The market crash started in China, where COVID-19 was first detected, before eventually spreading into international markets as COVID-19 make it way through other countries (Contessi & De Pace, 2021).

The factors that may cause the drop in stock price were examined. Al-Awadhi et al. (2020) and Pham et al. (2021) found that total cases and death negatively affected stock market return. Furthermore, Ashraf (2020) documented that stock markets reacted more negatively on confirmed cases than confirmed deaths as investor already took into account the related risk of COVID-19 when the number of confirmed cases raised. Therefore, they react less once the COVID-19 cases victim actually passed away.

As for the impact of COVID-19 on real economy, COVID-19 pandemic was found to impact various economic indicators which made up GDP on both the income and consumption side, at the personal level, the containment and closure measure as a response to the spread of COVID-19 caused an increase unemployment rate in the short term (Bauer & Weber, 2021). While income was also found to decline at the start of the pandemic as well (Han et al., 2020). Along with the income, Liu et al. (2020) found that household consumption declined in China.

As for corporations, Shen et al. (2020) found that COVID-19 had a negative effect on firm performance by reducing investment scales in fixed asset and firm's total revenue. This eventually contributed to negative return and drop in stock price. Furthermore, Gu et al. (2020) found that firm activities itself as measured from electricity usage also dropped for most industry except for the previously mentioned healthcare and software businesses. The trade of goods as in export and import were also reduced as studied by Vidya and Prabheesh (2020) and the reduction in trade was forecasted to continue at least until the end of 2020. All of these decline in economic activities caused a global negative GDP growth (Maliszewska et al., 2020). This negative GDP growth were severe and long enough to be considered an economic recession.

In response to COVID-19, government had implemented various policies to stop the spread of COVID-19 pandemic (Hale et al., 2020). Government response to COVID-19 can be classified as Containment and Closure measure such as lockdown and travel ban policies, Economic measure such as stimulus package in form of income support and debt relief policies and Health system measure which tracks public health policies such as COVID-19 testing, mask mandate, vaccination and public information campaign. These policies were found to have an impact on stock market and economy as well. Overall, all three measures have a positive impact on both stock market return and economy as they alleviate the spread of COVID-19. Phan and Narayan (2020), Deng et al. (2022) and Narayan et al. (2021) found that containment and closure as well as economic measures have significant positive effect on stock market return. While Chang et al. (2021) show that health system measure has a positive but small impact. As for it effect on economy, Economic measure directly increased income (Han et al., 2020), while containment and closure measure had mixed results since it also caused unemployment in short-term but as it stops the spread of COVID-19, it should have positive effect on economy long-term. Therefore, government response to COVID-19 should reduce recession caused by COVID

Time-varying Return Predictability

Stock return predictability is a measure of how well a variable or predictor can predict equity premium (Rapach & Zhou, 2013). Return predictability is founded to be tied to business cycles. it increases in recession and weakens in expansion. To explain this phenomenon, Campbell and Cochrane (1999) and Cochrane (2008) built a consumption-based model showing that people become more risk-aversed when the economy is in recession and demand higher risk premium to invest in risky asset, leading to high return predictability. There were many research papers that confirmed Campbell and Cochrane model with real results such as Rapach et al. (2010) finding that US stock return predictability increased during recession as dated by NBER, national bureau of economic research, who is seen as the authority for business cycle dating in US as well as paper by Fama and French (1989). While Golez and Koudijs (2018) confirmed the same evidence as well for US and European countries by dating business cycles back for four hundred years and finding the increase in return predictability during recessions.

Aside from the dynamic of equity premium and expected return increasing return predictability, Henkel et al. (2011) mentioned that the change in return predictability may come from dynamics of predictors. Macroeconomic interest rate variables such as short interest rate, term spread and default spread are the result of interaction between market participants and central banks. Short interest rate in expansion is usually persistence due to smoothing efforts by monetary authority where as in recession, interest rate become more varying and informative as a predictor. Rapach et al. (2016) also mentioned that short interest is a significant predictor of the equity risk premium from a cash flow channel as short sellers are informed traders who are able to anticipate changes in future aggregate cash flows. Henkel et al. (2011) also suggested that term spread, a difference between long-term yield and short interest, also have similar properties to short interest. As for default yield spread, the spread between investment grade bond, is expected to be more informative in recession due to conservatism in accounting where accounting standard requires company to recognize potential loss such as provision before the loss actually happens but forbids them from recognizing potential profit. The result is that company become more informative during recession when there are potential losses.

As predictors become more informative in recession, predictive power of these variables increase resulting in higher return predictability.

Hypothesis development

Since COVID-19 became a pandemic in 2020 and caused recession, researchers such as Ciner (2021) started examining various predictors' return predictability and noted the predictability of bond yield in US. Meanwhile, Hong et al. (2021) found the increase in return predictability in the US. It happened in February which is around the same time stock market crashed. As equity premium and return predictability increased in the COVID-19 recession, the model by Campbell and Cochrane (1999) can explain why the stock price dropped in literature relating to the impact of COVID-19 and stock market return. When equity premium increases from a recession, the discount rate also increases and therefore reducing the value of the firm. The rise in return predictability is a byproduct of the rise in equity premium.

As COVID-19 caused recession and recession increased return predictability, if government responses were able to reduce the spread of COVID-19 or alleviate recession, we may be able to find these measures as factors explaining the decrease in return predictability. These assumptions lead to the following hypotheses

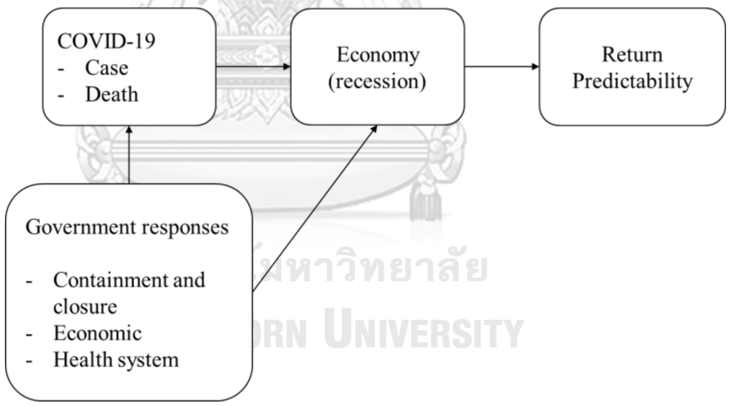


Figure 1. Conceptual framework

Hypothesis 1: during COVID-19 recession, return predictability is more than Pre-COVID return predictability

People become more risk averse in recession and demand more equity premium while also making it more predictable. This increase return predictability during recession.

Hypothesis 2: death and case have a positive impact on return predictability

Death and injury from COVID-19 reduce economic activities by reducing income and consumption and should intensify the recession causing an increase in return predictability.

Hypothesis 3: health system measure has a negative impact on return predictability

Health system reduce the spread of COVID-19. This increases trust and promotes investment and consumption. The recession should be de-intensified and results in a decrease in return predictability.

Hypothesis 4: containment and closure measure has an impact on return predictability

While containment and closure measure reduces the spread of COVID-19 and improves trust in the countries, it also reduces economic activity by reducing employment rate, income and consumption at least in the short run. Therefore, whether it reduces recession and return predictability or not is still uncertain but it is not zero.

Hypothesis 5: economic measure has a negative impact on return predictability and its impact is the strongest among the government response measure

Economic measure focuses on income support and debt relief therefore it ties directly to the household income and consumption expenditure. This should alleviate recession more than other measures and results in a more reduction and change in return predictability.

3. Data

Financial data were obtained from Bloomberg while data on COVID-19 and government response to COVID-19 were collected from Oxford covid-19 tracker. This paper covered the period from 2019 to 2021 which are period before and after COVID-19 outbreak. This paper data's cover 41 countries ranging from secondary emerging stock markets to developed stock markets as classified by FTSE equity classification 2021 with the exception of Egypt, Hong Kong, Kuwait, Pakistan, Qatar and Saudi Arabia due to data availability (see the list of countries in the appendix). There are roughly two step in methodology and here are the data use for each.

Step 1. Finding monthly and quarterly return predictability

Dependent variable:

As stock return predictability is equity premium prediction. Equity premium is required to find how well predictors of the previous period predict them.

1. Equity premium: log return on stock index minus log return on a risk-free bill

Independent variables:

These interest rate from secondary market are chosen as predictors as they are expected to have changing predictive power during recession and expansion as previously mentioned in Henkel et al (2011). The change in predictive power would highlight the effect of COVID-19 and response to COVID-19 on return predictability. These predictors are also available in frequency of daily allowing us to have more observation due to the short period of time of COVID-19 pandemic.

1. Short interest rate: treasury bill rate (3 months)
2. Long-term yield: long-term government bond yield (10 years)
3. Term spread: difference between long-term yield and the Treasury bill rate.
4. Default yield spread: difference between Baa- and Aaa-rated corporate bond yields.

Step 2. Regress death and case from COVID-19, and Government response indices on monthly and quarterly return predictability

Dependent variable:

1. Return predictability: measure of how well a predictor predict future equity premium. Obtained from finding monthly and quarterly R squared of the predictive regression model from step one.

Control variables:

Harvey (1995) found that developed countries stock market tend to have lower level of return predictability than developing countries'. Shamsuddin and Kim (2010) further investigated and found equity market development factors to be the cause of the difference. Therefore, they are to be controlled to find the impact of COVID-19 and government response on stock return predictability.

1. Producer Price Index (PPI): the change over time in the prices domestic producers receive for their output is an environmental factor. It is accounted for attributes of equity market development which are difficult to directly observed. Originally, Shamsuddin and Kim (2010) used GDP per capita but this study already used GDP as a channel for recession therefore, PPI is used instead and it is also available monthly.
2. Market turnover: measure how often stock is traded in the market. Developed market have higher market liquidity than developing market. Defined as value of stock traded over market capitalization.

Independent variables:

1. Case dummy: dummy for the increase in cases of COVID-19 compared to the last period, monthly and quarterly.
2. Death dummy: dummy the increase in deaths from COVID-19 compared to the last period, monthly and quarterly.

Government Response indices: Oxford collected daily data on government policies and categorized it into three group: containment and closure, economic and health system measure. Each of these measure consists of many individual policies which oxford call: indicators. the indicators are then given a score and used to form index as following:

ID	Name	Type	Targeted/ General?
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 international 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

Figure 2. Oxford's government measures

3. Containment and closure index: this index tracks policies relating to containment and closure such as 1) lockdown: closing of school/workplace, cancellation of public events and restriction on gathering size as well as 2) travel ban: close of public transport, stay at home requirement and restriction on movement (C1-C8).
4. Economic Response index: this index tracks policies on economic measure on stimulus package/income support and debt relief for household (E1-E2).
5. Health system index: this index tracks policies on public health which include public health campaign, testing policy, contact tracing, facial covering, vaccination policy and policies relating to protection of elderly people (H1-H3 and H6-H8).

For indicators that are used, Oxford ranked them by ordinal number (i.e. 0,1,2,3) to measure how severe government response was. Furthermore, some indicator has an additional binary flag with value of 0 and 1. For example, in C1-C7, H1 and H6, the flag indicates the geographic scope. The higher number means the more severe response for ordinal scale or the bigger scope for the flag. To construct Containment and closure, Economic and Health system index, I would transform ordinal value into a score from 0 to 100 for each indicator.

$$I_{i,t} = 100\,\frac{v_{i,t} - 0.5\left(F_j - f_{j,t}\right)}{N_i}$$

Where $v_{i,t}$ are policy value on the ordinal scale. N_i are maximum value of the indicator. F_j indicate if the indicator has flag variable (0 = no binary flags and 1 = binary flags). $f_{j,t}$ is the binary flag. Then, I average all of the indicators of the corresponding measure(daily) to form the measure.

$$\text{Index} = \frac{1}{k}\sum_{j=1}^{k} I_{i,t}$$

Where K are numbers of indicator which make up the measure. Finally, I average daily measure score into monthly and quarterly.

Table 1. data table

Data	Notation	Description	Frequency
Equity premium	r	Excess return over risk-free rate	Daily
Return Predictability	R^2	Equity premium forecastability	Monthly, Quarterly
Short interest rate	ST	3 months treasury bill	Daily
Long-term yield	LTY	10 years government bond	Daily
Term spread	TS	Difference in between bill and bond	Daily
Default yield spread	DFY	Difference between Aaa and Baa bond	Daily
Case dummy	CASE	Dummy for increase in cases compared to last period	Monthly, Quarterly
Death dummy	DEATH	Dummy for increase in deaths compared to last period	Monthly, Quarterly
Containment and Closure index	CC	Index tracking policy on Containment and Closure	Monthly, Quarterly
Economic Index	E	Index tracking policy on economy	Monthly, Quarterly
Health system index	HS	Index tracking policy on health system	Monthly, Quarterly
Producer Price Index	PPI	Change over time in the prices producers receive	Monthly, Quarterly
Market turnover	MKT	Stock value traded divided by market capitalization quarterly	Monthly, Quarterly

4. Methodology

The first step is to find R square, the measure of return predictability. From the predictive regression model, I will run regressions to find monthly and quarterly return predictability.

$$r_t = \beta_0 + \beta_1 X_{t-1} + \varepsilon_t$$

Where, r_t is the equity premium (log return on stock index minus the log return on a risk-free bill) and X_{t-1} is a daily lagged predictor (Short interest rate, Long term yield, Term spread, Default yield spread). This resulted in the following equation:

$$r_t = \beta_0 + \beta_1 SI_{t-1} + \varepsilon_t \quad (1)$$
$$r_t = \beta_0 + \beta_1 LTY_{t-1} + \varepsilon_t \quad (2)$$
$$r_t = \beta_0 + \beta_1 TS_{t-1} + \varepsilon_t \quad (3)$$
$$r_t = \beta_0 + \beta_1 DFY_{t-1} + \varepsilon_t \quad (4)$$

Furthermore, as past equity premium may have impact on future equity premium due to its nature as a time series data, the following equations are also regressed to accounted for those factors. This will give us a total of nine equations.

$$r_t = \beta_0 + \beta_1 SI_{t-1} + \beta_2 r_{t-1} + \varepsilon_t \quad (5)$$
$$r_t = \beta_0 + \beta_1 LTY_{t-1} + \beta_2 r_{t-1} + \varepsilon_t \quad (6)$$
$$r_t = \beta_0 + \beta_1 TS_{t-1} + \beta_2 r_{t-1} + \varepsilon_t \quad (7)$$
$$r_t = \beta_0 + \beta_1 DFY_{t-1} + \beta_2 r_{t-1} + \varepsilon_t \quad (8)$$
$$r_t = \beta_0 + \beta_1 r_{t-1} + \varepsilon_t \quad (9)$$

These second models which previous period equity premium along with a predictor are regressed on current equity premium are meant for robustness check in case I cannot find the increase in return predictability from the normal predictive regression model.

Monthly and quarterly return predictability from each equation are obtained in form of ${R^2}_t$ for each period and for each country. Before I further try to find the impact of government response on return predictability, I can first test if monthly and quarterly return predictability increase during COVID-19 outbreak.

$$R^2_{i,t} = \beta_0 + \beta_1 D + \varepsilon_{i,t}$$

Where $R^2_{i,t}$ is return predictability and D is COVID-19 dummy which the value is 1 when there is COVID outbreak and 0 when there is no COVID-19 outbreak.

Hypothesis 1: COVID-19 return predictability is more than Pre-COVID return predictability $\beta_1 > 0$

In the second step, government response indices, case and death dummy and control variables are regressed on monthly and quarterly return predictability to find the impact of those independent variables on return predictability using fixed effect model. Note that the R squared used are in a unit of percent to keep the number from being too small. The main equation which is used for both monthly and quarterly return predictability for the second step is as the following:

$$R^2_{i,t} = \alpha_i + \beta_{CC}\, CC_{i,t} + \beta_E\, E_{i,t} + \beta_{HS}\, HS_{i,t} + \beta_{CASE}\, CASE_{i,t} + \beta_{DEATH}\, DEATH_{i,t} + \boldsymbol{\beta^c}\, \boldsymbol{X^c}_{\boldsymbol{i,t}} + \varepsilon_{i,t} \quad (10)$$

Where government measure are containment and closure (X_{cc}), economic (X_e) and health system index (X_{hs}). $CASE$ and $DEATH$ are case dummy and death dummy. $\boldsymbol{X^c}_{\boldsymbol{i,t}}$ is a vector of control variables, the equity market development factors which include PPI and market turnover.

However, for monthly return predictability alone, the government policies implemented in the same month may take time for it to have effect on the economy, therefore, in addition to the first equation above, one more equation is tested where the government indices and, case and death dummy used to test the impact on return predictability are monthly lagged.

$$R^2_{i,t} = \alpha_i + \beta_{CC}\, CC_{i,t-1} + \beta_E\, E_{i,t-1} + \beta_{HS}\, HS_{i,t-1} + \beta_{CASE}\, CASE_{i,t-1} + \beta_{DEATH}\, DEATH_{i,t-1} + \boldsymbol{\beta^c}\, \boldsymbol{X^c}_{\boldsymbol{i,t-1}} + \varepsilon_{i,t} \quad (11)$$

The reason I planned to run a total of 9 predictive regressions model is to avoid kitchen sink regression. (Welch & Goyal, 2008) mentioned that while the regression model with all the predictors (kitchen sink) may have higher R squared in-sample but it tends to perform worse out-of-sample. Although this research paper uses in-sample R squared, I still want to avoid overfitting the model and misinterpreting the relationship and effect of each variable.

Hypothesis 2.1. Cases dummy has a positive impact on return predictability

$\beta_{CASE} > 0$

Hypothesis 2.2. Death dummy has a positive impact on return predictability

$\beta_{DEATH} > 0$

Hypothesis 3: Health system measure has a negative impact on return predictability

$\beta_{HS} < 0$

Hypothesis 4: Containment and Closure measure have an impact on return predictability

$\beta_{CC} \neq 0$

Hypothesis 5.1: Economic measure have a negative impact on return predictability

$\beta_{E} < 0$

Hypothesis 5.2: Economic measure have the strongest impact than among the government response measure

$|\beta_{e}| > |\beta_{other\ measure}|$

5. Results and Discussion

First, I tested for the potential multicollinearity problems by building a correlation matrix of variables as shown in tables in the appendix. From the monthly matrix in table G, none of the independent variables such as government response measures and control variables are too highly correlated so none of the independent variable had to be dropped for monthly period. However, for quarterly period in table H, case and death dummy are highly correlated and therefore, one of the variable had to be dropped. The regression results for quarterly period are separated into two tables one with only case dummy and another with only death.

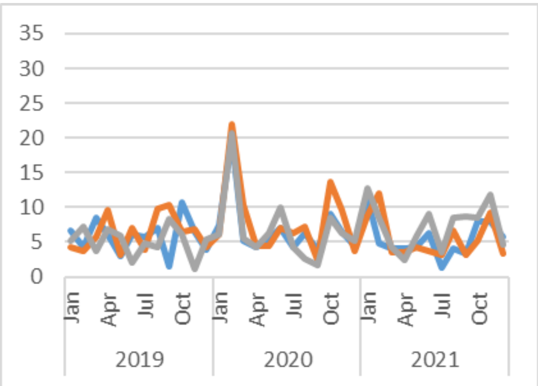
As for the overall result, I found the increase in return predictability after COVID-19. Furthermore, the government responses to COVID-19 are shown to have negative impact on return predictability with each kind of response resulting in varying amount of change in R squared from different predictors. However, case and death dummy were found to have no significant effect. I will discuss mainly from monthly period results' perspective with explanations for the other models if there are difference between each version. The quarterly charts and tables are in the appendix.

6.1 Return predictability before and after COVID-19

By gathering the data as stated in the previous chapter, I can find return predictability from the chosen predictors. Here are the monthly line charts showing R squared from each equation overtime in a unit of percent. The R squared shown in Y axis here is an average R squared of countries within the same stock market development level (Developed: red, Advanced Emerging: blue and Secondary Emerging: grey). Quarterly charts are in the appendix.

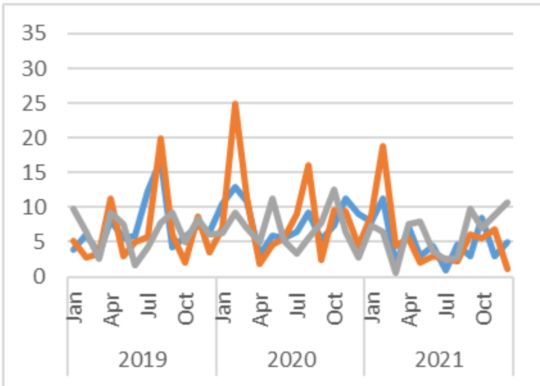
<u>Monthly average R squared line charts</u>

Treasury bill



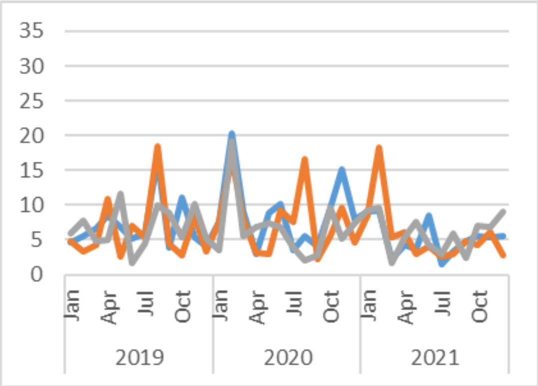
	Developed	Advance E.	Secondary E.
Max	0.2198	0.1985	0.2076
Min	0.0232	0.0126	0.0104
Average	0.0662	0.0607	0.0639
S.D.	0.0383	0.0319	0.0362

Government bond



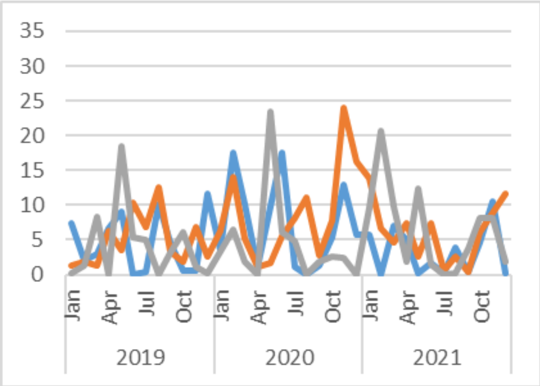
	Developed	Advance E.	Secondary E.
Max	0.2499	0.1685	0.1256
Min	0.0102	0.0086	0.0057
Average	0.0693	0.0677	0.0653
S.D.	0.0543	0.0344	0.0284

Term spread



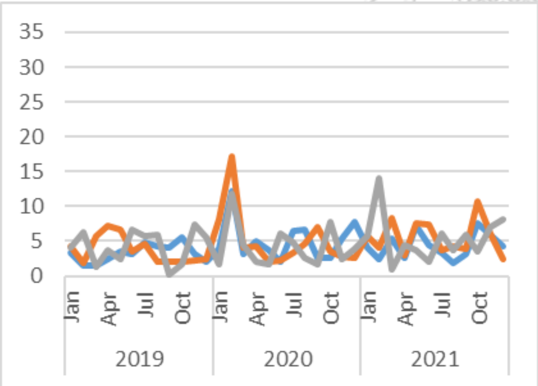
	Developed	Advance E.	Secondary E.
Max	0.1854	0.2039	0.1911
Min	0.0225	0.0152	0.0167
Average	0.0663	0.0701	0.0645
S.D.	0.0447	0.0395	0.0333

Default yield spread



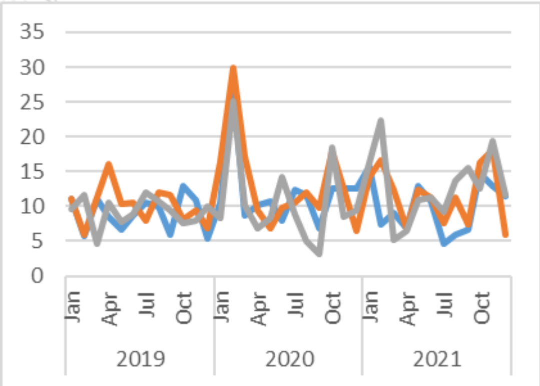
	Developed	Advance E.	Secondary E.
Max	0.2401	0.1761	0.2338
Min	0.0036	0.0006	0.0000
Average	0.0653	0.0504	0.0499
S.D.	0.0509	0.0486	0.0582

Equity premium



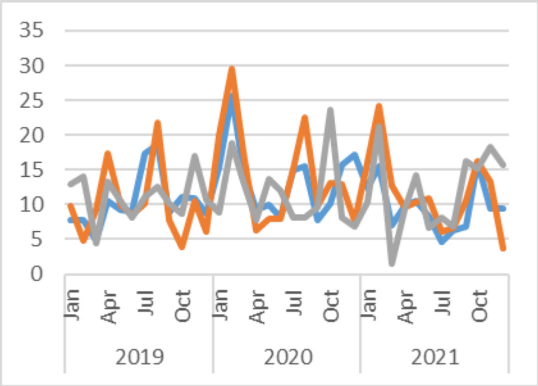
	Developed	Advance E.	Secondary E.
Max	0.1725	0.1223	0.1403
Min	0.0187	0.0148	0.0026
Average	0.0481	0.0423	0.0464
S.D.	0.0303	0.0215	0.0290

Treasury bill with equity premium



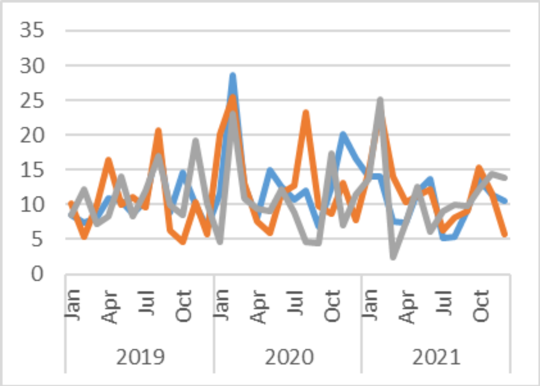
	Developed	Advance E.	Secondary E.
Max	0.2993	0.2725	0.2513
Min	0.0595	0.0457	0.0321
Average	0.1168	0.1028	0.1086
S.D.	0.0468	0.0399	0.0474

Gov bond with equity premium



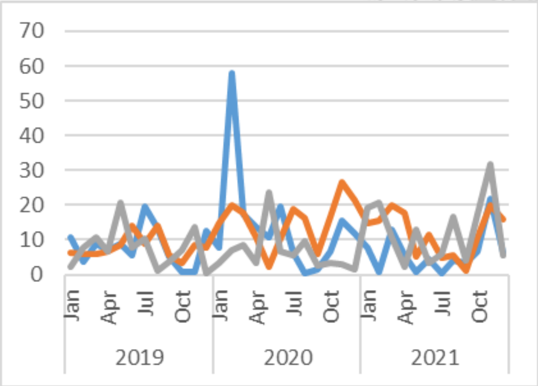
	Developed	Advance E.	Secondary E.
Max	0.2946	0.2558	0.2366
Min	0.0361	0.0453	0.0151
Average	0.1195	0.1127	0.1155
S.D.	0.0594	0.0442	0.0462

Term spread with equity premium



	Developed	Advance E.	Secondary E.
Max	0.2545	0.2855	0.2518
Min	0.0457	0.0512	0.0245
Average	0.1171	0.1152	0.1098
S.D.	0.0531	0.0447	0.0484

Default yield spread with equity premium



	Developed	Advance E.	Secondary E.
Max	0.2658	0.5779	0.3187
Min	0.0127	0.0041	0.0051
Average	0.1165	0.0948	0.0891
S.D.	0.0621	0.1001	0.0723

The trend in all of these graphs for both monthly and quarterly periods are the same except for the default yield spreads due to low sample size as only data for India, South Korea, Thailand, UK and US are available. The trend is that the return predictability raised to its highest point during February or March 2020 when COVID-19 was announced as a global pandemic by World Health Organization then it went down possibly due to government response to COVID-19. Afterward, it raised again periodically as new waves and new strands of COVID-19 pandemic hit each stock market.

From the charts, all type of R squared in both monthly and quarterly periods experienced a sharp increase when COVID-19 became a pandemic. As both the results from normal predictive regression model and the second model where, previous period equity premium along with a predictor are regressed on current equity premium, showed similar increase in return predictability, these models are robust.

Furthermore, I also calculated the quartiles, the range, upper bound and lower bound of the R squared in order to find the outliers among the data as shown the table below for monthly and in the appendix for quarterly period. From what we can see here compared to the R squared in summary statistics in both monthly term in table A and quarterly term in table I, I noticed that the maximum R squared of all types are higher than the upper bound in both the monthly and quarterly model. For examples, upper bound for R squared from treasury bill in monthly and quarterly period are 0.2133 and 0.0490 respectively however from the summary statistics in table B in the next page and table J in the appendix, the maximum R squared are 0.6496 and 0.1808 respectively. This means that all types of R squared contain outlier data.

Table A. Upper bound and lower bound of monthly R squared

	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
Quartile 1	0.0074	0.0069	0.0063	0.0087	0.0047	0.0335	0.0359	0.0331	0.0343
Quartile 3	0.0898	0.0991	0.0967	0.0822	0.0603	0.1594	0.1739	0.1706	0.1522
Interquartile Range	0.0824	0.0922	0.0904	0.0734	0.0556	0.1258	0.1380	0.1375	0.1180
Upper Bound	0.2133	0.2374	0.2322	0.1923	0.1437	0.3481	0.3810	0.3769	0.3292
Lower Bound	-0.1161	-0.1314	-0.1293	-0.1014	-0.0787	-0.1552	-0.1712	-0.1732	-0.1426

Next. I can use the R squared I obtained to the regression analysis that will allow us to do hypothesis testing to determine whether COVID-19 recession increase return predictability in a global scale. The summary statistics and regression result are obtain as shown below:

Table B. Summary statistics for Return predictability before and after COVID-19, monthly

Variables	Obs	Mean	Std. Dev.	Min	Max
R^2_{tb}	1476	0.0645	0.0829	0.0000	0.6496
R^2_{gb}	1476	0.0682	0.0861	0.0000	0.5724
R^2_{ts}	1476	0.0669	0.0868	0.0000	0.6676
R^2_{dys}	180	0.0593	0.0712	0.0000	0.3612
R^2_{ep}	1476	0.0464	0.0636	0.0000	0.4595
R^2_{tbep}	1476	0.1120	0.1013	0.0002	0.6677
R^2_{gbep}	1476	0.1172	0.1053	0.0001	0.6594
R^2_{tsep}	1476	0.1154	0.1052	0.0000	0.6698
R^2_{dysep}	180	0.1067	0.1000	0.0006	0.5779
Dummy for COVID-19	1476	0.6450	0.4787	0.0000	1.0000

Table C. Regression for Return predictability before and after COVID-19, monthly

Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
COVID dummy	0.0020	0.0004	-0.0023	0.0188**	0.0088***	0.0147***	0.0133***	0.0105**	0.0414***
	(0.0045)	(0.0047)	(0.0047)	(0.0110)	(0.0034)	(0.0055)	(0.0057)	(0.0057)	(0.0154)
Constant	0.0632***	0.0680***	0.0684***	0.0468***	0.0407***	0.1025***	0.1086***	0.1086***	0.0791***
	(0.0036)	(0.0038)	(0.0038)	(0.0090)	(0.0028)	(0.0044)	(0.0046)	(0.0046)	(0.0125)
Observation	1,476	1,476	1,476	180	1,476	1,476	1,476	1,476	180
R-squared	0.0001	0.0000	0.0002	0.0164	0.0045	0.0050	0.0038	0.0024	0.0401

Standard error in the parentheses
*** p<0.01, ** p<0.05, * p<0.1

Hypothesis 1 result and discussion

Starting with effect of COVID-19, in a monthly period in table C, the dummy for the spread of COVID-19 have significant positive effect on return predictability for default yield spread as well as all other factors (treasury bill, government bond, term spread and default yield spread) once I included previous period equity premium when finding R squared. This supports our hypothesis that the recession from the spread of COVID-19 cause economic recession which heightens the equity premium and results in the increase in return predictability.

Here, the COVID dummy is significant mostly for R squared from a predictor (treasury bill, government bond, term spread and default yield spread) with previous period equity premium. A possible explanation is that during COVID-19. People became more risk averse and demanded more equity premium to invest in stock. While the equity premium did increase, it still might not be high enough for the more risk-averse traders. The result is that there were less trading in the stock market compared to before COVID-19 causing the equity premium to become more persistent. Hence, we saw that when regressing COVID dummy on the R squared, only R squared where, the previous period equity premium is regressed along with a predictor, have significant effect.

For quarterly period in table K, the results only showed significant positive effect for R squared of previous equity premium and R squared of treasury bill with equity premium. This could be due to low sample size of quarterly periods resulting in high standard error and lowering the precision of estimator when compared to monthly periods as well as the contamination effect as the spread of COVID-19 could happen in a month later on in the quarter and not at the start of the quarter itself. **Overall, the result is consistent with hypothesis 1:** COVID-19 recession cause an increase in return predictability for the R squared from previous period equity premium and a predictor.

6.2 Impact of government response to COVID-19 on return predictability

With the government response indices from Oxford, I can now find the impact of government response to covid-19 on return predictability as well as other factors that might affected it such as cases and deaths. Following the methodology in previous chapter, the results are obtained as shown in the next page. Note that the return predictability or R squared, PPI and market turnover used here are in a unit of percent to keep the number from being too small.

Table D. Summary statistics for impact of government response on COVID-19, monthly

Variables	Obs	Mean	Std. Dev.	Min	Max
CC	984	48.7507	22.5316	0.0000	100.0000
E	984	54.9658	31.7788	0.0000	100.0000
HS	984	64.5911	20.9239	0.0000	100.0000
CASE	984	0.5793	0.4939	0.0000	1.0000
DEATH	984	0.4746	0.4996	0.0000	1.0000
PPI	1476	0.4940	1.5354	-7.7640	18.9284
MKT	1476	6.1550	7.6054	0.4613	64.1855
R^2_{tb}	1476	6.4479	8.2898	0.0000	64.9621
R^2_{gb}	1476	6.8235	8.6143	0.0000	57.2377
R^2_{ts}	1476	6.6903	8.6799	0.0001	66.7553
R^2_{dys}	180	5.9284	7.1217	0.0000	36.1185
R^2_{ep}	1476	4.6397	6.3550	0.0000	45.9452
R^2_{tbep}	1476	11.1991	10.1315	0.0167	66.7740
R^2_{gbep}	1476	11.7164	10.5295	0.0121	65.9443
R^2_{tsep}	1476	11.5387	10.5166	0.0045	66.9788
R^2_{dysep}	180	10.6702	10.0024	0.0649	57.7873

Table E. Regression for government responses impact on return predictability, monthly

Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	-0.0460***	-0.0056	0.0051	0.0046	-0.0296**	-0.0613***	-0.0047	0.0008	-0.0042
	(0.0174)	(0.0175)	(0.0176)	(0.0593)	(0.0138)	(0.0215)	(0.0219)	(0.0218)	(0.0853)
E	-0.0097	-0.0132	-0.0047	-0.0149	-0.0131	-0.0193	-0.0288**	-0.0163	-0.0665
	(0.0133)	(0.0134)	(0.0135)	(0.0387)	(0.0105)	(0.0165)	(0.0168)	(0.0167)	(0.0556)
HS	-0.0528	-0.0895***	-0.0917***	0.0373	-0.0255**	-0.0542**	-0.1161***	-0.1134***	0.0121
	(0.0194)	(0.0195)	(0.0196)	(0.0511)	(0.0153)	(0.0240)	(0.0245)	(0.0243)	(0.0735)
CASE	0.2411	0.5364	0.0881	2.1737	0.0970	0.1786	0.3895	0.1432	0.6598
	(0.6340)	(0.6382)	(0.6417)	(1.7370)	(0.5012)	(0.7848)	(0.7991)	(0.7953)	(2.4969)
DEATH	-0.0219	-0.3017	-0.6747	0.7592	-1.4161	-0.8644	-1.9081	-2.0603	-0.8018
	(0.6420)	(0.6463)	(0.6498)	(1.6229)	(0.5075)	(0.7947)	(0.8092)	(0.8054)	(2.3330)
PPI	-0.1656	0.0540	0.2470	-0.0409	0.2760**	0.1312	0.4607**	0.7032***	-1.0155
	(0.2051)	(0.2064)	(0.2076)	(0.9509)	(0.1621)	(0.2538)	(0.2584)	(0.2572)	(1.3669)
MKT	0.0835	-0.0091	0.0247	0.1958	0.0250	0.1211	-0.0221	0.0272	0.5106
	(0.0971)	(0.0978)	(0.0983)	(0.2481)	(0.0768)	(0.1202)	(0.1224)	(0.1219)	(0.3566)
Constant	12.3071***	13.5883***	12.6193***	0.9722	9.1814***	18.9080***	22.2526***	20.5720***	10.0740*
	(1.2578)	(1.2661)	(1.2731)	(4.0725)	(0.9943)	(1.5569)	(1.5853)	(1.5779)	(5.8543)
Observation	984	984	984	120	984	984	984	984	120
R-squared	0.0556	0.0582	0.0439	0.0386	0.0491	0.0549	0.0733	0.0613	0.0561

Since there are four models and four regression results in this step, table F in the next page was made to help us compared monthly model (table E) with monthly lagged government response model (table M) and the quarterly models (table O and P) from the appendix.

Table F. Significance level and sign of significant variables for all government response models

	Normal government response model, monthly									Lagged government response model, monthly								
Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	***(-)				**(-)	***(-)				***(-)				**(-)	***(-)			
E							**(-)											
HS		***(-)	***(-)		**(-)	**(-)	***(-)	***(-)		***(-)	***(-)	***(-)		***(-)	***(-)	***(-)	***(-)	
CASE																		
DEATH																		
PPI					**		**	***			**	**		***	**	***	***	
MKT																		

	Model with case as independent variable, quarterly									Model with death as independent variable, quarterly								
Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC		***(-)	***(-)								***(-)	***(-)						
E	**(-)	***(-)	**(-)	**(-)						*(-)	***(-)	**(-)	**(-)					
HS	**(-)	***(-)	**(-)			**(-)	***(-)	***(-)		**(-)	***(-)				**(-)	***(-)	**(-)	
CASE																		
DEATH																		
PPI																		
MKT				**									**					

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

Hypothesis 2 result and discussion

Moving on to the impact of COVID-19 and responses to COVID-19 on return predictability, first, we have dummy for an increase in cases and deaths due to COVID-19 compared to the last period.

For monthly period in table F, both case and death dummy were found to have insignificant effect on return predictability. This finding contradicts with my initial hypothesis. For both dummy variables, the contradiction might be due to the quality of data which did not reflect the severity of COVID-19 pandemic and recession. Dummy for cases and deaths cannot link or indicate the recession sufficiently. For example, an increase in number of cases from 1 cases to 2 cases or 20 cases to 800 cases are all equal to 1 in dummy which make the dummy noisy.

There is another potential explanation for the difference. Early papers on COVID-19 such as Ashraf (2020) had documented various negative effect on economy and stock market. One possible explanation is that those papers were published when COVID-19 was considered a life-threatening disease with no vaccination and medication made specifically for it. People suffering from the disease were likely unable to engage in economic activities. Therefore, stock markets reacted strongly to the increase in cases and deaths early on. However, as time passed, vaccination and medicine had greatly improved. Cases and deaths from COVID-19 are viewed as not so different from common influenza's. Essentially, COVID became normalized and stock markets no longer reacted to it.

As for quarterly period in table F, both case and death dummies are also insignificant with the possible causes being the same as discussed above. Due to these results, **we fail to reject null hypothesis for 2.1 and 2.2:** death and case have a positive impact on return predictability.

Hypothesis 3 result and discussion

Health system measure turned out to be the measure with significant negative effect on most type of R squared from different predicting factors except for the two default yield spread possibly due to low sample size skewing the results in monthly period. Quarterly period also showed significant negative effect on most models as well.

The overwhelming significant negative effects to return predictability are due to health measure such as COVID-19 testing, mask mandate, public information campaign, vaccination and medicine reducing the impact of COVID-19 on the economy as it protected healthy people from catching COVID. Health system measure could reduce the severity of COVID-19 by reducing fear of COVID-19 pandemic and improving the trust in the countries' abilities to recover from the COVID-19 recession. This promoted consumption and investment in the economy and therefore, improved the GDP. As the recession is alleviated and return predictability is reduced back to normal.

This finding is consistent with hypothesis 3: health system measure has a negative impact on return predictability for government bond, term spread, equity premium, treasury bill with equity premium, government bond with equity premium and term spread with equity premium for monthly model with an addition of treasury bill for lagged monthly model.

As for the quarterly model, health system measure has a negative impact on return predictability for treasury bill, government bond, treasury bill with equity premium, government bond with equity premium and term spread with equity for death dummy model with an addition of term spread for case dummy model.

Hypothesis 4 result and discussion

Containment and closure measure is shown to have an impact on return predictability. The impact is significant and negative for R squared from treasury bill, equity premium and treasury bill with equity premium for monthly period. For quarterly, it is significant negative for government bond and term spread.

The R squared from T-bill is significant in the monthly model while government bond and term spread (government bond minus treasury bill) are significant in the quarterly model. This could be due to the underlying securities' duration matching the period of the regression better and therefore, it showed significant effect in the corresponding period. For example, the monthly containment and closure measure may take 2-3 months to see the total effect, therefore it had significant effect on the 3-month treasury bill. Similarly, for quarterly containment and closure measure, it may take almost a year to see all effect so its impact is significant on 1-year government bond instead.

Papers such as Bauer and Weber (2021) were pessimistic about the containment and closure measure's impact on economy due to the loss in economic activities from lockdown and travel ban. For example, government and business entities were either forced to close or had to operate online instead as people were not allowed to congregate for a period of time. However, the measure is proven to reduce the severity of the impact COVID-19 on economy by reducing the opportunities for COVID-19 to spread from the infected people. Similar to the heath measure, it reduced the fear of COVID-19 and improved the trust in the countries which promoted consumption and investment in the economy and therefore, reduced the recession resulting in a reduction in return predictability.

The finding is consistent with hypothesis 4: containment and closure measure has an impact on return predictability for treasury bill, equity premium and treasury bill with equity premium for monthly and lagged monthly model as well as government bond and term spread for the quarterly models.

Hypothesis 5 result and discussion

Finally, Economic measure has a negative effect on return predictability but it is only significant for model with R squared from government bill with past equity premium for monthly period. Interestingly, this measure is the only measure where monthly lagged government response model showed different result from monthly model as I did not find any significant effect in table F. For quarterly, in both case and death dummy model, the R squared from government bond, term spread and default yield spread became significant instead.

The quarterly periods showed more significant R squared than the monthly period. This may be due to the amount of money given monthly was small but as it culminated into a quarter, it became a more effective measure in combating poverty from COVID-19.

Furthermore, the shift to R squared without equity premium being significant in the quarterly model may be explained as when economic measure gave the money to the people, some of the money may also be spent on trading by retail traders and increase the trade volume such that equity premium lost its persistent and the R squared with previous equity premium became insignificant.

The lack of effect on lagged model may also indicate that economic measure such as debt relief and income support only have an effect in the same period the policies were implemented in. This makes sense as when money is given to people via income support or debt payments are frozen. People would immediately see the benefit of the economic measure in that same period without needing to wait for the next period unlike other measures which take effects slower.

Overall, economic measure stimulated the economy by increasing income and consumption, reduced the severity of the COVID-19 recession and caused a drop in return predictability as mentioned in the hypothesis development. **The result is consistent with hypothesis 5.1**: Economic measure has a negative impact on return predictability for government bond for normal monthly model as well as treasury bill, government bond, term spread and default yield spread for quarterly models

Finally, the beta from regression showed that economic response had lower impact on return predictability in all models compared to health system and confinement measure. Possible explanation is that while economic measure gave money directly to people affected by recession from COVID-19, it did not solve the spread of COVID itself which is the root cause for the recession. Therefore, it has a lower impact than measures which reduce the spread. As a result, **we fail to reject null hypothesis for 5.2:** Economic measures has the strongest impact than among the government response measures.

6. Conclusion

(Campbell & Cochrane, 1999) linked the increase in return predictability to recession due to risk aversion in US. Later on, researchers would find similar results on many other stock markets. With the outbreak of COVID-19, (Hong et al., 2021) proved that COVID-19 recession caused increase in return predictability USA. This study first tried to confirm this finding but in a global scale and then extended the scope to find variables that affect return predictability.

Due to the effect of COVID-19 on people as well as the measures against it being extensively recorded. It gave this research an opportunity to examine which kind of government policies affect the performance of stock return predictability. The main contribution of this paper is to show that all government responses to COVID-19 which includes containment and closure, economic and health system measures can reduce the recession from COVID and cause the reduction in stock return predictability from some of the predictors. These measures worked by either reducing the spread of COVID itself or the economic effects of it. Furthermore, this paper found that measures that are more direct to treating the root cause, the spread of COVID, such as health measure and containment measure are more effective than measure which only treats the symptom such as economic measure as viewed through the reduction in return predictability from the beta.

As for the limitation, this paper only studied one specific recession caused by COVID-19 pandemic. Therefore, the measures that were used are specific to public health policies with a few economic policies in the economic measure. Further studies can try to expand the scope by looking at recession that could be alleviated by a more general solution. This would allow researcher to find measures that can be more useful in normal recession and not just ones used for pandemic which rarely causes a recession. Finally, this study also contains outlier return predictability in the data set. Further study can also try removing these outliers as well.

7. Appendix

Figure 3. FTSE country classification of equity markets

The table below shows the FTSE country classification of equity markets as at September 2021.

Developed	Advanced Emerging	Secondary Emerging	Frontier
Australia	Brazil	Chile	Bahrain
Austria	Czech Republic	China	Bangladesh
Belgium/Luxembourg	Greece	Colombia	Botswana
Canada	Hungary	Egypt	Bulgaria
Denmark	Malaysia	India	Côte d'Ivoire
Finland	Mexico	Indonesia	Croatia
France	South Africa	Kuwait	Cyprus
Germany	Taiwan	Pakistan	Estonia
Hong Kong	Thailand	Philippines	Ghana
Ireland	Turkey	Qatar	Iceland
Israel		Romania	Jordan
Italy		Russia	Kazakhstan
Japan		Saudi Arabia	Kenya
Netherlands		UAE	Latvia
New Zealand			Lithuania
Norway			Malta
Poland			Mauritius
Portugal			Morocco
Singapore			Nigeria
South Korea			Oman
Spain			Palestine
Sweden			Peru
Switzerland			Republic of North Macedonia
UK			Serbia
USA			Slovak Republic
			Slovenia
			Sri Lanka
			Tanzania
			Tunisia
			Vietnam

Source: https://research.ftserussell.com/products/downloads/FTSE-Country-Classification-Update-2021.pdf

Table G. Correlation matrix, monthly

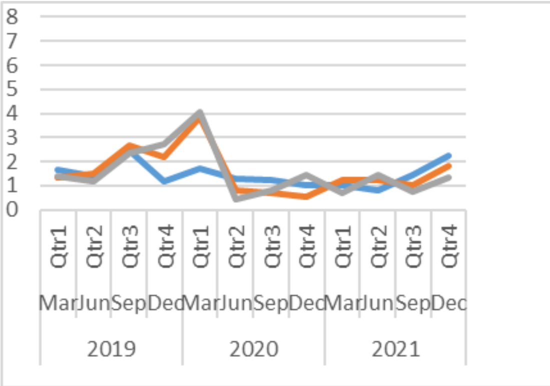
	CC	E	HS	CASE	DEATH	PPI	MKT	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	1.000															
E	0.545	1.000														
HS	0.564	0.305	1.000													
CASE	-0.236	-0.123	-0.304	1.000												
DEATH	0.054	0.010	-0.011	0.478	1.000											
PPI	0.115	-0.049	0.378	-0.286	-0.098	1.000										
MKT	-0.106	-0.208	0.074	0.065	0.110	-0.099	1.000									
R^2_{tb}	-0.075	-0.023	0.051	-0.052	0.031	0.107	0.094	1.000								
R^2_{gb}	0.056	-0.100	-0.051	-0.076	-0.025	0.015	0.021	0.170	1.000							
R^2_{ts}	0.030	-0.024	-0.019	-0.053	-0.006	0.057	0.091	0.337	0.762	1.000						
R^2_{dys}	0.022	0.112	-0.003	0.158	0.133	-0.026	-0.129	0.338	0.351	0.301	1.000					
R^2_{ep}	-0.115	-0.158	-0.128	-0.108	-0.109	-0.123	-0.001	0.092	0.083	-0.001	0.028	1.000				
R^2_{tbep}	-0.174	-0.136	-0.095	-0.068	-0.036	0.012	0.105	0.802	0.121	0.223	0.250	0.592	1.000			
R^2_{gbep}	-0.053	-0.165	-0.173	-0.119	-0.155	-0.040	-0.026	0.139	0.766	0.526	0.261	0.602	0.434	1.000		
R^2_{tsep}	-0.102	-0.117	-0.172	-0.081	-0.122	-0.029	0.043	0.275	0.642	0.724	0.279	0.600	0.548	0.879	1.000	
R^2_{dysep}	-0.099	-0.022	-0.144	0.080	0.006	-0.097	-0.106	0.223	0.280	0.190	0.714	0.654	0.535	0.617	0.624	1.000

Table H. Correlation matrix, quarterly

	CC	E	HS	CASE	DEATH	PPI	MKT	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	1.000															
E	0.547	1.000														
HS	0.566	0.306	1.000													
CASE	-0.080	-0.121	-0.353	1.000												
DEATH	0.000	-0.229	-0.332	0.734	1.000											
PPI	0.095	-0.163	0.501	-0.218	-0.221	1.000										
MKT	-0.152	-0.226	0.058	0.223	0.136	-0.108	1.000									
R^2_{tb}	0.137	0.287	0.023	-0.123	-0.075	-0.045	-0.063	1.000								
R^2_{gb}	-0.397	-0.484	-0.411	0.105	0.193	-0.364	-0.027	0.002	1.000							
R^2_{ts}	-0.056	-0.139	-0.224	0.055	0.150	-0.429	-0.228	0.229	0.715	1.000						
R^2_{dys}	0.092	-0.231	0.031	0.117	0.082	0.093	-0.070	-0.144	0.211	0.452	1.000					
R^2_{ep}	-0.384	-0.227	-0.370	0.024	0.068	-0.111	0.088	-0.220	0.024	-0.088	0.123	1.000				
R^2_{tbep}	-0.340	-0.116	-0.387	-0.006	0.045	-0.138	0.056	0.153	0.022	-0.013	0.056	0.928	1.000			
R^2_{gbep}	-0.572	-0.454	-0.603	0.093	0.171	-0.358	0.048	-0.190	0.584	0.341	0.129	0.804	0.744	1.000		
R^2_{tsep}	-0.453	-0.308	-0.518	0.062	0.136	-0.342	-0.012	-0.120	0.372	0.364	0.221	0.878	0.843	0.937	1.000	
R^2_{dysep}	-0.345	-0.279	-0.368	0.081	0.105	-0.076	0.058	-0.234	0.063	0.036	0.405	0.950	0.870	0.764	0.865	1.000

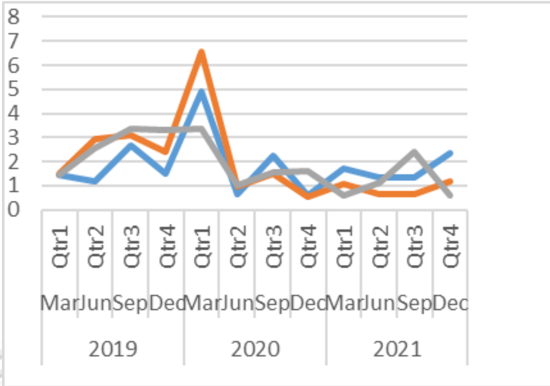
Quarterly average R squared line charts

Treasury bill



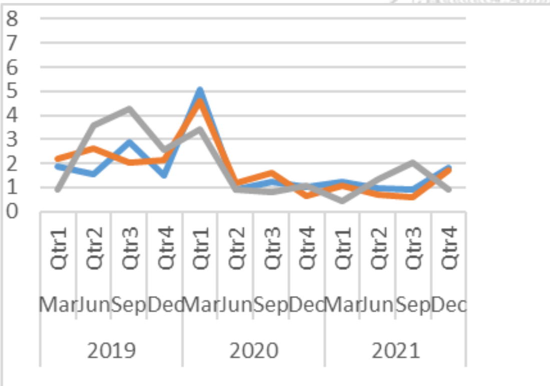
	Developed	Advance E.	Secondary E.
Max	0.0383	0.0247	0.0404
Min	0.0052	0.0079	0.0044
Average	0.0158	0.0146	0.0155
S.D.	0.0088	0.0047	0.0096

Government bond



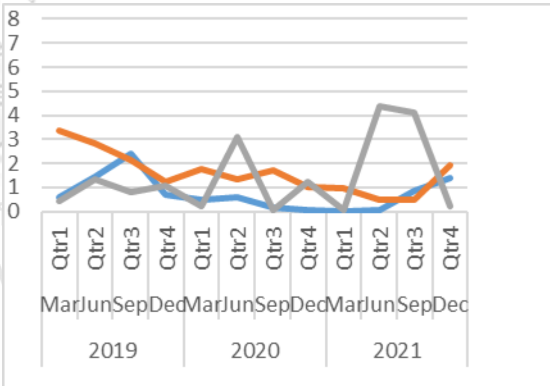
	Developed	Advance E.	Secondary E.
Max	0.0656	0.0493	0.0336
Min	0.0055	0.0062	0.0058
Average	0.0192	0.0182	0.0190
S.D.	0.0159	0.0109	0.0099

Term spread



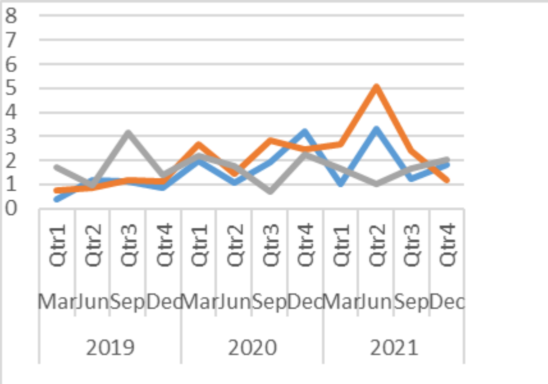
	Developed	Advance E.	Secondary E.
Max	0.0461	0.0504	0.0428
Min	0.0056	0.0089	0.0045
Average	0.0175	0.0174	0.0186
S.D.	0.0106	0.0111	0.0121

Default yield spread



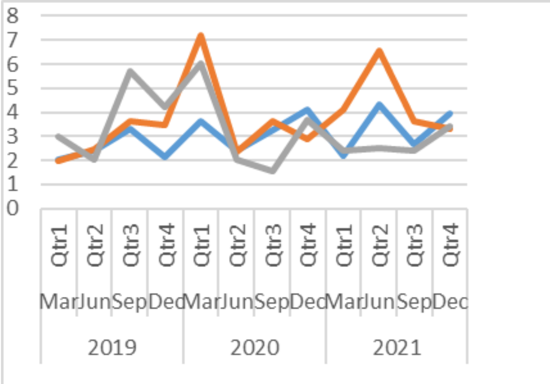
	Developed	Advance E.	Secondary E.
Max	0.0336	0.0238	0.0435
Min	0.0049	0.0001	0.0007
Average	0.0161	0.0073	0.0142
S.D.	0.0082	0.0067	0.0146

Equity premium



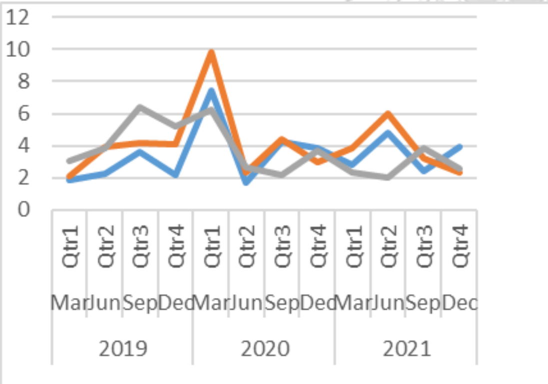
	Developed	Advance E.	Secondary E.
Max	0.0506	0.0332	0.0315
Min	0.0076	0.0040	0.0071
Average	0.0204	0.0159	0.0171
S.D.	0.0116	0.0085	0.0062

Treasury bill with equity premium



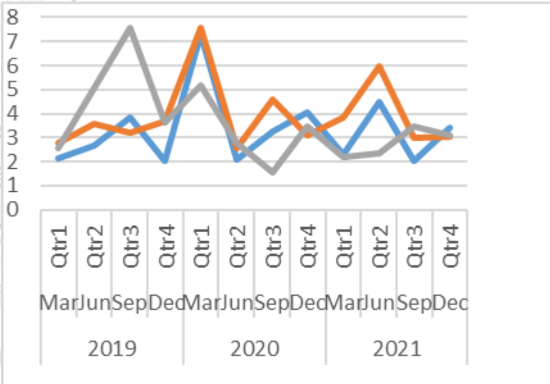
	Developed	Advance E.	Secondary E.
Max	0.0718	0.0432	0.0602
Min	0.0197	0.0203	0.0155
Average	0.0376	0.0303	0.0325
S.D.	0.0149	0.0078	0.0135

Gov bond with equity premium



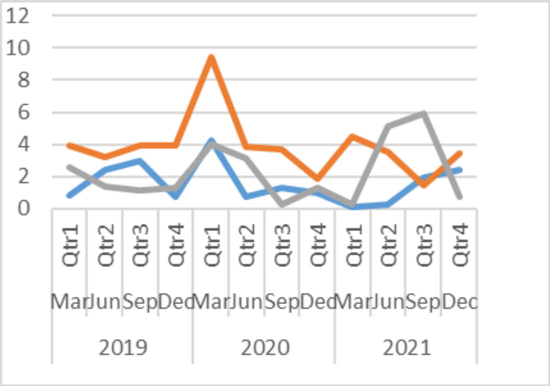
	Developed	Advance E.	Secondary E.
Max	0.0982	0.0744	0.0640
Min	0.0211	0.0169	0.0204
Average	0.0409	0.0342	0.0366
S.D.	0.0198	0.0153	0.0144

Term spread with equity premium



	Developed	Advance E.	Secondary E.
Max	0.0759	0.0729	0.0758
Min	0.0255	0.0203	0.0152
Average	0.0391	0.0330	0.0357
S.D.	0.0139	0.0143	0.0156

Default yield spread with equity premium



	Developed	Advance E.	Secondary E.
Max	0.0943	0.0421	0.0591
Min	0.0142	0.0006	0.0024
Average	0.0389	0.0156	0.0224
S.D.	0.0183	0.0116	0.0179

Table I. upper bound and lower bound of R squared, quarterly.

	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
Quartile 1	0.0016	0.0023	0.0020	0.0023	0.0017	0.0101	0.0116	0.0112	0.0081
Quartile 3	0.0205	0.0267	0.0227	0.0181	0.0250	0.0480	0.0531	0.0511	0.0423
Interquartile Range	0.0190	0.0243	0.0207	0.0158	0.0233	0.0379	0.0416	0.0399	0.0342
Upper Bound	0.0490	0.0632	0.0537	0.0417	0.0600	0.1048	0.1155	0.1110	0.0936
Lower Bound	-0.0269	-0.0342	-0.0290	-0.0213	-0.0333	-0.0467	-0.0508	-0.0486	-0.0432

Table J. Summary statistics for return predictability before and after COVID-19, quarterly

Variables	Obs	Mean	Std. Dev.	Min	Max
R^2_{tb}	492	0.0154	0.0213	0.0000	0.1808
R^2_{gb}	492	0.0189	0.0259	0.0000	0.1851
R^2_{ts}	492	0.0177	0.0253	0.0000	0.1989
R^2_{dys}	60	0.0140	0.0180	0.0000	0.1008
R^2_{ep}	492	0.0188	0.0270	0.0000	0.2037
R^2_{tbep}	492	0.0349	0.0360	0.0000	0.3250
R^2_{gbep}	492	0.0386	0.0368	0.0001	0.2231
R^2_{tsep}	492	0.0370	0.0359	0.0000	0.2132
R^2_{dysep}	60	0.0310	0.0366	0.0006	0.2423
Dummy for COVID-19	492	0.6667	0.4719	0.0000	1.0000

Table K. Regression of Return predictability before and after COVID-19, quarterly

Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
COVID dummy	-0.0048	-0.0063	-0.0076	0.0118***	-0.0072	0.0085***	0.0057	0.0046	0.0028
	(0.0020)	(0.0025)	(0.0024)	(0.0025)	(0.0048)	(0.0034)	(0.0035)	(0.0034)	(0.0099)
Constant	0.0186***	0.0232***	0.0227***	0.0109***	0.0188***	0.0293***	0.0348***	0.0340***	0.0290***
	(0.0017)	(0.0020)	(0.0020)	(0.0020)	(0.0039)	(0.0028)	(0.0028)	(0.0028)	(0.0081)
Observation	492	492	492	492	60	492	492	492	60
R-squared	0.0120	0.0142	0.0212	0.0473	0.0396	0.0137	0.0059	0.0040	0.0015

Table L. Summary statistics for impact of government response on COVID-19, monthly with lagged government response indices

Variables	Obs	Mean	Std. Dev.	Min	Max
CC	943	49.2338	22.6778	0.0000	100.0000
E	943	55.1346	31.7213	0.0000	100.0000
HS	943	63.9434	21.0232	0.0000	100.0000
CASE	943	0.5779	0.4941	0.0000	1.0000
DEATH	943	0.4698	0.4994	0.0000	1.0000
PPI	1476	0.4940	1.5354	-7.7640	18.9284
MKT	1476	6.1550	7.6054	0.4613	64.1855
R^2_{tb}	1476	6.4479	8.2898	0.0000	64.9621
R^2_{gb}	1476	6.8235	8.6143	0.0000	57.2377
R^2_{ts}	1476	6.6903	8.6799	0.0001	66.7553
R^2_{dys}	180	5.9284	7.1217	0.0000	36.1185
R^2_{ep}	1476	4.6397	6.3550	0.0000	45.9452
R^2_{tbep}	1476	11.1991	10.1315	0.0167	66.7740
R^2_{gbep}	1476	11.7164	10.5295	0.0121	65.9443
R^2_{tsep}	1476	11.5387	10.5166	0.0045	66.9788
R^2_{dysep}	180	10.6702	10.0024	0.0649	57.7873

Table M. Regression for government responses impact on return predictability, monthly with lagged government response indices

Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	-0.0604***	-0.0211	-0.0103	0.0303	-0.0236**	-0.0805***	-0.0202	-0.0126	0.0747
	(0.0171)	(0.0173)	(0.0174)	(0.0614)	(0.0138)	(0.0212)	(0.0218)	(0.0217)	(0.0854)
E	0.0144	0.0182	0.0237	-0.0031	-0.0030	0.0110	0.0108	0.0199	-0.0874
	(0.0136)	(0.0138)	(0.0139)	(0.0414)	(0.0110)	(0.0169)	(0.0174)	(0.0173)	(0.0576)
HS	-0.1085***	-0.1407***	-0.1330***	-0.0342	-0.0613***	-0.1097***	-0.1586***	-0.1512***	-0.0822
	(0.0200)	(0.0202)	(0.0203)	(0.0583)	(0.0161)	(0.0248)	(0.0255)	(0.0253)	(0.0811)
CASE	-1.9789	0.6171	-0.1206	-0.1186	-1.0777	-2.1473	-0.1058	-0.6144	-3.0950
	(0.6431)	(0.6514)	(0.6538)	(1.8264)	(0.5175)	(0.7983)	(0.8211)	(0.8158)	(2.5395)
DEATH	0.1486	-0.8054	-1.4367	0.4512	-0.1093	0.1733	-1.0035	-1.6106*	-0.0666
	(0.6481)	(0.6565)	(0.6589)	(1.7214)	(0.5216)	(0.8046)	(0.8275)	(0.8223)	(2.3936)
PPI	0.1920	0.3849**	0.4861**	-0.0348	0.5897***	0.5897**	0.8750***	1.0394***	-0.3676
	(0.2057)	(0.2084)	(0.2091)	(1.0581)	(0.1655)	(0.2554)	(0.2627)	(0.2610)	(1.4713)
MKT	-0.0453	-0.1664**	-0.0993	0.0902	-0.0919	-0.0231	-0.1894	-0.1207	0.2744
	(0.0983)	(0.0996)	(0.0999)	(0.2699)	(0.0791)	(0.1220)	(0.1255)	(0.1247)	(0.3753)
Constant	17.0846***	16.8390***	15.5293***	6.2162	11.2081***	23.1607***	23.9909***	22.4106***	17.2478**
	(1.3727)	(1.3904)	(1.3955)	(4.8128)	(1.1046)	(1.7040)	(1.7526)	(1.7414)	(6.6921)
Observation	943	943	943	115	943	943	943	943	115
R-squared	0.1017	0.0906	0.0751	5	0.0512	0.0836	41	0.0669	0.0775

Table N. Summary statistics for impact of government response on COVID-19, quarterly

Variables	Obs	Mean	Std. Dev.	Min	Max
CC	328	48.7506	20.4404	3.8932	90.7168
E	328	54.9658	30.9112	0.0000	100.0000
HS	328	64.5909	19.9840	5.4186	100.0000
CASE	328	0.7378	0.4405	0.0000	1.0000
DEATH	328	0.6433	0.4798	0.0000	1.0000
PPI	492	1.4883	3.5771	-12.4893	32.0978
MKT	492	18.4148	22.3686	1.7360	180.6241
R^2_{tb}	492	1.5441	2.1333	0.0000	18.0805
R^2_{gb}	492	1.8947	2.5922	0.0000	18.5092
R^2_{ts}	492	1.7677	2.5276	0.0000	19.8947
R^2_{dys}	60	1.3953	1.8048	0.0000	10.0841
R^2_{ep}	492	1.8780	2.6973	0.0000	20.3683
R^2_{tbep}	492	3.4944	3.5976	0.0027	32.4973
R^2_{gbep}	492	3.8552	3.6771	0.0118	22.3126
R^2_{tsep}	492	3.7048	3.5936	0.0010	21.3198
R^2_{dysep}	60	3.0956	3.6563	0.0600	24.2254

Table O. Regression for government responses impact on return predictability, case dummy, quarterly

Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	-0.0125	-0.0225***	-0.0213***	0.0060	0.0028	-0.0124	-0.0212	-0.0213	-0.0755
	(0.0086)	(0.0095)	(0.0090)	(0.0197)	(0.0127)	(0.0162)	(0.0153)	(0.0152)	(0.0614)
E	-0.0109**	-0.0180***	-0.0145**	-0.0268**	0.0067	-0.0073	-0.0136	-0.0071	0.0035
	(0.0060)	(0.0067)	(0.0063)	(0.0115)	(0.0089)	(0.0114)	(0.0108)	(0.0107)	(0.0358)
HS	-0.0205**	-0.0358***	-0.0198**	0.0327	-0.0231	-0.0425**	-0.0665***	-0.0431***	-0.0260
	(0.0103)	(0.0115)	(0.0108)	(0.0200)	(0.0153)	(0.0195)	(0.0184)	(0.0183)	(0.0624)
CASE	0.1044	0.1911	0.1321	0.3546	-0.8893	-0.6807	-0.6890	-0.6827	-0.9972
	(0.2837)	(0.3160)	(0.2985)	(0.5320)	(0.4208)	(0.5362)	(0.5059)	(0.5045)	(1.6596)
PPI	0.0355	-0.0508	-0.0576	-0.1616	0.0740	0.1124	0.0349	0.0205	-0.3030
	(0.0436)	(0.0486)	(0.0459)	(0.1645)	(0.0647)	(0.0824)	(0.0778)	(0.0776)	(0.5132)
MKT	0.0169	0.0099	0.0241	0.0711**	-0.0170	-0.0017	-0.0096	0.0052	0.1517
	(0.0174)	(0.0194)	(0.0183)	(0.0342)	(0.0258)	(0.0329)	(0.0311)	(0.0310)	(0.1068)
Constant	3.4212***	5.8461***	4.1621***	-2.1213	4.1035***	7.8303***	10.7537***	8.4287***	4.8178
	(0.6724)	(0.7491)	(0.7076)	(1.5905)	(0.9976)	(1.2710)	(1.1992)	(1.1959)	(4.9618)
Observation	328	328	328	40	328	328	328	328	40
R-squared	0.1336	0.3087	0.2244	0.2693	0.0242	0.0636	0.1912	0.1051	0.2772

Table P. Regression for government responses impact on return predictability, death dummy, quarterly

Variables	R^2_{tb}	R^2_{gb}	R^2_{ts}	R^2_{dys}	R^2_{ep}	R^2_{tbep}	R^2_{gbep}	R^2_{tsep}	R^2_{dysep}
CC	-0.0118	-0.0247***	-0.0240***	0.009099	0.003816	-0.010329	-0.021483	-0.022600	-0.097942
	(0.0088)	(0.0098)	(0.0093)	(0.0219)	(0.0131)	(0.0167)	(0.0158)	(0.0157)	(0.0682)
E	-0.011027*	-0.0169***	-0.0133**	-0.0276**	0.0053	-0.0089	-0.0143	-0.0074	0.0118
	(0.0061)	(0.0068)	(0.0064)	(0.0124)	(0.0091)	(0.0116)	(0.0110)	(0.0109)	(0.0386)
HS	-0.0214**	-0.0341***	-0.0174	0.0286	-0.0222	-0.0431**	-0.0648***	-0.0404**	-0.0036
	(0.0104)	(0.0116)	(0.0109)	(0.0208)	(0.0154)	(0.0196)	(0.0185)	(0.0185)	(0.0648)
DEATH	0.0123	0.3214	0.3303	0.0199	-0.7065	-0.6501	-0.4505	-0.3554	0.5815
	(0.2709)	(0.3013)	(0.2845)	(0.5033)	(0.4028)	(0.5120)	(0.4839)	(0.4828)	(1.5642)
PPI	0.0370	-0.0531	-0.0609	-0.1569	0.0716	0.1124	0.0316	0.0156	-0.3211
	(0.0436)	(0.0485)	(0.0458)	(0.1656)	(0.0649)	(0.0824)	(0.0779)	(0.0777)	(0.5148)
MKT	0.0175	0.0090	0.0227	0.0728**	-0.0181	-0.0018	-0.0111	0.0031	0.1537
	(0.0174)	(0.0194)	(0.0183)	(0.0348)	(0.0259)	(0.0329)	(0.0311)	(0.0311)	(0.1083)
Constant	3.5083***	5.7360***	3.9884***	-1.7773	3.9044***	7.7765***	10.5123***	8.1073***	2.9060
	(0.6640)	(0.7385)	(0.6972)	(1.6751)	(0.9873)	(1.2548)	(1.1860)	(1.1833)	(5.2058)
Observation	328	328	328	40	328	328	328	328	40
R-squared	0.1332	0.3106	0.2276	0.2581	0.0195	0.0636	0.1884	0.1010	0.2716

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