informs
http://pubsonline.informs.org/journal/mnsc

MANAGEMENT SCIENCE
Articles in Advance, pp. 1–10
ISSN 0025-1909 (print), ISSN 1526-5501 (online)

Combating the COVID-19 Pandemic: The Role of the SARS Imprint

Hong Ru,[a] Endong Yang,[b] Kunru Zou[c]

[a] Nanyang Business School, Nanyang Technological University, Singapore 639798; [b] Faculty of Business Administration, University of Macau, Macau, China; [c] School of Finance, Renmin University of China, 100872 Beijing, China

Contact: hongrucn@icloud.com, https://orcid.org/0000-0002-9369-2725 (HR); endongyang@um.edu.mo, https://orcid.org/0000-0002-2737-6070 (EY); kunru.zou@outlook.com, https://orcid.org/0000-0003-0239-7147 (KZ)

Received: June 3, 2020
Revised: November 1, 2020
Accepted: January 7, 2021
Published Online in Articles in Advance: June 3, 2021

https://doi.org/10.1287/mnsc.2021.4015

Abstract. We provide evidence of delayed attention and inaction in response to COVID-19 in countries that did not experience SARS in 2003. Using cross-country data, we find that individuals in countries that had SARS infections in 2003 searched more intensively for COVID-19-related information on Google in late January 2020, the time of the first known outbreak in Wuhan, China. Early attention to the novel virus, as measured by Google searches, is associated with deeper stock market drops in countries with SARS experience. In contrast, people in countries without SARS experience started to pay more attention much later, in March. Moreover, governments in these countries responded significantly more slowly in implementing social distancing policies to combat domestic COVID-19 outbreaks than governments in countries with SARS experience. Moreover, such early responses of individuals and governments in countries with SARS experience are prevalent within continent, even in non-Asian countries. Furthermore, people in countries with SARS experience are more compliant with social distancing rules. These timely attention and proactive responses of individuals and governments are more pronounced in countries that reported deaths caused by SARS, which left deeper imprints. Our findings suggest that the imprint of similar viruses' experience is a fundamental mechanism underlying timely responses to COVID-19.

History: Accepted by Haoxiang Zhu, finance.
Funding: This work was supported by Ministry of Education, Singapore, under its Tier 1 RG60/17, University of Macau, Start-up Research Grant [SRG2019-00151-FBA].
Supplemental Material: The online appendix is available at https://doi.org/10.1287/mnsc.2021.4015.

Keywords: COVID-19 • imprint • SARS experience • delayed response

1. Introduction

The coronavirus disease 2019 (COVID-19) is one of the deadliest global pandemics in human history, one that accounted for more than 1.8 million deaths worldwide in 2020 and is estimated to cause a 4.3% contraction in the global GDP in 2020.[1] Despite its severity, people and governments across the globe have responded differently in their containment measures and economic policies (e.g., Ding et al. 2020a, b; Huang et al. 2020).

This paper studies how the imprint of an experience with similar viral outbreaks affects countries' responses to COVID-19. In particular, we explore the heterogeneous attention and responses to the first known outbreak of COVID-19 in Wuhan, China, between countries severely affected by Severe Acute Respiratory Syndrome (SARS) in 2003 and other countries, given the similarity between the viruses that cause SARS and COVID-19. We found that countries with the experience of SARS infections paid attention to COVID-19 earlier and responded in a more timely and proactive manner.

First, we directly examined whether an imprint of SARS experience exists using Google search data. We studied people's attention to the first known outbreak of COVID-19 in China from January 20 to January 31, 2020, which covers the initial government responses and the first extensive media coverage of COVID-19 in China and abroad. We found that searches for "SARS" and "coronavirus" in Google were eight times and two times higher, respectively, in the 28 countries with SARS cases in this two-week window than in other countries without SARS experience. People in countries without SARS experience paid attention to COVID-19 much later, when the disease began to spread rapidly outside China in March. Furthermore, the number of Google searches for "SARS" was 12 times higher in the 10 countries with SARS deaths than in other countries without SARS deaths, suggesting that the imprint is stronger when the disease causes fatalities. In addition, earlier search attention to COVID-19 in countries with SARS imprints is prevalent within continent, even in non-Asian countries (e.g., countries in Europe and North America).

Second, we examined how different search attention to COVID-19 affected stock market performance across countries during the first COVID-19 outbreak in Wuhan. In particular, we found that Google search attention for SARS was negatively associated with the cumulative abnormal returns (*CAR*) of stock market indexes from January 20 to January 31. Furthermore, a one-standard deviation increase in Google search attention explained by the SARS imprint lead to a 61.35 basis point drop in *CAR*. This finding further supports the imprint channel we propose, since the investors imprinted by SARS reacted more strongly than other investors to the first COVID-19 outbreak. These findings complement those of Da et al. (2011, 2015), which showed that investors' search attention plays a substantial role in the stock market.

Next, we examined the role of SARS imprints in government responses to domestic COVID-19 outbreaks. We performed a duration analysis of various government containment measures on the interactions between COVID-19 case numbers and the indicator denoting SARS experience. We found that contemporaneous COVID-19 case numbers were positively associated with the timeliness of containment measures (i.e., school closures, workplace closures, cancellation of public events, restrictions on public gatherings, restrictions on domestic movements, and international travel controls), and this effect was significantly more pronounced for countries with SARS imprints. For example, a 100% increase in COVID-19 cases was associated with 69.7% and 22.6% increases in the rates of school closures in countries with and without SARS infections, respectively. Furthermore, following government social distancing rules, people in countries with SARS deaths were also more constrained in their daily movements, which was associated with lower COVID-19 infection rates in such countries.

Our findings contribute to the literature examining the impact of prior experience on subsequent economic and social activities. Ever since the seminal work by Stinchcombe (1965), the social and economic impacts of imprints have been studied widely (e.g., see Marquis and Tilcsik 2013). A number of studies have shown that early life experiences can leave imprints that influence individuals' careers (e.g., see Elder 1986, 1998; Gibbons and Waldman 2006, Oyer 2006, 2008; Law and Zuo 2020), risk attitude (e.g., see Chiang et al. 2011, Malmendier and Nagel 2011, 2016, Guiso et al. 2015, Bernile et al. 2017), investments (e.g., see Kaustia and Knüpfer 2008, Knüpfer et al. 2017, Huang 2019, Malmendier et al. 2020), and corporate management (e.g., see Bayus and Agarwal 2007, Billett and Qian 2008, Malmendier et al. 2011, Kaplan et al. 2012, Benmelech and Frydman 2015, Schoar and Zuo 2017, He et al. 2018). In particular, inexperienced investors tend to neglect risk until they experience severe and adverse investment outcomes (e.g., see Gennaioli et al. 2012, Chernenko et al. 2016). For the first time, this paper documents a crucial fundamental mechanism underlying the different responses to COVID-19 across the globe: the experience of similar viruses.[2] This has important policy implications for economic aid programs and containment measures worldwide, as early responses to COVID-19 can mean the difference between life and death.

2. Background

2.1. COVID-19 (Caused by SARS-CoV-2)

According to the World Health Organization (WHO), severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) causes COVID-19. The first known outbreak of COVID-19 was in Wuhan, China. The earliest known COVID-19 case, detected by SARS tests, was recorded on December 15, 2019. The media and public in China started to pay attention to COVID-19 in late January 2020. In particular, on January 20, 2020, Dr. Zhong Nanshan, a Chinese epidemiologist who had earned international fame for managing the 2003 SARS outbreak in China, addressed the nation on China Central Television (CCTV) and, for the first time, confirmed the human-to-human transmission of COVID-19. Ever since then, the Chinese government has initiated several strong containment measures. On January 23, the Chinese government started a complete lockdown of Wuhan after 444 cases had been confirmed. This lockdown, which affected approximately 57 million people, was the first major move to contain the outbreak. On January 25, the first day of the Chinese Lunar New Year, the Standing Committee of the Politburo, the highest authority of the Chinese Communist Party, held an emergency meeting regarding COVID-19. It was unprecedented for the Standing Committee of the Politburo to convene on the Chinese New Year, so this meeting sent a strong signal of the severity of the COVID-19 situation to the rest of the world. On January 30, the WHO declared COVID-19 a global public health emergency. To examine people's attention to the first known COVID-19 outbreak, we thus use the two-week window from January 20 to January 31, which covers the first widespread media reports and government actions.[3]

2.2. SARS (Caused by SARS-CoV-1)

There are many similarities between viruses SARS-CoV-1 and SARS-CoV-2, which cause SARS disease and COVID-19 disease, respectively. Specifically, SARS-CoV-2 is most closely related to SARS-CoV-1, according to an article by the National Institutes of Health titled "SARS-CoV-2 stability similar to original SARS virus" (NIH 2020). SARS-CoV-2 is recognized as a SARS family virus with similar symptoms and forms of transmission. Moreover, both first known outbreaks of SARS and COVID-19 were in mainland China. In summary,

Table 1. Summary Statistics

Panel A: Attention and stock returns						
	Sub-sample				Full sample	
	(1)	(2)	(3)	(4)	(5)	(6)
	SARSCase=		*SARSDeath*=			
Variables	0	1	0	1	Mean	SD
GoogleSARS	0.661	13.554	1.381	25.600	2.848	9.439
	(137)	(28)	(155)	(10)	(165)	
GoogleCoronavirus	6.288	27.750	8.429	33.200	9.930	16.857
	(137)	(28)	(155)	(10)	(165)	
CAR	−0.827	−1.828	−0.902	−2.922	−1.218	1.891
	(39)	(25)	(54)	(10)	(64)	
CumRet	−2.226	−4.041	−2.540	−5.068	−2.935	2.295
	(39)	(25)	(54)	(10)	(64)	

Panel B: Social distancing						
Variables	*N*	Mean	SD	Median	P25	P75
School	32,860	0.462	0.499	0	0	1
WorkPlace	32,860	0.142	0.349	0	0	0
PublicEvent	32,860	0.543	0.498	1	0	1
Gathering	32,860	0.274	0.446	0	0	1
InternalMovement	32,860	0.360	0.480	0	0	1
Travel	32,860	0.380	0.485	0	0	1
COV19Cases	32,860	26,178.500	163,558.900	234.5	0	4,410.5

Notes. Summary statistics of sample data. Panel A is for Google search indexes across 165 countries and stock market returns across 64 countries. Mainland China is excluded. Columns (1) and (2) show *SARSCase*=0 and 1 countries, respectively. Columns (3) and (4) show *SARSDeath*=0 and 1 countries, respectively. Columns (5) and (6) show the full sample. The mean values of *GoogleSARS*, *GoogleCoronavirus*, *CAR*, and *CumRet* are reported, with observation numbers in parentheses below. Panel B is for the country/date panel data on government social distancing policies and domestic COVID-19 development across 155 countries from January 1 to July 30, 2020. See the Appendix Table for detailed variable definitions.

COVID-19 is similar to SARS in many respects but quite different from other known pathogens, such as MERS and the influenza virus.[4] Hence, in this paper, we use SARS infections to measure past adverse experience.

3. Data and Summary Statistics

We collected data on the 2003 SARS epidemic from the WHO website. The first SARS patient was identified in the Guangdong province of China in November 2002, after which the disease spread to the other 28 countries. Ten out of these 28 countries across four continents reported SARS fatalities (see Table A1 in the online appendix). As of December 31, 2003, the WHO had reported 8,096 SARS cases worldwide, with a fatality rate of 9.6%. We obtain data for the COVID-19 pandemic from WHO and Johns Hopkins University, whose databases cover daily COVID-19 confirmed cases and deaths for 165 countries/territories.

To measure Google search attention, we used two keywords: "SARS" and "coronavirus." Google Trends provides search index measures ranging from zero (i.e., no search on the keyword) to 100 (i.e., peak popularity for the keyword), which represents search interests relative to the highest point for a given region and time. We obtained cross-sectional data for 165 countries from the "Interest By Region" section to compare relative search intensities among regions. For countries with low search volumes, the search indexes were missing, and we replaced them with zero. Panel A of Table 1 shows the summary statistics. From January 20 to 31, 2020, the average Google search index values for the keywords "SARS" and "coronavirus" were 2.848 and 9.930, respectively. Among *SARSCase*=0 countries, the average *GoogleSARS* and *GoogleCoronavirus* were 0.661 and 6.288, respectively. These numbers were much higher for *SARSCase*=1 countries (i.e., 13.554 and 27.750), especially for *SARSDeath*=1 countries (i.e., 25.6 and 33.2). This unconditional pattern suggests that people in countries with SARS imprints paid more attention to COVID-19-related information, especially people in countries with SARS deaths.

Moreover, we obtained information for government social distancing policies from the Oxford COVID-19 Government Response Tracker (OxCGRT) for the following six categories: school closure, workplace closure, public events cancellation, gathering restrictions, restrictions on internal movement between cities/regions, and international travel controls (Hale et al. 2020). As shown in Panel B of Table 1, closing schools

Table 2. Imprints of SARS (Google Search Indexes)

	Full sample				Excluding Asia	
	Panel A: SARS searches					
Variables	(1) *Google SARS*	(2) *Google SARS*	(3) *Google SARS*	(4) *Google SARS*	(5) *Google SARS*	(6) *Google SARS*
SARSCase	5.282**	5.527**			5.167*	
	(2.33)	(2.29)			(1.75)	
SARSDeath			16.477***	16.595***		13.721*
			(3.37)	(3.34)		(1.86)
Controls	YES	YES	YES	YES	YES	YES
Continent FE	NO	YES	NO	YES	YES	YES
Observations	165	165	165	165	124	124
Adjusted R^2	0.562	0.554	0.648	0.641	0.340	0.522

	Full sample				Excluding Asia	
	Panel B: Coronavirus searches					
Variables	(1) *Google Coronavirus*	(2) *Google Coronavirus*	(3) *Google Coronavirus*	(4) *Google Coronavirus*	(5) *Google Coronavirus*	(6) *Google Coronavirus*
SARSCase	12.679***	15.469***			18.516***	
	(2.72)	(3.69)			(4.29)	
SARSDeath			17.878**	20.824***		17.071***
			(2.17)	(2.84)		(3.06)
Controls	YES	YES	YES	YES	YES	YES
Continent FE	NO	YES	NO	YES	YES	YES
Observations	165	165	165	165	124	124
Adjusted R^2	0.361	0.509	0.355	0.497	0.636	0.586

Notes. Results of cross-sectional OLS regressions of Google search indexes on SARS imprints during the initial COVID-19 outbreak in Wuhan. In Panel A (B), the dependent variable, *GoogleSARS* (*GoogleCoronavirus*), is the Google search index for keyword "SARS" ("coronavirus") from January 20 to 31, 2020. The main independent variable, *SARSCase* (*SARSDeath*), is an indicator denoting the country that had SARS cases (deaths). *Log*(*GDP*), *Log*(*Popu*), *Log*(*AvgCOV19*), *TradeIntensity*, *LifeExpectancy*, and *Log*(*GovDebt*) are controlled in all columns. Mainland China is excluded. See the Appendix Table for detailed variable definitions. Robust standard errors are used, and *t*-statistics are reported in parentheses.

***Statistical significance at the 1% level; **statistical significance at the 5% level;*statistical significance at the 10% level.

and canceling public events were the most frequently implemented government policies, whereas closing workplaces was the least frequently implemented policy. Of the 155 countries in our sample, 147 countries implemented school closures at all levels, and 99 countries implemented workplace closures for all nonessential industries.

4. Empirical Analyses and Results

4.1. The Imprint of the 2003 SARS Epidemic

We began our analysis by estimating whether an imprint of the 2003 SARS experience existed during the initial COVID-19 outbreak in Wuhan. Specifically, we performed an OLS regression of Google search indexes for SARS during the two-week window from January 20 to January 31, 2020, on the country's SARS experience. This two-week window covers the entire first government response in China and broad media coverage of COVID-19, as described in Section 2.1.[5] Formally, the regression can be expressed as follows:

$$GoogleSARS_i = \alpha + \beta \times SARSCase_i + Controls_i + Fixed\ \ Effects + \varepsilon_i, \quad (1)$$

where $GoogleSARS_i$ indicates the Google search index for the keyword "SARS" in country i during the initial outbreak in Wuhan; $SARSCase_i$ is an indicator variable denoting that country i has recorded domestic SARS cases. Panel A of Table 2 shows the results. In column (1), the coefficient on *SARSCase* is 5.282 at the 5% significance level. Given that the average *GoogleSARS* among *SARSCase* = 0 countries is 0.661, the search attention for SARS-related information is about eight times (5.282/0.661 = 7.991) higher in countries with SARS experience.

Furthermore, we use $SARSDeath_i$ as the main independent variable in the regression, an indicator variable denoting that country i has recorded domestic SARS deaths. In column (3), the coefficient on *SARSDeath* is 16.477 at the 1% significance level, suggesting that people in countries with SARS fatalities searched about 12 times (16.477/1.381 = 11.931) more intensively than people in countries without SARS fatalities. These results suggest that the 2003 SARS experience left an imprint in the memories of people who started to search for SARS information at the very beginning of the COVID-19 outbreak in China, and the experience of SARS deaths left an even stronger imprint. In addition, people in countries without SARS deaths started to pay attention to SARS and COVID-19-related information much later, at the beginning of March, when COVID-19 spread widely outside of China (see Figure A2 in the online appendix).

In Panel B, we use "coronavirus" as the Google search keyword to estimate the attention to COVID-19-related information in late January, since the WHO did not officially name the pandemic "COVID-19" until March 11, 2020. In column (1), the coefficient on *SARSCase* is 12.679 at the 1% significance level, suggesting that people in countries with SARS cases searched for coronavirus-related information about two times (12.679/6.288 = 2.016) more intensively than people in countries without SARS experience.

In addition to the imprint hypothesis, several alternative mechanisms may explain the higher search attention for SARS. First, the countries that recorded SARS infections might be more vulnerable to COVID-19 as well, given the similarity between the two viruses, which were also both discovered in mainland China. To mitigate this concern, we excluded mainland China from our analyses to estimate other countries' responses before COVID-19 spread globally. Google is also restricted in mainland China.

Second, 13 of the 28 countries that suffered from SARS in 2003 are in Asia and are geographically close to mainland China. Those countries could be more seriously affected by COVID-19. We control for the average number of daily new COVID-19 cases in this window, which measures the severity of the domestic COVID-19 situation. Only four out of the 165 countries had more than 10 confirmed COVID-19 cases as of January 31, 2020. Furthermore, we control for life expectancy to proxy for the robustness of a country's healthcare systems, the size of the government debt to proxy for the government's fiscal capacity to combat COVID-19, GDP, and population.[6] We also control for countries' trade intensity with China to mitigate the concern that economic proximity to mainland China could explain the higher attention to COVID-19.

Third, in columns (2) and (4), to further mitigate the concern of geographic proximity to mainland China, we included continent fixed effects to use the variation within continent and found consistent results. Moreover, in columns (5) and (6), we excluded Asian countries and restricted our sample to the other continents, mainly countries in Europe, North America, and Africa. The coefficients on *SARSCase* and *SARSDeath* are both significantly positive. These findings serve as strong evidence that even in non-Asian countries such as Europe, people in countries affected by SARS in 2003 paid significantly greater attention to the COVID-19 outbreak in Wuhan even when there were zero (or close to zero) domestic cases.[7]

Table 3. SARS Experience, Attention, and Return

Variables	(1) *CAR*	(2) *CumRet*	(3) *CAR*	(4) *CAR*	(5) *CumRet*	(6) *CumRet*
GoogleSARS	−0.044**	−0.049*				
	(−2.63)	(−1.80)				
$\widehat{GoogleSARS}_{Case}$			−0.065*		−0.123**	
			(−1.75)		(−2.20)	
$\widehat{GoogleSARS}_{Death}$				−0.074***		−0.142***
				(−3.07)		(−3.60)
Controls	YES	YES	YES	YES	YES	YES
Continent FE	YES	YES	YES	YES	YES	YES
Observations	64	64	64	64	64	64
Adjusted R^2	0.469	0.362	0.433	0.453	0.364	0.416

Notes. Results of cross-sectional OLS regressions of stock market returns during the initial COVID-19 outbreak in Wuhan on SARS imprints for 64 markets (mainland China is excluded). The dependent variable *CAR* (*CumRet*) is the cumulative abnormal return (cumulative return) from January 20 to 31, 2020. $\widehat{GoogleSARS}_{Case}$ ($\widehat{GoogleSARS}_{Death}$) is the predicted Google search index using *SARSCase* (*SARSDeath*). *Log*(*GDP*), *Log*(*Popu*), *Log*(*AvgCOV19*), *TradeIntensity*, *LifeExpectancy*, and *Log*(*GovDebt*) are controlled in all columns. See the Appendix Table for detailed variable definitions. Robust standard errors are used, and *t*-statistics are reported in parentheses.

***Statistical significance at the 1% level; **statistical significance at the 5% level; *statistical significance at the 10% level.

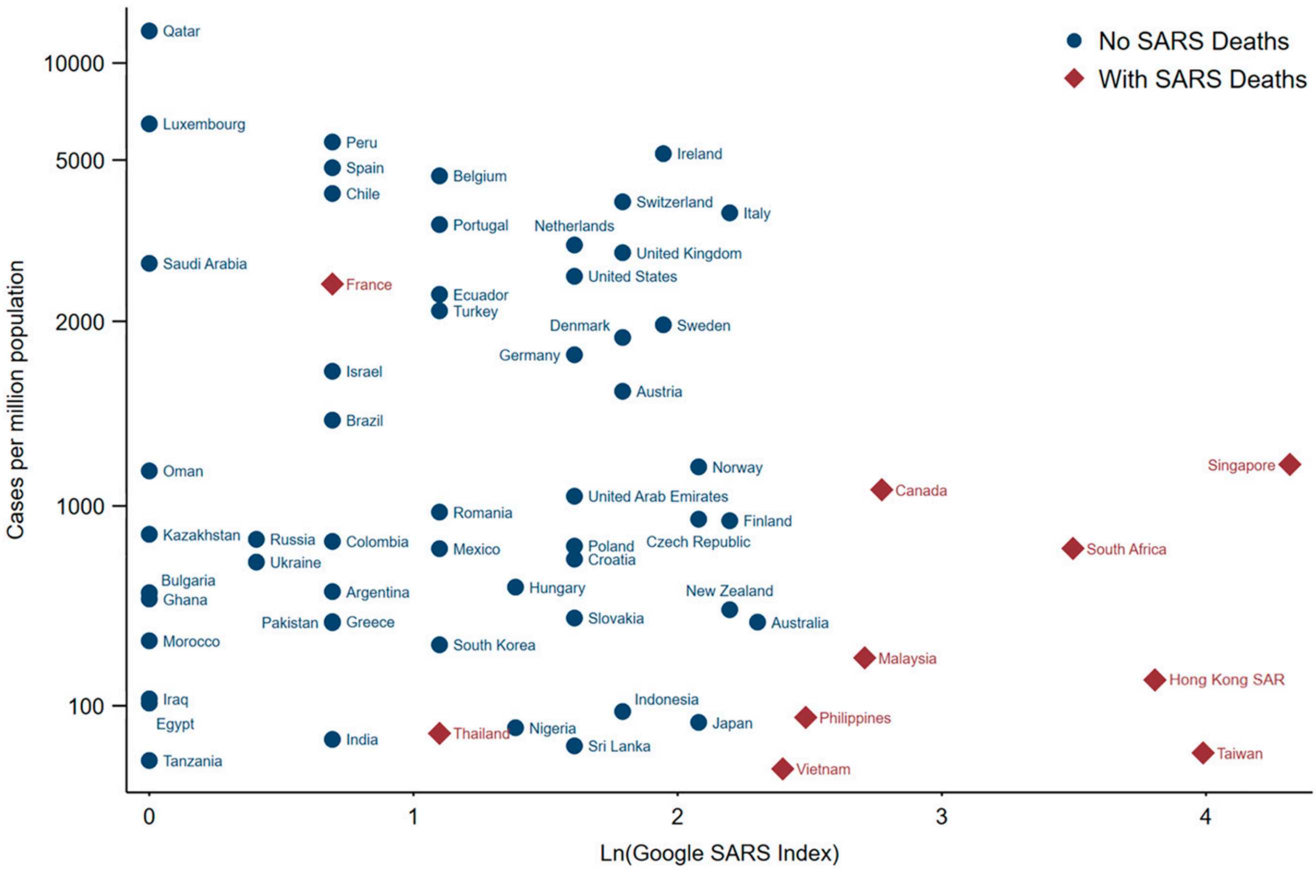
4.2. Attention, Stock Market Reaction, and SARS Imprints

This section further examines the relation between the increased search attention in Google and the stock market performance at the beginning of the pandemic. Specifically, we obtained stock market index data from Thomson Reuters Eikon for the biggest 65 markets, which comprised more than 99% of the total global stock market capitalization in 2018. We chose the MSCI World Price Index as the global market index.

Following the seminal work by Da et al. (2011, 2015), we regressed *CAR* from January 20 to January 31, 2020, on Google search indexes for SARS. Table 3 reports the regression results. In column (1), the coefficient on *GoogleSARS* is −0.044 at the 5% significance level, suggesting that increased search attention is associated with decreases in the stock market. In column (2), we calculated the cumulative return and obtained similar results.

Next, we explored whether the SARS imprint explains the association between Google search attention and stock market returns. For these 64 countries, we repeated the regression in column (2) of Table 2, Panel A, and calculated the predicted *GoogleSARS*. Then, we performed the regression of *CAR* on predicted *GoogleSARS*. In column (3) of Table 3, the coefficient on $\widehat{GoogleSARS}_{Case}$ is −0.065, suggesting that a one-standard deviation increase in Google search attention explained by the SARS imprint led to a 61.35 (9.439 × 0.065) basis point drop in *CAR*. In column (4), we used *SARSDeath* to predict *GoogleSARS* and found that the coefficient on $\widehat{GoogleSARS}_{Death}$ is −0.074, which is larger than that in

Figure 1. (Color online) COVID-19 Development, Google Search, and SARS Imprints



Notes. This figure shows the scatter plot of COVID-19 development and Google search attention across 64 countries/territories (mainland China is excluded). The vertical axis displays the cumulative number of COVID-19 cases per million population on the 90th day since the first confirmed domestic case. The horizontal axis displays the natural logarithm of one plus the Google search index for the keyword "SARS" from January 20 to 31, 2020. Diamonds and circles denote countries/territories with and without SARS deaths, respectively.

column (3), suggesting a deeper imprint resulting from SARS deaths and a stronger stock market reaction. In columns (5) and (6), we again used cumulative return as dependent variable and obtained similar results.

4.3. Government Actions to Combat COVID-19 Outbreaks

In this section, we aim to understand the impact of SARS imprints on government actions to combat domestic COVID-19 outbreaks. Figure 1 shows the scatter plot of Google search indexes for "SARS" from January 20 to January 31, 2020, versus the cumulative COVID-19 cases per million population on the 90th day since the first confirmed domestic case. The countries with SARS deaths are clustered in the bottom-right corner, suggesting that the SARS imprint is associated with higher search attention and lower COVID-19 infections.

One of the major criticisms of government containment measures is the slow response to COVID-19. We employed the Cox proportional hazard model to study the association between the likelihood of implementing various containment measures (e.g., lockdowns) and the SARS imprint. Formally, the regression can be expressed as follows:

$$h_i(t) = h_0(t)\exp\Big(\beta_1 \times Log(COV19Cases)_{i,t} + \beta_2 \times Log(COV19Cases)_{i,t} \times SARSCase_i + \beta_3 \times SARSCase_i + Controls_i + Continent\ FE\Big), \quad (2)$$

where $h_i(t)$ is the expected hazard at date t for country i; $h_0(t)$ is the baseline hazard and represents the hazard when all of the predictors are equal to zero; $Log(COV19Cases)_{i,t}$ is the natural logarithm of one plus the cumulative number of confirmed COVID-19 cases in country i on date t; and $Controls_i$ includes life expectancy, government debt, GDP, population, and trade intensity with China. We also control for continent fixed effects. Each country enters the hazard regression on the date of its first confirmed domestic COVID-19 case and exits after the respective policy takes effect. We cluster the standard errors by date to allow the correlation of errors across countries.

The sample contains 155 countries worldwide for which we have data on government actions. We

Table 4. Policy Responses to Combat COVID-19

Variables	(1) *School*	(2) *WorkPlace*	(3) *Public Event*	(4) *Gathering*	(5) *Internal Movement*	(6) *Travel*
Panel A: SARS Case						
Log(*COV19Cases*)	0.294***	0.202***	0.393***	0.040	0.225***	0.122
	(4.15)	(3.02)	(3.42)	(0.70)	(3.61)	(1.49)
Log(*COV19Cases*)×*SARSCase*	0.469***	0.405***	0.341***	0.437***	0.261***	0.197***
	(5.60)	(5.89)	(3.45)	(5.48)	(3.15)	(3.25)
Controls	YES	YES	YES	YES	YES	YES
Continent FE	YES	YES	YES	YES	YES	YES
Observations	3,060	11,036	3,033	10,121	6,420	7,551
Chi-Squared	127.9	147.2	119.5	118.6	63.62	66.96
Panel B: SARS Death						
Log(*COV19Cases*)	0.373***	0.273***	0.459***	0.101**	0.283***	0.167**
	(5.00)	(4.40)	(4.23)	(2.12)	(4.93)	(2.22)
Log(*COV19Cases*)×*SARSDeath*	0.608**	1.138***	0.773***	0.485***	0.748***	0.637***
	(2.38)	(5.25)	(3.36)	(3.24)	(3.58)	(4.89)
Controls	YES	YES	YES	YES	YES	YES
Continent FE	YES	YES	YES	YES	YES	YES
Observations	3,060	11,036	3,033	10,121	6,420	7,551
Chi-squared	122.8	173.8	96.41	70.57	87.80	64.92

Notes. Results of Cox proportional hazard regressions for policy responses to COVID-19 at the country/date level. Each country entered the hazard regression (origin date) when the country reported its first COVID-19 case. The failure date is the date when the respective policy took effect. *Log*(*COV19Cases*) is the natural logarithm of one plus the number of concurrent cumulative confirmed cases. *SARSCase* (*SARSDeath*) is an indicator denoting the country had SARS cases (deaths). *SARSCase* (*SARSDeath*), *Log*(*GDP*), *Log*(*Popu*), *TradeIntensity*, *LifeExpectancy*, and *Log*(*GovDebt*) are controlled in all columns. Mainland China is excluded. See the Appendix Table for detailed variable definitions. Standard errors are clustered at the calendar date level, and *t*-statistics are reported in parentheses.
***Statistical significance at the 1% level; **statistical significance at the 5% level; *statistical significance at the 10% level.

estimate the hazard probabilities for six different containment measures in Table 4. Panel A uses *SARSCase* to proxy for the SARS imprint, and Panel B uses *SARSDeath*. In columns (1) to (6) of Panel A, the coefficients on *Log*(*COV19Cases*) are all positive, suggesting that the likelihood of enforcing these containment measures is higher when there are more contemporaneous COVID-19 cases. Moreover, in columns (1) to (6), the coefficients on *Log*(*COV19Cases*)×*SARSCase* are all significantly positive, suggesting that the positive associations between COVID-19 case number and the likelihood of containment measures are higher in countries with SARS imprints: governments with SARS experience respond more quickly to domestic outbreaks than governments without SARS experience.

For example, for school closure in column (1), a 100% increase in the COVID-19 case number yields a hazard ratio equal to 1.226 (Exp(0.294×Ln(2))=1.226) in countries without SARS experience, indicating that the rate of school closure increases by 22.6%. For countries with SARS cases, a 100% increase in the COVID-19 case number leads to a 69.7% increase in the rate of school closure (Exp((0.294 + 0.469)×Ln(2))-1).

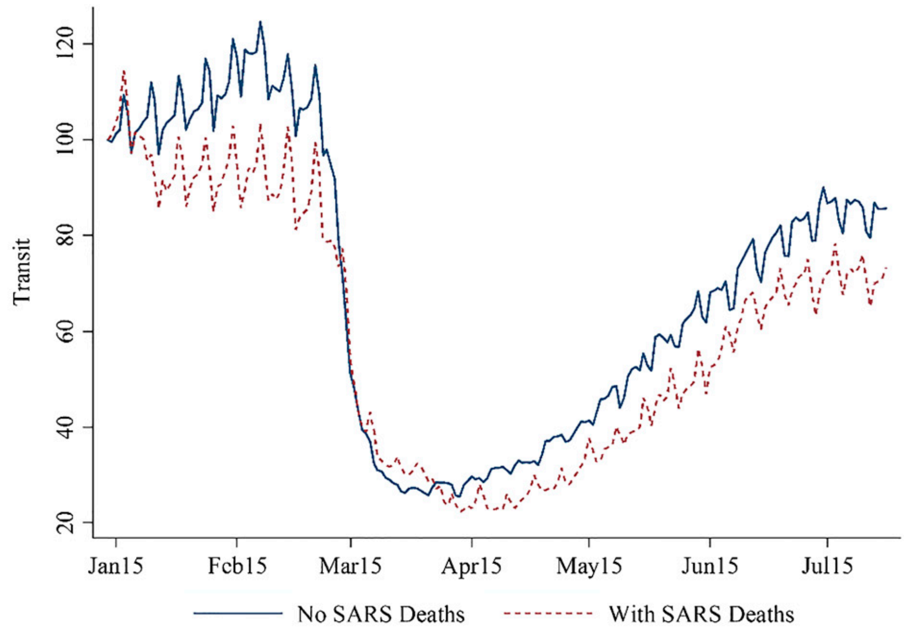
In Panel B, we use *SARSDeath* to proxy for the SARS imprint and find similar but stronger results. These findings are consistent with Table 2, which shows that the imprint of SARS experience, especially SARS deaths, plays an important role in how a country later copes with similar crises. Again, we restrict the sample to non-Asian countries and find consistent results for all six containment measures (see Table A4 in the online appendix).

Figure 2 shows that people's daily transit movements are substantially lower in countries with SARS deaths (i.e., dashed line) than in other countries without SARS deaths (i.e., solid line) during both the beginning of the pandemic (January to early March) and the reopening stages (May to July). Many countries started to implement social distancing rules in March and relaxed those rules gradually beginning in May. In summary, both governments and individuals with SARS imprints started social distancing earlier and were more cautious in the reopening stage.[8] This could explain the lower infection rates in such countries, as suggested in Figure 1.

5. Conclusion

The current COVID-19 pandemic is a once-in-a-century global crisis. A universally accepted tenet of public health is that healthcare systems should respond to pandemics as early and as intensively as possible. Although many countries have been working hard to combat this disease, COVID-19 has nevertheless spread dramatically in many parts of the world, and its impacts are detrimental to human life and well-being. Although we document the impact of SARS experience on individual and governmental responses to COVID-19, understanding the long-term consequences of this pandemic experience will be left for future research.

Figure 2. (Color online) SARS Experience and Residential Mobility



Notes. This figure shows the average transit movement trend for two groups of countries from January 13 to July 30, 2020, based on Apple mobility data. The vertical axis represents the daily number of requests made to Apple Maps for directions by transportation type "Transit," which is normalized to 100 on January 13, 2020, for each country. Dashed and solid lines represent the countries with and without SARS deaths, respectively. Figure A3 in the online appendix shows the pattern for transportation types "Walking" and "Driving".

Acknowledgments

The authors thank Xin Chang, Zuzana Fungáčová, Zhiguo He, Yi Huang, Jun-Koo Kang, Andrew Karolyi, Laura Liu, Angie Low, Linlin Ma, Yueran Ma, Andrey Malenko, John Matsusaka, Wenlan Qian, Antoinette Schoar, Srinivasan Selvam, Richard Thakor, Pengfei Wang, Xin Wang, Tak-Jun Wong, Liyan Yang, Jake Zhao, Haoxiang Zhu (Editor), Luo Zuo, the anonymous associate editor, and two anonymous referees for their helpful comments. The authors also thank the participants in the seminars at Bank of Finland, NTU, PKU, PKU HSBC Business School, and the USC China workshop. Please send correspondence to Kunru Zou and Endong Yang. The views are the authors' own, and the authors are solely responsible for any errors.

Endnotes

[1] See further details in the World Bank's report, Global Economic Prospects: https://www.worldbank.org/en/publication/global-economic-prospects.

[2] Several contemporaneous studies examine the economic consequences of COVID-19 outbreaks in China and beyond as well as policy responses to the virus. For example, see Atkeson (2020), Baker et al. (2020), Barrot et al. (2020), Chen et al. (2020), Ding et al. (2020), Duan et al. (2020), Eichenbaum et al. (2020), Fahlenbrach et al. (2020), Feng et al. (2020), Gormsen and Koijen (2020), Hassan et al. (2020), Ramelli and Wagner (2020), and Stock (2020).

[3] See Figure A1 in the online appendix for the important events and dates of COVID-19 developments worldwide, from the first known case in December 2019 to March 2020, when it became a global pandemic.

[4] See, for example, "Sars-family' virus claims the second victim in China", BBC, January 16, 2020 (https://www.bbc.com/news/world-asia-china-51141007). Section 1.1 in the online appendix shows more detailed discussions for the similarities between SARS and COVID-19.

[5] Table A2 in the online appendix shows similar results for different time windows of the outbreak in Wuhan.

[6] We thank the editorial team for these useful suggestions.

[7] Following Ding et al. (2020a), we compare Google search attention before and after the date at which each country surpassed 100 COVID-19 cases. Table A3 in the online appendix shows that people in countries with SARS cases paid significantly more attention to COVID-19 following domestic outbreaks.

[8] Table A5 in the online appendix shows similar results obtained via multivariate analysis.

Appendix Table: Variable Definitions

Variable names	Variable definitions
SARSCase	An indicator variable that equals one if the country had SARS cases and zero otherwise.
SARSDeath	An indicator variable that equals one if the country had SARS deaths and zero otherwise.
GoogleSARS	Google search index for keyword "SARS" from January 20 to January 31, 2020. For countries with low search volumes, the search indexes are missing, and we replace them with zero.
GoogleCoronavirus	Google search index for keyword "coronavirus" from January 20 to January 31, 2020. For countries with low search volumes, the search indexes are missing, and we replace them with zero.
Log(*GDP*)	Natural logarithm of the country's GDP (in U.S. dollars) (World Bank Database).
Log(*Popu*)	Natural logarithm of the country's total population (World Bank Database).
Log(*AvgCOV19*)	Natural logarithm of one plus the average daily new COVID-19 cases from January 20 to January 31, 2020.
CAR	Cumulative abnormal return, computed as the sum of abnormal daily returns (in percentage points) from January 20 to January 31, 2020, where the abnormal return is calculated based on the market model: $Abnormal\ Return_{i,t} = Ret_{i,t} - \widehat{\alpha}_i - \widehat{\beta}_{1i,t-1} Ret_{M,t-1} - \widehat{\beta}_{2i} Ret_{M,t} - \widehat{\beta}_{3i} Ret_{M,t+1}$, where $\widehat{\alpha}_i$, $\widehat{\beta}_{1i}$, $\widehat{\beta}_{2i}$, and $\widehat{\beta}_{3i}$ are estimated in the pre-event window period from July 1 to December 31, 2019, $Ret_{i,t}$ is the index return in country/territory i on date t, and $Ret_{M,t}$ is the return of the global market index (i.e., the MSCI World Price Index).
CumRet	Cumulative return computed as the sum of daily returns (in percentage points) of the stock index from January 20 to January 31, 2020 (Thomson Reuters Eikon Database).
TradeIntensity	The ratio between the country's trade amount with China and its total trade amount calculated using 2018 data, where trade amount equals the sum of imports and exports (United Nations ComTrade Database).
LifeExpectancy	The average number of years an individual in the country is expected to live (United Nations Population Division Database).
Log(*GovDebt*)	Natural logarithm of one plus the country's government debt amount (in U.S. dollars). (IMF Database).
School	An indicator variable that equals one when the school closure policy is enforced at all levels in the country and zero before the policy takes effect.
Workplace	An indicator variable that equals one when the work-from-home policy is enforced for all but essential workplaces in the country and zero before the policy takes effect.
PublicEvent	An indicator variable that equals one when the country requires public events to be canceled and zero before the policy takes effect.
Gathering	An indicator variable that equals one when the country bans gatherings of 10 people or more and zero before the policy takes effect.
InternalMovement	An indicator variable that equals one when the country restricts domestic transit between cities/regions and zero before the policy takes effect.
Travel	An indicator variable that equals one when the country closes its border (i.e., an international travel ban) and zero before the policy takes effect.
Log(*COV19Cases*)	Natural logarithm of one plus the country's cumulative number of COVID-19 cases at date t.

References

Atkeson A (2020) What will be the economic impact of COVID-19 in the US? Rough estimates of disease scenarios. NBER Working Paper No. 26867, National Bureau of Economic Research, Cambridge, MA.

Baker SR, Bloom N, Davis SJ, Kost KJ, Sammon MC, Viratyosin T (2020) The unprecedented stock market impact of COVID-19. NBER Working Paper No. 26945, National Bureau of Economic Research, Cambridge, MA.

Barrot JN, Grassi B, Sauvagnat J (2020) Costs and benefits of closing businesses in a pandemic. Working paper, HEC Paris, Paris.

Bayus BL, Agarwal R (2007) The role of pre-entry experience, entry timing, and product technology strategies in explaining firm survival. *Management Sci.* 53(12):1887–1902.

Benmelech E, Frydman C (2015) Military CEOs. *J. Financial Econom.* 117(1):43–59.

Bernile G, Bhagwat V, Rau PR (2017) What doesn't kill you will only make you more risk-loving: Early-life disasters and CEO behavior. *J. Finance* 72(1):167–206.

Billett MT, Qian Y (2008) Are overconfident CEOs born or made? Evidence of self-attribution bias from frequent acquirers. *Management Sci.* 54(6):1037–1051.

Chen H, Qian W, Wen Q (2020) The impact of the COVID-19 pandemic on consumption: Learning from high frequency transaction data. Working paper, Wang Yanan Institute for Studies in Economics, Department of Finance, School of Economics, Xiamen University, Xiamen, China.

Chernenko S, Hanson S, Sunderam A (2016) Who neglects risk? Investor experience and the credit boom. *J. Financial Econom.* 122 (2):248–269.

Chiang YM, Hirshleifer D, Qian Y, Sherman A (2011) Do investors learn from experience? Evidence from frequent IPO investors. *Rev. Financial Stud.* 24(5):1560–1589.

Da Z, Engelberg J, Gao P (2011) In search of attention. *J. Finance* 66 (5):1461–1499.

Da Z, Engelberg J, Gao P (2015) The sum of all FEARS: Investor sentiment and asset prices. *Rev. Financial Stud.* 28(1):1–32.

Ding H, Fan H, Lin S (2020) COVID-19, firm exposure, and firm value: A tale of two lockdowns. Working paper, School of International Business Administration, Shanghai University of Finance and Economics, Shanghai, China.

Ding W, Levine R, Lin C, Xie W (2020a) Corporate immunity to the COVID-19 pandemic. *J. Financial Econom.* Forthcoming.

Ding W, Levine R, Lin C, Xie W (2020b) Social distancing and social capital: Why U.S. counties respond differently to COVID-19. NBER Working Paper No. 27393, National Bureau of Economic Research, Cambridge, MA.

Duan H, Wang S, Yang C (2020) Coronavirus: limit short-term economic damage. *Nature* 578(7796):515.

Eichenbaum MS, Rebelo S, Trabandt M (2020) The macroeconomics of epidemics. NBER Working Paper No. 26882, National Bureau of Economic Research, Cambridge, MA.

Elder GH (1986) Military times and turning points in men's lives. *Developmental Psych.* 22(2):233–245.

Elder GH (1998) *Children of the Great Depression*, 25th Anniversary Edition. (Westview Press, Boulder, CO).

Fahlenbrach R, Rageth K, Stulz RM (2020) How valuable is financial flexibility when revenue stops? Evidence from the COVID-19 Crisis. Fisher College of Business Working Paper. No. 2020-03-007, Fisher College, Columbus, OH.

Feng Q, Wu LG, Yuan M, Zhou S (2020) What does cross-country data speak about COVID-19? Working paper, 1 Economics Division, School of Social Sciences, Nanyang Technological University, Singapore.

Gennaioli N, Shleifer A, Vishny R (2012) Neglected risks, financial innovation, and financial fragility. *J. Financial Econom.* 104(3): 452–468.

Gibbons R, Waldman M (2006) Enriching a theory of wage and promotion dynamics inside firms. *J. Labor Econom.* 24(1):59–107.

Gormsen NJ, Koijen RS (2020) Coronavirus: Impact on stock prices and growth expectations. *Rev. Asset PricingStud* 10(4):574–597.

Guiso L, Sapienza P, Zingales L (2015) The value of corporate culture. *J. Financial Econom.* 117(1):60–76.

Hale T, Webster S, Petherick A, Phillips T, Kira B (2020) Oxford COVID-19 Government Response Tracker. Blavatnik School of Government, University of Oxford, Oxford, UK.

Hassan TA, Hollander S, Van Lent L, Tahoun A (2020) Firm-level Exposure to Epidemic Diseases: Covid-19, SARS, and H1N1. NBER Working Paper No. 26971, National Bureau of Economic Research, Cambridge, MA.

He X, Kothari SP, Xiao T, Zuo L (2018) Long-term impact of economic conditions on auditors' judgment. *Account. Rev.* 93(6): 203–229.

Huang X (2019) Mark Twain's Cat: Investment experience, categorical thinking, and stock selection. *J. Financial Econom.* 131(2):404–432.

Huang Y, Lin C, Wang P, Xu Z (2020) Saving China from the coronavirus and economic meltdown: experiences and lessons. Working paper, Graduate Institute of International and Development Studies, Geneva.

Kaplan SN, Klebanov MM, Sorensen M (2012) Which CEO characteristics and abilities matter? *J. Finance* 67(3):973–1007.

Kaustia M, Knüpfer S (2008) Do investors overweight personal experience? Evidence from IPO subscriptions. *J. Finance* 63(6): 2679–2702.

Knüpfer S, Rantapuska E, Sarvimäki M (2017) Formative experiences and portfolio choice: Evidence from the Finnish great depression. *J. Finance* 72(1):133–166.

Law K, Zuo L (2020) How does the economy shape the financial advisory profession? *Management Sci.*, ePub ahead of print September 3, https://doi.org/10.1287/mnsc.2020.3655.

Malmendier U, Nagel S (2011) Depression babies: Do macroeconomic experiences affect risk taking? *Quart. J. Econom.* 126(1): 373–416.

Malmendier U, Nagel S (2016) Learning from inflation experiences. *Quart. J. Econom.* 131(1):53–87.

Malmendier U, Pouzo D, Vanasco V (2020) Investor experience and financial market outcomes. *J. Financial Econom.* 136(3):597–622.

Malmendier U, Tate G, Yan J (2011) Overconfidence and early-life experiences: The effect of managerial traits on corporate financial policies. *J. Finance* 66(5):1687–1733.

Marquis C, Tilcsik A (2013) Imprinting: Toward a multilevel theory. *Acad. Management Ann.* 7(1):195–245.

NIH (2020) New coronavirus stable for hours on surfaces. National Institutes of Health (March 17), https://www.nih.gov/news-events/news-releases/new-coronavirus-stable-hours-surfaces/.

Oyer P (2006) Initial labor market conditions and long-term outcomes for economists. *J. Econom. Perspect.* 20(3):143–160.

Oyer P (2008) The making of an investment banker: Stock market shocks, career choice, and lifetime income. *J. Finance.* 63(6): 2601–2628.

Ramelli S, Wagner AF (2020) Feverish stock price reactions to COVID-19. *Rev. Corporate Finance Stud.* 9(3):622–655.

Schoar A, Zuo L (2017) Shaped by booms and busts: How the economy impacts CEO careers and management styles. *Rev. Financial Stud.* 30(5):1425–1456.

Stinchcombe AL (1965) Social structure and organizations. *Handbook of Organizations* (Rand-McNally, Chicago), 142–193.

Stock JH (2020) Data gaps and the policy response to the novel coronavirus. NBER Working Paper No. 26902, National Bureau of Economic Research, Cambridge, MA.