The Impact of COVID-19, Containment Measures, and Central Bank Monetary Policy on the US Stock Market

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Abstract

Using daily data on COVID-19 growth rates, government stringency index, central bank monetary policy interventions and stock excess returns from January 1, 2020, to June 30, 2021, this study finds the COVID-19 epidemic had a negative impact on the S&P 500 and its stock constituents. The results show that both government containment measures and central bank monetary interventions fail to mitigate the adverse impact of COVID-19 on the US stock market. In the cross-industry analysis, financials, real estate, and technology sectors are the most disturbed by government containments, while consumer staples and utilities are the least sensitive to the variations of containments strictness. The empirical findings demonstrate that most of the central bank monetary policies do not alleviate the impact of the pandemic on equity markets. However, lending operations help mitigating such adverse impact. These results have crucial implications for investor decision-making, as well as providing valuable suggestions for central banks to further improve their policy instruments and design new policy packages to support the economy during unexpected crisis.

Utilizando dados diários sobre taxas de crescimento do COVID-19, índice de rigor da contenção, intervenções de política monetária do banco central e retornos em excesso de ações desde 1 de Janeiro de 2020, até 30 de Junho de 2021, este estudo conclui que a pandemia teve um impacto negativo sobre o S&P 500 e os seus constituintes. Os resultados mostram que tanto as medidas de contenção governamentais como as intervenções monetárias do banco central não conseguiram mitigar o impacto adverso do COVID-19 no mercado de ações dos Estados Unidos. Na análise intersectorial, os sectores financeiro, imobiliário e tecnológico são os mais perturbados pelas medidas de contenção governamentais, enquanto os bens de consumo básicos e os serviços públicos são os menos sensíveis às variações de rigor das medidas de contenção. As conclusões empíricas demonstram que a maioria das políticas monetárias do banco central não atenuam o impacto da pandemia nos mercados de ações. No entanto, as operações de crédito ajudam a atenuar esse impacto adverso. Estes resultados têm implicações importantes para a tomada de decisões dos investidores, bem como fornecem sugestões valiosas para os bancos centrais melhorarem ainda mais os seus instrumentos de política e conceberem novos pacotes de políticas para apoiar a economia durante crises inesperadas.

Keywords: COVID-19; containment measures; monetary policy; panel regression

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I. Introduction

Thousands of years of human civilization have seen countless epidemics and destructive disasters, but the year 2020 will undoubtedly be one of the most remarkable years in human history because of the worldwide outbreak of the Coronavirus (COVID-19) that has severely affected the lifestyles and attitudes of many people, as well as financial markets, economies, societies, and government decisions making. According to the newest real-time statistics from Our World in Data, the world confirmed cases has reached to 528 million, and 6.29 millions of people have died from COVID-19, as of 28 of May 2022. COVID-19 is extremely contagious – its infectiousness is at least 10 times that of SARS and its rate of mortality is estimated to be 30 times larger than seasonal influenza (Wilder-Smith et al., 2020). The pandemic not only exposed the global health care systems shortcomings, but the economy also suffered massive damage, as the implementation of quarantine policies world widely resulted into a sharply reduction of population mobility, therefore decreases production, purchasing power and stagnates the economy (Shen et al., 2020). COVID-19 is considered the most devastating shock to the global economy, more than any previous infectious disease (Baker et al., 2020). At the macro level, it causes a decline in production, consumption and investment, financial institutions risk management are harder than ever, which in turn, uncertainty in the social development, short-term capital, employment expectations and economic recovery arises (Long et al., 2021). According to the World Economic Outlook 2021[1] published by the International Monetary Fund (IMF) in April 2021, the world GDP fell by 3% throughout the year of 2020, while according to the UNCTAD[2] (United Nations Conference on Trade and Development) report published in December 2021, global trade in goods experienced a decline of 7.4% in 2020 during the pandemic. Global exports significantly lowered by approximately USD 1.4 trillion amounted compared with 2019, which was the major decline relating to that of 2009. This suggests that the pandemic caused economic crisis more than any extreme event in the past, as its impact on the economy is different to a cyclical fluctuation in the conventional economic development process but an exogenous shock. Hence, assessing and criticising the economic impact of COVID-19 is a foremost challenge to the researchers. One of the objectives of this dissertation is to comprehend how a single extreme event, such as a pandemic, translates into an economy level, and consequently affects firm valuation.

[1] https://www.imf.org/en/Publications/WEO/Issues/2021/03/23/world-economic-outlook-april-2021
[2] https://unctad.org/news/global-merchandise-trade-exceeds-pre-covid-19-level-services-recovery-falls-short

At the point of March 2020, as the pandemic worsened, the governments over the world acted quickly and started implementing a number of measures to alleviate the adverse impact of the COVID-19 pandemic (Georgieva et al., 2021). These measures include workplace and school closures, cancellation of public events, testing policies, restrictions on public gatherings, tracing of close contacts, restrictions on international travel, limitation of circulation, closures of public transport, masking, quarantines, restrictions on internal movements, public awareness campaigns, and vaccination policies, etc (Deb et al., 2021). Although the introduction of nationwide lockdowns and close-contact quarantines may, on the one hand, efficiently contain the spread of the virus and significantly reduce the number of daily infections, it may, on the other hand, further worsen the production and employment situation in certain sectors and increase the severity of the economic downturn (Eichenbaum et al., 2020). According to some studies, the pandemic and the government containment measures brought significant negative impact in the financial market. The social distancing policies implemented by governments from many countries have lowered returns of 45 stock market indices in general (Alexakis et al., 2021). Specific government measures, such as the cancelling public events, providing income support, and announcing fiscal measures, can boost stock market returns because investor confidence is strengthened and stock markets are less sensitive to government measures on the health care system (Chang et al., 2021). At a firm level, stock prices of traditional sectors, such as solar energy, mining, electricity, environment, transportation, and heating were severely affected by the COVID-19 pandemic. Conversely, it promoted the development of high-tech sectors like pharmaceuticals, computers, manufacturing, and education, as they responded positively to the pandemic (He et al, 2020; Wang et al., 2021). Indeed, different firms' stock price within different industries may respond distinctly when facing the pandemic and related government measures, leading to different outcomes on firm valuation. This is supported by the behavioral finance theory, where stock prices are usually influenced by investor sentiments, the market environment, and firm-specific determinants (Moskowitz & Grinblatt, 1999). For instance, when the pandemic occurs, companies in the same industry are strongly correlated with each other due to their similar business and regulatory environment. Thus, how the pandemic and government containment measures has impacted the excess returns across different industries is also analyzed in this dissertation.

Meanwhile, not only the government, but also the central banks are trying to alleviate the impacts of the COVID-19 pandemic through implementing monetary and fiscal policies according to the real-time economic situations. Monetary policy includes interest rate policy,

asset purchase policy, reserve policy, foreign exchange policy, lending operations policy, and other policies. At the same time, in response to the COVID-19 shock, supervisory authorities adopted macroprudential policy decisions on financial institutions, easing the countercyclical capital buffer (CCyB), liquidity coverage ratios (LCRs), loan-to-value ratios (LTV), etc. Empirical results appoint that the stricter the macroprudential policy stance during the pandemic, the more efficient is to alleviate bank systemic risk, as the risk reduction was mainly driven by limits on credit growth, the use of dynamic provisioning and reserve policies (Igan et al., 2022). While Mosser (2020) points out that the real economy and financial markets are positively affected by central bank actions, however, the main economic problems can only be tackled in an indirect way by the central bank policy. However, whether the central bank actions and its activeness can mitigate the impact of the pandemic, or at least to have a stabilising effect, remains to be seen, as it would provide useful insights for policymakers to examine the effectiveness of monetary policy during the pandemic.

There is a growing literature that tend to examine the impact of pandemics as a factor affecting the stock market. However, the unexpected impact of COVID-19 provides a good opportunity to examine whether central banks actions provided meaningful protection against extreme and exogenous adverse shocks. Has monetary policy been effective in stabilising the economy and mitigating the recessions caused by the pandemic? To which extent did the government containment measures influence the stock market and simultaneously alleviate the public health problem? How severe has the pandemic damaged the stock market? This paper evaluates these questions in the context of the COVID-19 shocks of 2020 and the first half of 2021. Moreover, it contributes to the existing literature in terms of stock market reactions in the following ways. First, the impact of the pandemic itself on equity returns are explored. Second, the effect of the containment measures on the excess returns of the S&P 500 index and its stocks constituents is examined. Third, panel regression models are employed to study the firm-level effects of the pandemic, containment measures and central bank monetary policy announcements. Also, the effects for 11 industries are examined. Therefore, this study contributes to the growing literature on COVID-19, government containments, central banks actions, and their impact on various aspects of the economy and financial system. A limitation of this dissertation, however, is the difficulty in distinguishing the impact of the pandemic from the impact of containment measures and other policy decisions. This is because most of these events occurred simultaneously, making it difficult to capture counterfactuals of such extreme and unique shocks.

The dissertation is structured as the following. Section II presents the literature review related to the research topic. Section III briefly defines the sample, variables, descriptive data, and data treatment. Section IV proposes the methodology. Section V presents the empirical results and subsample analysis. While Section VI draws the conclusion and discuss its implications.

II. Literature Review

There are many recent studies focusing on the impact of COVID-19 outbreak, government containment measures and central banks policies on the world economy. First of all, this dissertation relates to the papers on the stock market responses to the pandemic. Baker et al. (2020) finds that previous contagious disease outburst, including the Spanish flu, have never had as strong negative impact on the US stock market as the COVID-19. Ashraf (2020) confirmed that an increase of confirmed cases had a direct negative impact by lowering stock market returns on the 64 sample countries. Albulescu (2021) finds that the world and US confirmed cases and death rate are positively correlated with the VIX (Financial market volatility index). Kusumahadi and Permana (2021), using daily data and TGARCH estimates from the period of January 2019 to June 2020, study the relation between the evolvement of COVID-19 cases and stock market volatility. They find that in all the 15 countries considered, stock returns volatility was high during the appearance of COVID-19 and has reached to its highest point in March 2020. Nonetheless, there is a lack of robust research on factors other than COVID-19, such as government and central bank reactions and policy formulations to COVID-19, which may influence stock returns. This dissertation differs from the rest of the literature in that it does not assess the impact of COVID-19 on stock market volatility, but solely on excess returns.

Secondly, this dissertation contributes to a large literature that examines the effects of COVID-19 containment measures. In terms of health issue, Xiu et al. (2022) finds that stricter containments effectively lower COVID-19 transmission rate, and such an effect becomes stronger one week after its implementation. At a macroeconomic level, Deb et al. (2021) find that production and economic activities decrease by about 10% in the first 30 days after the implementation of lockdown measures. In stock markets, Ozili and Arun (2020) reveals that the economic cost of pandemic control measures is large, as an increase in lockdown days, travel bans and monetary policy announcements had a significant impact on the level of economic activities and the closing, opening, low and high prices of major stock indices. By using panel regression analysis of daily data, Zhao et al. (2021) find that 6-month volatility index decreases after an announcement of lockdown measures, however, it does not decline significantly after the measures are eased. This dissertation differs with these analysis inputting University of Oxford's COVID-19 Government Response Tracker (OxCGRT) constructed by Hale et al. (2021) as an independent variable to take account of the overall measures' intensity impact as a whole on the stock market return, instead of analysing disaggregated measures from different policy areas, thus its mixture effects could be analysed.

Furthermore, this study also focuses on central bank policies that attempted to mitigate the adverse shocks of the pandemic and its effects on the economy during COVID-19. Ozili and Arun (2020) make comparison between the central bank fiscal policy spending and monetary policy decisions and find that fiscal policy spending is more effective in extenuating the impact of the pandemic. They note that this appears to be the case, especially when inflationary pressures are exacerbated by the stimulative monetary policies pursued by many central banks, which in turn, could further deteriorate macroeconomic stability. Deb et al. (2021) argue that central bank policies could offset the economic cost of containment measures partially. Wei and Han (2021) show that the emergence of the epidemic has weakened the transmission of monetary policy to financial markets. Rubbaniy et al. (2022) conclude that most of the ECB (European Central Bank) temporary interventions in the euro area did not mitigate the negative impact of COVID-19 on the European equity markets. However, these studies did not compare data after pandemic stabilization and fail to test the effectiveness of central bank's measures that were eventually implemented.

The two most relevant empirical papers to the present work are by Alexakis et al. (2021) and Klose and Tillmann (2021). Using daily stock index return, relative variation of the government responses index and Durbin Model with fixed effects to account for the interdependency between stock markets, Alexakis et al. (2021) examines the effects of COVID-19 containment measures on global stock markets indices. They find that a 10-percentage increase in the relative variation of the stringency index would lead to a 0.2-0.5% decrease in the stock returns. Klose and Tillmann (2021) assess different central bank policy announcements and the financial markets responses following the pandemic outbreak using an event study panel model for EU (European Union) member state countries. They find that markets response to COVID-19 development is a decline in stock prices and an increase in government bond yields. Some measures were effective in calming financial markets, but not all the measures. Asset purchases lowered government bond yields, while the fiscal stimulus measures announced in Europe increased yields. Many European countries announced a tax moratorium and suspension of the European SGP (Stability and Growth Pact), which boosted stock prices.

This dissertation is distinct from these two papers above in several aspects. In terms of scope, it not only covers the impact of pandemic outbreak, but also contains an detailed assessment of containment measures and central bank monetary policies by looking at index level and individual stocks per different groups of industries. In terms of approaches, in addition to using daily data and panel regression with fixed effects at company level, a sub-sample panel study is performed to distinguish the impacts on different sectors.

III. Data

3.1. Variables' Definitions and Data Sources

To analyse the impact of the pandemic on US stock excess returns and whether the government containment measures, and the Federal Reserve monetary policy measures could mitigate the adverse effect of COVID-19 on stock market, we start by conducting regression models on the index level (S&P 500 Index) to provide a market overview, then proceeds to an in-depth study of its behaviours per individual firm and industry. The variables inputted will be presented as the following.

This dissertation uses the first difference of excess returns of individual stock constituents from S&P 500 Index as the dependent variable. For each company, the stock price is retrieved from Thomson Reuters - DataStream. The risk-free rates used to calculate the excess returns are obtained from the Kenneth R. French website[3].

The core explanatory variables are *COVID*, which represents the daily growth rate of total cases within the US. The source of *COVID* is extracted from the website of Centers for Disease Control and Prevention (CDC[4]) of the US. This website provides data of total cases, daily cases, and deaths of the COVID-19 in the US domestically.

Another main explanatory variable included in the empirical model is the variation in government responses to COVID-19, denoted as *Stringency*. The data of government response index constructed by Hale et al. (2021) is downloaded from Oxford COVID-19 Government Response Tracker (OxCGRT) database and the index scales between 0 and 100, with 100 representing the most stringent measures and 0 meaning no measures are taken. According to Hale et al. (2021), there are different measurements used to calculate the indices. For example, school closures, workplace closures and other seven metrics are used for stringency index.

For the variable central bank policy announcements, denoted as *CBA*, the database constructed by Cantú et al. (2021) is employed to extracted and compile all the monetary policy announcement dates within the sample period issued by the Federal Reserve. Since the details of these announcements vary widely, they are implemented as lagged 0/1 dummies. In line with Cantú et al., (2021), *CBA* are disaggregated into six different types of tools: interest rate measures, asset purchase programs, reserve policies, foreign exchange operations, lending operations, and others.

In addition, *Industry* variable is created to provide cleaner identification of policy impacts on different sectors, where the stocks are sub-categorised into 11 different sectors: Energy,

[3] https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html
[4] ttps://covid.cdc.gov/covid-data-tracker

Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Telecommunication Services, Utilities, Real Estate.

The sample period for the empirical analysis spans between January 1, 2020, to June 30, 2021, and the data frequency is daily for a five-day week (Monday to Friday).

Table 1 presents variable definitions, sources of the data, and the units of each variable.

Table 1. Variable definitions and data sources

Variable	Definition	Source	Unit
Excess Return	Excess Return of S&P 500 Index Constituents	Thomson Reuters - DataStream	%
COVID	COVID-19 Total Cases Growth Rate	CDC - COVID Data Tracker	%
Stringency	Daily Government Stringency Index	Oxford COVID-19 Government Response Tracker	Index
CBA	Central Bank's Monetary Policy Announcements	Cantú et al. (2021)	0/1

3.2. Descriptive Statistics

Table 2 reports the results of descriptive statistics for the main variables used in this study. The average excess return for stock constituents is 0. The minimum value of excess return is −0.524 and the maximum value is 0.731, indicating the huge fluctuation of excess return caused by the pandemic. The average COVID daily growth rate is 0.102 indicating that the US have experienced a positive growth of COVID cases during the pandemic within the predetermined time frame. At the same time, the minimum COVID growth rate is -0.692 and the maximum is 8, which fully demonstrates that the COVID-19 pandemic was most severe on the day 16 of March 2020, while on the day 29 of June 2021, nearly at the end of the observation period, the growth rate of total cases is significantly lower than ever before. The average value of the government policy stringency index (*Stringency*) is 0.578, with a standard deviation of 0.218. The minimum and maximum value is 0 and 0.755, suggesting that the government in the sample implemented the strictest containment policies from 16th of November 2020 until 1st of December 2020. The average of CBA is 0.121, with a standard deviation of 0.017. The statistic indicates that approximately 12% of the days are with announcements. The total number of announcement dates was 47.

Additionally, a descriptive statistic of stock excess returns on different sectors are shown in table 3. The number of firms per industry is not uniformly distributed - most of the firms on S&P 500 are from industrials and consumer discretionary sectors, meanwhile, sectors such as

telecommunications, energy and basic materials have the least number of companies. It is noticed that consumer discretionary and energy sector have a standard deviation of 5 and 6.6 percent, respectively, suggesting that these sectors suffered from a more drastic variations of excess returns during the sample period. While consumer staples, industrials and utilities and health care have a standard deviation of 3.3, 3.6, and 3.8 percent, respectively, indicating that the excess returns are clustered around the mean (zero) and the variations are relatively stable during the shock.

Table 2. Descriptive statistics for stock constituents

Variable	Observations	Mean	Std Dev	Min	Max
Excess Return	195504	0	0.044	-0.524	0.731
COVID	526	0.102	0.570	-0.692	8.000
Stringency	546	0.578	0.218	0	0.755
CBA	505	0.121	0.017	0	1

Table 3. Descriptive Statistic of Excess Return per Industry

Industry	Nº of Firms	Mean	Std. Dev.	Min	Max
Basic Materials	18	0	.045	-.331	.45
Consumer Discretionary	84	0	.05	-.524	.731
Consumer Staples	33	0	.033	-.28	.347
Energy	23	0	.066	-.398	.681
Financials	64	0	.047	-.484	.502
Health Care	59	0	.038	-.515	.448
Industrials	88	0	.04	-.383	.464
Real Estate	30	0	.044	-.504	.497
Technology	60	0	.045	-.416	.454
Telecommunications	11	0	.037	-.277	.27
Utilities	30	0	.036	-.323	.371

Like many countries around the world, the US government had taken a variety of different measures to limit the spread of disease by restricting circulation of people and their social gatherings. The stringency index is calculated using all existing indicators of containment policies and public awareness campaigns to captures the severity of lockdown policies (Hale et al., 2021). Figure 1 shows the US COVID-19 total cases growth rate and the stringency index. As displayed, the government tightened its measures significantly in March 2020. Initial measures included restricting international travel, school closures, and cancelling public events. As the outbreak evolved, internal movement and gatherings were restricted, and workplaces were closed. The government plans to introduce the measures as soon as the first confirmed cases emerged in the country and the stock market entered into panic at the beginning of February 2020. After that, it continues to maintain and slightly adjust the measures according to the pandemic severity.

Figure 1. COVID Growth Rate and Stringency Index

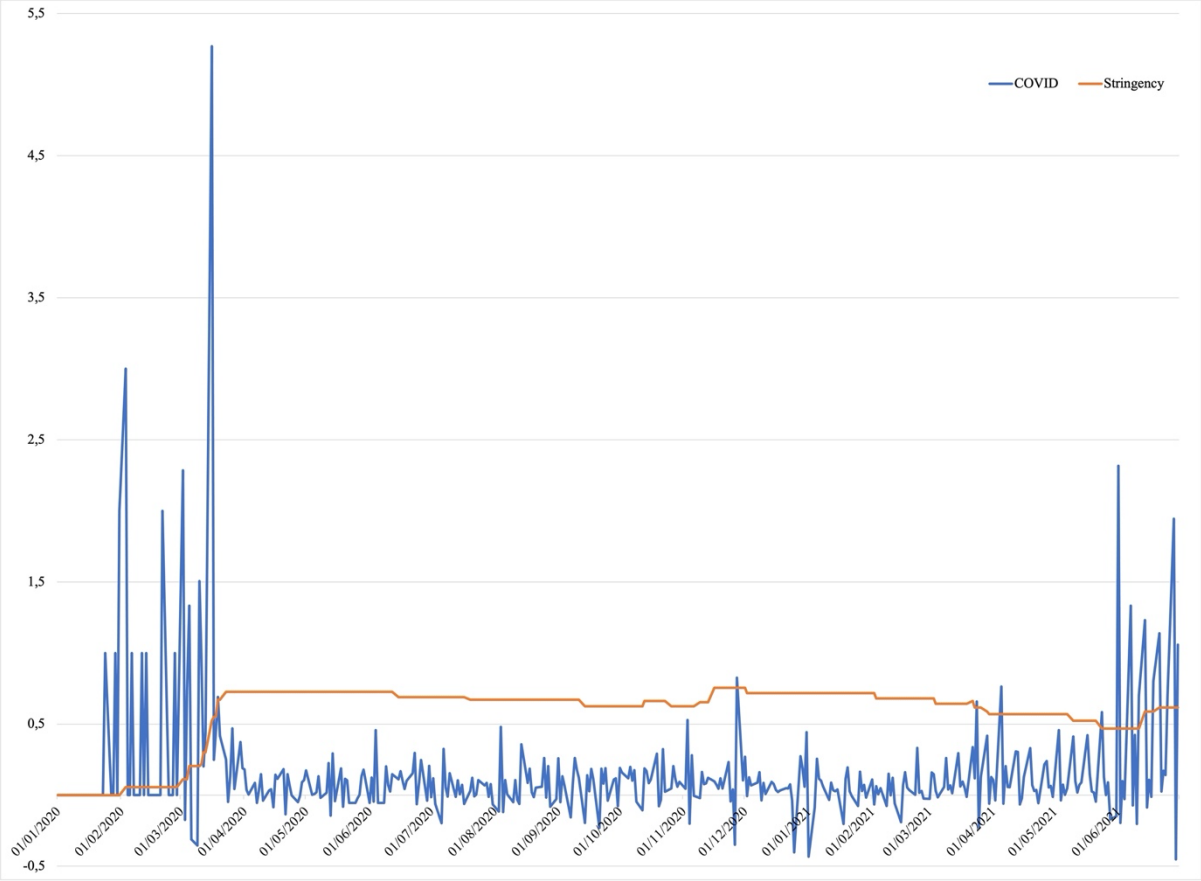


Table 4 depicts descriptive statistics of aggregated monetary policy announcement dates and different types of announcements. The final sample includes 47 announcement dates in total

during the observation period and consists of 6 policy categories, namely interest rate, asset purchase, foreign exchange, lending operations, reserve policy, and others. At each date there could be more than one announcement of different categories. In total, there were 13 announcements of interest rate policy, 25 announcements about asset purchase, 9 about foreign exchange, 38 lending operations announcements, and one reserve policy announcement. Almost half of the policy action announced was lending operations (43%), and the second place was asset purchase (approximately 28%).

From figure 2, one can clearly compare the weight of policy announcements during 2020. Lending operations and asset purchase were present all the months, while foreign exchange policies were only publicised quarterly. The Fed reacted quickly, and it was most active in March as the number of announcements peaked during the initial outburst of the pandemic. This partially reflects the quick adjustment of the policy responses, as policymakers learnt from each other and from the markets' reactions to their policies.

Figure 3 shows the S&P 500 Index and the announcement dates during the first outburst of the pandemic only during February 20 to 20 of June 2020 to allow clearer visualisation. During March 2020, the central bank was more proactive and consecutively launched 25 different types of monetary policies to soothe the market, as the index price have continued to decline in consecutive periods. Perhaps, this could be explained by the sudden exogenous shock from the first confirmed cases that devastated investors' confidence has a greater effect than emergency policy announcements. After the chaotic March, the market started to recover and excess returns tend to increase after some announcements, but not all the announcements, suggesting that not every type of announcements have a positive effect on the index, but only some of them.

Table 4. Descriptive statistics of different types of CBA for S&P 500

Variable	Nº Announcements	Observations	Mean	Std Dev	Min	Max
Interest Rate	13	505	0.061	0.24	0	1
Asset Purchase	25	505	0.079	0.27	0	1
Foreign Exchange	9	505	0.033	0.179	0	1
Lending Operations	38	505	0.118	0.322	0	1
Reserve Policy	1	505	0.005	0.071	0	1
Other	2	505	0.010	0.101	0	1
Total	47	505	0.12	0.325	0	1

Figure 2. Monthly Monetary Policy Announcements Outlook in 2020

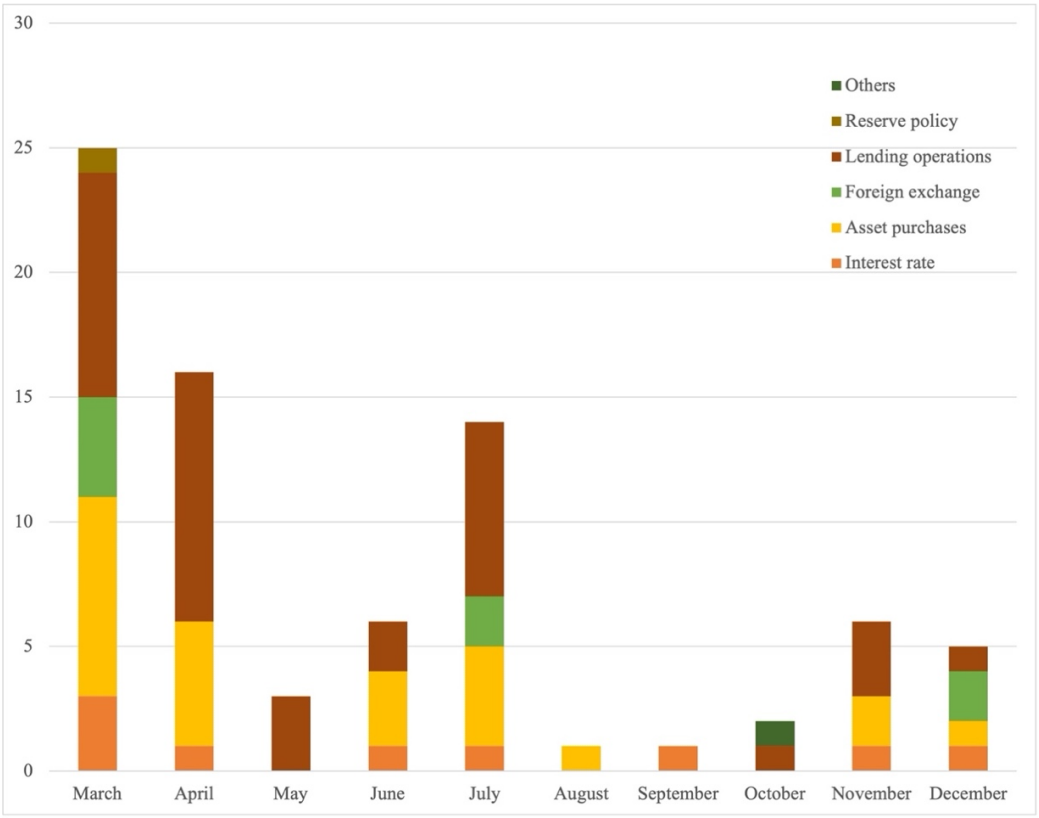
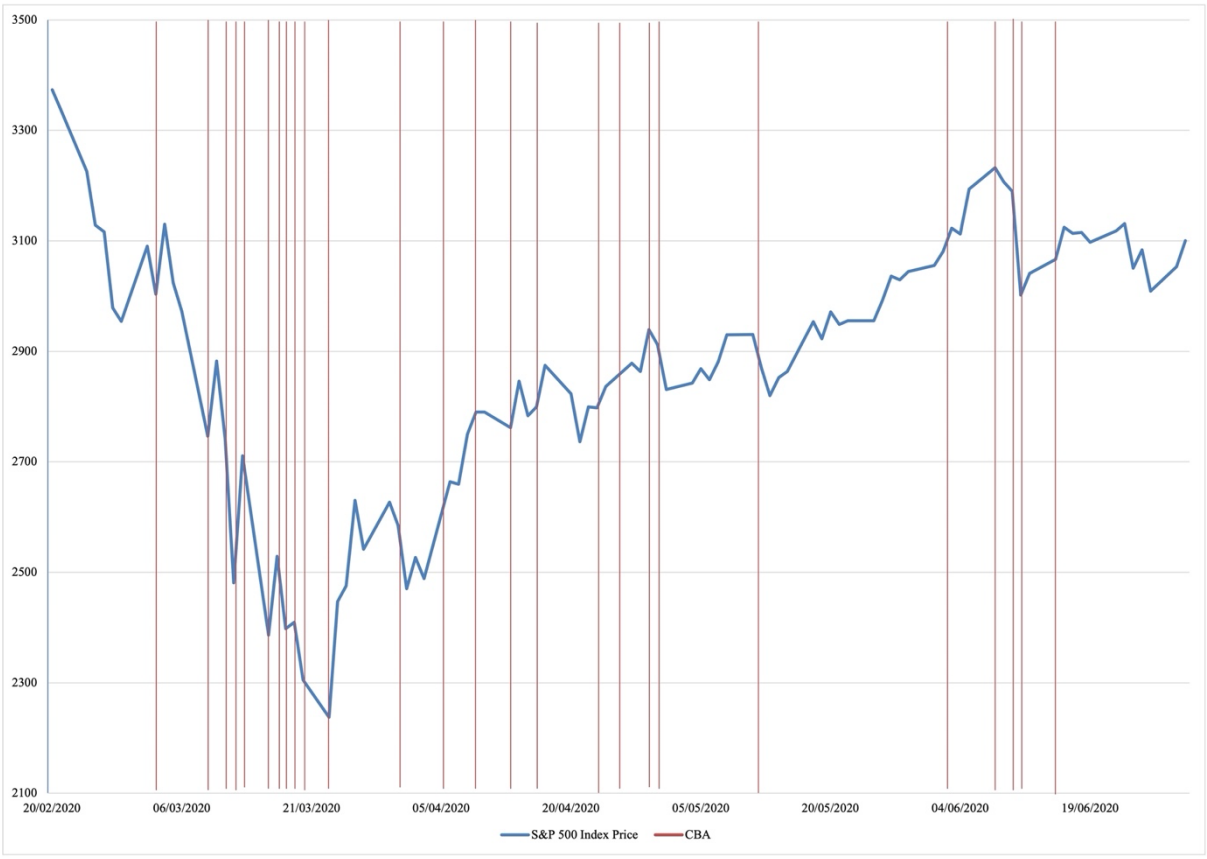


Figure 3. S&P 500 Index Price and Central Bank Announcement Dates



3.3. Data Treatment

The excess returns of the S&P 500 Index and of its stock constituents from are used as the dependent variables. The reason for that is to proxy the financial market conditions.

The explanatory variable *COVID* is calculated by the difference between the number of total cases at day *t* and that of day *t-1* divided by the number of total cases at day *t-1* within the US to measure the severity of the COVID-19 pandemic outbreak. *Stringency*[5] represents the strictness of government containments to COVID-19 to analyse whether the government's containment measures will negatively impact the financial markets. The dummy variable *CBA* is included to analyse the impact of the central bank's actions in the market. It takes the value of 1 on the announcement date (day *x*) and the day after (day *x+1*), and 0 otherwise, to capture the full effects of the announcements on the market. The 0/1 assignment follows the same fashion for disaggregated monetary policies, which is 1 on the announcement date (*day x*) and the day after (*day x+1*), and 0 otherwise. However, reserve policies and others were dropped for reasons of relatively narrow sample size. Also, there is correction for the time of the announcement - when an announcement was made after markets closed, then the event dummy is assigned to the next trading day and the day after.

IV. Methodology

Firstly, to explore the impact of the COVID-19 pandemic on the financial market and to test whether government lockdown measures and central bank monetary policy announcements have helped to mitigate the negative shock of the COVID-19 outbreak, a regression on the S&P 500 Index level is performed. Since it is a capitalization-weighted index, it is an appropriate indicator to provide a clearer outlook of the overall market situation in the US. The dependent variable, in this case, is the daily excess returns of the S&P 500 Index and all other variables remain the same as mentioned previously. Secondly, a time series panel regression controlling for company level and daily panel fixed effects is conducted, whereas the standard errors were clustered at a company level when it comes to stock constituents' analysis. This permits us to analyse the response of stocks per different industries and firms. And the model is set as the following:

[5] The unit of measurement of the variable Stringency was changed, i.e., we divide it by 100 to minimize the unit differences between *Stringency* and other variables in the empirical model.

At Index level:

$$ER_t = c + \beta_1 L.ER_t + \beta_2 COVID_t + \beta_3 Stringency_t + \beta_4 CBA_t \quad (1)$$

At Firm level:

$$\Delta ER_{it} = c + \beta_2 COVID_t + \beta_3 Stringency_t + \beta_4 CBA_t + \quad Company_i \quad (2)$$

$$\Delta ER_{it} = c + \beta_2 COVID_t + \beta_3 Stringency_t + \beta_4 Interest\ Rate_t + \beta_5 Asset\ Purchase_t + \beta_6 Foreign\ Exchange_t + \beta_7 Lending\ Operations_t + \quad Company_i \quad (3)$$

Where ΔER_t represents the first difference[6] of excess returns of individual stocks of S&P 500 Index at time *t*; or, it could be the excess returns of the index S&P 500 when analysing the index; $COVID_t$ represents the growth rate of COVID-19 total cases at time *t*; $Stringency_{it}$ includes the extent of government containment action at time *t*; CBA_t denotes the central bank policy announcements as a lagged dummy variable that takes the value of 1 on the announcement date (day *x*) and the day after (day *x+1*), and 0 otherwise.; $Interest\ Rate_t$, $Asset\ Purchase_t$, $Foreign\ Exchange_t$ and $Lending\ Operations_t$ in equation (2) represent the disaggregated policy announcements, which are lagged dummy variables that take 1 on the announcement date (*day x*) and the day after (*day x+1*), and 0 otherwise. $Company_i$ represents the panel fixed effects that may affect the excess return.

The coefficients of *COVID* and *Stringency* are expected to have negative signs meaning that the increase of total confirmed cases and the stricter containments would negatively affect the equities. The expected sign of coefficient of *CBA* is not obvious because the impact of four types of announcements can be different between each other. Investors can perceive any kind of information from the central bank as an exhibition the true state of the economy and thus tend to derive investment decisions accordingly. For instance, the announcements could have the potential to depress stock prices, provided that extraordinary policy announcements are interpreted as private information by investors and expecting the conditions may be worse than estimated. As regards the disaggregated policy instruments, the introduction of lending operations and asset purchase are expected to be positive correlated with the excess earnings, as companies will have more access to funds to recover production, boost confidence in

[6] The first difference of excess returns is used to mitigate the problem of autocorrelation.

economic development, increase the supply, and thus lowers inflation rate and boosts economy recovery. Interest rate and foreign exchange, on the other hand, are likely to have negative coefficients, as they may not be directly addressing the problems in stock market immediately and their real effects on the economy usually take time to realize.

V. Empirical Results

5.1. COVID-19 Pandemic, Containment Measures, CBA, and S&P 500 Index

In this section, the impact of the COVID-19 pandemic, containment measures and CBA on the financial market, on excess returns of S&P 500 Index is analysed. Table 4 to 6 show the estimated coefficients of the OLS regression model in line with equation (1).

In table 4, it is found that the variable *COVID* is negative and statistically significant, indicating that the escalating COVID-19 pandemic has decreased excess returns of the index, concluding that one percentage increase on the COVID-19 growth rate would decrease the index excess return by 0.04. This finding is consistent with the findings of Bambra et al. (2020).

From table 5, with the variables *Stringency* solely in the model, it has a slightly opposite effects on the excess returns, but not statistically significant, which means that containment measures by governments do not impact equity returns directly.

From table 6, when including *COVID* and *Stringency* simultaneously into the model, the results remain consistent. Containment measures seem to reduce excess earnings but continue to be statistically insignificant, while the coefficient of *COVID* is negative and statistically significant. This could be explained as containment, represented by measures such as limitation of movements and gatherings, cancellations of public events and activities, and closure of workplaces, therefore the implementation of such may result into a significant loss in production and other economic activities and consequently negatively impact the economy. The evolution of COVID would have more influence on the excess return because the market is highly driven by investors' expectations, as investors infer the severity of the pandemic situation. Containment measures, instead, are adjusted by the government based on the evolution of COVID-19 and may not have an impact on markets for that reason. Overall, the pandemic significantly reduced excess returns. This would suggest that the pandemic has a negative impact on business valuations and restrictive measures, despite limiting economic activity and possibly underpinning corporate returns, do not add to that negative effect. Thus, it could be advisable for governments to implement containment measures to help to contain the spread of the virus only, because what really hurts firms is the pandemic itself.

Table 4. The Response of S&P 500 Index to COVID-19 Pandemic Outbreak

Index ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lagged Index ER	-.699	.115	-6.06	0	-.926	-.472	***
COVID	-.04	.011	-3.70	0	-.061	-.019	***
Constant	.002	.004	0.47	.639	-.005	.009	
Observations	312						
R^2	0.141						

*** p<.01, ** p<.05, * p<.1*

Table 5. The Response of S&P 500 Index to Government Containment Measures

Index ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lagged Index ER	-.7	.118	-5.94	0	-.932	-.468	***
Stringency	.089	1.574	0.06	.955	-3.007	3.186	
Constant	-.004	.01	-0.42	.676	-.023	.015	
Observations	312						
R^2	0.103						

*** p<.01, ** p<.05, * p<.1*

Table 6. The Response of S&P 500 Index to Government Containment Measures

Index ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lagged Index ER	-.701	.115	-6.08	0	-.928	-.474	***
COVID	-.042	.011	-3.82	0	-.064	-.021	***
Stringency	-.015	.161	-0.95	.342	-.047	.016	
Constant	.011	.01	1.06	.29	-.009	.031	
Observations	312						
R^2	0.143						

*** p<.01, ** p<.05, * p<.1

Since the beginning of the COVID-19 pandemic, in March of 2020, the US Federal Reserve, has implemented a number of monetary policy decisions (Mosser, 2020), including interest rate cuts, asset purchase programs, reserve policies, foreign exchange operations and lending operations, etc. These policies are undoubtedly aimed at coping with the adverse effects of COVID-19 on the macroeconomy. Therefore, the dummy variable of central bank monetary policy announcements is introduced to study the role of central bank actions in equity markets during the pandemic.

Table 7 shows the results of the equation (1) OLS regression analysis on the response of the S&P 500 to the announcements. The coefficient on the *CBA* variable is 0 and not statistically significant, implying that the central bank measures did not have a significant impact on the equity market. One possible explanatory reason for this is due to the nature of monetary policy, because usually they are designed to have a broad impact and thus does not target the equity markets.

Policy announcements are further subdivided into four categories to take account of different initiatives, as illustrated by table 8. By adding the disaggregated monetary policies announcements into the regression model, one could find that asset purchase, lending operations and foreign exchange have the positive sign. An announcement of a policy initiative in these categories is expected to raise the excess return between 0.001 and 0.008. The interest rate changes have a negative sign, and the coefficient of foreign exchange is nearly zero. However, none of these impacts is statistically significant, suggesting that the central bank is unable to immediately alleviate the financial market crisis as the pandemic created idiosyncrasies and macroeconomic instabilities. Moreover, it may be difficult to assess the impact of individual policy announcements in isolation, since, other than monetary policies, a number of fiscal and macroprudential policies were also introduced during the pandemic.

Table 7. The Response of S&P 500 Index to CBA

Index ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lagged Index ER	-.701	.116	-6.06	0	-.929	-.473	***
COVID	-.042	.011	-3.80	0	-.064	-.02	***

Stringency	-.015	.161	-0.95	.342	-.047	.016
CBA	0	.01	0.02	.984	-.02	.021
Constant	.011	.01	1.06	.291	-.009	.031
Observations	312					
R^2	.143					

*** p<.01, ** p<.05, * p<.1

Table 8. The Response of S&P 500 Index to Different Categories of CBA

Index ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Lagged Index ER	-.729	.124	-5.88	0	-.973	-.485	***
COVID	-.043	.011	-3.82	0	-.066	-.021	***
Stringency	-.167	.163	-0.83	.305	-.034	.015	
Interest Rate	-.006	.014	-0.42	.673	-.025	.027	
Asset Purchase	.001	.013	0.08	.933	-.025	.027	
Foreign Exchange	.005	.02	0.26	.792	-.034	.045	
Lending Operations	.008	.012	0.67	.504	-.015	.031	
Constant	.012	.01	1.11	.27	-.009	.032	
Observations	312						
R^2	.145						

*** p<.01, ** p<.05, * p<.1

5.2. COVID-19 Pandemic, Government Stringency Index, and the Index Constituents

In this section, the impact of the COVID-19 pandemic, containment measures and CBA on the excess returns of single stock constituents of the S&P 500 Index is examined. The regression models in this section are panel and with the standard errors clustered at a company level. The dependent variable used here is the first difference of excess returns to mitigate for possible autocorrelation problem[7]. Table 9 and 10 shows the estimated coefficients of the panel regression model in line with equation (2).

In table 9 and 10, a panel regression with firm fixed effects and clustered standard errors is conducted to obtain the following results. Similar to the section 5.1. for the overall S&P500 index, the coefficient of *COVID* is negative and statistically significant, which indicates every percentage increase of COVID-19 growth rate is associated with a 0.01 decline in the variation of stock excess returns. This result remains consistent with the results from previous section.

Although the government containment does not have a relevant impact at the aggregate level, as shown from previous section on the index, an increase in *Stringency* indeed decreases firms' excess earnings. However, when including the variable *Stringency* into the firm-level panel regression, the coefficient of government stringency index becomes negative and statistically significant. This could be linked to the composition of firms on the S&P 500, where larger capitalization companies have more weights in it and therefore *Stringency* do not have a significant impact at the index level, while at the firm level, there is a larger number of companies that are impacted significantly by containment measures. The stricter the set of measures imposed, the lower the excess returns – suggesting that firms that either require human-intensive productions or international mobility could not sustain their business development during country wide lockdowns. The results in table 10 suggest that one point higher on stringency index would therefore result into a decrease in the variation of excess returns by 0.005, holding all else constant.

In addition, for the variable *COVID* and *Stringency*, interaction terms are added with the industry to verify whether the impact of pandemic and stringency index varies with the extent to which the industry the companies are from. Adding the interaction terms into the model would allow us to see the differential impact and the overall impact from *COVID* and *Stringency* at the same time. Table 11 presents the results with interaction terms.

Overall, both the pandemic and containment have a negative impact on the entire market. At an industry level, *COVID* affects even more negatively some sectors and significantly different.

[7] The result from Stata shows serial correlation:
H0: no first-order autocorrelation; F(1, 499) = 52.751; Prob > F = 0.0000

Consumer discretionary, financials, real estate and technology have the largest negative impact on excess returns relative to the overall market in a statistically significant way. The impact from COVID is slightly mitigated for utilities and consumer staples.

The stringency index also led to decline of excess returns in all the industries, with Financials, Technology and Real estate being significantly more affected industries than the overall market, whereas consumer staples and utilities sectors being the least sensitive to the variation of containment measures (although the impact is not statistically significant from the overall market impact). This could be explained by the substantially increase of consumption of utilities and essential groceries by households during lockdowns and quarantines. By contrast, financials, technology, and real estate sectors are generally human-intensive and normally relies on international mobility and public events, therefore they suffered from larger shocks during workplace closure, quarantines, and business interruption. In particular, financial sector is probably more related to its potential contagion effects with other industries and their borrowers – if an industry or firms are in financial distress and in case it enters into default, its consequences can quickly spread through the financial sector.

Table 9. The Response of Stock Constituents to Pandemic Outbreak

ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
COVID	-.01	0	-46.41	0	-.011	-.01	***
Constant	.002	0	15.69	0	.001	.002	***
Observations	195496						
R^2	.011						

*** p<.01, ** p<.05, * p<.1*

Table 10. The Response of Stock Constituents to Containment Measures

ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
COVID	-.011	0	-47.42	0	-.011	-.01	***
Stringency	-.005	0	-9.70	0	-.005	-.004	***
Constant	.004	0	14.64	0	.004	.005	***
Observations	195496						

R^2	.011

*** p<.01, ** p<.05, * p<.1

Table 11. The Response of Stock Constituents with Interaction Terms

ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
COVID	-.009	.002	-6.08	0	-.012	-.006	***
Stringency	-.005	.001	-5.58	0	-.006	-.003	***
COVID # Industry							
Consumer Discretionary	-.004	.002	-2.19	.029	-.007	0	**
Consumer Staples	.002	.002	1.33	.185	-.001	.006	
Energy	-.001	.002	-0.65	.516	-.005	.003	
Financials	-.004	.002	-2.62	.009	-.008	-.001	***
Health Care	0	.002	0.26	.793	-.003	.004	
Industrials	-.001	.002	-0.87	.383	-.005	.002	
Real Estate	-.005	.002	-2.82	.005	-.009	-.002	***
Technology	-.004	.002	-2.47	.014	-.007	-.001	**
Telecommunications	-.001	.002	-0.54	.59	-.004	.003	
Utilities	.001	.002	0.63	.527	-.002	.004	
Stringency # Industry							
Consumer Discretionary	-.001	.001	-1.60	.111	-.003	0	
Consumer Staples	.001	.001	0.82	.411	-.001	.003	
Energy	-.001	.001	-0.49	.623	-.003	.002	
Financials	-.002	.001	-2.44	.015	-.004	0	**
Health Care	0	.001	0.08	.933	-.002	.002	
Industrials	-.001	.001	-0.65	.517	-.002	.001	
Real State	-.002	.001	-2.18	.03	-.004	0	**

Technology	-.002	.001	-2.54	.011	-.004	-.001	**
Telecommunications	-.001	.001	-1.03	.305	-.003	.001	
Utilities	.001	.001	0.73	.463	-.001	.002	
Interest Rate	0	0	0.08	.94	-.001	.001	
Asset Purchase	.002	0	6.32	0	.001	.003	***
Foreign Exchange	.001	.001	2.08	.038	0	.002	**
Lending Operations	.012	0	45.64	0	.011	.012	***
Constant	.005	0	46.69	0	.005	.005	***
Observations	195496						
R^2	.02						

**** p<.01, ** p<.05, * p<.1*

5.3. Central Bank Policy Announcements and Index Constituents

Again, the regression in table 12 uses the first difference of excess returns as dependent variable and provides a measure of the difference between the dates with announcements identified by the dummy variable and the dates without announcements that serves as a reference. In general, central bank monetary policy announcements have a negative effect on stocks. The coefficient of CBA is -0.006 and statistically significant, which indicates that on the announcement days, excess returns will be 0.6 percent lower than on the days without any announcements.

In table 13, monetary policies are split into subcategories as previously. All the announcements enter significantly. Announcements of lending operations have the expected positive coefficient and are statistically significant. An announcement of lending operations tends to raise excess returns by 0.8 percent. Interest rate, asset purchase and foreign exchange announcements have negative but statistically significant coefficients, ranging from -0.6 to -0.1 percent. This is consistent with previous results.

Table 12. The Response of Stock Constituents to CBA

ER	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
COVID	-.01	0	-44.97	0	-.011	-.01	***
Stringency	0	0	-7.56	0	0	0	***
CBA	-.006	0	-20.59	0	-.007	-.006	***
Constant	.004	0	15.03	0	.004	.005	***
Observations	195496						
R^2	0.014						

*** *p<.01,* ** *p<.05,* * *p<.1*

Table 13. The Response of Stock Constituents to Disaggregated CBA

Excess Return	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
COVID	-.011	.001	-14.12	0	-.013	-.01	***
Stringency	-.006	0	-12.87	0	-.007	-.005	***

Interest Rate	-.004	.001	-3.33	.008	-.007	-.001	***
Asset Purchase	-.002	.001	-2.82	.018	-.003	0	**
Foreign Exchange	-.001	.002	-0.40	.697	-.005	.003	
Lending Operations	.008	.001	10.22	0	.006	.01	***
Constant	.005	0	12.75	0	.004	.005	***
Observations	195496						
R^2	0.015						

**** p<.01, ** p<.05, * p<.1*

5.4. Subsample Analysis

In order to further observe the impact of the COVID-19 pandemic, containment measures and monetary policy announcements on different sectors, the 500 listed companies are divided into 11 groups, specifically Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Telecommunication Services, Utilities, Real Estate, and regressed separately using panel data and clustered standard errors. The results remain consistent with regression with interaction terms from table 11 in previous section. Table 14 present the results of subsample analysis.

The pandemic has significantly affected excess earnings of consumer discretionary, financials, real estate, and technology sectors. For instance, stocks excess return would decrease by 1.3, 1.4, 1.5 and 1.4 percent by one percentage increase of COVID growth rate, respectively. While the industries less affected by the pandemic are basic materials, consumer staples, health care and utilities, as one percentage increase of COVID growth rate would only decline the excess returns of consumer staples company stock by 0.7 percent, which is 50% less than that of real estate industry.

Furthermore, the reaction of different industries to the central bank interventions are analysed in the same grouping model. The central bank's interventions produced different results in distinct sectors. The effect of interest rate policy is positively correlated in basic materials, consumer staples, utilities, and health care, but some of them are statistically insignificant. Lending operation announcements generally have a positive and statistically significant effect on all the sectors, however, in particular, the excess return of health care, consumer staples, telecommunications and utilities sectors are less sensitive to it. Perhaps, it could be interpreted

as monetary policy turns ineffective on these industries, as most of them are backed by the government to some extents, from which its commodity and workforce markets are considerably administered by the government or overregulated by other responsible supervision authorities (Long et al., 2021).

Table 14. Regression Analysis across 11 Different Industries

Excess Return	Basic Materials	Consumer Discretionary	Consumer Staples	Energy	Financials
COVID	-0.009***	-0.013***	-0.007***	-0.010***	-0.014***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Stringency	-0.000*	-0.000***	-0.000**	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Interest Rate	0.004	-0.006***	0.003*	-0.007**	-0.001
	(0.003)	(0.001)	(0.001)	(0.003)	(0.001)
Asset Purchase	-0.004*	-0.000	0.005***	0.004	0.001
	(0.002)	(0.001)	(0.001)	(0.003)	(0.001)
Foreign Exchange	-0.000	0.006***	0.001	-0.002	-0.005***
	(0.003)	(0.002)	(0.002)	(0.004)	(0.002)
Lending Operations	0.016***	0.012***	0.007***	0.014***	0.015***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Constant	0.004**	0.006***	0.003***	0.005**	0.006***
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)
Observations	7,037	32,844	12,902	8,993	25,024
Number of Firm	18	84	33	23	64

Excess Return	Health Care	Industrials	Real Estate	Technology	Tele-communications	Utilities
COVID	-0.009***	-0.011***	-0.015***	-0.014***	-0.010***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Stringency	-0.000***	-0.000***	-0.000***	-0.000***	-0.000**	-0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Interest Rate	0.004***	0.003**	-0.002	-0.001	-0.001	0.007***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)
Asset Purchase	0.006***	0.002**	-0.003	0.004***	0.006***	0.003**
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Foreign Exchange	-0.002	-0.002	0.004	0.009***	-0.002	0.000
	(0.002)	(0.001)	(0.003)	(0.002)	(0.004)	(0.002)
Lending Operations	0.010***	0.013***	0.013***	0.012***	0.010***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Constant	0.004***	0.004***	0.006***	0.006***	0.005***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
Observations	23,069	34,408	11,729	23,460	4,300	11,730
Number of Firm	59	88	30	60	11	30

*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*

VI. Conclusion and Policy Implications

The objective of this study is to investigate the impact of the COVID-19 pandemic, containment measures and central bank policy actions on the excess return of US equities and across industry. After the appearance of the first COVID-19 cases in the country, the US stock market crashed drastically, as shown by the descriptive data analysis that high excess returns fluctuations occurred during the initial phase of the pandemic, and the excess return reached to its bottom in March 2020. As expected, empirical results reveal that the epidemic had indeed a strong negative impact on the stock market and the economy as a whole, where one percentage increase in COVID-19 growth rate is associated with a 4% reduction of index excess return.

The Federal Reserve implemented a series of monetary policy measures in order to promote market stability after the outburst of COVID-19, but the actual impact of these policies is not only hard to estimate, but also indistinguishable from the effect of the pandemic itself and other policy decisions. This dissertation also attempts to understand the effects of monetary policy announcements on the US equity market. The response of S&P 500 is examined to give a broader view on index level. After that, the panel fixed effects model was used to examine the impacts on industry and company level. The empirical results suggest that central bank announcements have a mixed impact on the stock market and did not immediately revert the negative impact of the COVID-19 to stock returns. In particular, lending operations and asset purchase have little effect in alleviating the negative impact of the pandemic, while interest rate and foreign exchange announcements have provoked negative market reactions. However, their true impact in the economy might be difficult to determine due to a number of other unobserved relevant determinants during the sample timeframe. Containment measures, which were crucial in containing the transmission of the virus, also reduced excess returns, but varied across industries. The results show that after the introduction of containment measures, the index excess returns fell on average by about 1.5 percent, while the stock constituents are slightly responsive to the variations of stringency index but at a significant level. In terms of cross-sectors analysis, financials, real estate, and technology are, by their nature, the most vulnerable to the strictness of containment measures. Consumer staples and utilities are the least responsive to the containments adjustments, as households are heavily reliant on these sectors during the quarantine period.

The results of this dissertation provide the subsequent policy reflections. Firstly, during turbulent periods, central banks make use of policies such as lending operations and asset purchase to reduce the adverse effects of the pandemic on excess earnings and achieve immediate results, at the same time, it should continue to be highly reactive and motivated to play a significant role in the calming the market. There are many other channels through which monetary policy works and transmits its effects to the economy besides equity markets. Thus, although this study does not find a significant impact from monetary policy announcements, it does not mean it did not help to stabilize markets and create the conditions to mitigate the overall negative impact of the pandemic on the economy. Secondly, in addition to monetary policy, further research is necessary on the effectiveness of central bank fiscal policy and other extraordinary government policies during a pandemic, and whether their coordination achieves the desired goals. Nonetheless, the empirical results indicate that central bank monetary policy

amplifies the negative effect of COVID-19 on stock market. This means that pandemic shocks cannot be addressed by solely relying on central bank decisions but requires the combination of different policies. Governments should work together with central bank and other supervisory authorities to develop and improve their strategy, and perhaps the best lesson for the government would be the pandemic itself.

Finally, this study can provide valuable information for central banks to reflect on their actions, and to formulate better extraordinary policies. Also, it raises investors and corporates' awareness to the impact of the pandemic, government measures and central bank policies on every aspect of the economy, and hence to establish the appropriate tactic accordingly. Moreover, it is desirable to have more research on the economic effects of central bank policies in the recovering period, which deserve a thorough deliberation.

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