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ABSTRACT

A Literature Review of the Economics of COVID-19

The goal of this piece is to survey the emerging and rapidly growing literature on the economic consequences of COVID-19 and government response, and to synthetize the insights emerging from a very large number of studies. This survey (i) provides an overview of the data sets used to measure social distancing and COVID-19 cases and deaths; (ii) reviews the literature on the determinants of compliance and effectiveness of social distancing; (iii) summarizes the literature on the socio-economic consequences of COVID-19 and government interventions, focusing on labor, health, gender, discrimination and environmental aspects; and (iv) discusses policy proposals.

JEL Classification: E00, I15, I18, J20

Keywords: COVID-19, coronavirus, employment, lockdowns

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1 Introduction

The World has been gripped by a pandemic over the first half of 2020. It was identified as a new coronavirus (severe acute respiratory syndrome coronavirus 2, or SARS-CoV-2), and later named as Coronavirus Disease-19 or COVID-19 (Qiu et al., 2020). While COVID-19 originated in the city of Wuhan in the Hubei province of China, it has spread rapidly across the world, resulting in a human tragedy and tremendous economic damage. By mid-June, there had been over 8 million cases of COVID-19 globally, with over 436,000 deaths.

Given the rapid spread of COVID-19, countries across the World have adopted several public health measures intended to prevent its spread, including social distancing (Fong et al. (2020)).[1] As part of social distancing, businesses, schools, community centres, and non-governmental organization (NGOs) have been required to close down, mass gatherings have been prohibited, and lockdown measures have been imposed in many countries, allowing travel only for essential needs.[2] The goal is that through social distancing, countries will be able to "flatten the curve", i.e., reduce the number of new cases related to COVID-19 from one day to the next in order to halt exponential growth and hence reduce pressure on medical services (John Hopkins University, 2020a).

The spread of COVID-19 is expected to result in a considerable slowdown of economic activities. According to an early forecast of the International Monetary Fund (2020a), the global economy would contract by about 3 percent in 2020. The contraction is expected to be of far greater magnitude that that of the 2008-2009 Global Financial Crisis. However, in its latest update (June 2020), the International Monetary Fund (2020b) revised the forecast to 4.9 percent contraction in 2020. The report cites the following reasons for the updated forecast: i) greater persistence in social distancing activities; ii) lower activity during lockdowns; iii) steeper decline in productivity amongst firms which have opened up for business; and iv) greater uncertainty.[3] The economic implications will be wide-ranging and

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[1] According to Mandavilli (2020), this strategy saved thousands of lives both during other pandemics such as the Spanish flu of 1918 and more recently in Mexico City during their 2009 flu.

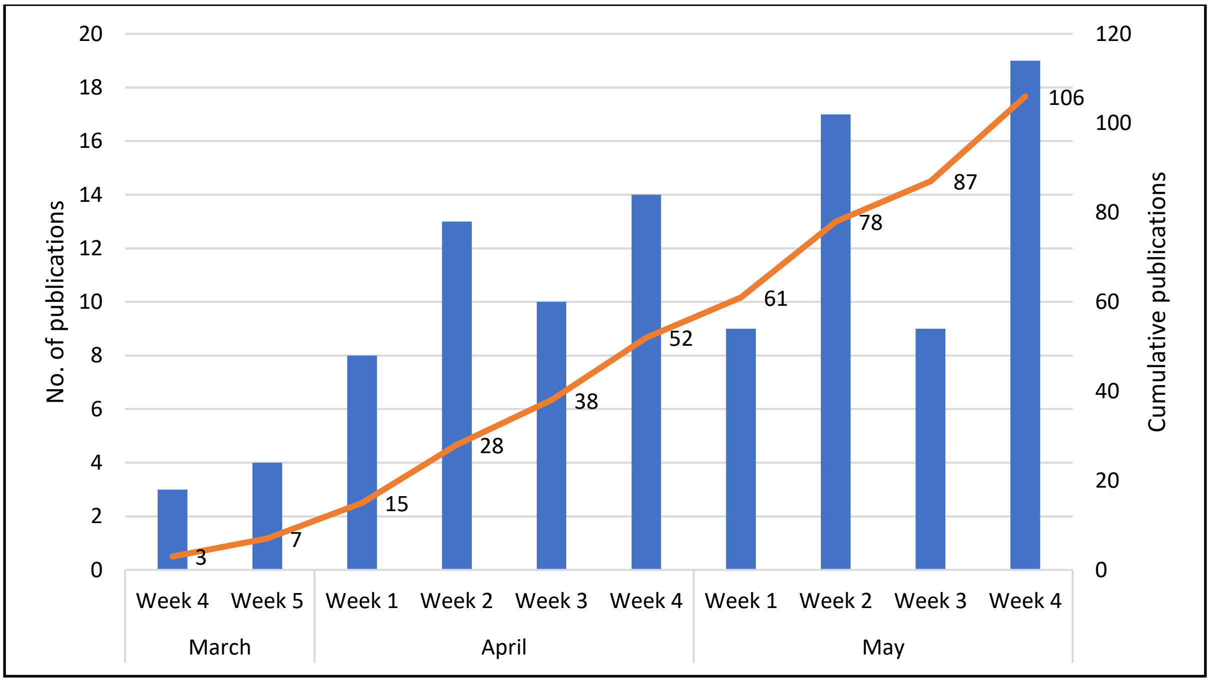
[2] According to CDC (2020), social distancing (or physical distancing) means keeping space between yourself and other people outside home. To practice social/physical distancing: i) stay at least 6 feet (about 2 arms' length) from other people: ii) do not gather in groups; and iii) avoid crowded places and mass gatherings.

[3] World Bank (2020) forecasts a 5.2 percent contraction in global GDP. Similarly, OECD (2020) forecasts a fall in global GDP by 6 percent to 7.6 percent, depending on the emergence of a second wave of COVID-19.

uncertain, with different effects on the labor markets, production supply chains, financial markets, and the World economy. The negative economic effects may vary by the stringency of the social distancing measures (e.g., lockdowns and related policies), its length of implementation, and the degree of compliance. In addition, the pandemic and the government intervention may lead to mental health distress, increased economic inequality, and affect some socio-demographic groups particularly adversely.

The goal of this piece is to survey the emerging literature on the economic consequences of COVID-19 and government response, and to synthesize the insights emerging from a growing number of studies. Figure 1 illustrates the number of National Bureau of Economic Research (NBER) working papers that have been released related to the pandemic between March 2020 and May 2020.[4] By the end of May, there had been 106 papers related to COVID-19. Similarly, over 60 discussion papers on the pandemic were released by the IZA Institute of Labor Economics[5] during March-May 2020.

Figure 1: COVID-19 Publications in NBER



Source: Author's Research drawn from the NBER website

[4] The list of NBER working papers is available here: https://www.nber.org/wp_covid19.html.
[5] The list of IZA discussion papers is available here: https://covid-19.iza.org/publications.

We hope our literature review will help better inform academic and policy debate. We list throughout our paper government responses and how they vary across local, provincial (or state), and federal governments. We investigate policies implemented not only aimed at mitigating the deaths and the morbidities related to COVID-19, i.e. the direct health and public health-related issues, but also those measures providing a cushion in the form of short-run income maintenance and subsidies to business. We also cover interventions aimed at addressing the more persistent scarring economic effects that are expected to manifest themselves in the longer run.

This paper will focus on five broad areas: i) measurement of spread of COVID-19 and social distancing, ii) the degrees of disease transmission, effectiveness, and compliance with social distancing, iii) economic and financial impacts of COVID-19, iv) socioeconomic consequences of lockdowns, and v) governmental response to the pandemic.

The rest of the paper is structured as follows. Section 2 focuses on the background of COVID-19, including a historical context of pandemics and evolution of COVID-19. Section 3 provides an outline on the measurement of COVID-19 and social distancing by documenting and describing the most popular data sources. Section 4 discusses the socioeconomic determinants and effectiveness of social distancing. Section 5 focuses on the economic and financial impacts, including the plausible mechanisms and economic modelling of infections. Section 6 reviews the literature on socioeconomic consequences of social distancing measures, focusing on the labor, health, gender, discrimination, and environmental aspects. Section 7 touches upon the policy measures. Section 8 provides the conclusion.

2 Background

2.1 History of Pandemics and Economic Impact

Pandemics are not new and have occurred at different stages in human history (Ferguson et al., 2020). Table 1 below provides a historical timeline of major pandemics across the World. While there have been many outbreaks and human catastrophes, there has been a notable rise in the frequency of pandemics from the year 2000 and thereafter. This is particularly due to increased emergence of viral disease amongst animals (Madhav *et al.*, 2017). Given the rise in the frequency of pandemics, many researchers including Garrett (2007), Keogh-Brown *et al.* (2008) and most recently Madhav et al. (2017) and Fan *et al.* (2018) argue that a large-scale global pandemic was inevitable. Ferguson *et al.* (2020) from the Imperial College London COVID-19 Response Team claim that COVID-19 is the most serious episode since the 1918 Spanish Influenza pandemic. Despite the comparisons, Barro (2020) concludes that the non-pharmaceutical interventions implemented during 1918 Spanish Influenza pandemic were not successful in reducing overall deaths. This was because the interventions were not maintained for a sufficiently long period of enough time. He estimates that the mean duration of school closings and prohibitions of public gatherings was only 36 days, whereas the mean duration of quarantine/isolation was 18 days (0.05 years). These numbers were quite small compared to the number of days that the 1918 Spanish influenza pandemic was active.

Table 1: Major Pandemics: Historical Timeline

Name	**Time Period**	**Type/Pre-human host**	**Estimated Death Toll**
Antonine Plague	165-180	Believed to be either smallpox or measles	5 million
Japanese smallpox epidemic	735-737	Variola major virus	1 million
Plague of Justinian	541-542	Yersinia pestis bacteria/rats, fleas	30 to 50 million
Black Death	1347-1351	Yersinia pestis bacteria/rats, fleas	200 million
New World Smallpox Outbreak	1520-onwards	Variola major virus	56 million
Great Plague of London	1665	Yersinia pestis bacteria/rats, fleas	100,000
Italian Plague	1629-1631	Yersinia pestis bacteria/rats, fleas	1 million

Cholera Pandemics 1-6	1817-1923	V. cholerae bacteria	1 million+
Third Plague	1885	Yersinia pestis bacteria/rats, fleas	12 million (China & India)
Yellow Fever	Late 1800s	Virus/Mosquitoes	100,000-150,000 (US)
Russian Flu	1889-1890	H2N2 (avian origin)	1 million
Spanish Flu	1918-1919	H1N1 virus/pigs	40 to 50 million
Asian Flu	1957-1958	H2N2 virus	1.1 million
Hong Kong Flu	1968-1970	H3N2 virus	1 million
HIV/AIDS	1981-present	Virus/chimpanzees	25 to 35 million
Swine Flu	2009-2010	H1N1 virus/pigs	200,000
SARS	2002-2003	Coronavirus/bats, civets	770
Ebola	2014-2016	Ebolavirus/ wild animals	11,000
MERS	2015-present	Coronavirus/bats, camels	850

Source: World Economic Forum (2020)

Pandemics are expected to have a severe negative impact on economic activities, at least in the short run. According to Jonas (2013), the impact ranges from: i) avoidance reaction due to social distancing measures (e.g., individuals might forgo consumption and purchases of certain goods and services), ii) small direct costs (e.g., hospitalization and medical costs), iii) larger indirect costs (loss of labor, production), and iv) offsetting and cascading effects (disruption of services, travel and others). A number of studies tried to anticipate the economic loss from a pandemic.[6] For example, Jonung and Roeger (2006) forecasted that a hypothetical global pandemic would lead to 1.6 percent drop in GDP for the European Union

[6] Please see Boissay & Rungcharoenkitkul (2020, p. 2) for a list of studies estimating the economic loss from past or hypothetical pandemics.

(EU) due to both demand and supply side factors. Other studies analyze the impact with a historical comparison. For example, 'how would the casualty numbers during the 1918 Spanish Influenza pandemic transpire today?' Barro *et al.* (2020) estimate that, holding everything else constant, the 2.1 percent death rate during the Spanish Influenza pandemic in 1918-1920 would translate to roughly 150 million deaths worldwide (compared to the World's population of 7.5 billion in 2020) during COVID-19 pandemic. The authors also find that, on average, the 2.1 percent death rate corresponds to 6 percent decline in GDP and 8 percent fall in private consumption.

2.2 Evolution of COVID-19

According to Zhu *et al.* (2020), the first pneumonia case was discovered on December 8, 2019 in a wet market in Wuhan, the capital city of Hubei Province of China. Afterwards, several clusters of patients with such pneumonia were reported throughout late December 2019. Table 2 below provides a timeline of key events, starting from January 2020.

Table 2: COVID-19 - Timeline

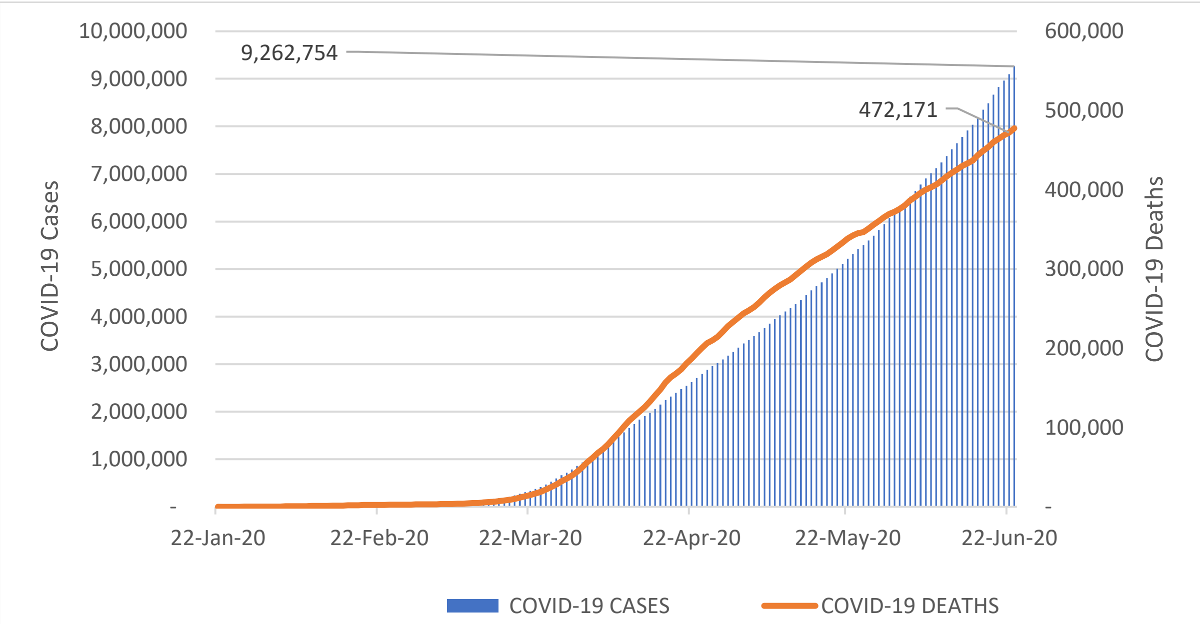
Date	Events
4 January 2020	WHO reports cluster of pneumonia cases in Wuhan, Hubei, China
7 January 2020	WHO identifies COVID-19
11 January 2020	China announces 1st death from COVID-19
13 January 2020	1st official case of COVID-19 reported outside China in Thailand
17 January 2020	Authorities in the Nepal, France, Australia, Malaysia, Singapore, South Korea, Vietnam and Taiwan confirm cases
21 January 2020	1st case of COVID-19 reported in the United States of America (US)
22 January 2020	WHO finds evidence of human-to-human transmission from China
23 January 2020	China imposes lockdown in the cities of Wuhan, Xiantao and Chibi of the Hubei province
30 January 2020	WHO declares COVID-19 to be a Public Health Emergency of International Concern
31 January 2020	US declares COVID-19 a domestic public health emergency

2 February 2020	1st death due to COVID-19 outside of China in Philippines
9 February 2020	The death toll in China surpasses that of 2002-03 Severe Acute Respiratory Syndrome (SARS)
14 February 2020	Egypt reports 1st case of COVID-19, the 1st case in the African continent
15 February 2020	France reports 1st death from COVID-19 outside of Asia
23 February 2020	COVID-19 cases rise in Italy in what becomes the largest outbreak outside of Asia
26 February 2020	Brazil confirms 1st case of COVID-19, the 1st case in South America
27 February 2020	1st case of community transmission reported in the US
29 February 2020	1st death due to COVID-19 in the US
8 March 2020	Over 100 countries report COVID-19 cases Italy imposes quarantine in Lombardy region
11 March 2020	WHO declares COVID-19 a pandemic
13 March 2020	Donald Trump declares national emergency in the US
17 March 2020	All 50 states in US have at least one confirmed case of COVID-19 California first state to implement 'stay-at-home' order in US
19 March 2020	Italy's death toll surpasses that of China
21 March 2020	EU suspends public deficit rules to inject fiscal stimulus across countries
25 March 2020	The White House and Senate leaders of both the Democratic and Republican parties in the US come to an agreement on a US$2 trillion stimulus to aid workers, businesses, and the health-care system in response to the pandemic
26 March 2020	US leads the world in COVID-19 cases
2 April 2020	Global cases of COVID-19 reach 1 million
8 April 2020	China lifts lockdown in Wuhan, 76 days after it was sealed off to contain COVID-19
11 April 2020	US records 2,000 deaths in one day, the highest single-day death toll recorded by any country

15 April 2020	Global cases of COVID-19 reach 2 million
24 April 2020	US's death toll surpasses 50,000
27 April 2020	Global cases of COVID-19 reach 3 million
28 April 2020	COVID-19 cases in US surpass 1 million
21 May 2020	Global cases of COVID-19 surpass 5 million
22 May 2020	Brazil surpasses Russia as the country with the 2nd highest number of cases, after the US
27 May 2020	US's death toll surpasses 100,000

Figure 2 shows the cumulative cases and deaths from the COVID-19 pandemic. Note that both cases and deaths started rising from March 2020. As of 23 June, total, cumulative cases were over 9.2 million, while there were over 470,000 deaths across the World. Table 3 lists the top 10 countries in terms of COVID-19 cases and deaths. The table shows that US, UK, Brazil, and some countries in the European Union (Italy, France, Spain, Germany) are in the top 10 in terms of COVID-19 cases and deaths.

Figure 2: COVID-19 Cases and Deaths – Global Pandemic (as on 23 June)



Source: Data from the Coronavirus Resource Center, John Hopkins University

Table 3: Cumulative Cases: Top 10 Countries (as of 23 June)

Rank	Country	Confirmed Cases (Cumulative)	Country	Confirmed Deaths (Cumulative)
1	US	2,364,874	US	121,662
2	Brazil	1,145,906	Brazil	52,645
3	Russia	606,043	UK	43,165
4	India	456,183	Italy	34,644
5	UK	308,334	France	29,723
6	Peru	260,810	Spain	28,327
7	Chile	254,416	Mexico	23,377
8	Spain	247,086	India	14,476
9	Italy	239,410	Iran	9,996
10	Iran	212,501	Belgium	9,722

Source: Data from the Coronavirus Resource Center, John Hopkins University.

Compared to previous pandemics, COVID-19 has a disproportionate impact on the elderly from a health perspective. The lockdown measures, however, are more global in scope and scale than their predecessors, and they have disrupted international supply chains as well as aggregate demand and consumption patterns. This in turn has led to heightened financial market turbulence and amplified the economic shock. Moreover, greater borrowing and higher debt levels among firms and households during this time make the short-term shocks more potent compared to previous pandemics (Boissay and Rungcharoenkitkul, 2020).

3 Measurement of COVID-19 and Social Distancing

3.1 Measurement of COVID-19

Before reviewing the potential economic impact, socioeconomic consequences, and governmental response, it is important to contextualize the data related to COVID-19. Without such data, it will not be possible to comprehend the scope of the pandemic. Timely and reliable data inform the World of how the disease is spreading, what impact the pandemic has on the lives of people around the world, and whether the counter measures taken are successful or not (Roser *et al.*, 2020).

The three key indicators are: i) the total number of tests, ii) the number of confirmed COVID-19 cases, and iii) the number of COVID-19 deaths. These numbers are provided by different local, regional and national health agencies/ministries across countries over the World. However, for research and educational purposes, the data are accumulated by the *Center for Systems Science and Engineering* at John Hopkins University.[7] The database provides the numbers as well as visual maps of COVID-19 cases across the World. The cases are reported at the provincial level for China, at the city level for US, Australia and Canada, and at the country level for all other countries (Dong *et al.*, 2020). The data are corroborated with the WHO,[8] the Center for Disease Control (CDC) in US, and the European Center for Disease Control (ECDC).

Based on these figures, the Case Fatality Rate (CFR) is calculated as the number of confirmed deaths divided by the number of confirmed cases and is used to assess the mortality rate of COVID-19.[9] However, Roser *et al.* (2020) caution against taking the CFR numbers at face value to understand mortality risks,[10] because the CFR is based on the number of *confirmed* cases. Due to limited testing capacities, not all COVID-19 cases can be confirmed. Moreover, the CFR reflects the severity of the disease in a particular context at a particular point in time. Therefore, CFR changes over time and is sensitive to the location and population characteristics.

Recent studies show that there are large measurement errors associated with COVID-19 case numbers. Using data on influence-like illnesses (ILI) from the CDC, Silverman *et al.* (2020) show that ILIs can be a useful predictor of COVID-19 cases. The authors find that there was an escalation of ILI patients during March 2020. These cases could not be properly identified as COVID-19 cases due to the lack of testing capabilities during the early stages. The authors suggest that the surge in ILIs may have corresponded to 8.7 million new COVID-19

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[7] Please see the link for the numbers and visual representation. https://coronavirus.jhu.edu.
[8] Please see the WHO COVID-19 Dashboard. https://covid19.who.int.
[9] Please refer to John Hopkins University (2020b) for CFR across countries.
[10] Please see the link for further details. https://ourworldindata.org/mortality-risk-covid.

cases between March 8 and March 28. Intuitively, the number suggests that almost 80 percent cases of COVID-19 in US were never diagnosed.

While the above dataset focuses on counts and tests, the COVID Tracking Project[11] in the US provides additional data on patients who have been hospitalized, are in intensive care units (ICU), and are on ventilator support for each of the 50 states. It also grades each state on data quality. Recently, it has included COVID Racial Data Tracker,[12] which shows the race and ethnicity of individuals affected by COVID-19. All of these combined measures and statistics provide a more comprehensive perspective of the spread of the pandemic in the US.

3.2 Measurement of Social Distancing

In comparison to measuring the spread of the virus, social distancing is not easy to quantify. We determined from the literature that there are three main techniques of quantification: i) measures of the mobility of the population, ii) modelling proxies, and iii) the formation of indices. Proxies and indices are based on data related to the spread of infection and to the implementation of policies, respectively. On the other hand, the movement of people is based on their observed travelling patterns. Mobility measures have been used extensively in the last two months to understand mobility patterns during the COVID-19 pandemic (Nguyen *et al.*, 2020). However, mobility data providers have slight differences in their methodologies. Table 4 provides a summary of how different mobility data providers compile their data.

Table 4: Social Distancing – Mobility Measures and How They Work

Mobility Measures	**How Do They Work?**
Google LLC Community Mobility Reports	Google Mobility[13] aggregates anonymous data from users' mobile-device-location history. It shows how visits to, or length of stay at, different types of location change over time compared to a baseline period. The reports

[11] Please see the link for further details. https://covidtracking.com/data.
[12] Please see the link for further details. https://covidtracking.com/race.
[13] Please see the link for further details. https://www.google.com/covid19/mobility.

	have six locational categories: i) retail and recreation, ii) grocery and pharmacy, iii) parks (parks, beaches, etc.), iv) transit stations (subways, bus, train stations), v) workplaces, and vi) residential areas.
'Unacast'	'Unacast'[14] has a Social Distancing Scoreboard. It uses location data from cellphones to compare the number of average visitations for each day to its 'normal' levels prior to the pandemic. The 'Scorecard' assigns a letter grade of A through F based on peoples' social distancing behavior. The assigned score is based on three different metrics: i) percent change in the average distance travelled; ii) percent change in "non-essential visitation"; and iii) change in "human encounters".
'Safegraph'	'Safegraph'[15] data track the GPS locations from millions of US cellphones to construct a daily panel of census-block-level aggregate movements measures.
'Baidu' Maps	'Baidu' Maps[16] track the population flow of more than 300 cities in China every day. This includes the flow of passengers and urban travel intensity as well as city migration trends. This platform was used to track the early spread of COVID-19 from Wuhan.

Mobility data[17] are more dynamic, available at a daily rate, and they can be used to measure the effect of social distancing on other aspects, such as adherence to shelter-in place policies or labor employment (Gupta *et al.*, 2020). They also offer key insights into human behavior. For example, 'Safegraph' data suggest that social activity in the US started declining

[14] Please see the link for further details. https://www.unacast.com/covid19
[15] Please see the link for further details. https://www.safegraph.com/dashboard/covid19-commerce-patterns
[16] Please see the link for further details. http://research.baidu.com/Blog/index-view?id=133
[17] Please see Oliver et al. (2020) for a detailed analysis as to why mobility data is scarcely used in case of epidemics, even though it might be useful.

substantially, rapidly, and well before lockdown measures were imposed (Farboodi *et al.*, 2020).

Nevertheless, mobility data have their own restrictions. Mobility data are a proxy for time spent in different locations. They do not allow one to determine the context of the contacts (needed to understand the spread of COVID-19), i.e. whether they place in the workplace or in the general community (Martín-Calvo *et al.*, 2020). Those situations involve different levels of risk of transmission. In regards to the productive activities of the individuals that are tracked, information on the context is also indeterminate. For those who are working virtually from their homes, for instance, these measures do not capture the value added from the time that they allocate to their jobs. It is also likely that the quality of these measures can deteriorate when overall unemployment rates and job disruptions are high (Gupta *et al.*, 2020).[18] Telecom operator data are deemed to be more representative compared to location data, as telecom data are not limited to people with smartphones, GPS locator, and history of travel using GPS location (Lomas, 2020).

4 Social Distancing: Determinants, Effectiveness and Compliance

A large range of social distancing policies have been implemented,[19] ranging from full-scale lockdowns to voluntary self-compliance measures.[20] For example, Sweden imposed relatively light restrictions (Juranek and Zoutman, 2020). Large-scale events were prohibited, and restaurants and bars were restricted to table service only; however, private businesses were generally allowed to operate freely. The populations were encouraged to stay home if they were feeling unwell and to limit social interaction if possible (M. Andersen *et al.*, 2020).

Stringent social distancing measures are implemented in countries with a greater proportion of the elderly population, a higher population density, a greater proportion of

[18] Mobility measures track work-location based on movement to workplace from a reference point i.e. home. However, if a person works from home or becomes unemployed, there will not be a distinct workplace reference point. Hence, the quality of mobility measures is expected to fall.

[19] The WHO Health System Response Monitor provides a cross country analysis and other details: https://analysis.covid19healthsystem.org/

[20] People tend to adopt social distancing when there is a specific incentive to do so in terms of risk of health and financial health cost (Makris, 2020). Maloney and Taskin (2020) also attribute voluntary actions to either fear or a sense of social responsibility.

employees in vulnerable occupations, greater degrees of democratic freedom, more international travelling, and further distance from the equator (e.g., Jinjarak *et al.*, 2020). Appealing to a game theory approach, Cui *et al.* (2020) argue that states linked by economic activities will be "tipped"[21] to reach a Nash equilibrium, where all other states comply with shelter-in-place policies. Social distancing policy determinants have been linked to party leader characteristics, political beliefs and partisan differences (Baccini and Brodeur, 2020; Barrios and Hochberg, 2020; Murray and Murray, 2020).[22] Barrios and Hochberg (2020) correlate the risk perception for contracting COVID-19 with partisan differences. They find that, in absence of social distancing imposition, counties in the US which have higher Donald-Trump-vote shares are less likely to engage in social distancing. This persists even when mandatory stay-at-home measures are implemented across states. Allcott *et al.* (2020) find a similar pattern. In addition, the authors show through surveys that Democrats and Republican supporters have different risk perceptions about contracting COVID-19 and hence the importance of social distancing measures.

Researchers are trying to establish the effectiveness of social distancing policies in reducing social interaction and ultimately COVID-19 infections and deaths. Abouk and Heydari (2020) show that reductions in out-of-home social interactions in the US are driven by a combination of policy and voluntary measures, with strong causal impact of state-wide stay-at-home orders, and more moderate impacts of non-essential business closures and limitations placed on bars/restaurants. Ferguson *et al.* (2020) argue that multiple interventions are required to have a substantial impact on transmission. The optimal mitigation strategy, which is a combination of case isolation, home quarantine, and social distancing of high-risk groups (aged over 70), would reduce the number of deaths by half, and

[21] "A tipping set is a set of players with the following property: if all members of this set choose to implement shelter-in -place policies, then the best response of every other agent will be to follow suit. So the member of the tipping set can drive all others to the adoption of shelter-in-place policies, even in the absence of a federal mandate for such policies." (Cui et al., 2020, p. 4).

[22] Baccini and Brodeur (2020) find that US states with Democratic governors are 50 percent more likely to implement lockdown/stay-at-home orders. Moreover, governors without term limits were 40 percent more likely to implement stay-at-home orders.

the demand of beds in intensive care units (ICUs) by two-thirds in the UK and US.[23] Note that this set of interventions falls well short of an economic shutdown.

Similarly, Dave *et al.* (2020b) find that counties in Texas that adopted shelter-in-place orders earlier than the statewide shelter-in-place order experienced a 19 to 26 percent fall in COVID-19 case growths two weeks after implementation of such orders. Andersen *et al.* (2020) find that temporary paid sick leave, a federal mandate enacted in the US, which allowed private and public employees two weeks of paid leave, led to increased compliance with stay-at-home orders. On a more global scale, Hsiang *et al.* (2020) show that social distancing interventions prevented or delayed around 62 million confirmed cases, corresponding to averting roughly 530 million total infections in China, South Korea, Italy, Iran, France, and USA.

Testing is another facet of COVID-19 which has been investigated (Baunez *et al.*, 2020; Gollier and Gossner, 2020). This process is crucial in informing about the number of people who have fallen ill with COVID-19 and to understand in real-time whether the dynamics of the pandemic are accelerating or decelerating (Baunez et al., 2020).[24] Moreover, it allows tested non-infected individuals to rejoin the workforce without being a risk to others. However, according to Gollier and Gossner (2020), there is insufficient production level of tests in order to conduct mass-testing across all affected countries. These authors call for "group-testing" as a way to get around the problem, but there might be practical problems related to such measures e.g., the maximum number of people present in a group and the acceptable error band for tests in groups. Baunez *et al.* (2020) suggest "test allocation" across regions in a specific country based on the marginal benefit of testing. Using data for Italy, the

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[23] Fang *et al.* (2020) argue that if lockdown policies were not imposed in Wuhan, then the infection rates would have been 65% higher in cities outside Wuhan. Hartl *et al.* (2020) show that growth rate of COVID-19 cases in Germany dropped from 26.7 percent to 13.8 percent after implementation of lockdown in the country. Greenstone and Nigam (2020) project that 3 to 4 months of social distancing would save 1.7 million people in USA by October 2021, 630,000 of which would be due to avoided overcrowding of ICUs across hospitals. Friedson *et al.* (2020) argue that early intervention in California helped reduced significantly COVID-19 cases and deaths during the first three weeks following its enactment.

[24] Using data for testing numbers and socioeconomic characteristics at the zip-code level in New York City, Borjas (2020) finds that there is a significant correlation between tests conducted, positive test results, and income. This suggests that people residing in poorer neighborhoods are less likely to be tested. However, if they are tested, they have a higher chance of obtaining a positive test result.

authors find that the allocation of tests was not efficient in relation to the criteria provided by the authors.

Another important related issue is the determinants of compliance behavior [e.g. (Y. Fan *et al.*, 2020)]. The documented socioeconomic determinants of compliance to lockdowns (or safer-at-home orders) include, among others, income, trust and social capital, beliefs, public discourse, and to some extent, news channel viewership. Chiou and Tucker (2020) show that Americans living in higher-income regions with access to high-speed internet are more likely to comply with social distancing directives. Coven and Gupta (2020) find that low-income neighborhoods in New York City comply less with shelter-in-place activities during non-work hours. According to the authors, this pattern is consistent with the fact that low-income populations are more likely to be front-line workers and are also are more likely to make frequent retail visits for essentials, making for two compounded effects.

Individual beliefs need to be taken into consideration, as they affect behavior and compliance. Based on an experimental setup with participants in US and UK, Akesson *et al.* (2020) conclude that individuals over-estimated the infectiousness of COVID-19 relative to expert suggestions (i.e., compared to the true R_0 number).[25] If they saw/heard expert opinion, individuals were prone to correct their beliefs. However, the more infectious COVID-19 was deemed to be, the less likely they were to undertake social-distancing measures. This was perhaps due to beliefs that the individual will contract COVID-19 regardless of social distancing practices.

Briscese *et al.* (2020) model the impact of “lockdown extension” on compliance using a representative sample of residents from Italy. The authors find that, if a given hypothetical extension is shorter than expected (i.e. a positive surprise), the residents are more willing to increase self-isolation. Therefore, to ensure compliance, these authors suggest that it is imperative for the government/local authorities to work on communication and to manage peoples’ expectations.

[25] Provided that all individuals in the population are susceptible to an infection, R_0 number is the expected number of cases that can be generated from one case in the population (Fraser et al., 2009).

Trust in government and social capital also play key roles. Bargain and Aminjonov (2020) show that residents in European regions with high levels of trust decrease mobility related to non-necessary activities compared to regions with lower levels of trust. Similarly, Brodeur *et al.* (2020c) find that counties in the US with relatively more trust in others decrease their mobility significantly more once a lockdown policy is implemented. They also provide evidence that the estimated effect on compliance post-lockdown is especially large for trust in the press, and relatively smaller for trust in science, medicine or government. Barrios et al. (2020) and Durante *et al.* (2020) also provide evidence that regions with stronger higher civic culture engaged in more voluntary social distancing.

Simonov *et al.* (2020) analyze the causal effect of cable news on social distancing compliance. The authors examine the average partial effect of Fox News viewership, a news channel that mostly defied expert recommendations from leaders of the US and global health communities on COVID-19 and on compliance and find that 1 percentage point increase in Fox News viewership reduced the propensity to stay at home by 8.9 percentage points.

5 COVID-19: Potential Economic and Financial Impacts

5.1 Plausible Mechanisms

To understand the potential negative economic impact of COVID-19, it is important to understand the economic transmission channels through which the shocks will adversely affect the economy. According to Carlsson-Szlezak *et al.* (2020a) and Carlsson-Szlezak *et al.* (2020b), there are three main transmission channels. The first is the direct impact, which is related to the reduced consumption of goods and services. Prolonged lengths of the pandemic and the social distancing measures might reduce consumer confidence by keeping consumers at home, wary of discretionary spending and pessimistic about the long-term economic prospects. The second one is the indirect impact working through financial market shocks and their effects on the real economy. Household wealth will likely fall, savings will increase, and consumption spending will decrease further. The third consists of supply-side disruptions; as COVID-19 keeps production halted, it will negatively impact supply chains, labor demand, and employment, leading to prolonged periods of lay-offs and rising unemployment. In particular, Baldwin (2020) discusses the expectation shock by which there is a “wait-and-see” attitude adopted by economic agents. The author argues that this is common during economic climates characterized by uncertainties, as there is less confidence in markets and economic transactions. Ultimately, the intensity of the shock is determined by the underlying epidemiological properties of COVID-19, consumer and firm behavior in the face of adversity, and public policy responses.

Gourinchas (2020, p. 33) summarizes the effect on the economy by stating: “A modern economy is a complex web of interconnected parties: employees, firms, suppliers, consumers, and financial intermediaries. Everyone is someone else’s employee, customer, lender, etc.” Due to the very high degrees of inter-connectiveness and specialization of productive activities, a breakdown in the supply chains and the circular flows will have a cascading effect. Baldwin (2020) describes the impact of COVID-19 on the flows of income in the economy. First, households do not get paid and hence reduce their consumption and savings levels. The decrease in savings reduce investment and hence ultimately diminish the capital stock.[26] Second, households reduce their demand for imports, which in turn reduces income for the rest of the World, and hence the country’s exports decrease. Third, the demand/supply shocks cause disruption in domestic and international supply chains. Fourth, all of the previous shocks and disruptions lead to a fall in output – causing reductions in the usage of the factors of production. In this case, labor is more affected than capital through reduced working hours or layoffs and hence lower earnings

It is also important to understand the processes that generate recoveries from economic crises. Carlsson-Szlezak *et al.* (2020a) explain different types of recovery after shocks through the concept of “shock geometry”. There are three broad scenarios of economic recoveries, which we mention in ascending order of their severity. First, there is the most optimistic one labelled ‘V-shaped’, whereby aggregate output is displaced and quickly recovers to its pre-crisis path. Second, there is the ‘U-shaped’ path, whereby output drops swiftly but it does not return to its pre-crisis path. The gap between the old and new output path remains large. Third, in the case of the very grim ‘L-shaped’ path, output drops, and growth rates continue to decline. The gap between the old and new output path

[26] In a dynamic model, the reduction in capital stock will occur in the next period, as is the case in standard dynamic general equilibrium models.

continues to widen. Notably, Carlsson-Szlezak *et al.* (2020b) state that after previous pandemics, such as the 1918 Spanish Influenza, the 1958 Asian Influenza, the 1968 Hong Kong influenza, and the 2002 SARS outbreak, economies have experienced 'V-shaped' recoveries. However, the COVID-19 economic recovery is not expected to be straightforward. This is because the effects on employment due to social distancing measures/lockdowns are expected to be much larger. According to Gourinchas (2020), during a short period, as much as 50 percent of the working population might not be able to find work. Moreover, even if no containment measures were implemented, a recession would occur anyway, fueled by the precautionary and/or panic behavior of households and firms faced with the uncertainty of dealing with a pandemic as well as with an inadequate public health response (Gourinchas, 2020).

5.2 Susceptible-Infected-Recovered (SIR) Epidemiological Models

A key tool used by epidemiologists is the seminal SIR model developed by Kermack *et al.* (1927). A large number of studies estimate and forecast disease scenarios for COVID-19 using a SIR model of the pandemic (e.g., Atkeson *et al.* (2020)).[27] In these models there are three states of health: i) susceptible (S) (at risk of getting infected), ii) infected (I) (and contagious), and iii) recovered/resistant (R) (previously infected). Those who have died from the disease are no longer contagious. These models assume that susceptible people interact with infected people at a given rate. The infected people recover over time at a given rate and acquire immunity.[28] Eventually, the susceptible population declines over time as people gain 'herd immunity' from COVID-19.[29] These different rates of infection, recovery and their associated probabilities form the main parameters of the SIR models.

The SIR models help simulate the effect of social distancing measures on the spread of the infection. If only infected cases are isolated, the infection reaches a peak within 4 months and reduces quickly. With social distancing measures, the infection reaches a peak around the same point in time, however, the number of reported cases is significantly lower.

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27 See Ellison (2020) for a brief survey of results.

28 The simplest versions of these models abstract from the fact that there is a chance of re-infection. In such a case, the infected people would rejoin the pool of agents in the S group.

29 Please see D'souza and Dowdy (2020) for details on gaining herding immunity for COVID-19.

If containment measures are lifted early, there is a chance of re-emergence of the infection. These qualitative outcomes give a sense of the role of social distancing on COVID-19 transmission (Anderson *et al.*, 2020).

An underlying assumption in these epidemiology models is that the transitions between the states of health are exogenous with respect to economic outcomes. This means that the expected decrease in consumption activities or hours worked due to COVID-19 are not accounted for in SIR models. This condition cannot be ignored because of the "lives vs. livelihood" tradeoff that weighs heavily in any general analysis of pandemics that incorporates the public health outcomes and the economic outcomes. A central focus of this strand of the literature is the efficiency of that tradeoff, i.e. how to reduce the rate of infections at the lowest possible costs to economic welfare.

Eichenbaum *et al.* (2020a) address that question by integrating a macroeconomic general equilibrium model with the standard SIR model. In their SIR-Macro model, the prevalence of infection depends on the degree of interaction between agents when consuming and working, as well as the random chance of contracting the virus. Therefore, the susceptible population can lower the chances of infection by reducing their consumption activities and their labor supply (outside of their residences). Based on their assumptions and calibration techniques, Eichenbaum *et al.* (2020a) find that aggregate consumption fell by 9.3 percent over a 32-week period. On the other hand, labor supply or hours worked followed a U-shaped pattern, with a peak decline of 8.25 percent in the 32nd week from the start of the pandemic. However, long-run declines in hours worked are lower because a higher proportion of the population survive and return to work compared to the counterfactual.

While the SIR-Macro model abstracts from real-world problems such as bankruptcy costs, mass hysteria, loss of effective labour supply, and also do not consider dynamics present in other models, such as consumption uncertainty, price rigidities (which would make consumption and hours worked fall further), there are certain caveats that have been accounted for in the literature, namely incomplete information, infection externalities and risks across sub-populations. These are explained below.

Infected populations might be asymptomatic and might unknowingly increase infection. Berger *et al.* (2020) outline a Susceptible-Exposed-Infectious-Recovered (SEIR) based on Kermack *et al.* (1927) to account for this incomplete information. They bring forward the idea of increasing testing of susceptible populations to identify infected-asymptomatic patients and quarantining this segment of the population. The authors find that the targeted quarantine policy would have a lower negative impact on the economy compared to the standard uniform quarantine policy. Similarly, Eichenbaum *et al.* (2020b) conclude that 'smart containment' policies, which are a combination of testing and quarantining of infected people, would render the economic activity vs. public health tradeoff more favorable.

Eichenbaum *et al.* (2020a) focus on the infection externality problem. They mention that the competitive equilibrium is not Pareto optimal, as agents do not consider that their actions impact the infection and death rates of other economic agents. To properly internalize the externality, the authors suggest that the containment measures are optimal if they are tightened over time in proportion to the spread of infection. If a strict containment policy is enforced from the beginning, it will have a much more severe impact on the economy. Bethune and Korinek (2020) focus on the infection externality in a more formal manner. The authors develop Susceptible-Infected-Susceptible (SIS) and SIR models to quantify the infection externalities using a decentralized and then the social planners' approach. The authors find that in a decentralized approach, infected individuals continue to engage in economic activities to maximize their utility. On the other hand, susceptible agents do reduce their activities to reduce the risk of infection. The resulting behavioral outcome is that infected individuals do not engage in adequate social distancing, as they do not internalize the effects of their activities on the overall infection risk. Based on the model assumptions and calibration for the US economy, the results suggest that the infection persists for more than two years. In contrast, with the social planner approach, the planner forcibly reduces the activity of infected agents to mitigate the risks to susceptible agents and eventually to reduce infections to zero. In addition, the authors calculate the marginal cost of additional infection to be $80,000 in the decentralized approach and $286,000 with the social planner's approach (nominal 2020 dollars). This shows that private agents underestimate the cost of the externality, and the social planner's approach of containment of the infected population is Pareto efficient compared to a uniform containment policy.

Acemoglu *et al.* (2020) introduce heterogeneity of risks across sub-populations. The different sub-populations (young, middle-aged, and old) have different infection, morbidity, and fatality rates, as well as different levels of interaction with others. These conditions give rise to targeted quarantine measures. This is because a differential lockdown between different risk groups (aggressive lockdown of older groups compared to younger ones) can reduce the number of lives lost and negative economic outcomes to a greater extent compared to uniform lockdown measures for all age groups. The authors find that with a uniform lockdown lasting 434 days, the total number of fatalities reaches 1.8 percent of the population, with economic costs of about 24.3 percent of annual GDP. On the other hand, a targeted lockdown policy lasting 230 days reduces fatalities to 1 percent of the population and the economic cost to 10 percent of annual GDP. Similarly, Aum *et al.* (2020b) shows that the progression of the virus in South Korea and UK can be effectively managed with aggressive testing and contact tracing, which can in turn reduce both the economic and health costs.

An interesting question is whether differentiating containment/social distancing measures across sectors and occupations can help to reduce the extent of lives lost and lower the severity of the economic downturn. Bodenstein *et al.* (2020) and Krueger *et al.* (2020) focus on this aspect through their variants of the SIR-Macro model.

Bodenstein *et al.* (2020) rely on a supply-side perspective that is centered on the effects of the pandemic on the parts of the economy that provide essential inputs. The authors develop an integrated framework by combining a standard SIR model containing two groups of a heterogeneous population with a macroeconomic model. The transmission mechanism between the epidemiological variables and the economic variables is through the change in labor supply, i.e. infected people cannot participate in the workforce, which is a direct cost of the disease. The economic activities are divided between two groups: “core” and “non-core” sectors with a low degree of substitutability in production between them. The former produce raw and intermediate inputs, while the latter produces final-stage outputs. The indirect cost stems from the fact that the slowdown/closure of core industries will affect non-core industries through input-output linkages – what is typically called the ‘supply chains’ in the media. The social distancing measures help to attenuate deaths and morbidities, hence to curb the decrease in labor supply. The model shows that the absence of social distancing leads to a negative 40 percent deviation from steady state in output in this two-sector economic model. This contraction shrinks to a negative 20 percent deviation from the steady state with the enforcement of social distancing. Intuitively, “All else equal, a lower infection peak shields better the core sector, resulting in economic gains (while reducing the strain on the national health care systems). However, these gains now imply some economic losses from reducing the labor supply and some economic gains from smoothing out the infection peak." (Bodenstein *et al.*, 2020, p. 23).

Krueger *et al.* (2020) also focus on the heterogeneity across sectors by introducing a multi-sector economy with varying degrees of elasticity of substitution of consumption across goods. In this case sectors differ according to the riskiness of consuming their respective services. Based on their model, susceptible households substitute consumption from the high-infection sector with those from the low-infection sector in the event of an outbreak. This re-allocation of spending patterns helps maintain a relatively stable consumption path and lowers the risk of being infected from participating – as either a provider or a consumer - in high-infection activities. According to the authors, with all other things equal, this "reallocation" of economic activity may helps reduce the number of infections i.e. flatten the curve.

Other researchers try to model the endogenous response of economic agents and time-varying nature of infection risks. Quaas (2020) and Dasaratha (2020) provide theoretical propositions of behavioral responses to various changes in policies or infection levels. Alfaro *et al.* (2020) modify the existing SIR models to account for optimizing decisions on social interaction based on the infection risks. Typically, infection rates are taken as exogenous in SIR models. However, after accounting for heterogeneity in preferences, they find that preference traits, such as patience, altruism, and reciprocity, play important roles in reducing the infection externalities. An approach that balances strict social distancing restrictions with social preferences is expected to help mitigate the economic and public health costs. To provide an example, Argente *et al.* (2020) find that public disclosure of COVID-19 cases in Seoul, South Korea led to a decrease in foot-traffic to neighborhoods/areas with more cases. These data were calibrated into an SIR model with a heterogenous population to account for infection transmission and economic outcomes. The authors find that, compared to a scenario with no disclosure, public disclosure led to a decrease in infection by 400,000 cases and deaths by 13,000 cases over a period of 2 years. The same policy is also expected to lower economic costs by 50%. Fernández-Villaverde and Jones (2020) extend the endogenous behavioral response by accounting for time-variation of infection rate or R_o parameter in SIR models. Using a Susceptible-Infectious-Recovered-Died (SIRD) model and different values of R_0 across countries, they find that forecasts prior to the peak death rates are 'noisy'. After the peak has occurred, however, these forecasts converged well with the actual data. Liu *et al.* (2020) find that COVID-19 growth rates can be forecasted by autoregressive fluctuations and also suggested that the forecasts contain a lot of uncertainties due to parameter uncertainties and realization of future shocks.[30] Pindyck (2020) estimates how different values of the R_0 parameter affect death rates, durations of pandemics, and the possibility of a 'second wave' of infection. The author also analyzes the benefits of social distancing measures in terms of value of statistical life (VSL) and its implications in terms of realism.

5.3 Macroeconomic Impacts

As COVID-19 unfolds, many researchers have been trying to think about the economic impact from a historical perspective. Ludvigson *et al.* (2020) find that, in a fairly conservative scenario without non-linearities, pandemics such as COVID-19 are tantamount to large, multiple-period exogenous shocks. Using a 'costly disaster' index, the authors find that multi-period shocks in US (assumed to be a magnitude of 60 standard deviations from the mean of the costly disaster index for a period of 3 months) can lead to a 12.75 percent drop in industrial production, a 17 percent loss in service employment, sustained reductions in air travel, and macroeconomic uncertainties which linger for up to five months. Jordà *et al.* (2020) analyze the rate of return on the real natural interest rate (the level of real returns on safe assets resulting from the demand and supply of investment capital in a non-inflationary environment) from the 14th century to 2018. Theoretically, a pandemic is supposed to induce a downward negative shock on the real natural interest rate. This is because investment demand decreases due to excess capital per labor unit (i.e. a scarcity of labor being utilized), while savings flows increase due to either precautionary reasons or to replace lost wealth. The authors find that real natural rate remains depressed for a period of 40 years, decreasing to -1.5 percent within 20 years.

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30 Please see Hong *et al.* (2020) for an intuitive explanation behind the uncertainties through the caveats related to the R_0 number in managing COVID-19 risks.

However, analysis using historical data might not be sufficient. According to Baker *et al.* (2020b), COVID-19 has led to massive spike in uncertainty, and there are no close historical parallels. Because of the speed of evolution and timely requirements of data, the authors suggest that there is a need to utilize forward-looking uncertainty measures to ascertain its impact on the economy. Using a real business cycle (RBC) model, the authors find that a COVID-19 shock[31] leads to year-on-year contraction of GDP by 11 percent in 4th quarter of 2020. According to the authors, more than half the contraction is caused by COVID-19-induced uncertainty. Coibion *et al.* (2020b) use surveys to assess the macroeconomic expectations of households in US. They find that it is primarily lockdowns, rather than COVID-19 infections, that lead to drops in consumption, employment, lower inflationary expectations, increased uncertainty, and lower mortgage payments.[32]

Other researchers have examined the role of global supply chains. Bonadio *et al.* (2020) use a quantitative framework to simulate a global lockdown as a contraction in labor supply for 64 countries. The authors find that the average decline in real GDP constitutes a major contraction in economic activity, with a large share attributed to disruptions in global supply chains. Elenev *et al.* (2020) model the impact of COVID-19 as a fall in worker productivity and a decline in labor supply which ultimately adversely affect firm revenue. The fall in revenue and the subsequent non-repayment of debt service obligations create a wave of corporate defaults, which might bring down financial intermediaries. Céspedes *et al.* (2020) formulate a minimalist economic model in which COVID-19 also leads to loss of productivity. The authors predict a vicious cycle triggered by the loss of productivity causing lower collateral values, in turn limiting the amount of borrowing activity, leading to decreased employment, and then lower productivity. The COVID-19 shock is thus magnified through an 'unemployment and asset price deflation doom loop'.[33]

Mulligan (2020) assesses the opportunity cost of "shutdowns" in order to document the macroeconomic impact of COVID-19. Within the National Accounting Framework for the

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31 This shock is formulated from the Standard &Poor's (S&P) 500 Volatility Index (VIX) and the news-based economic policy uncertainty (EPU) developed by Baker et al. (2016). Refer to Baker et al. (2020b) for details.

32 According to Coibion *et al.* (2020b), these findings have implications on monetary and fiscal policies and their respective transmission mechanisms.

33 Please see Fornaro and Wolf (2020) for a broader explanation of the mechanism.

US, the author extrapolates the welfare loss stemming from "non-working days", the fall in labor-capital ratio resulting from the absence/layoff of workers, and the resulting idle capacity of workplace. After accounting for dead-weight losses stemming from fiscal stimulus, the replacement of normal import and export flows with black market activities, and the effect on non-market activities (lost productivity, missed schooling for children and young adults), the author finds the welfare loss to be approximately $7 trillion per year of shutdown. Medical innovations such as vaccine development, contact tracing, and workplace risk mitigation can help offset the welfare loss by around $2 trillion per year of shutdown.

Consumption patterns and debt responses from pandemic shocks have not been analyzed prior to COVID-19 (Baker *et al.*, 2020a). Using transaction-level household data, Baker *et al.* (2020a) find that households sharply increased their spending during the initial period in specific sectors such as retail and food spending. These increases, however, were followed by a decrease in overall spending. Binder (2020) conducted an online survey of 500 US consumers to understand their concerns and responses related to COVID-19, which indicated items of consumption on which they were spending either more or less. They find that 28 percent of the respondents in that survey delayed/postponed future travel plans, and that 40 percent forewent food purchases. Interestingly, Binder (2020) finds from the surveys that consumers tend to associate higher concerns about COVID-19 with higher inflationary expectations, a sentiment which is found to be a proxy for "pessimism" or "bad times".

The economic impact of shocks such as pandemics is usually measured with aggregate time series data, such as industrial production, GDP growth, unemployment rate, and others. However, these datasets are available only after a certain lag - usually months or until the end of the quarter. On the other hand, economic shocks resulting from COVID-19 are occurring at real time. In order to analyze the economic impact at a higher frequency, Lewis *et al.* (2020) developed a weekly economic index (WEI) using ten different economic variables to track the economic impact of COVID-19 in the US. According to the study, between March 21 and March 28, the WEI declined by 6.19 percent. This was driven by a decline in consumer confidence, a fall in fuel sales, a rise in unemployment insurance (UI) claims, and other variables. Similarly, Demirguc-Kunt *et al.* (2020) estimate the economic impact of social distancing measures via three high-frequency proxies (electricity consumption, nitrogen dioxide emissions, and mobility records). The authors find that social distancing measures led to a 10 percent decline in economic activity (as measured by electricity usage and emissions) across European and Central Asian countries between January and April.

6 Socio-economic Consequences

We now review studies documenting the socioeconomic consequences of COVID-19 and lockdowns. Social distancing and lockdown measures have been shown to affect labor markets, mental health and well-being, racial inequality and gender roles. The environmental implications, while likely to be positive, also need careful analysis.[34]

6.1 Labor Market Outcomes

A large number of studies document the effect of COVID-19 on hours of work and job losses (e.g., Adams-Prassl et al., 2020; Béland et al. 2020c; Coibion et al., 2020a; Kahn et al., 2020).

The unemployment increases observed in the US are partly driven by lockdown/social distancing policies (Rojas *et al.*, 2020). Accounting for cross-state variation in the timing of business closures and stay-at-home mandates in US, Gupta *et al*. (2020) find that the employment rate in the US falls by about 1.7 percentage points for every extra 10 days that a state experienced a stay-at-home mandate during the period March 12 - April 12.

Coibion *et al.* (2020a) find that the unemployment/job loss in the US is more severe than one might judge based on the rise in unemployment insurance (UI) claims, which is to be expected given the low coverage rate for UI regimes in the US. They also calculate a severe fall in the labor participation rate in the long run accompanied by an increase in "discouraged workers" (unemployed workers who have actively stopped searching for work effectively withdrawing from the labour force). This might be due to the disproportionate impact of COVID-19 on the older population. Aum *et al.* (2020a) find that an increase in infections leads to a drop in local employment in the absence of lockdowns in South Korea, where there were

[34] A number of studies also investigate the effect of income and occupations on COVID-19 transmission [e.g. Baum and Henry (2020), Lewandowski (2020)]. Using an instrumental variable approach, Qiu *et al.* (2020) find that the spread of COVID-19 cases "between cities" in China is much smaller compared to "within city" spread. Cities with higher income levels (measured by GDP per capita ay the city level) are more likely to have higher transmission rates owing to more social interactions and higher levels of economic activity.

no government mandated lockdowns. This number increased for countries such as the US and the UK where mandatory lockdown measures were imposed.

Adams-Prassl *et al.* (2020) analyze the inequality in job/income losses based on the type of job and individual characteristics for the US and the UK. The authors find that workers who can perform none of their tasks from home are more likely to lose their job. The study also finds that younger individuals and people without a university education were significantly more likely to experience drops in their income. Yasenov (2020) finds that workers with lower levels of education, younger adults, and immigrants are concentrated in occupations that are less likely to be performed from home. Similarly, Alstadsæter *et al.* (2020) find that the pandemic shock in Norway has a strong socio-economic gradient, as it has disproportionately affected the financially vulnerable population, including parents with younger children.

Béland *et al.* (2020c) discuss heterogeneous effects across occupations and workers in the US. They show that occupations that have a higher share of workers working remotely were less affected by COVID-19. On the other hand, occupations with relatively more workers working in proximity to others were more affected. They also find that occupations classified as 'more exposed to disease' are less affected. This finding is possibly due to the number of essential workers in these occupations. Based on these results, it can be reasonably expected that workers might change (or students might select different) occupations in the short or medium-term.

Kahn *et al.* (2020) show that firms in the US have dramatically reduced job vacancies from the 2nd week of March 2020. The authors find that the job vacancy declines occurred at the same time when UI claims increased. Notably, the labor market declines (proxied through the reduction in job vacancy and the increase in UI claims) were uniform across states, with no notable differences across states which experienced the spread of the pandemic earlier than others or implemented stay-at-home orders earlier than others. The study also finds that the reduction in job vacancies was uniform across industries and occupations, except for those in front line jobs, e.g. nursing, essential retail and others.

With the enforcement of social distancing measures, work from home has become increasingly prevalent. The degree to which economic activity is impaired by such social distancing measures depends largely on the capacity of firms to maintain business processes from the homes of workers [Alipour *et al (*2020), Papanikolaou and Schmidt (2020)]. Brynjolfsson *et al.* (2020) find that the increase in COVID-19 cases per 100k individuals is associated with a significant rise in the fraction of workers switching to remote work and the fall in the fraction of workers commuting to work in the US. Interestingly, the authors find that people working from home are more likely to claim UI compared to people who are still commuting to work and are likely working in industries providing essential services.

Dingel and Neiman (2020) analyze the feasibility of jobs that can be done from home. They find that 37 percent of jobs can be feasibly performed from home, which is related to the extent that the job involves face-to-face interaction. According to Avdiu and Nayyar (2020), the job-characteristic variables of home-based work (HBW) and face-to-face (F2F) interaction differ along three main dimensions, namely: i) temporal (short run vs. medium run); ii) the primary channel of effects (supply and demand of labour); and iii) the relevant margins of adjustment (intensive vs. extensive). They argue that the supply of labor in industries with HBW capabilities and low F2F interactions (e.g. professional, scientific and technical services) might be the least affected. Nevertheless, those industries and occupations with HBW capabilities and high F2F interactions are likely to experience negative productivity shocks. For example, teachers in high schools and universities might provide lectures online through web-based applications during lockdown restrictions. This mode of teaching, however, is not as interactive as standard classroom sessions. As lockdown restrictions are lifted, industries with low HBW capabilities and low F2F interactions (e.g. manufacturing, transportation and warehousing) might be able to recover relatively quickly. The risk of infection through physical proximity can be mitigated by wearing personal protective equipment (PPE) and by taking other relevant precautionary measures. However, those industries with low HBW capabilities and high F2F interactions (e.g. accommodation and food services, arts entertainment and recreation) are likely to experience slower recoveries, as consumers might be apprehensive about patronizing them, e.g. going to cinemas and restaurants.

From the firm's perspective, there are large short-term effects of temporary closures, the (perhaps permanent) loss of productive workers, and declines in job postings characterized by strong heterogeneity across industries. Bartik *et al.* (2020) survey a small number of firms in the US and document that several of them have temporarily closed shop and reduced their number of employees compared to January 2020. The surveyed firms were not optimistic about the efficacy of the fiscal stimulus (CARES Act loan program) implemented by the federal government. Campello *et al.* (2020) find that job losses have been more severe for industries with highly concentrated labor markets (i.e., where hiring is concentrated within few employers), non-tradable sectors (e.g., construction, health services), and credit-constrained firms. Hassan *et al.* (2020) discern a pattern of heterogeneity of firm resilience across industries in the US and around the World. Based on earnings call reports, they provide evidence that some firms are expecting increased business opportunities in the midst of the global disruption (e.g., firms which make medical supplies or others whose competitors are facing negative impression after the outbreak of COVID-19). Barrero *et al.* (2020) measure the reallocation of labor in response to the pandemic-induced demand response (e.g., increased hiring in delivery companies, delivery-oriented restaurant/fast food chains, technology companies).

6.2 Health Outcomes

The impact of the pandemic on physical health and mortality has been documented in many studies (e.g., Goldstein and Lee, 2020; Lin and Meissner, 2020).[35] A growing number of studies also document worsening mental health status and well-being e.g. Brodeur *et al.* (2020c); Davillas and Jones (2020); de Pedraza *et al.* (2020); Tubadji *et al.* (2020). Chatterji and Li (2020) document the effect of the pandemic on the US health care sector. The authors find that COVID-19 is associated with a 67 percent decline in the total number of outpatient visits per provider by the week of April 12th - 18th 2020 relative to the same week in prior years. This might have negative health consequences, especially amongst individuals with chronic health conditions. Others such as Alé-Chilet *et al.* (2020) explore the drop in emergency cases in hospitals around the world.

[35] Lin and Meissner (2020) show that places that performed poorly in terms of mortality in 1918 were more likely to have higher mortality during COVID-19. They also find that countries more strongly affected by SARS are likely to have lower mortality rates from COVID-19.

Nevertheless, during a crisis such as the COVID-19 pandemic, it is common for everyone to experience increased levels of distress and anxiety, particularly the sentiment of social isolation (American Medical Association, 2020). According to Lu *et al.* (2020), social distancing or lockdown measures are likely to affect psychological well-being through lack of access to essential supplies, discrimination or exclusion by neighbors or other groups, financial loss, boredom, and frustration due to lack of information. They determine that maintaining a positive attitude (in terms of severity perception, the credibility of real-time updates, and confidence in social distancing measures) can help reduce depression.[36] Public mental health is also affected by the cognitive bias related to the diffusion of public death toll statistics (Tubadji *et al.*, 2020).

Using the Canadian Perspective Survey Series, Béland *et al.* (2020b) find that older individuals and employed individuals who have less than a high school education reported lower mental health status. Their assessment also reveals that those who missed work not due to COVID-19, and those who were unemployed, showed declines in mental health. Using panel data in the UK, Etheridge and Spantig (2020) report a large deterioration in the state of mental health, with much larger effects for women.[37]

The implementation of lockdown policy also adversely affected public mental health. Armbruster and Klotzbücher (2020) demonstrate that there were increases in the demand for psychological assistance (through helpline calls) due to lockdown measures imposed in Germany. The authors find that these calls were mainly driven by mental health issues such as loneliness and depression. Brodeur *et al.* (2020a) show that there has been a substantial increase in the search intensity on 'boredom' and 'loneliness' during the post-lockdown period in nine Western European countries and the US during the first few weeks of lockdowns.

Fetzer *et al.* (2020) find that there has been broad public support for COVID-19 containment measures. However, some of the respondents believe that the general public

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[36] Using pre-COVID-19 data, Hamermesh (2020) provide evidence that, adjusted for numerous demographic and economic variables, happiness is affected by how people spend time and with whom.

[37] Galasso *et al*. (2020) rely on survey data from eight OECD countries and provide evidence that women are more likely to agree with restraining public policy measures and to comply with them.

fail to adhere to health measures, and that the governmental response has been insufficient. These respondents have significant correlation with lower mental health. If governments are seen to take decisive actions, then the respondents altered their perception about governments and other citizens, which in turn improved mental health.

6.3 Gender and Racial Inequality

A growing literature points out that COVID-19 has had an unequal impact across genders and across genders across OECD countries; specifically, women and racial minorities such as African-Americans and Latinos have been unduly and adversely affected.

While recessions typically affect men more than women, many studies provide suggestive evidence that COVID-19 has a disproportionate impact on women's socioeconomic outcomes (Adams-Prassl *et al.* (2020), Forsythe (2020), Yasenov (2020)). Alon *et al.* (2020) argue that women's employment is concentrated in sectors such as health care and education. Moreover, the closure of schools and daycare centers led to increased childcare needs, which would have a negative impact on working mothers/single mothers.

Béland *et al.* (2020a) analyze the domestic violence aspect of COVID-19 in Canada. The authors find that work arrangements such as remote work is not increasing women's perceived impacts of COVID-19 on the levels of family stress and domestic violence. Instead, women's concerns regarding their inability to meet financial obligations due to COVID-19 contributed to a significant increase in reported family stress and domestic violence. They also suggest that women's concerns about maintaining social ties is positively associated with concerns regarding domestic violence and family stress from confinement.

Fairlie *et al.* (2020) examine the variation in unemployment shocks amongst minority groups in the US. The authors find that Latino groups were disproportionately affected by the pandemic. The authors attribute the difference to an unfavorable occupational distribution (e.g., more Latino workers work in non-essential services) and to lower skills amongst Latino workers. Borjas and Cassidy (2020) determine that the COVID-19 shock led to a fall in employment rates of immigrant men compared to native men in US, which was in contrast to the historical pattern observed during previous recessions. The immigrants' relatively high rate of job loss was attributed to the fact that immigrants were less likely to hold jobs that could be performed remotely from home. The likelihood of being unemployed during March was significantly higher for racial and ethnic minorities (Montenovo *et al.*, 2020).

Schild *et al.* (2020) find that COVID-19 occasioned a rise of Sinophobia across the internet, particularly when western countries started showing signs of infection. Bartos *et al.* (2020) document the causal effect of economic hardships on hostility against certain ethnic groups in the context of COVID-19 using an experimental setup. The authors find that the COVID-19 pandemic magnifies hostility and discrimination against foreigners, especially from Asia.

6.4 Environmental Outcomes

The global lockdown and the considerable slowdown of economic activities is expected to have a positive effect on the environment (He *et al.*, 2020; Almond *et al.*, 2020; Cicala *et al.*, 2020). He *et al.* (2020) show that lockdown measures in China led to a remarkable improvement in air quality. The Air Quality Index and the fine particulate matter ($PM_{2.5}$) concentrations were brought down by 25 percent within weeks of the lockdown, with larger effects in colder, richer, and more industrialized cities. Similarly, Almond *et al.* (2020) focused on air pollution and the release of greenhouse gases in China during the post COVID-19. The authors determined that, while nitrogen dioxide (NO_2) emissions fell precipitously, sulphur dioxide emissions (SO_2) did not fall. For China as whole, $PM_{2.5}$ emissions fell by 22 percent; however, ozone concentrations increased by 40 percent. These variations show that there is not an unambiguous decrease in air pollution due to slowdown of economic activities. The reduction can be attributed to less personal vehicle travel causing lower nitrous oxide (NO_2) emissions. Brodeur *et al.* (2020b) examine the causal effect of 'safer-at-home' policies on air pollution across US counties. They find that 'safer-at-home' policies decreased air pollution (measured as $PM_{2.5}$ emissions) by almost 25%, with a larger effect for populous counties.[38] Cicala *et al.* (2020) focus on the health and mortality benefits of reduced vehicle travel and electricity consumption in the US due to the stay-at-home policies. The authors suggest that

[38] Andree (2020) focuses on the effect of pollution on COVID-19 cases, finding that $PM_{2.5}$ is a highly significant predictor of COVID-19 incidence using data from 355 municipalities in Netherlands.

reductions in emissions from less travel and from lower electricity usage reduced deaths by over 360 per month.

Based on the research discussed above, Table 5 provides a summary of the literature focusing on the socioeconomic outcomes of social distancing/stay-at-home orders/lockdowns, including measures and methodologies.

Table 5: Socioeconomic Outcome of COVID-19 Lockdowns: Summary of Studies

Country	**Socioeconomic domain**	**Socioeconomic Outcome Measure**	**Methodology**	**Author(s)**
US	Labor Market	Impact of Safer-at-Home Policies on Labor Market Outcomes	Difference-in-Differences	Béland *et al*. (2020c)
US	Labor Market	Impact of Social Distancing Policies on Labor Market Outcomes	Difference-in-Differences	Gupta *et al.* (2020)
US	Labor Market	Impact of Safer-at-Home Policies on Different Occupations	Data Analysis	Yasenov (2020)
US	Labor Market	Impact on Job Market Conditions in Response to COVID-19 infections and Mitigation Policies	OLS	Rojas *et al*. (2020)
China	Mental Health & Wellbeing	Impact of Quarantine and Attitudes Towards COVID-19 on Depressive	Quantile Regression	Lu *et al.* (2020)

		Symptoms and Happiness		
US	Mental Health & Wellbeing	Impacts of Spending Time "With Whom" and "How" during Lockdowns on Happiness	OLS	Hamermesh (2020)
Canada	Mental Health & Wellbeing	Effects of COVID-19 and lockdown on Individuals' Mental Health and Financial and Work Concerns	Probit Regression	Béland *et al.* (2020b)
UK, Italy and Sweden	Mental Health & Wellbeing	Causal Effect of Lockdown on Mental Health	Difference-in-Differences	Tubadji *et al.* (2020)
Global	Mental Health & Wellbeing	Effect of Lockdown on Mental Health	OLS	Fetzer *et al.* (2020)
US	Gender Inequality	Disproportionate Effect of COVID-19 on Gender Equality (in terms of labor force participation, childcare needs, workplace flexibility)	Survey	Alon *et al.* (2020)
Canada	Gender Inequality/Domestic Violence	Effect of COVID-19 and subsequent confinement on family stress and domestic violence	OLS	Béland *et al.* (2020a)

China	Environment	Effect of COVID-19 Lockdown on Air Pollution	Difference-in-Differences	Almond *et al.* (2020)
China	Environment	Effect of COVID-19 Lockdown on Air Quality	Difference-in-Differences	He *et al.* (2020)
US	Environment	Impact of Social Distancing on Emissions and Expected Health Effects Through Reduced Personal Vehicle Travel and Electricity Consumption.	OLS	Cicala *et al.* (2020)
US	Environment	Causal Effect of Safer-At-Home Orders on Pollution and Collision Externalities	Difference-in-Differences/ Synthetic Control Method	Brodeur *et al.* (2020b)
Netherlands	Environment	Incidence of COVID-19 Lockdown and Connections with Air Pollution Exposure: Evidence from the Netherlands	OLS	Andree (2020)

7 Policy Measures

The economic literature deals with many different policy measures. In order to bring coherence to our discussion of them, we organize our discussion according to five broad topics: i) the types of policy measures, ii) the determinants of government policy, iii) the lockdown measures and their associated factors, iv) the lifting of lockdowns, and v) the economic stimulus measures.

To mitigate the negative effects of public health controls on the economy and to sustain and promote public welfare, governments all around the World have implemented a variety of policies in a very short time frame. These include fiscal, monetary, and financial policy measures (Gourinchas, 2020). The economic measures vary across counties in breadth and scope, and they target households, firms, health systems and/or banks (Weder di Mauro, 2020).

Using a database of economic policies implemented by 166 countries, Elgin *et al.* (2020) employ Principal Component Analysis (PCA) to develop their COVID-19 Economic Stimulus Index. The authors correlate the standardized index with predictors of government response, such as population characteristics (e.g. median age), public-health-related measures (e.g. number of hospital beds per capita), and economic variables (e.g. GDP per capita). They find that the economic stimulus is larger for countries with higher COVID-19 infections, median age and GPD-per-capita. In addition, the authors develop a 'Stringency Index', which includes the measures such as school closures and travel restrictions. The authors find that the 'Stringency Index' is a not a significant predictor of economic stimulus, which suggests that public health measures do not drive economic stimulus measures (Weder di Mauro, 2020).

On a similar note, Porcher (2020) has created an index of public health measures using the PCA technique. The index is based on 10 common public health policies implemented across 180 countries to mitigate the spread of COVID-19. The index is designed to measure the stringency of the public health response across countries. The author finds that, abstracting from the COVID-19 case numbers and deaths, countries which have better public-health systems and effective governance tend to have less stringent public health measures.

Cheng *et al.* (2020) develop the CoronaNet – COVID-19 Government Response Database, which accounts for policy announcements made by countries globally since 31 December 2019. The information that is contained in the data base is categorized according to: i) type of policy, ii) national vs. sub-national enforcement, iii) people and geographic region targeted by the policy, and iv) the time frame within which the policy is implemented. Table 6 provides a description of the government response database for 125 countries.

The dataset shows variations across policy measures. The policy most governments have implemented in response to COVID-19 is “external border restriction”, i.e., the one which seeks to restrict access to entry through ports.[39] The authors find that external border restrictions have been imposed by 186 countries. Similarly, the second most common policy measure, implemented by 153 countries, is “school closures”. However, in terms of policies which have implemented the greatest number of times, “obtaining or securing health resources” come first. This includes materials (e.g. face masks), personnel (e.g. doctors, nurses) and infrastructure (e.g. hospital). The second most implemented policy is “restriction on non-essential businesses”. In terms of stringency of policy enforcement, “emergency declaration” and formation of “new task force” or “administrative reconfiguration to tackle pandemic” are implemented with 100 percent stringency.

Due to these idiosyncratic differences between policy responses across countries over time, the authors use a Bayesian dynamic item-response approach to measure the implied economic, social and political cost of implementing a particular policy over time. They further develop a ‘Policy Activity Index’. Intuitively, the index gives a higher rank for policy activity to countries that are more willing to implement a ‘costly’ policy i.e. meet the implied cost. Based on the ‘Policy Activity Index’, the authors determine that school closure is the costliest to implement across the 125 countries. Mandatory business closure and social distancing policies come second. Moreover, internal border restrictions are seen to be more costly compared to external border restriction.

[39] Harris (2020a) maps the incidence of COVID-19 in New York City with subway usage. The author finds that the shutoff of subway ridership in Manhattan correlates strongly with the substantial increase (doubling of new cases) in this borough. This is arguably due to alternative modes of transport (e.g. local train lines, bus lines) leading to “closer interaction” amongst riders.

Table 6: Summary Statistics of COVID-19 Government Response Dataset

Type of Policies	**Cumulative Total Number of Implemented Policies**	**Number of Countries which have Implemented Policies**	**Stringency of Policy Enforcement (%)**
Obtaining or Securing Health Resources	2342	148	54
Restriction of Non-Essential Businesses	1855	135	92
School Closures	1583	169	90
Quarantine/Lockdown/Stay-at-Home Measures	1102	161	87
External Border Restrictions	1064	186	83
Public Awareness Campaigns	609	137	23
Restrictions on Mass Gathering	575	159	87
Social Distancing (Voluntary)	518	127	71
Restrictions on Non-Essential Government Services	373	99	80
New Task Force/Configuration of Administration to Tackle Pandemic	345	104	100
Emergency Declaration	330	114	100
Health Monitoring	318	110	71
Internal Border Restrictions	313	111	89
Health Testing	283	98	67
Curfew	172	91	95

Source: Cheng et al. (2020)

Optimal lockdown policies have been studied mostly using epidemiology-macroeconomic models, some of which are oriented around the dichotomy between the case in which the choices (and responses) are made by private agents and the case in which the choices are made by a social planner (Acemoglu *et al*. (2020), Alvarez *et al.* (2020), Berger *et al.* (2020), Bethune and Korinek (2020), Eichenbaum *et al*. (2020a)). Jones *et al.* (2020) argue that in contrast to private agents, the social planner will seek to front-load mitigation strategies, i.e. impose strict lockdowns from the beginning to reduce spread of infection and let the economy fall into a recession or a depression. Others add that the outcomes are dependent on the parameters of these models. The optimal policy reflects the rate of time preference, epidemiological factors, the hazard rate for a vaccine discovery, the learning effects in the health care sector, and the severity of output losses due to a lockdown (Gonzalez-Eiras and Niepelt, 2020). The intensity of the lockdown depends on the gradient of the fatality rate as a function of the infected and on the assumed value of a statistical life (VSL). The absence of testing increases the economic costs of the lockdown and shortens the duration of the optimal lockdown (Alvarez *et al.*, 2020). Chang and Velasco (2020) argue that the optimality of policies depends on peoples' expectations. For instance, fiscal transfers must to large enough to induce people to stay at home to reduce the degree of contagion; otherwise they might not change their behavior, which will increase the risk of infection. Their analysis also provides a critique of the use of SIR models, as the parameters used in these models (which remain fixed in value) would shift as individuals change their behavior in response to policy.[40]

With the decrease in daily death rates, policies regarding re-opening of economy are of primary importance.[41] Gregory *et al.* (2020) describe the lockdown measure as a "loss of productivity", whereby relationships between employers and labors are suspended, terminated, or continued. They further explain that post COVID-19, the speed and the type (V-shaped or L-shaped) of recovery depend on at least three factors: i) the fraction of workers who, at the beginning of the lockdown, enter unemployment while maintaining a relationship

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[40] Chang & Velasco (2020) compare their critique of SIR models with that of the Lucas (1976) critique of macro-econometric models for policy estimation.

[41] See, for example, T. M. Andersen *et al.* (2020), Glover *et al.* (2020) and Zhao *et al.* (2020) for how to relax restrictions and whether the lockdowns should remain in place.

with their employer, ii) the rate at which inactive relationships between employers and employees dissolve during the lockdown, and iii) the rate at which workers who, at the end of the lockdown, are not recalled by their previous employer can find a new, stable jobs elsewhere (Gregory *et al.*, 2020).

Harris (2020b) points out the importance of utilizing several status indicators (e.g., results of partial voluntary testing, guidelines for eligibility of testing, daily hospitalization rates) in order to decide the course of action on re-opening the economy. Kopecky and Zha (2020) state that decreases in deaths are either due to implementation of social distancing measures or to herd immunity, which is hard to identify using standard SIR models. They argue that with the 'identification problem', there will be considerable uncertainty about restarting the economy. Only comprehensive testing can help resolve this ambiguity by quickly and accurately identifying new cases so that future outbreaks could be contained by isolation and contact-tracing measures (Kopecky and Zha, 2020).

Agarwal *et al.* (2020) develop a synthetic control group from mobility restriction interventions applied in different countries to understand the trade-off between different levels of interventions in US. They find that a small decrease in mobility reduces the number of deaths; however, after registering a 40 percent drop in mobility, the benefits from mobility restrictions (in terms of the number of deaths) diminish. Using a counterfactual scenario, the authors find that lifting severe mobility restrictions and retaining moderate mobility restrictions (e.g. by imposing limitations in retail and transport locations) might effectively reduce the number of deaths in US. Others such as Rampini (2020) make the case for sequential lifting of lockdown measures for the younger population at the initial stages followed by the older population at later stages. The authors state that the lower effect on the younger population group is a fortunate coincidence, and thus the economic consequences of interventions can be greatly reduced by adopting a sequential approach. Oswald and Powdthavee (2020) make a similar case for releasing the younger population from mobility restrictions first on the grounds of higher economic effectiveness and their greater resilience against infections.

As some US states reopened, researchers now focus on the immediate consequences.[42] Nguyen *et al.* (2020) find that four days after reopening, mobility has increased by 6 to 8 percent, with greater increases across states which were late adopters of lockdown measures. These findings have important implications for the resurgence of cases, hospital capacity, and further deaths. Dave *et al.* (2020a) analyze the effect of lifting the shelter-in-place order in Wisconsin, after the Wisconsin Supreme Court abolished it, on social distancing and COVID-19 cases and find no statistically significant impact.

It is important to recognize that the economy also faces a "flatten the curve" problem. According to Gourinchas (2020), without substantial and timely macroeconomic intervention, the output lost from the economic downturn will be greatly amplified, especially as economic agents try to protect themselves from COVID-19 by reducing consumption spending, investment spending, and engaging in lower credit transactions.[43] Gourinchas (2020) suggests that there should be cross-regional variation in government responses based on country characteristics. Therefore, the type and level of fiscal and monetary stimulus designed to buffer the economic downturn will vary significantly across countries.

With high amounts of government debt and historically low interest levels existing in most developed countries, Bianchi *et al.* (2020) suggest a coordinated monetary and fiscal policy to tackle the COVID-19 economic fallout. They recommend that fiscal policy should be used to enact an emergency budget with a ceiling on the debt-to-GDP ratio. This measure would increase aggregate spending, raise the inflation rate, and reduce real interest rates. The monetary authorities would coordinate with fiscal policy authorities by adopting an above-normal inflation target. In the long run, governments would try to balance the budget, and future monetary policy would aim to bring inflation back to normal levels.

Bigio *et al.* (2020) focus on the cases for government transfers vs. credit subsidy policies. They determine that the optimal mix between them depends on the level of financial

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[42] See Balla-Elliott *et al.* (2020) for a survey of small American businesses' expectations about re-opening.

[43] Collard et al. (2020) explain that efficient allocation is determined by the marginal rate of substitution between consumer utility and infection risks. For dynamic models, the resource allocation is determined by the interplay between immunization and infection externalities. Hall et al. (2020) analyze the maximum amount of consumption people would be willing to forgo to avoid death from COVID-19. The authors find that the decrease in consumption ranges from 41 percent to 28 percent, depending on the average mortality rate for a group.

development in the economy. According to these authors, economies with a developed financial system should utilize credit policies. On the other hand, developing economies should engage in more transfer spending. Guerrieri *et al.* (2020) explore whether a supply shock such as COVID-19 leads to a fall in excess demand in a multi-sector economy with incomplete markets. They find that a negative supply shock can lead to overreaction in terms of falling demand, especially in cases where there is low substitutability across goods, incomplete markets, and liquidity constraints amongst consumers. They argue that the optimal policy response is to combine loosening of monetary policy with enhanced social insurance. In contrast, unconventional policies such as wage subsidies, helicopter drops of liquid assets, equity injections, and loan guarantees can keep the economy in a full-employment, high-productivity equilibrium (Céspedes *et al.*, 2020). These policies can stop the cycle of negative feedback loops between corporate default and financial intermediary weakness, which can create a macro-economic disaster (Elenev *et al.*, 2020). Didier *et al.* (2020) discuss the policy menu, priorities and trade-offs of providing direct financing to firms.

8 Conclusion

This study delved into the research related to the economics of COVID-19 that has been released in a relatively short time. The aim is to bring coherence to the academic and policy debate and to aid further research.

Before delving into the impacts of COVID-19 and government response on the economy, we documented the most popular data sources to measure COVID-19 known cases/deaths and social distancing. We first pointed out that COVID-19 cases and deaths suffer from measurement error due to many factors including testing capacity. Mobility measures using GPS coordinates from cell phones have been used extensively to measure social distancing. However, there are certain caveats that apply, particularly in terms of privacy concerns and the representativeness of data. The paper also reviewed different research related to social distancing itself, particularly in regards to its determinants, its effectiveness in mitigating the spread of COVID-19, and its compliance. Going forward, social distancing and its measurements will continue to play a key role in academic research and policy development.

Going forward, the policy measures related to COVID-19 will continue to be an important area of research. These measures, which have varied both in terms of scope and implementation, are expected to yield a profound economic and social impact. This study tried to bring coherence to these issues by covering different public health and economic stimulus measures as well as providing a review of the literature on policy determinants, optimal lockdown measures, factors affecting lifting of lockdown, and combinations of fiscal and monetary policy measures aimed at 'flattening the recession curve'.

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