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Article

Chasing for information during the COVID-19 panic: The role of Google search on global stock market

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GENERAL & APPLIED ECONOMICS | LETTER

Chasing for information during the COVID-19 panic: The role of Google search on global stock market

Chaiyuth Padungsaksawasdi^{1*} and Sirimon Treepongkaruna²

Abstract: This paper examines the causal relationship between global stock market performance and Google search volume index (SVI) surrounding the disastrous event of the coronavirus (COVID-19) outbreak. Based on 6,106 stock index-day observations of 71 countries during the period from 1 January 2020 to 29 May 2020, we find that both the SVI and the growth in confirmed cases lower the global stock market returns. Consistent with the information discovery theory, we find when the confirmed cases increase, retail investors search for more information, improving their returns on stock indices during the outbreak. Finally, our further instrumental-variable analysis shows that our results are unlikely confounded by endogeneity.

Subjects: Finance; Corporate Finance; Investment & Securities

Keywords: Investor attention; Google Search volume index; Behavioral finance; COVID-19; Stock market performance

1. Introduction

The COVID-19 pandemic originating from the city of Wuhan, China, is a very unique situation that calls emergency around the globe. This is the first time that a health crisis has severely affected the global financial landscape. Employing the structural vector autoregression, Lee et al. (2021) document that shocks from the COVID-19 outbreak caused the Chinese stock market to move down, especially in the hospitality industry over the early stage of the spread

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PUBLIC INTEREST STATEMENT

This paper examines the causal relationship between global stock market return and retail investor attention surrounding the disastrous event of the coronavirus (COVID-19) outbreak. Based on 6,106 stock index-day observations of 71 countries during the period from 1 January 2020 to 29 May 2020, we find that both the investor attention and the growth in confirmed cases lower the global stock market returns. Moreover, we find when the confirmed cases increase, retail investors search for more information, improving their returns on stock indices during the outbreak.

of the disease. This evidence was later confirmed in international equity markets (Shaikh, 2021a). Moreover, Fassas (2020) studying a dynamic connectedness of variance risk premium between developed and emerging markets finds that emerging markets are the root cause of spillover effect during the COVID-19 global pandemic. The global financial markets negatively respond instantaneously to the outbreak, especially during an early stage of the event. Definitely, the pandemic causes enormous impacts on real economies, social, and well-being of world population. Governments around the world have attempted to implement several policies to stop the spread of the virus outbreak such as travel restrictions and lockdowns. However, the exact outcomes are not yet clear.

Goodell (2020) summarizes the consequences of natural disasters on economies and emphasizes the severity of COVID-19 on financial sectors, calling for future research. Moreover, Shaikh (2021) finds that the COVID-19 outbreak news adversely affects commodity markets more than stock markets. This motivates us to explore the responses of stock markets around the world to the availability of the COVID-19 information. As the dissemination of the COVID-19-related news worldwide abounds, investors are more attentive to the arrival of new information through media outlets, including internet search. A change in stock prices occurs to reflect the search, inducing pressures on prices and volatility. Barberis et al. (1998) find that investors consistently overreact to news. During extreme market conditions, information is disseminated throughout the world at a very fast speed, overwhelming investors with an abundance of information to digest. However, attention is scarce cognitive resource (Kahneman, 1973); it is impossible to incorporate all available information into stock prices, subsequently violating market efficiency. Limited attention comoves with stock prices (Peng et al., 2007). As attention is important for investment decision (Barber & Odean, 2008), Da et al. (2001) demonstrate that investor attention measured by the Google search volume frequency shows a dynamic relationship with stock market performance at an individual stock level. The use of Google search volume index (SVI) as a proxy of retail investor attention in the financial context has gained popularity since the seminal work of Da et al. (2011). The intuition is based on the fact that attention is a limited resource, which investors will only allocate their attention to the information of interest. As such, investors will search for information on attention-grabbing stocks, but early research documents that a direct measure of investor attention is hard to find. Da et al. (2011) introduced SVI as a direct measure of retail investor attention with several advantages as follows. First, Google is the most popular search engine in the world; thus, the obtained information is a good representative for a market-wide interest. Second, a search for information related to stock in the Google truly shows the real interests in that particular stock by the person searching for such information. This makes a solid interpretation of using SVI as a proxy of investor attention. Third, SVI is a proxy of retail investor attention as institutional investors possess superior information and occupy their platforms to analyze stocks. Thus, the search from the Google is more likely to represent an interest from retail investors as described in Da et al. (2011). The use of SVI is now well established in finance and economic literature. The impact of GSVI has been evident in various types of financial assets around the world (Padungsaksawasdi et al., 2019).

Later, Vozlyublennaiia (2014) argues that the Google search volume index is better to measure the attention at the market level rather than the individual stock level in the U.S. The results remain the same as in Da et al. (2011), emphasizing the important role of limited attention in financial markets. In addition, Tantaopas et al. (2016) reemphasize that search at a broad index level rather than at a security level is a representative of retail investors by studying stock market in the Asia-Pacific region. Uses of SVI as a proxy of retail investor attention appear in bond (Pham & Huynh, 2020), foreign exchange (Goddard et al., 2015; Han et al., 2018), futures (Saxena & Chakraborty, 2020), oil (Xiao and Wang, 2020), and cryptocurrency (Zhang & Wang, 2020) markets. In general, the findings underpin the impact of investor attention on asset prices. We therefore attempt to investigate the role of retail investor attention at the country level on market responses during the COVID-19 outbreak. This is supported by Da et al. (2011), documenting that investor

attention is not constant and affects time-varying behaviors of global stock market performance due to investors' limited attention.

Smales (2021) finds that Google search frequency is negatively associated with stock market returns during the COVID-19 pandemic in 27 individual country level. Suggested by Padungsaksawasdi et al. (2019), it is important to take into account differences in cross-sectional and time-varying investor attention to improve investment decisions and overall economies. Hence, findings from particular country-level investor attention analyses can potentially be biased and not generalized. In this paper, we shed new lights by using the panel regression analysis of 71 countries, accounting for more than 95% of the 2019 world GDP.

As suggested by prior literature (Da et al., 2011), we employ Google search frequency as our proxy of retail investor attention. We carefully select the most appropriate COVID-19 search keyword, finding that "coronavirus" is the best. In general, the pooled regression and the panel regression with fixed effects show qualitatively similar evidence that the search keyword and the growth in the number of confirmed cases are negative and significant for stock market returns worldwide. These are in line with the findings of Smales (2021) on the effect of investor attention and of Al-Awadhi et al. (2020) on a linkage between the growth in confirmed cases and stock market returns. In addition, the interaction term between the two main variables provides an additional impact, which subsequently helps improve stock market performance around the world. Interestingly, the effect is less pronounced among emerging markets, which is supported by the fact that the severity and spread of the coronavirus are better in control than in developed markets. We confirm that Google search frequency by retail investors is informative, which is explained by the information discovery hypothesis suggested by Joseph et al. (2011) and Tantaopas et al. (2016). SVI demonstrates a temporary price pressure to stock and eventually pushes stock prices to be more efficient. The instrumental-variable regression shows that our proposed model is less subject to endogeneity biases.

This research contributes to prior literature at least threefold. First, our panel regression techniques provide more robust results than time-series analysis at an individual country level as the COVID-19 pandemic is a global phenomenon. Panel regressions with fixed effect also alleviate omitted variable biases. Second, only a few studies have investigated the role of investor attention on the stock market performance during the COVID-19 pandemic, though internet usage has increased over time worldwide. This emphasizes the important role of behavioral factors in investment decision, especially under extreme conditions. Finally, we document a causal relationship between investor attention and global stock market performance through our panel instrumental-variable analysis. While not impossible, reverse causality and endogeneity are unlikely to be of concern.

2. Theoretical framework

Attention is a scarce cognitive resource (Kahneman, 1973), which violates the prerequisite of market efficiency. Investors in financial markets are assumed to perceive, digest, analyze, and interpret all available information arriving at markets. Thus, the limitation on investor's attention affects a trading decision, especially during the age of big data. One of the well-known theories used to describe the attention effect in financial markets is the information discovery hypothesis suggested by Joseph et al. (2011), Vlastakis and Markellos (2012), and Vozlyublenniaia (2014). The theory suggests that limited attention causes a temporary price pressure to stocks. A change in stock prices from fundamentals draws attention from market-wide investors. After the stock price change occurs, it will draw other investors' attention who believe that information is not fully reflected into stock prices. This pattern would repeat over time, creating a dynamic process to reveal an intrinsic price. As the online information on the COVID-19 abounds and individuals are expected to stay at home from lockdown and social distancing policies, having more time to look for information, we hypothesize that search from investors possesses a relationship to stock market performance worldwide during the COVID-19 pandemic.

Al-Awadhi et al. (2020) find that the growth rate of confirmed cases and total deaths from the COVID-19 infectious disease adversely affect the performances of listed companies in the Hang Seng Index and Shanghai Stock Exchange Composite Index. As the number of confirmed cases is usually announced to public, we aim to investigate the informational role of the number of confirmed cases in the global equity market. Thus, the first hypothesis is

Hypothesis 1: A growth rate in confirmed cases reduces returns on stock indices around the world.

Moreover, we aim at investigating the role of investor attention on global equity markets. Smales (2021) finds that Google search frequency is negatively associated with stock market returns during the COVID-19 pandemic. Thus, the second hypothesis is

Hypothesis 2: Google search volume index improves the effect of the COVID-19 cases on returns of stock indices around the world.

3. Data and method

3.1. Data

Data are from several sources. We collect 71 daily stock market indices from the Refinitive Datastream as detailed in Appendix A over the period of 1 January 2020 to 29 May 2020. Data for confirmed cases, deaths, and the number of beds in hospitals per 1,000 populations are from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. Other country-level control variables such as gross domestic product (GDP), country risk, and the level of democracy are from the International Monetary Fund, the European Commission, and the Economist, respectively. The level of market development is classified by MSCI. Information on lockdown period is from Wikipedia.¹

Our comprehensive data cover 95.54% of the 2019 world GDP, including top 50 countries by their nominal GDPs, 81.60% of the 2019 world population, and 93.28% of the world COVID-19 confirmed cases at the end of May 2020, including top 20 countries by the number of confirmed cases.²

3.2. Google search volume index (SVI)

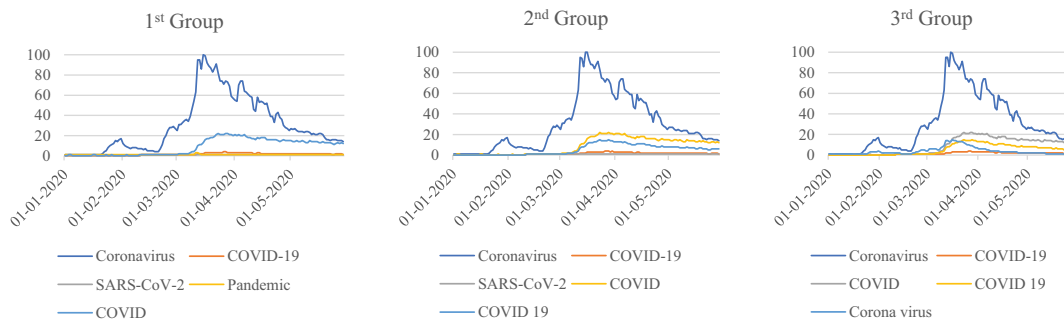
In 2019, the average internet penetration rate was 79.93%, which is higher than the world average of 53.60%. It appears that retail investors in our sample can easily access the internet for information. Among various search engines, Google accounted for more than 86% of market shares in 2020.³ Hence, we followed Da et al. (2011) and Tantaopas et al. (2016) by employing the Google search volume index⁴ from the Google Trends as a proxy for retail investor attention.

To capture retail investor attention about the Coronavirus disease, we utilize seven related search keywords as “Coronavirus,” “COVID-19,” “SARS-CoV-2,” “Pandemic,” “COVID,” “COVID 19,” and “Corona virus.” As Google Trends allows for five search keywords at a time, we conduct three groups of search as follows. The search terms include “Coronavirus-COVID-19-SARS-CoV-2-Pandemic-COVID” as the first attempt, “Coronavirus-COVID-19-SARS-CoV-2- COVID-COVID 19” as the second attempt, and “Coronavirus-COVID-19-COVID-COVID 19- Corona virus” as the last attempt. Figure 1 depicts trends of worldwide SVI in each group. It clearly shows that the “Coronavirus” search term is the most popular keyword, possessing the highest web search volume frequency.⁵ Therefore, in this study, we select “Coronavirus” as the search keyword on COVID-19 pandemic.

In addition, we collect local search volume index for each country.⁶ In general, the first peaks in search volume indices occurred during February to March 2020 that were in line with the announcements by the World Health Organization (WHO) on public health emergency of international concern and the global pandemic confirmation statement. This clearly indicates that retail

Figure 1. Worldwide Search Keywords.

This figure represents the Google search volume index from worldwide enquirers based on all categories of interest for web search result during 1 January 2020 to 29 May 2020. Each panel compares five search keywords regarding the Coronavirus disease (COVID-19). The first graph shows the search statistic of “Coronavirus,” “COVID-19,” “SARS-CoV-2,” “Pandemic,” and “COVID.” The second plot demonstrates the level of enquiry for “Coronavirus,” “COVID-19,” “SARS-CoV-2,” “COVID,” and “COVID 19.” The third group illustrates the interest of “Coronavirus,” “COVID-19,”



investors pay more attention to formal COVID-19 information. Globally, SVIs appear to reach their peaks around March to April 2020, when many governments made serious decisions to lockdown their countries to alleviate the spread of COVID-19. Potentially, staying home policies make people spend their time on the internet and likely to search for information on COVID-19.

3.3. Summary statistics

Table 1 shows the basic statistics of the variables used in this paper. On average, returns on global markets quickly recover from the COVID-19 pandemic, yielding approximately zero daily return. However, the minimum is -25.0% daily return. Changes in the search keyword generally increase over the period of study, confirming an increasing attention from retail investors around the globe. Unfortunately, the number of confirmed cases continues to rise with approximately 7.7% daily growth. These confirm our analysis on the impact of retail investor attention to the COVID-19 pandemic.

3.4. Methodology

To investigate the relationship between retail investor attention on the COVID-19 pandemic and stock market performance, we estimate the following regression models:

$$r_{i,t} = \alpha_0 + \beta_1 \Delta SVI_{i,t} + \beta_2 \Delta Cases_{i,t} + \sum_{i=1}^N \beta_i Control_{i,t} + \varepsilon_{i,t} \tag{1}$$

$$r_{i,t} = \alpha_0 + \beta_1 \Delta SVI_{i,t} + \beta_2 \Delta Cases_{i,t} + \beta_3 (\Delta SVI_{i,t} \times \Delta Cases_{i,t}) + \sum_{i=1}^N \beta_i Control_{i,t} + \varepsilon_{i,t} \tag{2}$$

where $r_{i,t}$ is a return on the stock market index, $\Delta SVI_{i,t}$ is a percentage change in SVI, $\Delta Cases_{i,t}$ is a percentage change or a growth in the number of confirmed cases, and $\varepsilon_{i,t}$ is the error term. i and t stand for country and time. Control variables include natural logarithm of total deaths per total confirmed cases ($\ln TDT C_{i,t}$), natural logarithm of new deaths per new confirmed cases

Table 1. Descriptive Statistics This table provides summary statistics for all variables in this paper. The data are from 71 countries as shown in Appendix A. The sample period starts from 1 January to 29 May 2020. *r*, *SVI*, and *Cases* are stock market returns, changes in Google search index, and growths in the number of confirmed cases, respectively. Other control variables are as follows. $\ln(NDNC)$, $\ln(TDTC)$, and $Cases^2$ are natural logarithms of total deaths per total confirmed cases, of new deaths per new confirmed cases, and a squared term in the growth in the confirmed cases. *Lockdown* is a dummy variable, being one for a lockdown period, zero otherwise. $\ln(GDP)$, *CountryRisk*, *HospitalBed*, and *Democracy* are natural logarithm of gross domestic product, an overall country risk index, the number of hospital beds per thousand populations, and the democracy index, respectively

Variable	Obs.	Mean	Std. Dev.	Min	Max
r	6,106	0.019	2.170	-25.011	23.947
SVI	6,106	0.070	0.602	-1.000	13.000
Cases	6,106	0.077	0.555	-1.000	38.667
$\ln(NDNC)$	6,106	-1.089	1.618	-7.307	1.640
$\ln(TDTC)$	6,106	-1.864	1.974	-7.274	0.000
$Cases^2$	6,106	0.314	19.152	0.000	1495.111
Lockdown	6,106	0.236	0.425	0.000	1.000
$\ln(GDP)$	6,106	5.894	1.459	2.699	9.973
CountryRisk	6,106	3.080	1.635	0.500	7.000
HospitalBed	6,106	3.541	2.518	0.500	13.050
Democracy	6,106	6.665	2.094	1.930	9.870

($\ln NDNC_{i,t}$), a squared term of the growth in the number of confirmed cases ($\Delta Cases^2$), and a dummy variable being one for the period of lockdown and zero otherwise (*Lockdown*). Country-level control variables are natural logarithm of gross domestic product $\ln(GDP)$, country risk index (*CountryRisk*), the number of beds in hospitals (*HospitalBed*), and the level of democracy (*Democracy*).⁷

Tantaopas et al. (2016) note that country’s specific characteristics such as culture and legal protection likely affect retail investor attention. As noted in Padungsaksawasdi et al. (2019), it is important to take into account for differences in cross-sectional and time-varying retail investor attention to improve investment decisions and overall economies. Hence, findings from country-level investor attention analyses can potentially be biased and not generalized. As such, we initially estimate our models by using pooled regression. To control for omitted variables and model misspecification biases, we also conduct panel regression with fixed effect (Gormley & Matsa, 2014).⁸ Finally, to alleviate endogeneity concerns, we estimate causal relationship using panel instrumental-variable regression.

4. Discussions and managerial implications

Tables 2 and 3 present the results of the pooled regression and the panel regression with fixed effect, which our variables of interest are a percentage change in Google search (ΔSVI) and a growth in the number of confirmed cases ($\Delta Cases$). In general, the results are robust as both models demonstrate indifferent main findings. The coefficients of both variables of interest are significantly negative in all cases. Obviously, an increase in the number of confirmed cases causes anxiety and bad sentiment to investors around the world, subsequently pushing the stock markets down. This is similar to the finding of Ashraf (2020). In terms of economic impact, for example, consider Model 1 of Full Sample of Table 3, an increase in a one standard deviation of $\Delta Cases$, global market returns diminish by 5.9367% ($0.077 \times -0.7710 \times 100\%$). We also find a similar negative relationship between the Google search frequency and stock market performance. Investors look

Table 2. Pooled Regression Estimation This table reports results of pooled regression estimation, where stock market index return (r) is the dependent variable. Variables of interest are *SVI* and *Cases*. Variable notations are described in Table 1. Clustered standard errors are shown in parentheses. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively

	Full Sample		Developed Markets		Emerging Markets		Frontier and Other Markets	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
SVI	-0.1620*** (0.0370)	-0.1830*** (0.0391)	-0.3200*** (0.0431)	-0.3660*** (0.0510)	-0.1500* (0.0793)	-0.1820** (0.0835)	-0.0824** (0.0344)	-0.0815** (0.0352)
Cases	-0.7610*** (0.1510)	-0.9060*** (0.1790)	-1.1150*** (0.338)	-1.3670*** (0.3150)	-0.6270** (0.2540)	-0.7900** (0.3200)	-1.4790*** (0.4270)	-1.4690*** (0.4360)
SVI × Cases		0.4660*** (0.1760)		0.8590** (0.3140)		0.5070* (0.2580)		-0.0380 (0.3260)
ln(NDNC)	-0.0235 (0.0249)	-0.0249 (0.0250)	-0.0313 (0.0410)	-0.0335 (0.0410)	0.0088 (0.0435)	0.0072 (0.0438)	-0.0318 (0.0626)	-0.0317 (0.0627)
ln(TDTC)	-0.0973*** (0.0194)	-0.0966*** (0.0195)	-0.0743* (0.0386)	-0.0752* (0.0386)	-0.1460*** (0.0433)	-0.1440*** (0.0438)	-0.0978*** (0.0250)	-0.0979*** (0.0251)
Cases ²	0.0168*** (0.0039)	0.0135*** (0.0036)	0.1250* (0.0612)	0.1110* (0.0556)	0.0133* (0.0066)	0.0099* (0.0055)	0.3370** (0.1480)	0.3370** (0.1490)
Lockdown	0.2320*** (0.0829)	0.2410*** (0.0837)	0.2790** (0.1290)	0.2860** (0.1290)	0.2680* (0.1380)	0.2810* (0.1390)	0.1320 (0.1720)	0.1310 (0.1730)
ln(GDP)	-0.0070 (0.0147)	-0.0087 (0.0149)	-0.0145 (0.0272)	-0.0156 (0.0276)	0.0254 (0.0321)	0.0213 (0.0328)	0.0600 (0.0914)	0.0601 (0.0915)
CountryRisk	-0.0200 (0.0130)	-0.0196 (0.0128)	-0.0189 (0.0234)	-0.0207 (0.0232)	-0.0125 (0.0173)	-0.0109 (0.0175)	-0.0995* (0.0538)	-0.0995* (0.0538)

(Continued)

Table 2. (Continued)

	Full Sample		Developed Markets		Emerging Markets		Frontier and Other Markets	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
HospitalBed	-0.0119 (0.0072)	-0.0115 (0.0071)	-0.0006 (0.0100)	-0.0003 (0.0100)	-0.0119 (0.0103)	-0.0106 (0.0101)	-0.0359 (0.0312)	-0.0359 (0.0311)
Democracy	-0.0165 (0.0147)	-0.0160 (0.0147)	0.0482** (0.0179)	0.0489** (0.0177)	0.0028 (0.0110)	0.0025 (0.0111)	-0.0601 (0.0666)	-0.0602 (0.0664)
Constant	0.0760 (0.1810)	0.0844 (0.1810)	-0.4220* (0.2350)	-0.4120* (0.2400)	-0.3640* (0.2070)	-0.3410 (0.2070)	0.4610 (0.7900)	0.4610 (0.7910)
Observations	6,106	6,106	2,064	2,064	2,236	2,236	1,806	1,806
R-squared	0.028	0.029	0.028	0.030	0.033	0.035	0.036	0.036

Table 3. Fixed Effect Panel Regression Estimation This table reports results of fixed effect panel regression estimation, where stock market index return (r) is the dependent variable. Variables of interest are *SVI* and *Cases*. Variable notations are described in Table 1. Clustered standard errors are shown in parentheses. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively

	Full Sample		Developed Market		Emerging Market		Frontier and Other Markets	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
SVI	-0.1580*** (0.0371)	-0.1800*** (0.0393)	-0.3180*** (0.0434)	-0.3640*** (0.0514)	-0.1460* (0.0798)	-0.1790** (0.0840)	-0.0809** (0.0340)	-0.0808** (0.0352)
Cases	-0.7710*** (0.1520)	-0.9190*** (0.1810)	-1.1210*** (0.346)	-1.3730*** (0.3230)	-0.6500** (0.2540)	-0.8180** (0.3220)	-1.4930*** (0.4320)	-1.4920*** (0.445)
SVI × Cases		0.4770*** (0.1780)		0.8610** (0.3170)		0.5220* (0.2610)		-0.0062 (0.3250)
ln(NDNC)	-0.0238 (0.0282)	-0.0250 (0.0282)	-0.0299 (0.0469)	-0.0321 (0.0467)	0.0111 (0.0537)	0.0104 (0.0542)	-0.0439 (0.0670)	-0.0439 (0.0672)
ln(TDTC)	-0.0937*** (0.0227)	-0.0931*** (0.0229)	-0.0716 (0.0449)	-0.0725 (0.0450)	-0.1370** (0.0541)	-0.1360** (0.0551)	-0.0913*** (0.0250)	-0.0913*** (0.0251)
Cases ²	0.0171*** (0.0400)	0.0137*** (0.0036)	0.1270* (0.0625)	0.1130* (0.0568)	0.0139** (0.0066)	0.0104* (0.0056)	0.3390** (0.1510)	0.3390** (0.1520)
Lockdown	0.2890*** (0.0935)	0.2990*** (0.0942)	0.3190** (0.1510)	0.3260** (0.1510)	0.3450* (0.1810)	0.3590* (0.1810)	0.1690 (0.1420)	0.1690 (0.1450)
Constant	-0.1860*** (0.0289)	-0.1810*** (0.0289)	-0.1520** (0.0642)	-0.1460** (0.0660)	-0.2710*** (0.0435)	-0.2650*** (0.0429)	-0.0898* (0.0440)	-0.0899* (0.0439)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,106	6,106	2,064	2,064	2,236	2,236	1,806	1,806
R-squared	0.028	0.029	0.028	0.030	0.033	0.034	0.033	0.033
No. of country	71	71	24	24	26	26	21	21

Table 4. Panel Instrumental-variable Regression Estimation This table reports results of instrumental-variable panel regression estimation, where stock market index return (r) is the dependent variable. Variables of interest are *SVI* and *Cases*. Variable notations are described in Table 1. Clustered standard errors are shown in parentheses. ***, **, * indicate statistical significance at 1%, 5%, and 10% levels, respectively

	Full Sample		Developed Market		Emerging Market		Frontier and Other Markets	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
SVI	-0.1580*** (0.0371)	-0.1800*** (0.0393)	-0.3180*** (0.0434)	-0.3640*** (0.0514)	-0.1460* (0.0798)	-0.1790** (0.0840)	-0.0809** (0.0340)	-0.0808** (0.0352)
Cases	-0.7710*** (0.1520)	-0.9190*** (0.1810)	-1.1210*** (0.3460)	-1.3730*** (0.3230)	-0.6500** (0.254)	-0.8180** (0.3220)	-1.4930*** (0.4320)	-1.4920*** (0.4450)
SVI × Cases		0.4770*** (0.1780)		0.8610*** (0.3170)		0.5220** (0.2610)		-0.0062 (0.3250)
ln(NDNC)	-0.0238 (0.0282)	-0.0250 (0.0282)	-0.0299 (0.0469)	-0.0321 (0.0467)	0.0111 (0.0537)	0.0104 (0.0542)	-0.0439 (0.0670)	-0.0439 (0.0672)
ln(TDTC)	-0.0937*** (0.0227)	-0.0931*** (0.0229)	-0.0716 (0.0449)	-0.0725 (0.0450)	-0.1370** (0.0541)	-0.1360** (0.0551)	-0.0913*** (0.0250)	-0.0913*** (0.0251)
Cases ²	0.0171*** (0.0040)	0.0137*** (0.0036)	0.1270** (0.0625)	0.1130** (0.0568)	0.0139** (0.0066)	0.0104* (0.0056)	0.3390** (0.1510)	0.3390** (0.1520)
Lockdown	0.2890*** (0.0935)	0.2990*** (0.0942)	0.3190** (0.1510)	0.3260** (0.1510)	0.3450* (0.181)	0.3590** (0.1810)	0.1690 (0.1420)	0.1690 (0.1450)
Constant	-0.1860*** (0.0289)	-0.1810*** (0.0289)	-0.1520** (0.0642)	-0.1460** (0.0660)	-0.2710*** (0.0435)	-0.2650*** (0.0429)	-0.0898** (0.0440)	-0.0899** (0.0439)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6,106	6,106	2,064	2,064	2,236	2,236	1,806	1,806
No. of country	71	71	24	24	26	26	21	21

for the COVID-19 information via Google and make decisions to push the stock market down. An increase in a one standard deviation of ΔSVI , global market returns diminish by 1.106% ($0.070 \times -0.1580 \times 100\%$). This is similar to the finding of Smales (2021) in 27 country-level analyses. Thus, our variables of interest are economically and statistically significant. Interestingly, the effects of both variables are less significant in emerging markets in both models. This reflects the fact that the severity and spread of the disease in emerging markets are less than those in developed markets. Moreover, economies in emerging markets seem to recover faster to the rest of the world. This gives an opportunity for international investors to reallocate their portfolio investment. In summary, the panel data analysis yields better estimations in the study of the investor attention and stock market performance as well as of the growth in the number of confirmed cases and stock market performance during the global health outbreak period. It is worth noting that investor attention as a behavioral factor plays an important role over this highly volatile period.

Interaction terms as shown in Model 2 of Tables 2 and 3 provide some interesting insights. The coefficients of $\Delta SVI \times \Delta Cases$ are significantly positive, except for frontiers and other markets. Given an increase in the number of confirmed cases,⁹ when investors search more, the stock market performance improves. This could happen as investors realize that the death rate from COVID-19 is relatively low and most infected people show unsevered symptoms. Investors might relieve from their panic during an early stage of pandemic and have a good hope from the recovery of the world's economy, reflecting in larger buying decisions in stocks. Likewise, given a decrease in the number of confirmed cases, investors search less as the situation of the COVID-19 pandemic improves, causing better performance in stock markets worldwide. This implies that attentive search by retail investors via Google represents informative investment decision, rather than a noise. This is described by the information discovery hypothesis, supported by Joseph et al. (2011) and Tantaopas et al. (2016). For control variables, it is interesting to note that the relationship between stock market returns and growth in confirmed cases is nonlinear as shown in significantly positive $\Delta Cases^2$. The lockdown policy is an effective plan to boost investors' confidence about the spread of the coronavirus, especially in developed markets.

Finally, we employ the panel instrumental-variable regression to alleviate endogeneity concerns using a regional median of ΔSVI as an instrument variable as shown in Table 4. The idea for the chosen instrument variable is that local ΔSVI may have some influence over local investor attention. However, it is unlikely that local ΔSVI could have any influence over investor attention in other countries. In other words, any variation at regional level is beyond the control of a country because there are many countries in a region. As such, each country takes any change at the regional level as given. A regional median is therefore likely to be exogenous. Hence, both the relevance and exclusion requirements for an instrumental variable should be satisfied. Results from Table 4 indicate causal relationship between ΔSVI and return. In summary, our main findings are not subject to potential problems of reverse causality and endogeneity.

5. Conclusion

The COVID-19 pandemic is a rare event, providing us with a unique setting to investigate the effect of retail investor attention on stock market performance around the world. The Google search frequency as a proxy of retail investor sentiment shows a negative relationship with the global stock market performance. When investors pay more attention, the stock markets move down. This holds true for the growth in the number of confirmed cases. These demonstrate that investors search online for information and make decisions in order to reduce investment uncertainty during the COVID-19 crisis. The interaction term between these two variables offers insightful meanings, which subsequently increases global stock market returns. Our results are robust as pooled regression and panel data with fixed effects models yield qualitatively similar results. While not impossible, reverse causality and endogeneity are unlikely of concerns as the instrumental-variable regressions perform well and indicate a causal relationship between retail investor attention and global stock market performance.

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Notes

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- Google search volume index is a relative number. The statistics are shown as a percentage of the highest search frequency over a given period. In addition, Google is the most popular search engine in our selected countries, excluding in China and Russia. For consistency, Google search volume index is employed as a proxy of retail investor attention in our sample. Moreover, Baidu and Yandex cannot represent investors' internet activities from abroad in Chinese and Russian equity markets, respectively.
- The search keyword of "Coronavirus" outperforms the other selected keywords in 65 countries, whereas "COVID" is the most popular keyword for the six remaining countries, mostly in the Southeast Asia. However, an average of search frequencies for "Coronavirus" and "COVID" in the six remaining countries is very closed. Thus, "Coronavirus" is selected to represent the market-wide attention on the COVID-19's outbreak.
- These plots are available upon request.
- Fernandez-Perez et al. (2021) find that stock markets of nations with lower individualism and higher uncertainty avoidance are more volatile and worse performance during the COVID-19 outbreak. The fixed effect model in this study takes the role of national culture into consideration.
- As our study deals with international country sample, it is logical and necessary to control for unobservable time-invariant factors. Thus, the panel data analysis

with the fixed effect is the most appropriate. Moreover, the Hausman test for panel data models suggests the same.

- We define the number of confirmed cases as the moderate variable.

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Appendix A: Sample

This table summarizes the key characteristics of 71 selected countries which are stock market index, nominal gross domestic product as the end of 2019 (billions of dollars), number of the COVID-19 confirmed cases as of 29 May 2020, number of populations as the end of 2019 (millions), and internet penetration rate as the end of 2019

Country	Market Index	GDP (USD Billions)	Confirmed Cases	Population (Millions)	Internet Penetration (%)
Argentina	S&P Merval	445.469	14,689	45.196	93.10
Australia	S&P/ASX 200	1,376.255	7,150	25.500	86.50
Austria	ATX	447.718	16,543	9.006	87.90
Bangladesh	DSE Broad	317.465	40,321	164.689	58.40
Belgium	BEL 20	517.609	57,849	11.590	93.90
Brazil	IBOVESPA	1,847.020	438,238	212.559	70.70
Bulgaria	SOFIX	66.250	2,485	6.948	66.70
Canada	S&P/TSX 60	1,730.914	88,501	37.742	89.90
Chile	S&P/CLX IGPA CLP	294.237	86,943	19.116	77.50
China	SSE A Share	14,140.163	84,106	1,439.32	59.30
Colombia	COLCAP	327.895	25,366	50.883	63.20
Croatia	CROBEX	60.702	2,245	4.105	91.50
Cyprus	Cyprus General	24.280	941	0.876	84.40
Czech Republic	Prague PX	246.953	9,140	10.709	87.70
Denmark	OMX Copenhagen All shares	347.176	11,512	5.792	97.80
Egypt	EGX 30	302.256	20,793	102.334	48.10
Estonia	OMX Tallinn	31.038	1,851	1.327	97.90
Finland	OMX Helsinki All Share	269.654	6,743	5.541	94.00
France	CAC 40	2,707.074	149,071	65.274	92.30
Germany	DAX 30	3,863.344	180,458	83.784	96.00
Greece	Athex Composite	214.012	2,906	10.423	72.90
Hong Kong	Hang Seng	372.989	1,079	7.497	89.30
Hungary	Budapest BUX	170.407	3,841	9.660	89.00
Iceland	OMX Iceland All-Share	23.918	1,805	0.341	99.00
India	NIFTY 500	2,935.570	165,799	1,380.004	40.60
Indonesia	IDX Composite	1,111.713	24,538	273.524	62.60
Iran	TEDPIX	458.500	143,849	83.993	80.50
Iraq	ISX Main 60	224.462	5,457	40.223	52.90
Ireland	ISEQ All-Share	384.940	24,841	4.938	91.90
Israel	TA-125	387.717	16,872	8.656	80.90
Italy	FTSE MIB	1,988.636	231,732	60.462	92.50
Jamaica	Jamaica Main	15.702	569	2.961	54.50
Japan	NIKKEI 225	5,154.475	16,719	126.476	93.80

(Continued)

Country	Market Index	GDP (USD Billions)	Confirmed Cases	Population (Millions)	Internet Penetration (%)
Jordan	ASE General	44.172	728	10.203	85.30
Kenya	NSE 20	98.607	1,618	53.771	87.20
Luxembourg	Lux General	69.453	4,008	625,976	97.80
Malaysia	FTSE Bursa Malaysia KLCI	365.303	7,629	32.366	81.40
Malta	MSE	14.859	616	0.442	83.10
Mexico	S&P/BMV IPC	1,274.175	81,400	128.933	65.00
Morocco	Moroccan All Shares	119.040	7,643	36.911	64.30
Netherlands	AEX	902.355	45,950	17.135	95.60
New Zealand	S&P/NZX 50	204.671	1,154	4.822	90.80
Nigeria	NSE All Share	446.543	8,915	206.140	61.20
Norway	Oslo Børs All Share	417.627	8,401	5.421	98.40
Oman	MSM 30	76.609	9,009	5.107	78.50
Pakistan	KSE-100	284.214	64,028	220.892	32.40
Peru	S&P/BVL Peru General	228.989	141,779	32.972	67.60
Philippines	PSEi	356.814	15,588	109.581	72.10
Poland	WIG	565.854	22,825	37.847	78.20
Portugal	PSI-20	236.408	31,596	10.197	78.20
Qatar	QE General	191.849	1,967	2.881	99.60
Romania	BET	243.698	18,791	19.238	73.80
Russia	MOEX	1,637.892	379,051	145.934	80.90
Saudi Arabia	Tadawul All Share	779.289	80,185	34.814	91.50
Singapore	Straits Times	362.818	33,249	5.850	88.40
Slovakia	SAX 16	106.552	1,520	5.460	84.90
South Africa	FTSE/JSE All-Share	358.839	27,403	59.309	55.00
South Korea	KOSPI	1,629.532	11,402	51.269	96.00
Spain	IBEX 35	1,397.870	238,564	46.755	92.50
Sri Lanka	Colombo All-Share	86.566	1,530	21.413	33.50
Sweden	OMX Stockholm 30	528.929	35,727	10.099	96.40
Switzerland	SMI	715.360	30,713	8.655	93.70
Taiwan	TAIEX	586.104	441	23.817	92.60
Thailand	Bangkok SET	529.177	3,065	69.800	81.70
Tunisia	TUNINDEX	38.732	1,068	11.819	66.80
Turkey	BIST National 100	743.708	160,979	84.339	83.30
United Arab Emirates	ADX General	405.771	32,532	9.890	96.40
United Kingdom	FTSE 100	2,743.586	269,127	67.886	94.90
United States	DJIA	21,439.453	1,721,750	331.003	95.60

(Continued)

(Continued)

Country	Market Index	GDP (USD Billions)	Confirmed Cases	Population (Millions)	Internet Penetration (%)
Venezuela	Caracas General	70.140	1,327	28.436	53.10
Vietnam	VNINDEX	261.637	327	97.339	70.40



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