# Global Storm

## The Effects of the COVID-19 Pandemic and Responses around the World

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# Executive Summary

The key event of 2020 was the COVID-19 virus and its impacts on health, mortality rates, economies, and government budgets. From the first reports of a pneumonia of unknown origin in Wuhan, China, the COVID-19 pandemic grew and spread to countries around the world, becoming a global storm affecting health and economic performance. Indeed, there is some debate amongst public health officials and epidemiologists as to when the virus began spreading from its origin point. By April of 2021, the tally reached 129 million infections and 2.8 million deaths. This study examines the pandemic by comparing the performance of countries in terms of (1) infection rates and mortality rates; (2) the response to dealing with the pandemic in terms of the strategies employed—testing and restrictions; (3) the severity of the economic shock (changes in GDP); and (4) the economic and fiscal response by governments to the economic shock brought about by the pandemic. As well, regression analysis is employed to assess the relationship between key indicators of the effect of the pandemic on the economy and the response of mitigating measures on the pandemic and the economy. The evidence and results in this study offer some early and tentative analysis as to the effects of the pandemic, differences in international impacts and containment efforts, and the economic and fiscal impacts and effectiveness of associated responses.

Within the range of recent modern experience, the COVID-19 pandemic is considered unprecedented but it is not the Black Death, which between 1347 and 1351 is estimated to have carried off up to half of the European population—nor to date has it mortality equal to the Spanish Flu, which is estimated to have killed anywhere from 20 to 100 million people. As well, the mortality and morbidity effects have been more concentrated on the elderly rather than the working-age population aged 20 to 65 years, though recent variants seem to be changing this pattern. While past pandemics had dramatic effects on long-term capital-to-labour ratios, wages, and interest rates, the COVID-19 pandemic's long-term effects have yet to emerge though it has had severe short-term effects through its disruption of modern economic production with its highly integrated supply chains and emphasis on personal services and, in the absence of vaccines and effective treatments, the effect upon economies of restrictions designed to limit the spread of the virus.

The pandemic's initial effects were exceptionally severe across highly developed and economically advanced countries with less-developed countries hit harder later on. While the IMF35 advanced economies account for 18% of the world's countries, in 2020 they accounted for just over 50% of the 30 worst-hit countries in the world in terms of cases adjusted for population. These same points also apply to mortality from COVID-19 given

that again the IMF35 advanced economies accounted for 40% of the 30 countries that had the most deaths per million but only 18% of the countries in this study. The fact that the advanced economies have older population distributions than the developing and emerging world may be a factor in the higher toll on advanced countries.

The economic effects of the pandemic saw an estimated drop in world real GDP in 2020 of 4.3%. Again, the IMF35 advanced economies were harder hit, with estimates by early 2021 suggesting a 5.4% fall in real GDP while IMF-defined emerging market and developing economies saw a 2.6% contraction. Unlike major pandemics of distant history, the economic toll of the pandemic resulted more from the toll of measures enacted to control the spread of the disease than the impact of mortality on working-age populations. Lockdowns, quarantines, and travel restrictions have drastically affected sectors such as international travel, the labour-intensive personal services, food and accommodation, tourism, and arts and entertainment as well as disrupted some aspects of the globalized supply chain. However, except early on in the pandemic, stringency does not appear to have been the major factor in curbing the long-term spread of the pandemic or curbing the death toll from COVID-19. Other important public-health measures included effective case testing and tracking, mask wearing, and general public compliance with, and enforcement of, rules.

Though all countries experienced the pandemic, its intensity and severity varied substantially across countries as did the economic and fiscal impact. Countries that were heavily affected by the SARS experience in 2004 collectively appear to have had a significantly lower incidence of COVID-19 and fewer deaths, suggesting that episode was a valuable learning experience. Nevertheless, application of this lesson appears inconsistent and incomplete based on differences in the number of cases and deaths across this group of countries. In the case of the fiscal response, some countries incurred deficits below what predictive models might suggest while others incurred much larger ones than the pandemic effects might suggest. Moreover, despite expectations that large public sectors might help stabilize economic performance, countries with relatively larger public sectors going into the pandemic do not seem to have experienced smaller drops in economic activity.

In the end, while there are common variables affecting the impact of COVID-19 in aggregate across countries, how each country chose to play the cards that were dealt was likely the bigger determinant of outcomes for health and the economy. Learning behaviour was not guaranteed even amongst countries who might have been expected to learn something from their recent past experiences with infectious diseases. Moreover, despite the marvels of instantaneous 21st-century communications and dissemination of information, during the early stages it often seemed as if each nation had to experience its own pandemic before it took the matter seriously.

# 1 Introduction

The central event of 2020 was the global storm marked by the onset and spread of the COVID-19 virus and its impact on populations and economies around the world. The basic timeline[1] of the pandemic is now well established starting with the initial reports (ProMED, 2019) of a mysterious undiagnosed pneumonia in Wuhan, China just before the start of the New Year celebrations with confirmation of human-to-human transmission in late January and the World Health Organization (WHO) declaring a global health emergency on January 30 (*BBC News*, 2020). By middle of February, while China began flattening its infection-rate curve, the virus began to spread dramatically around the world, with the world essentially shutting down in March as the pandemic surged and hospitals were overwhelmed in many countries by the cases. While the pandemic appeared to abate during the summer, by the fall a second wave had begun with peaks larger than the first wave and, moving into early 2021, the pandemic continued with rates peaking and a slow downward trend starting in many countries. The arrival of vaccines by the end of 2020 and their take up has heralded some much-needed optimism for 2021. At the same time, spring of 2021 is seeing another wave of infections as new variants of the virus take hold.

As of the end of January 2021, the pandemic had resulted in over 100 million infections worldwide and just over 2 million deaths and by April of 2021 the tally had grown to 129 million infections and 2.8 million deaths.[2] The macroeconomic impact has been quite large as with infections spreading, governments and their public-health authorities around the world put in place lockdowns and associated measures to curb infection rates. In the United States, the second quarter drop in GDP in 2020 was 9% with an annualized second quarter contraction in GDP that was the equivalent of 31.4% (Casselman, 2020). The Eurozone saw a second-quarter drop of 11.2%. The third quarter on the other hand saw a rebound of 11.7% from the second quarter, which when annualized was over 40% (Eurostat, 2021). These are record drops not seen since the Great Depression but perhaps less serious given that the similarly sized contractions of real GDP during the Great Depression persisted over a period of three to four years.

1. For basic media accounts over time, see Safi, 2020 and Taylor, 2021.

2. Statistics are continually updated at a number of sites around the world including that at the John Hopkins Coronavirus Resource Center (2021), <https://coronavirus.jhu.edu/>; and at the University of Oxford (2021), <https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker>.

Pandemics have happened before and, barring unforeseen new medical innovations, they will happen again. Yet, many countries were caught unprepared for this pandemic even in cases where they had the experience of a more recent outbreak such as SARS, suggesting that lessons are not always learned. It is important that lessons be drawn from the body of international evidence available on the COVID-19 pandemic in order to help shape responses to future outbreaks. However, there is a lack of current research and published studies relating the effects of country-level demographic and socio-economic variables to COVID-19 incidence and mortality rates (Cao, Hiyoshi, and Montgomery, 2020: 2). Moreover, while there have been international ranking comparisons of the effects of the pandemic in terms of mortality and incidence as well as economic effects such as GDP growth, employment, and trade impacts by organizations such as the International Monetary Fund (IMF) and the World Bank, there again has been little linking pandemic variables to economic impacts in a broader correlative framework.

This study will use international data to examine the pandemic on a number of levels: (1) infection rates and mortality from COVID-19 across the countries most affected as well as the 35 countries identified by the IMF as advanced economies (IMF35); (2) strategies employed in response to the pandemic—such as the degree to which countries imposed stringent restrictions like lockdowns and pandemic-control measures like testing—and their impact on mortality; (3) the severity of the economic shock (such as changes in GDP); and (4) the fiscal response by governments to the economic shock brought about by the pandemic and what factors seem to have mitigated the size of the shock.[3] Moreover, regression analysis will be employed in selective instances to see what the relationship in 2020 was between key indicators of the effect of the pandemic on the economy and the response of mitigating measures on the pandemic and the economy.

In general, the severity of the current COVID-19 pandemic and its associated disruptive effects has operated through several pathways. First is the initial absence of a vaccine and effective treatments given the novelty of the coronavirus, the lack of initial information, and the tendency towards easy and rapid transmission of the virus. In some respects, until vaccines were developed, the response to COVID-19 of travel restrictions, quarantine, and face masks was really not that far removed from the response to a medieval plague. Second is the supply-side disruption given widespread government-imposed infection control measures such as travel restrictions and stay-at-home orders and the accompanying disruption of an interdependent and more integrated global trade and production chain. This had some consequences for the importation of vital supplies such

3. See §4.2 for model specification and estimation techniques.

as personal protective equipment (PPE) and drugs given that many countries have come to rely on external trade and production for vital goods. Third is the fact that, unlike past pandemics when economic production was more goods intensive, the production and consumption patterns characterizing modern developed economies are dominated by services that have been particularly prone to disruption, including food, accommodation, retail, and travel. This hit advanced economies particularly hard given that their high level of economic development in many respects made them more prone to disruption. Fourth is the unprecedented size of the government fiscal and economic response to the pandemic, which has never been a feature marking past pandemics.

# 2 Pandemics Past and Present

The study of pandemics and their economic and health effects can be considered part of a general literature on health status, health spending, and economic growth. The long-term relationship between health status and economic growth in history is considered bi-directional because improving the health status of a labour force promotes economic growth while higher economic growth in turn affords more resources for improving health status, as illustrated by Preston (1975). However, the relationship can be complicated by confounding factors such as education, technological change, and institutional quality as noted by Deaton (2013) and Bloom, Kuhn, and Prettner (2018). As well, the long-term relationship between health and economic growth is further affected by specific short-term, immediate disease events such as pandemics.

Pandemics have been constant throughout human history with substantial health, population, economic, social, and political effects on society both in the short and long term often leading to major societal transformations in their wake, though those effects have varied across countries and continents.[4] For example, Alfani and Murphy (2017) and Alfani and Percoco (2019) note that major events such as the Black Death caused economic shocks across European countries that had divergent effects because of differences in population density and economic development.

Pamuk (2007) suggests that the Great Divergence of economic growth of western economies after 1500 may be rooted in the effects of the Black Death. Indeed, noting the relationship between health and economic performance, Arora (2001) finds that long-term health measures including stature and life expectancy appear to have permanently altered the slope of economic growth paths for ten major industrialized countries over the course of 100 to 125 years of industrialization. Meanwhile, Jordà, Singh, and Taylor (2020) connect pandemics and the rate of interest since the fourteenth century, finding that interest rates fall by about 1.5% for as much as 20 years afterwards given that pandemic mortalities historically reduce labour relative to capital.

The channels whereby pandemics affect the economy has received substantial attention. Rasul (2020) notes that viral outbreaks expose households to higher levels of risk and uncertainty with respect to acquiring infection, thereby affecting their consumption and personal behaviour. As human-to-human contact is the primary transmission

4. Some of the broader long-term impacts of viruses and germs in the rise and fall of civilizations have been documented in work by Diamond (2017) and Mann (2011).

mechanism, the effect on social interaction and networks as they are interrupted also affects economic activity. Meanwhile, the policy responses to a pandemic such as quarantines and lockdowns and closing down of transportation and trade networks as well as public facilities such as schools reduces economic activity and in the long run can even affect acquisition of human capital .

In terms of its short- and long-term impacts, the COVID-19 pandemic is not expected to be an exception and many comparisons of its effects have been made with the early-twentieth century Spanish Flu. The Spanish Flu has received particular attention in the literature as it was the first modern pandemic and has parallels with COVID-19. The Spanish flu occurred in three waves (some countries actually had a fourth in 1920) starting approximately spring 1918, then fall 1918, and finally spring 1919, and infected as many as 500 million people worldwide—about one third of the global population at the time. Mortality estimates vary, ranging anywhere from 20 to 50 to upwards of 100 million people, based on estimates. The pandemic coincided with and was complicated by the First World War then in progress and the global mortality of the war estimated at about 10 million civilians and nine million soldiers was compounded by a pandemic that hit males aged 18 to 40 the hardest.[5] However, given that COVID-19 has hit seniors particularly hard, it is less likely the mortality impact will be severe on labour supply with the short-term effects upon the labour supply primarily arising from lockdowns and other economic disruptions.

The international economic, health, and social impacts of the Spanish Flu have been documented in numerous studies. For example, Karlsson, Nilsson, and Pichler (2014) find the impact of the Spanish Flu across Swedish regions did not affect earnings but did increase the share of the population on welfare relief or poorhouse rates and reduce the return to capital. Garrett (2008, 2009) finds influenza mortalities reduced the supply of manufacturing workers, increased the marginal product of labour and capital per worker, and thus increased real wages in the United States. Brainerd and Siegler (2003) argue that US states that experienced higher influenza death rates during the Spanish Flu era had higher growth rates in per-capita income in subsequent periods. Eichenbaum, Rebelo, and Trabandt (2020) find that decisions to reduce work and consumption during a pandemic increases the severity of economic recession but reduced total deaths.

Given that COVID-19 to date has hit the elderly particularly hard, it is unlikely the mortality impact will be as severe on labour supply with the short-term effects primarily arising from restrictions and their resulting disruptions.[6] Indeed, the impact of lockdowns

5. For a classic account, see Barry, 2004. See also Garret, 2008 and History.com, 2020.

6. There is some evidence that the third wave of the pandemic, which features more new variants, is more infectious and also is affecting a larger proportion of the population aged below 60 (Tuite *et al.*, 2021).

and restrictions has been a source of study. Jung, Manley, and Shestha (2021) found that in the United States, stay-at-home mandates caused significantly higher reductions in mobility in high-income counties that experienced adverse weather shocks than counties that did not. Using weather shocks in combination with stay-at-home mandates as an instrument for social distancing, they find that measures taken to promote social distancing helped curb infections in high-income counties but not in low-income counties.

However, long-term effects upon labour supply from the COVID-19 pandemic might yet emerge, given the disruption in education and human-capital formation. Also, there are long-term health issues facing younger people who have had COVID that could affect the "quality" of the labour force going forward. The experience during the Spanish Flu is probably not completely comparable in terms of the effects upon acquisition of human capital by the young, given the lower take-up of formal elementary, secondary, and post-secondary education one hundred years ago. For example, in their OECD report, Hanushek and Woesmann(2020) maintain that elementary and secondary students in grades 1 to 12 in the G20 countries affected by the closures may see 3% lower income over their entire lifetimes. For nations, the lower long-term growth related to such losses could yield an average of 1.5 percentage points lower annual GDP for the remainder of the century. And, there are the long-term effects on productivity and research given the sifting of resources away from other areas of scientific research and into research related to COVID-19.

When the impact of measures taken to control COVID-19 are examined, what is important is also the ultimate impact on mortality. Cao, Hiyoshi and Montgomery (2020) using aggregate international data found testing policies are associated with a 2.23% decrease in case fatality rates (CFR) while strictness of anti-COVID-19 measures—from the COVID-19 Government Response Tracker (OxCGRT)[7] was not statistically significantly associated with CFR overall, but a higher position in the OxCGRT was actually associated with higher CFR in higher-income countries with active testing policies.

Beach, Clay, and Saavedra (2020) in their analysis of the impacts of the 1918 flu and its lessons for COVID-19 note that a fundamental issue in understanding the impacts for both is the lack of reliable data. Among the interesting results they document about the Spanish flu with application to COVID-19 are that per-capita country income was negatively and significantly related to mortality, the effect of non-pharmaceutical interventions such as face coverings was mixed, and like COVID-19 "long-haulers",[8] those who survived infection had elevated mortality risks and some physiological conditions

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7. See Blavatnik School of Government, University of Oxford, *COVID-19 Government Response Tracker (OxCGRT)*, <https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker>.

8. Those with lingering symptoms after the virus can no longer be detected in their bodies; see Komaroff, 2020.

that never healed. Moreover, the birth cohort *in utero* in 1918 appears to have grown up in worse health and in lower socio-economic status conditions than other birth years.

Barro, Ursua, and Weng (2020) argue that the size of the mortality and economic impacts of the Spanish flu offer a plausible upper bound for the outcomes of COVID-19. Using data for 48 countries accounting for 92% of world population at the time, they found that the Spanish flu from 1918 to 1920 killed 40 million people or 2.1% of the world's population, which they applied to current world population to construct an upper bound of 150 million deaths from COVID-19. As well, the economic impact of the Spanish flu suggests overall GDP declines in countries on average of about 6%. In addition, stock markets recovered from their short-term pandemic decline, while real interest rates declined, and inflation was higher. As an additional point, Barro, Ursua, and Weng (2020) note that mortality rates varied greatly across countries. For example, then as now, Australia had a swift quarantine response with a case fatality rate from the pandemic of 0.3% compared to 2.1% worldwide. The United States, on the other hand, had an overall case fatality rate from the Spanish flu of 0.5% with 550,000 deaths.[9]

The economic impact of the current pandemic can be summarized through four basic channels of effects. First, the initial absence of a vaccine and effective treatments given the novelty of the coronavirus, the lack of initial information, and the tendency towards easy and rapid transmission of the virus generates a response bearing more relation to historical pandemics than the twenty-first century: travel restrictions, quarantines, isolation, lockdowns, and facial coverings. Second, there is the economic and supply-side disruption given widespread government-imposed lockdowns and efforts to contain the spread of the virus and the accompanying disruption of an interdependent and more integrated global production chain. Third, unlike past pandemics when economic production was more goods intensive, production and consumption patterns characterizing modern economies are dominated by services that have been particularly prone to disruption, including personal service, food, accommodation, retail, and travel.[10] Fourth, government fiscal and economic response to the pandemic is of an unprecedented size that has never been a feature of past pandemics. The increase in public-sector deficits and debts will have fiscal implications for years to come. Meanwhile, the associated income-support programs could have long-term effects on both the size of government as well as on labour-force participation rates.

9. It should be noted that as of April 1, 2021, the United States had nearly 565,000 deaths from COVID-19 and a total death rate based on a population of 332.2 million people of 0.17%. The Spanish Flu, therefore, had an overall death rate that was three times higher. It should be noted that case fatality rates differ from overall death rates. Based on cases of 31.1 million as of April 1, the COVID-19 case fatality rate is 1.8%.

10. The COVID-19 pandemic, unlike past recessions, has been particularly severe in its economic effects on the consumption of services as opposed to consumption of non-durables (see Charalampidis and Guillochon, 2021).

# 3 The COVID-19 Pandemic—Overview of Data and Trends

## 3.1 A brief timeline and summary

The SARS-CoV-2 coronavirus known as COVID-19 first identified in December of 2019, is a new and highly infectious coronavirus easily spread from person to person via aerial transmission such as droplets. Its symptoms are similar to seasonal flus and include cough, fever, chills, muscle and body aches, and sore throat but can also include loss of taste or smell, diarrhea, fatigue, nausea, vomiting, and congestion. The severity can run from completely asymptomatic to severe to ultimately death. The virus is generally diagnosed with a nose-swab laboratory test though rapid tests have become more common (Sauer, 2021). Prevention measures have included hand washing, face masks, physical distancing, and most recently vaccines. While there are no drug treatments that cure COVID-19, there are some mitigation drugs.[11]

The mortality rate from the illness has varied across countries and estimates have ranged from 0.1% to 25% according to the World Health Organization (2020). Another more recent estimate in the *British Medical Journal* places the average of country/territory-specific COVID-19 case fatality rates at between 2% to 3% (Cao, Hiyoshi, and Montgomery, 2020). Even in the 20 most affected countries, the mortality rates per 100,000 population as of March 1, 2021 ranged greatly from a high of 191 in Czechia, to a low of 9 in Nepal. In this ranking, the United Kingdom was second at 185, Italy third at 162 and the United States fourth at 157 ( Johns Hopkins Coronavirus Resource Center, 2021).

The onset and progression of the COVID-19 pandemic spans the period from late December 2019 to all of 2020 and at the time of this report continues into 2021.[12] The initial reports of "pneumonia of unknown cause" originate in Wuhan, China in late December with connections to a seafood market in the city (ProMED, 2019). However, from the perspective of hindsight, it would appear that the COVID-19 virus had been spreading in China for some weeks (Bryner, 2020) if not months before then, and there may have been cases spreading in Europe (Vagnoni, 2020; *The Guardian*, 2020) prior to 2020.

11. There are a number of vaccines that have been developed and approved or are under development or approval. Most notable are those by Moderna, Pfizer-BioNTeach, AstraZeneca/COVIShield, Janssen, Johnson and Johnson, and Novavax. As well, antivirals have been developed by Dr. Reddys Laboratories (Faviporavir) and Gilead Sciences (Remdesivir).

12. For timelines of the pandemic, see Taylor, 2021 and Safi, 2020.

By the end of January 2020, it was apparent that there was indeed human-to-human transmission underway as announced on January 20 by Chinese respiratory expert, Zhong Nanshan, and cases were beginning to be detected in other parts of Asia as well as the United States. Wuhan was sealed off on January 23 and by January 30 the World Health Organization had declared a global health emergency (*BBC News*, 2020). On February 2, the first coronavirus death was reported outside of China and by February 11, the new disease caused by the novel coronavirus was named COVID-19, short for "Coronavirus disease 2019".

By mid-February, COVID-19 began to be contained in China, but it was spreading globally and particularly in Europe where Italy was especially hard hit by early March. On March 11, the World Health Organization declared the novel coronavirus (COVID-19) a pandemic (Cucinotta and Vanelli, 2020). As cases and deaths mounted, the world in March essentially came to a halt as countries closed their borders, international travel dried up, quarantines and lockdown measures hit and by early April, there were more than a million cases globally and over 50,000 deaths. Cases continued to mount and by June the tally had surpassed 6 million worldwide with just under 400,000 deaths worldwide.

By June, countries seemed to be over the first wave and began to reopen their economic activity and ease lockdown restrictions with some resumption of business and travel, but the economic impact was becoming quite apparent as countries around the world reported large drops in GDP and soaring unemployment rates. In the wake of containment measures, the summer saw a reprieve around the world as the number of daily new cases flattened. Nevertheless, between June 1 and September 1 of 2020, total cases worldwide still rose from 6.6 to 26.5 million and total deaths from 390,000 to 878,000. By the fall the virus resumed a more rapid upward climb and lockdowns and restrictions were reimposed around the world. By December 1 of 2020, the total number of cases worldwide had reached 65 million and with a total of 1.5 million deaths (Worldometer, 2021a). The news of the first successful vaccines arrived in late fall with November seeing the announcement of successful vaccines by drug companies Pfizer, Moderna, and AstraZeneca, and vaccination campaigns commencing in some countries.

In many respects, the first year of the pandemic unfolded like previous pandemics given that, in the absence of vaccines and even with modern medical knowledge and care and public health measures, control efforts consisted largely of wearing face masks, quarantining and lockdowns, and physical distancing measures. The early effects of the pandemic and responses to it were more akin to a medieval plague or the Spanish flu than many in the developed world would like to imagine.

The impact of the pandemic by the end of 2020 saw a tally of 84 million reported cases worldwide accompanied by 1.8 million reported deaths for a death rate of just over 2%. As of March 1, 2021, the number of cases had climbed to 115 million and 2.6 million deaths for a case fatality rate of about 2.3%. In terms of the distribution of cases worldwide to date, the largest share at 25% were in the United States. The next largest shares were India (10%), Brazil (9%), Russia and the United Kingdom (3.6%), France (3.3%), Spain (2.7%), and Italy (2.6%).

It should be noted that these figures do not take into account the possibility of under-reporting of both cases and deaths. For example, excess deaths are typically defined as the difference between the observed numbers of deaths in specific time periods and expected numbers of deaths in the same time periods (CDCP, 2021). Thus, a study analyzing US mortality in the period from March to July 2020 reported a 20% increase in excess deaths that was only partly explained by COVID-19 mortality. These excess deaths not attributed to reported COVID-19 deaths could be from immediate or delayed mortality from undocumented COVID-19 infection, or non–COVID-19 deaths secondary to the pandemic, such as from delayed care or behavioral health crises (Woolf, Chapman, Sabo, and Zimmerman, 2021). Another report for the United States estimates that at least two-thirds of excess deaths in the United States were due to the coronavirus (Hopkins Tanne, 2020). Some studies have even suggested a massive under-reporting of COVID-19 cases around the world (Lau *et al.*, 2021). However, it should be noted that estimates of excess deaths and under reporting are themselves also estimates and potentially incomplete. A more accurate picture of the extent of COVID-19 deaths and infections can only emerge through time.

The economic impact of the pandemic has been truly the most extraordinary in recent history, if not the last 100 years. According to the World Bank, the pandemic plunged most countries into recession with the largest annual contraction in per-capita income since 1870 (World Bank, 2020). In 2020, the estimated drop in world real GDP was 4.3% fueled by a 9.5% drop in the world volume of trade (World Bank, 2021). The advanced economies were exceptionally hard hit with a 5.4% fall in real GDP while emerging markets and developing economies saw a 2.6% contraction. It would appear that advanced economies with their specialized and highly developed service sectors were hit hard by the disruption of the pandemic.

Meanwhile, the *Fiscal Monitor Update* of the International Monetary Fund (IMF, 2021b) most recently summarized a government response to the pandemic of $14 trillion dollars, funded by massive deficits in 2020 estimated at an average overall share of GDP of 11.7% for advanced economies, 9.8% for emerging-market and middle-income economies, and 5.5% for low-income developing countries.

While both the World Bank and the IMF forecast a substantial rebound for 2021/22 given the multiple vaccine approvals and distribution that have begun to take effect in 2021 as well as adaptation to the restrictions that have been imposed, it remains that there is substantial uncertainty given the surging variants in late 2020 and early 2021 and the potential for future mutations, and logistical problems in vaccine distribution around the world. The strongest recoveries have been forecast for emerging market and developing economies relative to the advanced economies.

## 3.2 The data

The primary data sources used are from the International Monetary Fund, World Economic Outlook Database, as of January 2021 (IMF-WEO); the COVID-19 database of the World Health Organization; the Worldometer Corona Virus Data Base; Our World in Data; the COVID-19 Government Response Tracker (OxCGRT) at University of Oxford; and the World Bank.[13]

It should be noted that numbers and estimates especially for economic and fiscal variables are still subject to substantial change but the data used here is current as of January 2021. The data for this study is a comprehensive set of international variables for 200 countries though data availability for some of the variables is limited, reducing sample sizes for some of the variables under consideration. As well, as previously noted, there are always issues, particularly in the collection of COVID-19 incidence and mortality, with the reliability, accuracy, and breadth of the efforts of national systems to collect and disseminate data.[14]

For example, at the time of data compilation, there were 199 country observations for total COVID-19 cases and total deaths in 2020 in the Worldometer data whereas the IMF's World Economic Outlook Database had 193 country observations for real GDP, 192 observations for deficit-to-GDP ratios, and 86 observations for net debt. Measures of stringency employed in efforts to suppress the pandemic from the OxCGRT were for 176 countries; estimates of hospital beds per 1,000 were available for 164 countries and smoking rates for 138 countries were available from Our World in Data. A complete listing of the variables that were collected for this study is provided in Appendix 1.

Much of the impact of the COVID-19 pandemic is presented in total tallies of cases and deaths but the severity of the pandemic is best understood after adjusting for population

13. See "Data sources", page 72, for full information.

14. This is even an issue affecting developed countries with what are considered to be good data gathering systems. For example, it has emerged that mortality in the first few months of Canada's COVID-19 pandemic has turned out to be higher than initially indicated by official numbers (see Andrew-Gee, 2021).

given the diverse population sizes of the international community. Population data are available for 194 countries in the IMF-WEO and range from highs of approximately 1.4 billion for China and India to a low of about 13,000 and 11,000 for the Pacific countries of Tuvalu and Nauru. Even within the 35 economies designated as advanced by the International Monetary Fund, population ranges from a high of 330 million for the United States to a low of just over 360,000 for Iceland.

## 3.3 Overview of trends

### 3.3.1 Incidence and deaths

Figure 1 and figure 2 plot total COVID-19 cases per million population for the 30 countries with the most cases per million in the world, and for the 35 countries identified by the IMF as advanced economies (IMF35).[15] For the purposes of additional comparison, the figures for Canada, the United States, and the United Kingdom are highlighted in this and subsequent graphs. The country with the highest COVID-19 rate globally in 2020 was Andorra with the United States in 7th place international and the United Kingdom in 23rd place. Italy, which was hard hit by deaths from the pandemic does not make the top 30 countries for cases, coming in at 32nd highest. Globally, Canada was in 68th spot, just above Turkey and below the Bahamas.

When only the IMF35 advanced economies are considered, the highest incidence of COVID-19 is in the Czech Republic (Czechia) at about 87,000 cases per million population and the lowest in Taiwan at about 7. The United States had the fourth highest incidence in this grouping, the United Kingdom ranked 12th, and Canada 24th. What is interesting to note is the number of IMF35 countries actually amongst the top 30 countries for COVID-19 population-adjusted incidence; this suggests the advanced economies were either particularly hard hit or perhaps had better testing and reporting standards and reported more cases.[16]

While the IMF35 advanced economies account for 18% of the world's countries, they accounted for just over 50% of the 30 worst-hit countries in the world in terms of cases adjusted for population. One reason for this is that these countries appear to have been in the forefront of the first wave of the pandemic. This may also be the result of more complex, advanced, and inter-dependent economic, social, and population systems being hit harder by the disruptive effects of the pandemic relative to those that are less

15. This is ostensibly for 2020 but the period is from the start of the pandemic to January 23, 2021. Cases and deaths are from WHO with the exception of Taiwan, which was not available in the WHO data and comes from Worldometer.

16. Under-reporting bias has been reported in some countries (see Biswas, Afiaz, and Hug, 2020).

Figure 1: Total COVID-19 cases per million population, top 30 countries, 2020

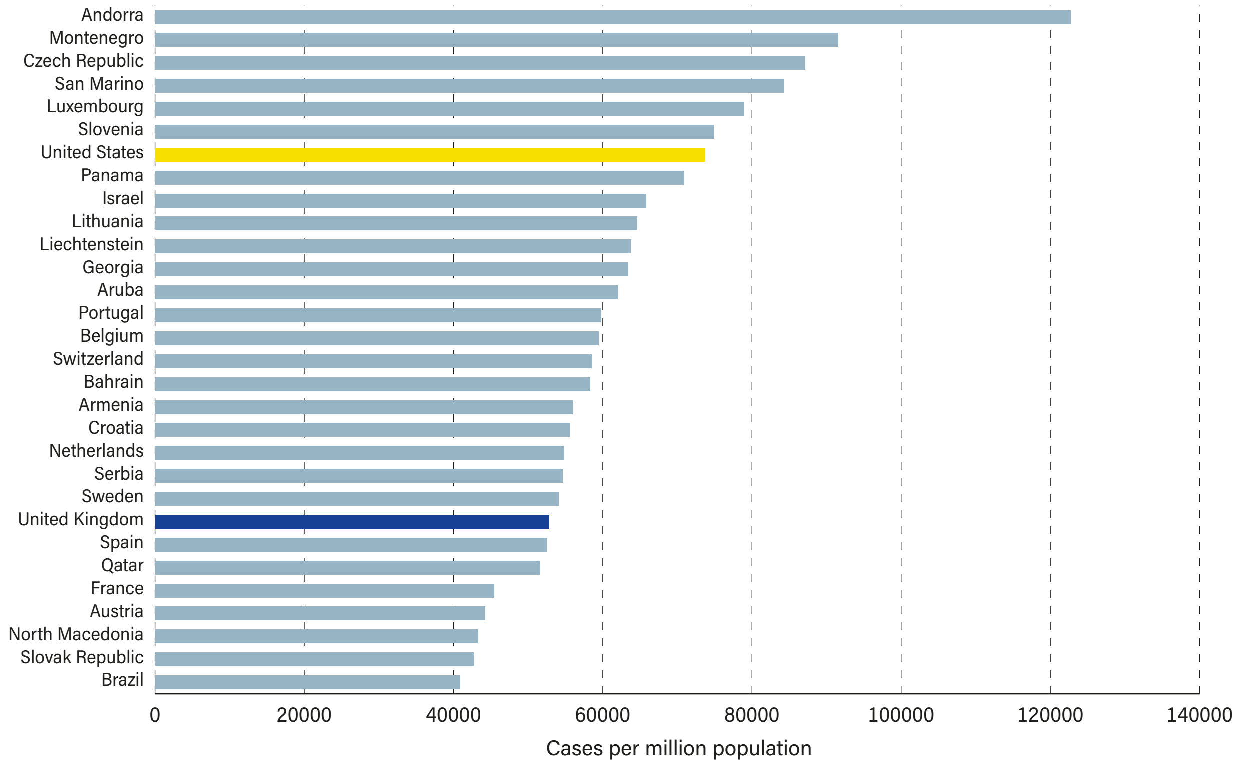
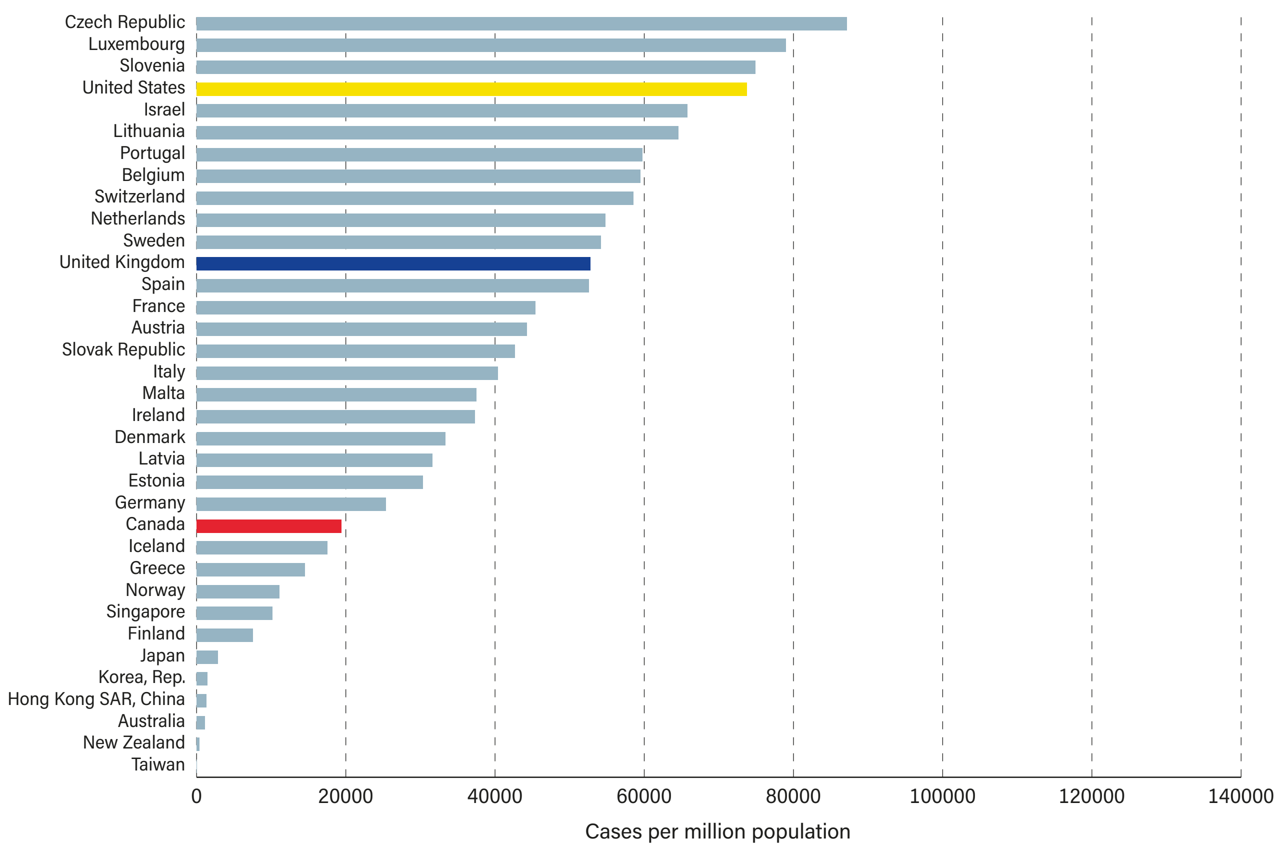



Figure 2: Total COVID-19 cases per million population, IMF35 advanced economies, 2020




Sources: World Health Organization, 2020b; Worldometer, 2021b.

so. Or, it could be the result of a weaker response at dealing with the pandemic by these advanced countries. Or, it could simply be that these advanced countries are freer and more open with data collection and dissemination as well as having better data-gathering infrastructure and therefore more cases recorded. As a case in point, the average value of the rankings for 2018 on the Fraser Institute's Economic Freedom Index (Gwartney, Lawson, Hall, and Murphy, 2020) for the IMF35 in this data set averaged 7.9 and ranged from a low of 6.7 to a high of 8.9. Meanwhile, for the remaining countries, it averaged a lower and less economically free 6.6 and ranged from a low of 3.3 to a high of 8.2.

This differential impact spills over when deaths from COVID-19 per million population are presented in figure 3 and figure 4. Looking at a global comparison, among the top 30 countries ranked in terms of deaths per million,[17] the highest death rates from COVID-19 were in San Marino, Belgium, and Slovenia, followed by the Czech Republic, the United Kingdom, and Italy. The United States and the United Kingdom were both in the top 30 countries: the United Kingdom was fifth with 1,400 deaths per million, and the United States was 13th with 1,200 deaths per million. Among the IMF35, Belgium and Slovenia ranked highest with over 1,700 deaths per million population while New Zealand, Singapore, and Taiwan were at the bottom with approximately five or less. In this grouping, the United Kingdom ranked fourth, the United States 6th, and Canada 22nd.

The IMF35 advanced economies accounted for 40% of the top 30 countries ranked for COVID-19 deaths per million, again a much larger proportion than their 18% share of countries. It should again be noted that the higher deaths from COVID-19 in North America and Europe in particular may also be partly the result of better data collection techniques and more complete data. It should also be noted that the developed countries in general have larger population shares of elderly and mortality from COVID-19 was particularly widespread among the elderly. For example, in the United States, six months into the pandemic, adults aged 65 years and older accounted for 16% of the US population but 80% of COVID-19 deaths, somewhat higher than their share of deaths from all causes (75%) over the same period (Freed, Cubanski, Neuman, Kates, and Michaud, 2020).

Cao, Hiyoshi, and Montgomery (2020) found a similar result with Case Fatality Rates (CFR) when comparing North America and Europe to other countries and suggest that a possible reason is that some countries counted COVID-19 deaths by counting those who died with it but not only from it. As well, they note that some countries attributed to COVID-19 any death once the patient became a confirmed case, even if the death

17. It should be noted COVID-19 deaths per million population is one mortality measure. Another is the Case Fatality Rate (CFR), which would be the total number of deaths from COVID-19 divided by the total number of confirmed cases.

Figure 3: Total COVID-19 deaths per million population, top 30 countries, 2020

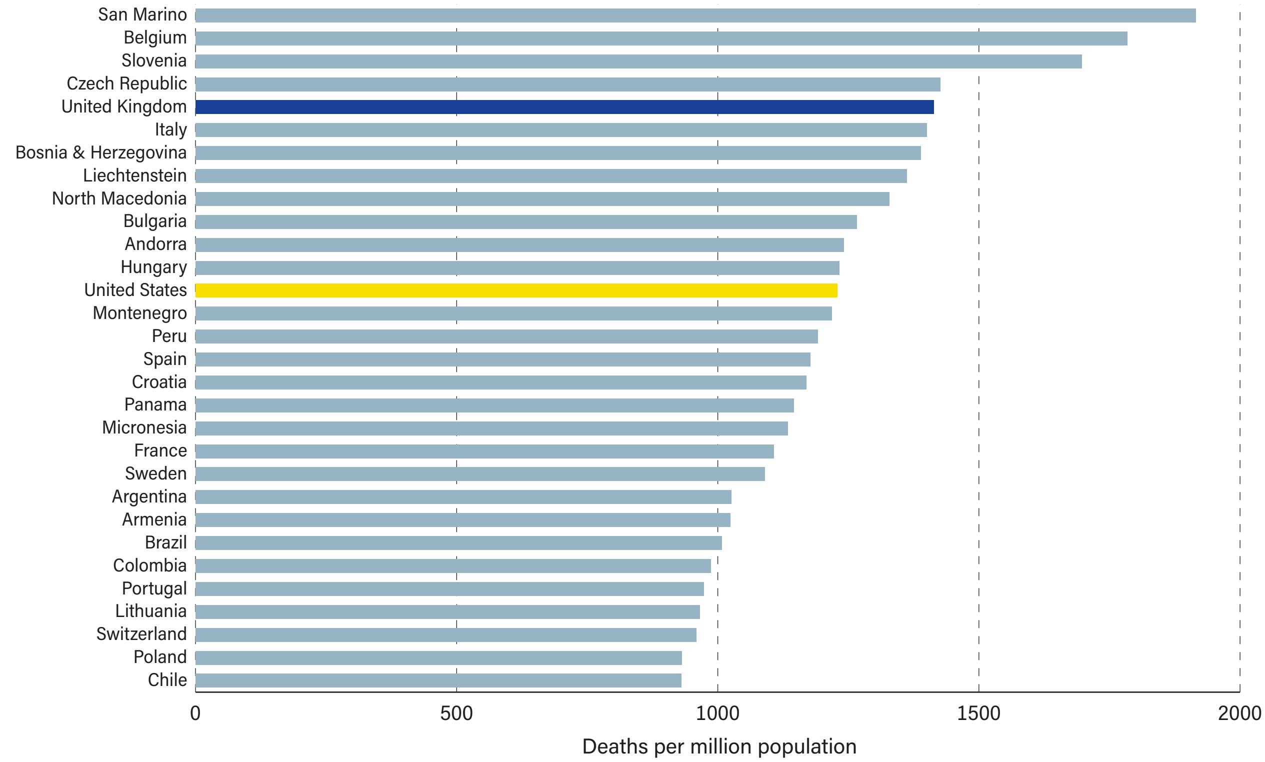
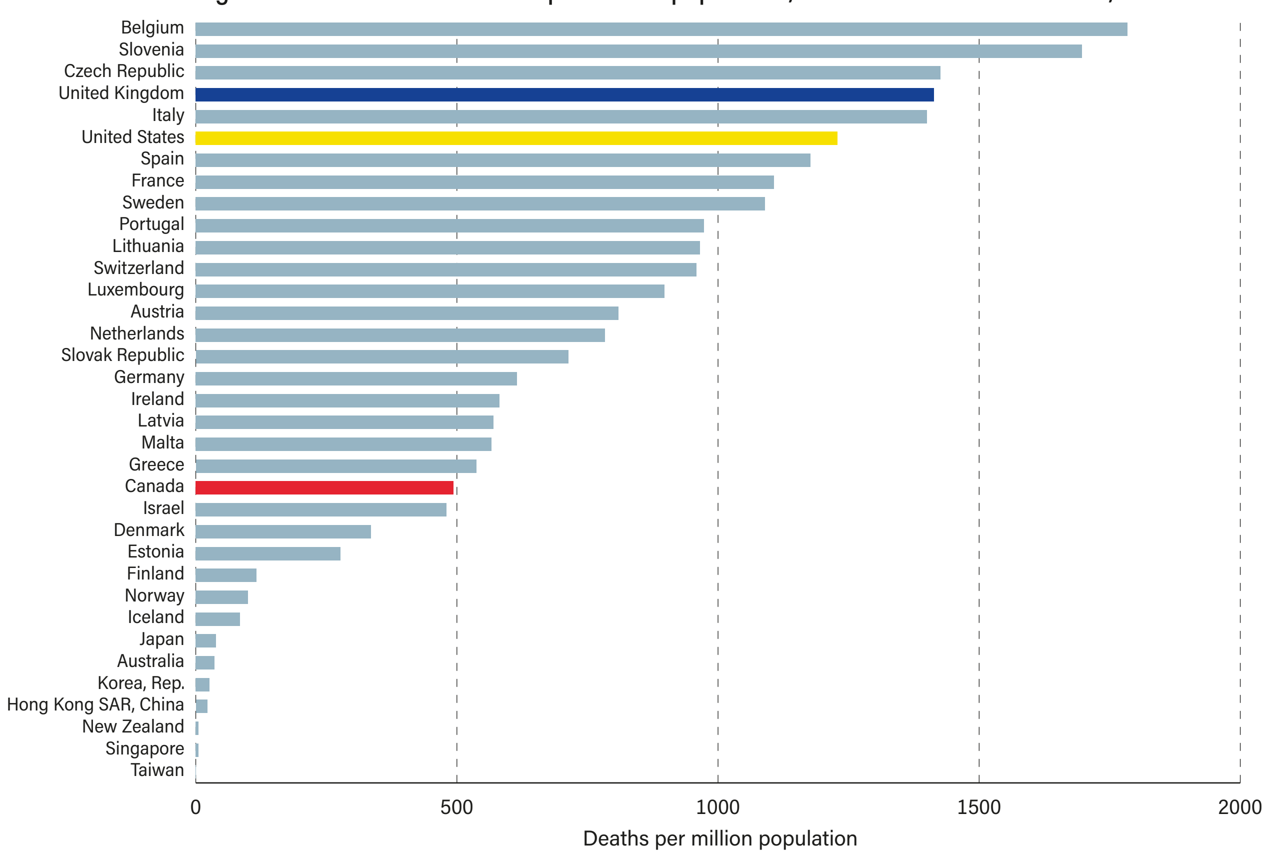



Figure 4: Total COVID-19 deaths per million population, IMF35 advanced economies, 2020




Source: Worldometer, 2021b.

happened after two months possibly for other reasons (such as an accident), while in some other countries, a COVID-19 death was recorded when death occurred within a certain period (ranging from 2 to 8 weeks) after the onset of COVID-19 symptoms.

### 3.3.2 Responses around the world

The initial world response to COVID-19 in the absence of a vaccine focused on diagnosing cases, which, once the virus was properly genetically sequenced, resulted in the development of tests that facilitated diagnosis followed by isolation and restrictions and treatment. The two main tests that were developed early on during the pandemic were first, one that looked for the virus RNA using swabs from the inside of the mouth or nose, and second, a test for antibody responses in blood serum. Both of these took time to deliver results and more rapid tests were developed later on as the pandemic progressed. Testing rates varied substantially as some countries mobilized very quickly and more intensively mass tested their populations (figure 5 and figure 6).

In the global ranking, testing rates were highest in Luxembourg, the United Arab Emirates, and Andorra. The United Kingdom ranked 11th and the United States, 13th. The IMF35 advanced economies accounted for just over 60% of the countries in the top 30 by testing rates. Among the IMF35, Luxembourg, Denmark, and Iceland were the leaders with South Korea, Japan, and Taiwan the lowest. The United Kingdom ranked 7th, the United States 8th, and Canada 26th out the 35 IMF advanced economy countries. What is noteworthy is that, despite the relatively low testing rates, South Korea, Japan, and Taiwan had some of the best success rates in controlling COVID-19 cases and achieving low mortality rates. Indeed, a distinct feature of the response of these three countries aside from testing that was more targeted, was the widespread use of masks almost immediately as well as a highly developed public health infrastructure that facilitated tracking and containment. Taiwan in particular had established a National Command Centre in 2004 following the SARS epidemic that helped coordinate and map out its pandemic response (Summers *et al.*, 2020).

Measuring the restrictions employed as a response to the pandemic has been given an empirical measure by the Oxford University's COVID-19 Government Response Tracker (OxCGRT), which is a composite measure of the strength of the restriction response to COVID-19. The measure is a simple additive score of nine policy indicators[18] available at points in time measured on an ordinal scale, rescaled to vary from 0 to 100 with 0 as the lowest stringency and 100 as the highest. Figure 7 and figure 8 plot

18. School closures, workplace closures, canceling of public events, restrictions on gatherings, closing public transport, public information campaigns, stay-at-home directives, restrictions on internal movement, international travel controls, testing policy, contact tracing, face coverings, and vaccination policy.

Figure 5: Total COVID-19 tests per million population, top 30 countries, 2020

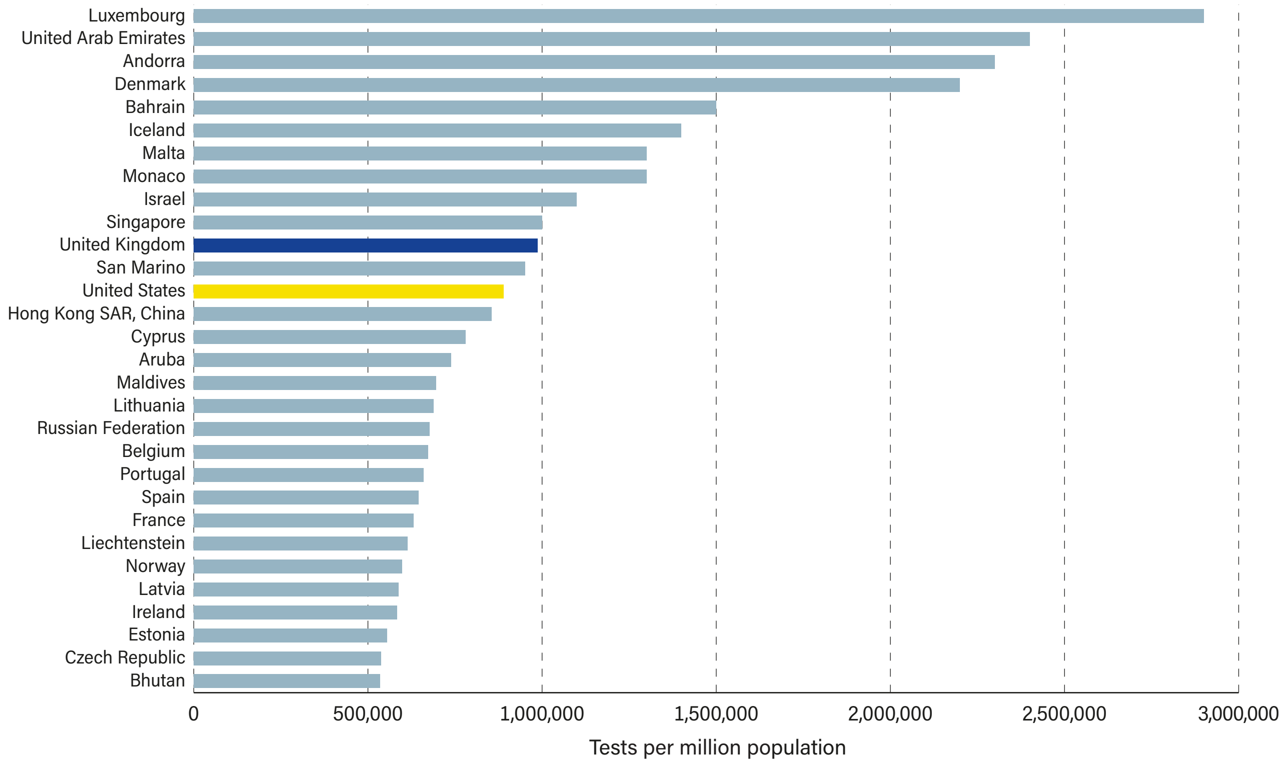
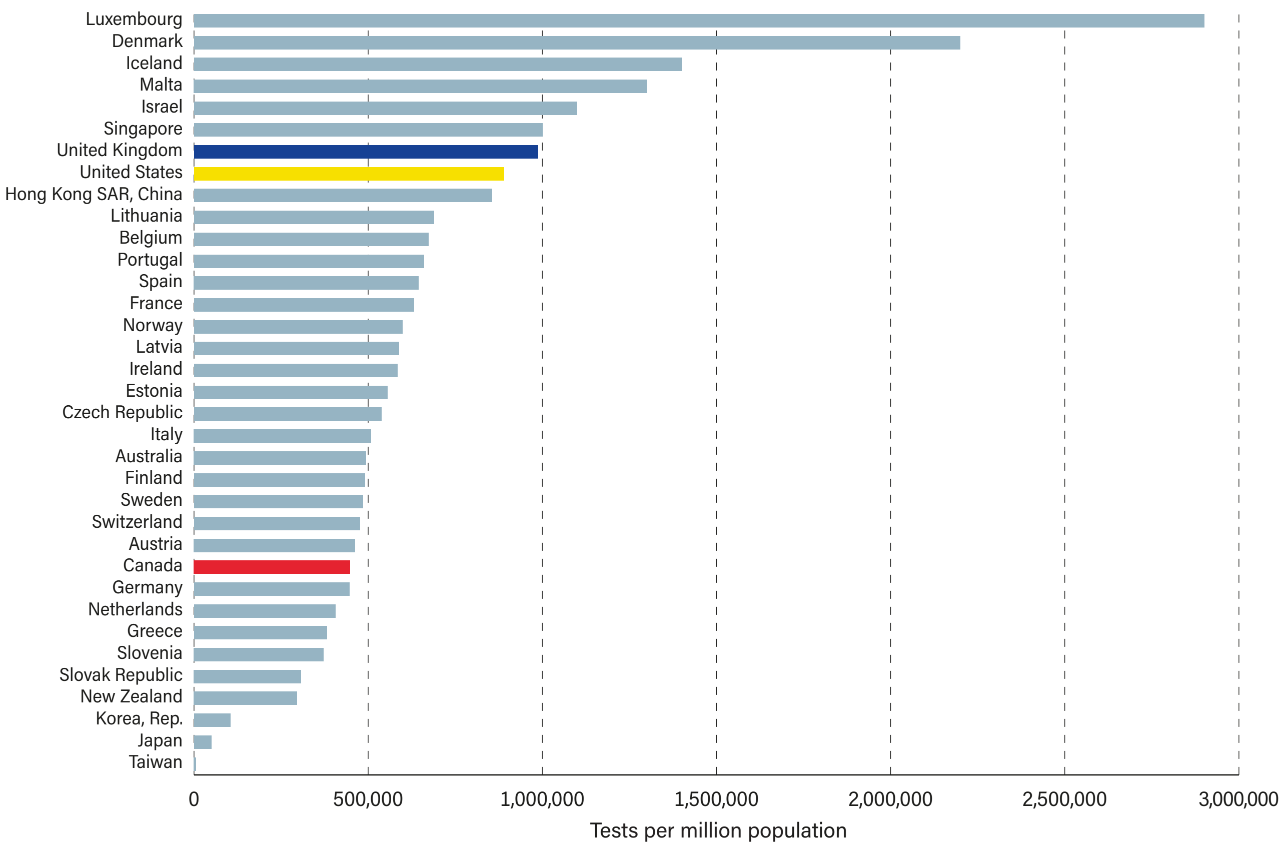



Figure 6: Total COVID-19 tests per million population, IMF35 advanced economies, 2020




Source: Worldometer, 2021b.

Figure 7: COVID-19 Government Response Tracker (OxCGRT), top 30 countries, April 1, 2020

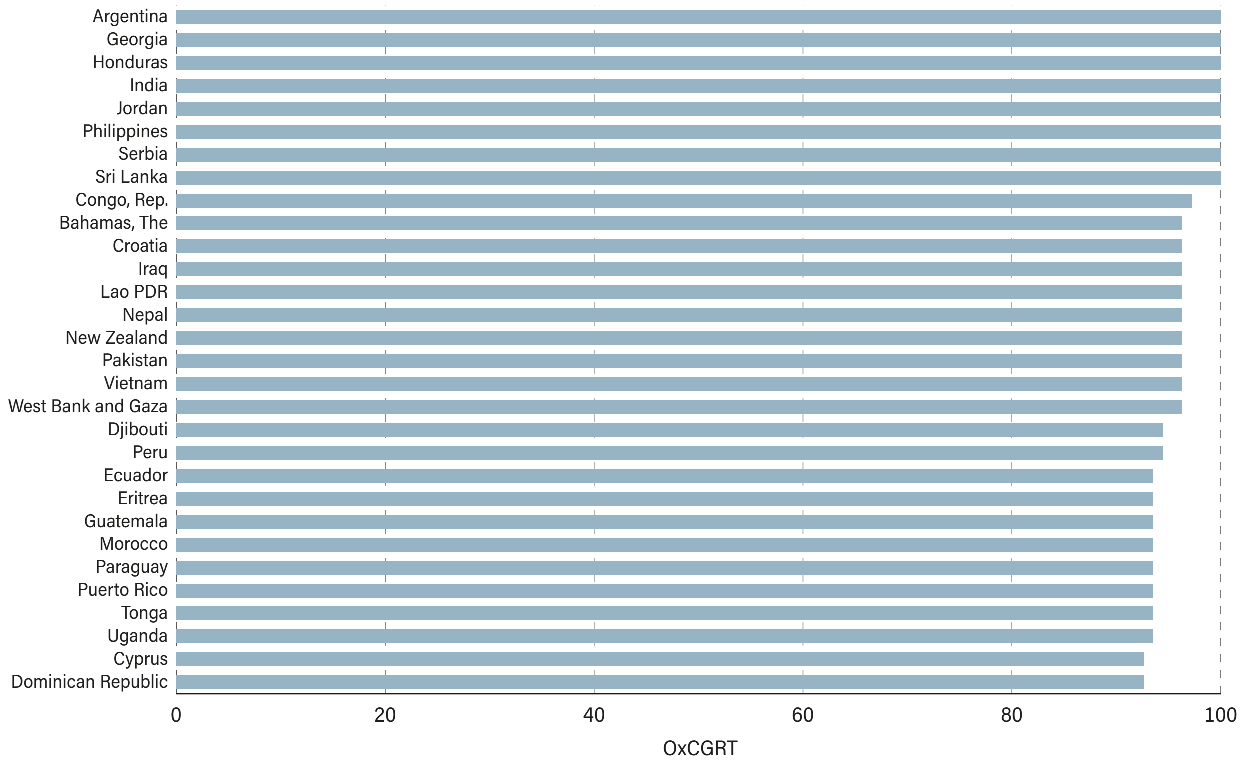
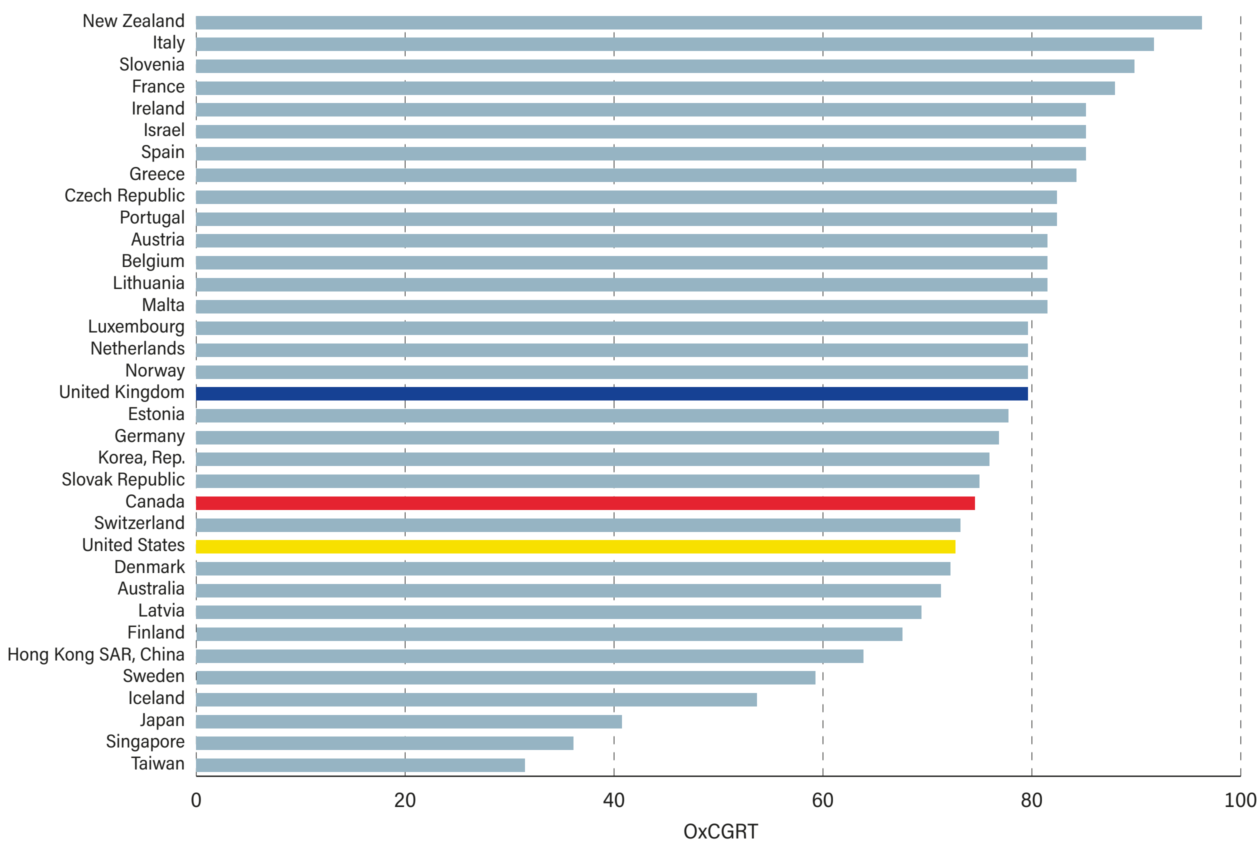



Figure 8: COVID-19 Government Response Tracker (OxCGRT), IMF35 advanced economies, April 1, 2020




Source: Our World in Data, 2021.

the top 30 most stringent countries globally and the IMF35 on April 1, 2020. The top 30 countries globally rank from highs of 100 for Argentina, Georgia, Honduras, India, Jordan, the Philippines, Serbia, and Sri Lanka to a low of 92.6 for Cyprus and the Dominican Republic. Of the IMF35 advanced economies, only one—New Zealand—makes this list.

Among the IMF35, New Zealand, Italy and Slovenia were the most stringent and Japan, Singapore, and Taiwan the least stringent. Here, the United Kingdom ranked 18th, Canada 23rd, and the United States 25th. It may seem surprising that Japan, Singapore, and Taiwan do not rank high in terms of stringency but given their traditional culture[19] of mask-wearing in public in response to infection, they likely did not need to mandate strict face-covering restrictions and were able to avoid severe workplace and school closures and more severe gathering restrictions. It should also be noted that these measures also varied over time and in the case of Singapore, the score on the OxCGRT was actually very high in January of 2020. There is also substantial variation across individual components of the OxCGRT. For example, see figure 9, figure 10, and figure 11, which provide the IMF35 rankings for three components of the OxCGRT on June 1, 2020: face coverings, restrictions on gatherings, and stay-at-home restrictions.

Japan and Taiwan both have a low ranking on face coverings and do not even have an entry for gathering or stay at home restrictions.[20] Singapore has a maximum stringency ranking on face coverings and somewhat lower scores on the other two components. Canada has one of the lowest stringency scores for face masks but one of the highest for restrictions on gatherings. A conclusion one can draw is that the response to the pandemic by restrictions and measures designed to contain spread has varied widely across countries. There has simply been no one-size-fits-all approach that was either implemented or works consistently across all countries. Moreover, any of these responses in the end require compliance by the general public as well as enforcement measures by authorities and this is not captured by any of these components.

19. Cultural differences as a factor in the spread and transmission of COVID-19 applies to countries around the world. For example, in the bilingual province of South Tyrol, in northern Italy, it was found that municipalities with higher proportions of German speakers had lower COVID-19 infection rates than those with higher proportions of Italian speakers, with the difference being attributed to the more future-oriented behaviour of German speakers compared to Italian speakers (see Bedendo, Febo, and Siming, 2021).

20. The low take-up in face coverings and masks in some countries may also be a function of shortages of masks. For example, early on in the pandemic there were shortages of face masks even in South Korea and Taiwan and this may be a reason that they may rank low on the face-covering indicator. Moreover, some countries such as Italy, South Korea, and Taiwan responded to the shortage of masks with price controls, which by keeping the price low may have made the initial shortage worse by creating an incentive for companies to produce less (see Lemieux, 2020; Mingardi, 2020).

Figure 9: Stringency ranking, face coverings, IMF35 advanced economies, June 1, 2020

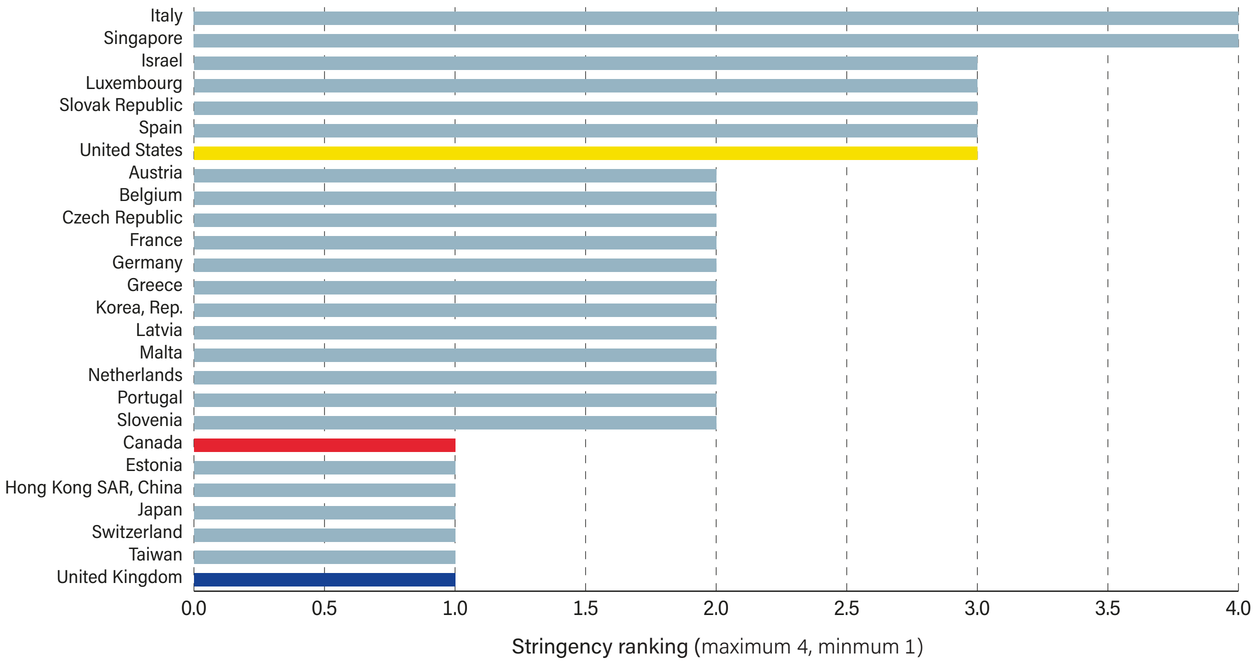
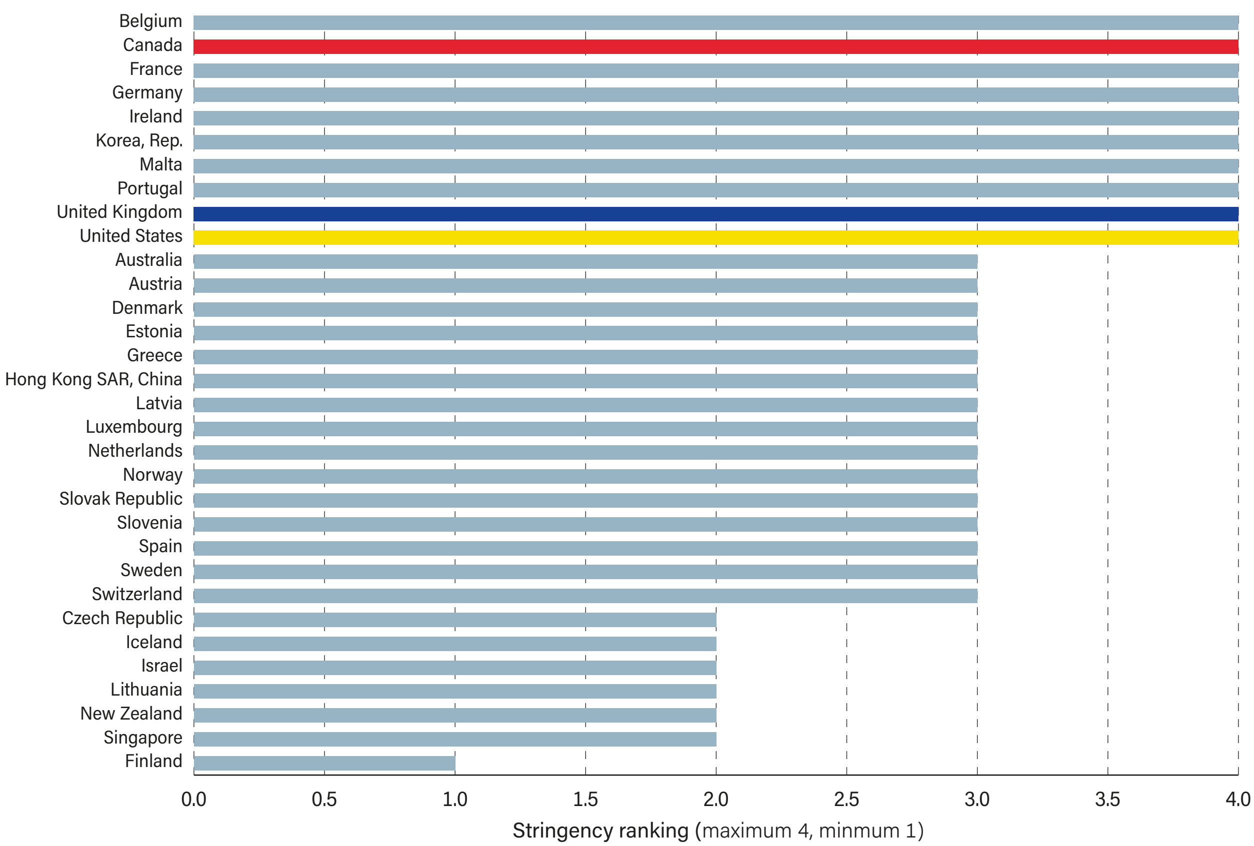
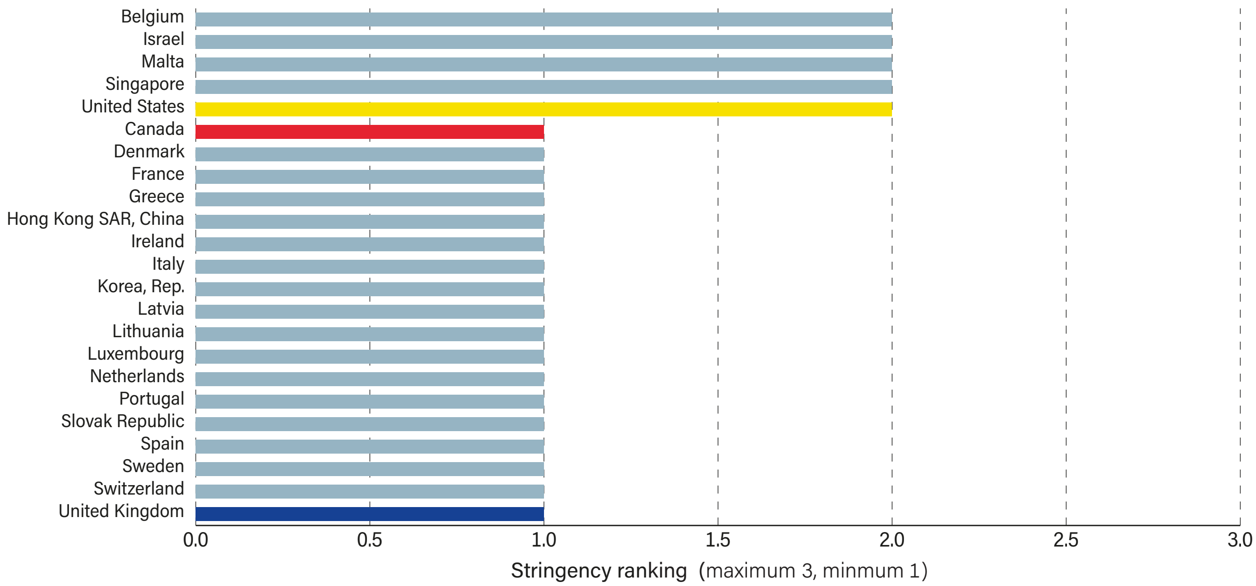



Figure 10: Stringency ranking, restrictions on gatherings, IMF35 advanced economies, June 1, 2020




Note: The maximum ranking = 4 and the minimum = 1 for these categories on the COVID-19 Government Response Tracker (OxCGRT). Appendix 2 has the description of these categories.
Source: Our World in Data, 2021.

Figure 11: Stringency ranking, stay-at-home restrictions, IMF35 advanced economies, June 1, 2020



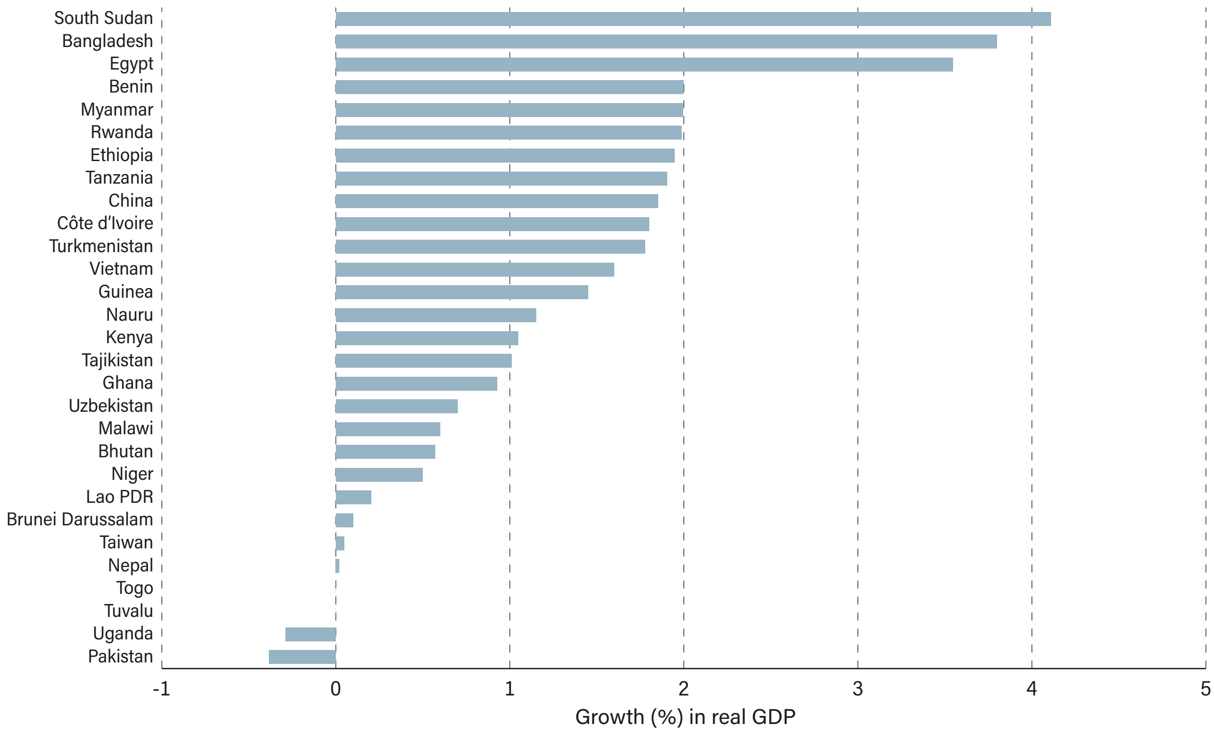

Note: The maximum ranking = 3 and the minimum = 1 for this categories on the COVID-19 Government Response Tracker (OxCGRT). Appendix 2 has the description of this categories.
Source: Our World in Data, 2021.

### 3.3.3 Economic impact

The impact of COVID-19 on economies around the world has been substantial. The economic toll of the illness has of course been amplified by the measures implemented to contain the spread of the virus. Lockdowns, quarantines, and travel restrictions have drastically reduced sectors such as international travel, the labour-intensive personal services, food and accommodation, tourism, and arts and entertainment as well as disrupted some aspects of the globalized supply chain. As a result, 2020 saw some of the largest contractions in recorded macroeconomic history as much of the world came to a standstill. Figure 12, figure 13, and figure 14 document the contraction in real GDP.

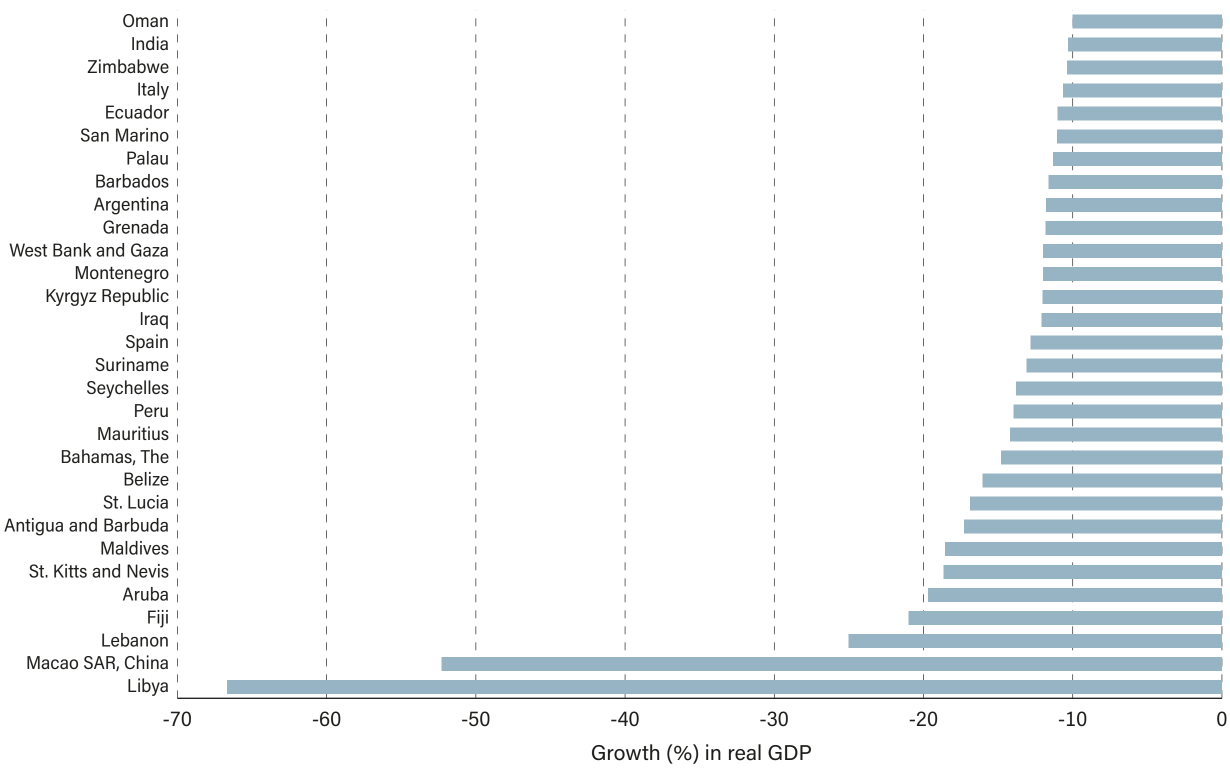
In 2020, the estimated drop in world-wide real GDP was 4.3% fueled by a 9.5% drop in the volume of trade around the world. The IMF35 advanced economies saw a 5.4% fall in real GDP while IMF-defined emerging market and developing economies saw a 2.6% contraction. However, even this latter group had some very diverse experiences and indeed some of the largest individual drops were for emerging market and developing countries. Figure 12 provides the real GDP growth rates for the top 30 countries and illustrates that even during the pandemic some countries nevertheless saw an overall expansion in real output, though only one of these countries—Taiwan—was an advanced economy. The countries that saw an increase in real GDP were dominated by emerging market and developing economies, including China.

## Figure 12: Growth (%) in real GDP, top 30* countries, 2020




Note *: In 2020, Guyana actually had the highest growth in GDP at over 25% but was omitted as an extreme outlier to facilitate visual presentation.

## Figure 13: Growth (%) in real GDP, bottom 30 countries, 2020



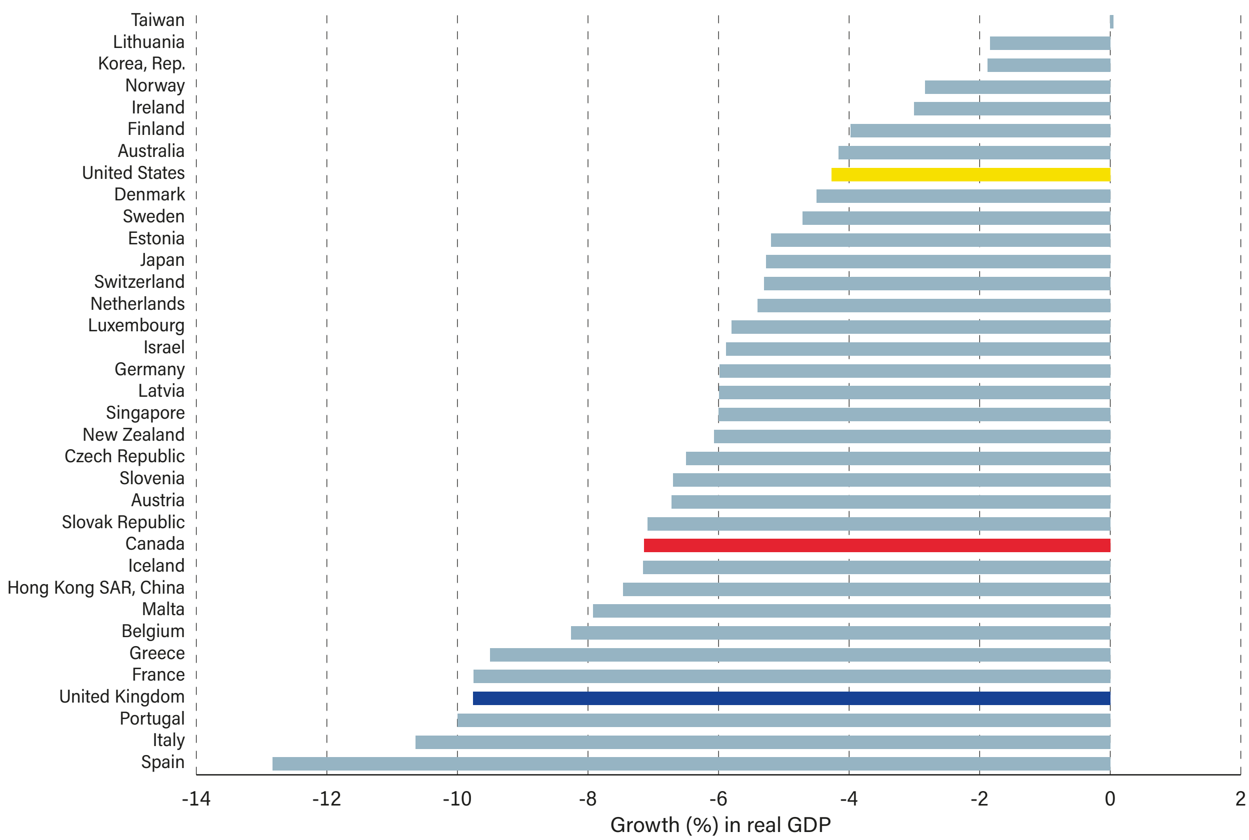

Source: International Monetary Fund, 2021c.

Despite being the point of origin of the pandemic, China got its pandemic under control and its economy recovered to the point where it saw its real output in 2020 grow an estimated 2%. Emerging and developing economies predominate in the bottom 30 countries in terms of real GDP performance (figure 13), but two major advanced economies are here also: Italy and Spain. Indeed, the IMF35 advanced economies were particularly hard hit by the economic devastation of the pandemic.

Figure 14 plots the ranked estimated real GDP growth in 2020 of the IMF35 and only one country saw positive growth: Taiwan at barely one tenth of one percent. The remainder all shrank, with contractions ranging from a 1.8% for Lithuania to 12.8% for Spain. Amongst the IMF35, Canada ranked as the 25$^{th}$ worst performance whereas the United States was 8$^{th}$ worst, and the United Kingdom 32$^{nd}$.

The devastation undergone by the IMF35 advanced economies is particularly significant given their importance in the world economy. The IMF35 advanced economies, well developed and with high per-capita income, accounted in 2019 for just over one billion population, 14% of world population, and about 40% of world GDP. By way of

Figure 14: Growth (%) in real GDP, IMF35 advanced economies, 2020

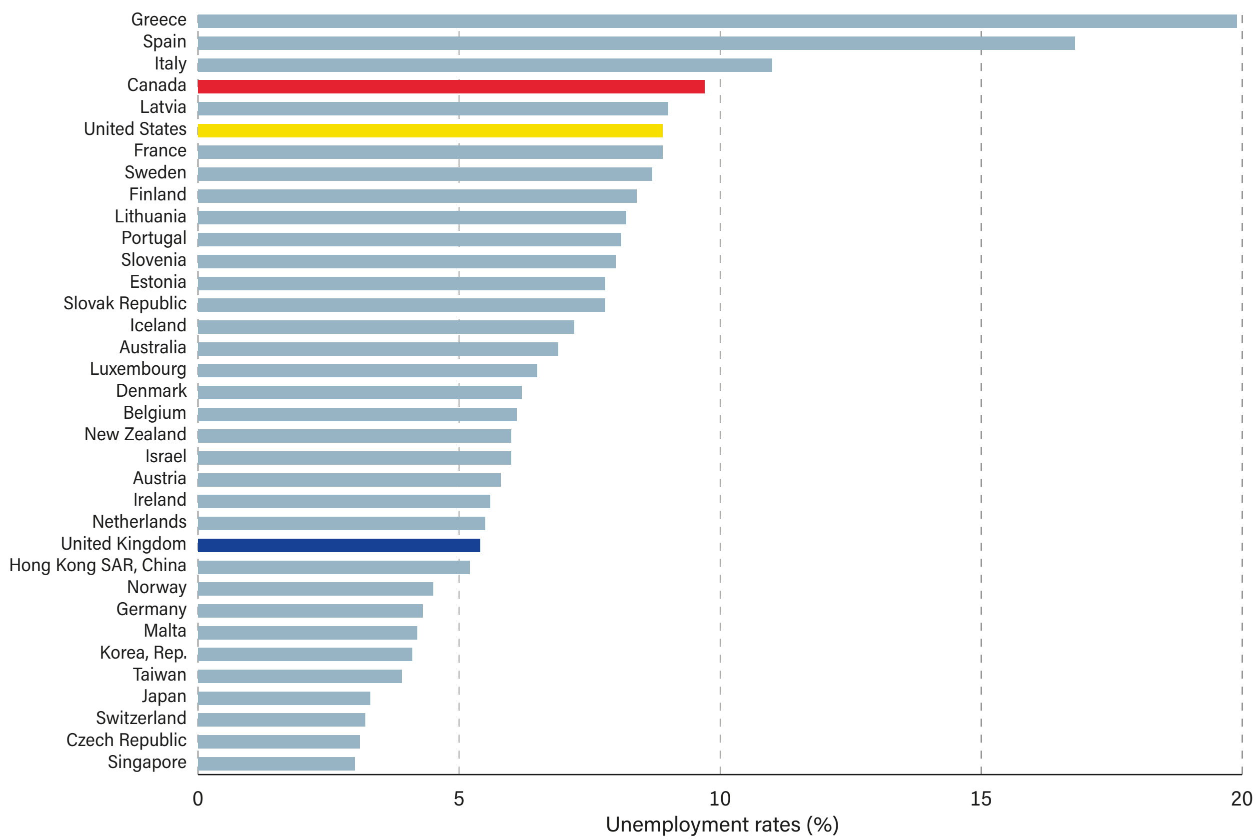



Source: International Monetary Fund, 2021c.

comparison, China accounted for well over one billion population—nearly 19% of world population—and yet despite its record growth of the last two decades it accounted for about 19% of world output (IMF, 2020). Despite the recent phenomenal growth and development of the Chinese economy, in per-capita terms it still lags far behind the IMF35 advanced economies.

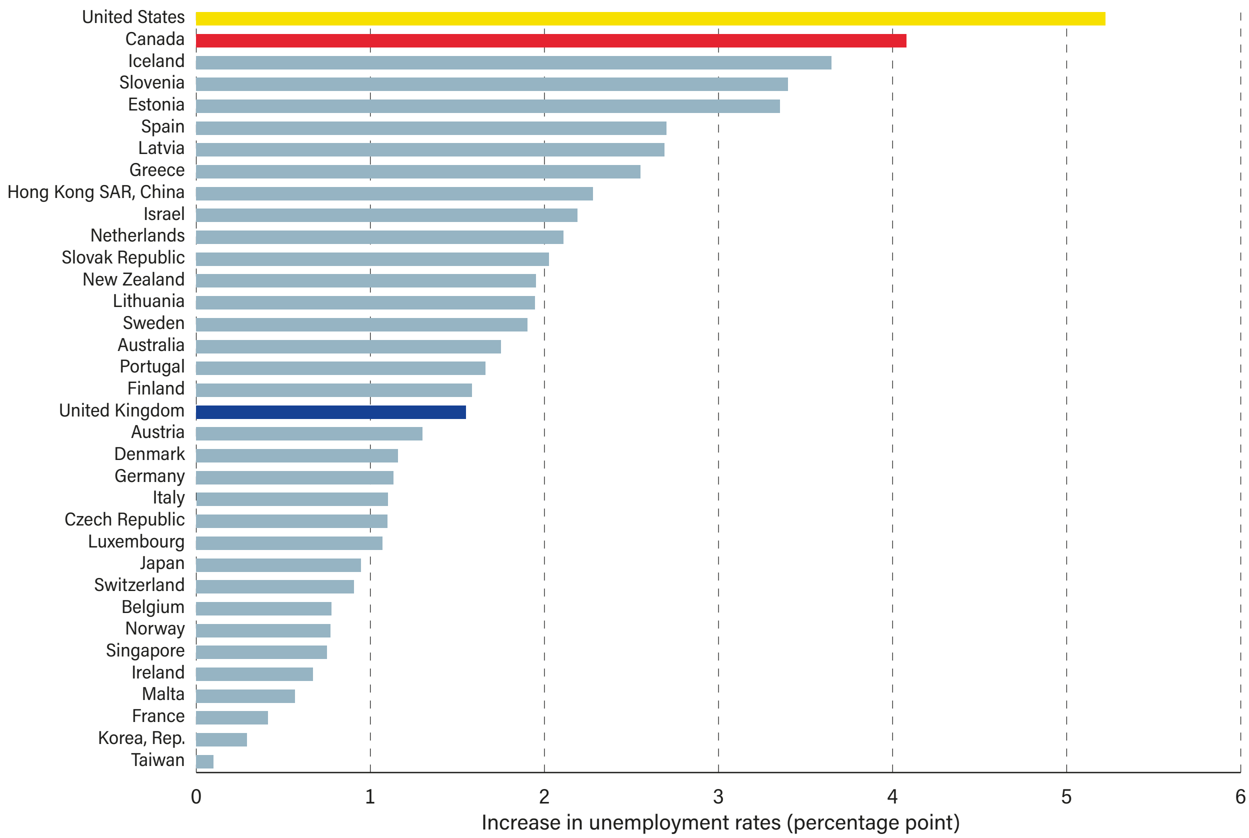
Figure 15A shows the impact on unemployment rates of the pandemic year amongst the IMF35 countries while figure 15B plots the percentage-point increase in unemployment rates from 2019. Unemployment rates in the IMF35 in 2020 ranged from a high of nearly 20% for Greece to a low of 3% in Singapore. In 2020, Canada had the fourth highest unemployment rate of the IMF35 advanced economies with the United States in 6th place and the United Kingdom 25th. The United States ranked highest for percentage-point increase in the unemployment rate at just over 5 percentage points and Taiwan the lowest at an increase of one tenth of one percent. Meanwhile, Canada saw the second highest increase, while the United Kingdom was 19th.

Figure 15A: Unemployment rates (%), IMF35 advanced economies, 2020




Source: International Monetary Fund, 2021c.

Figure 15B: Percentage point increase in unemployment rates, IMF35 advanced economies, 2020



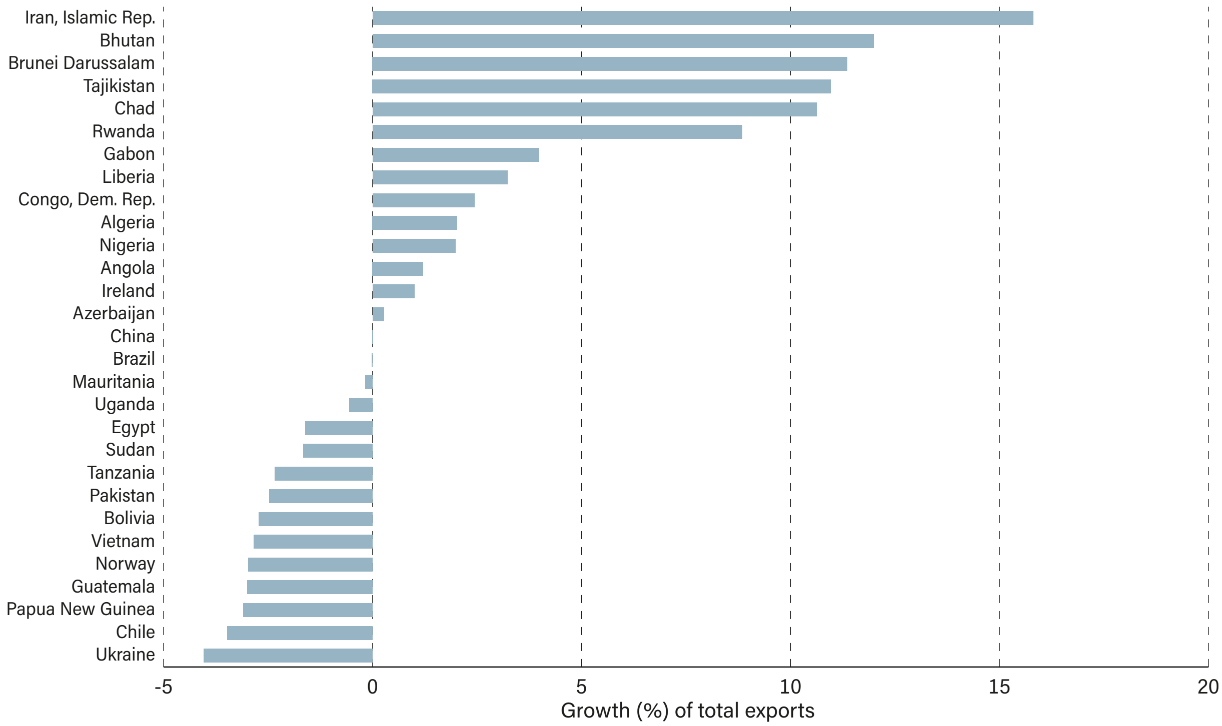

Source: International Monetary Fund, 2021c.

International trade was also hard hit by the pandemic in 2020 and figure 16 illustrates the 30 countries with the greatest trade growth as measured by the percentage change in the total exports of goods and services whereas figure 17 ranks the IMF35 advanced economies. Of all the world's countries, only 16 saw an expansion in exports in 2020 and they account for half of the top 30 countries, with increases ranging from a high of 76% for Guyana[21] to two tenths of one percent for China, after which the ranking goes into negative territory bottoming out at a 4% drop for the Ukraine.[22] As for the IMF35 advanced economies, only Ireland saw export growth in 2020 at one percent and the worst hit countries were Iceland (−31%), Portugal (−29%), and Spain (−25%). The United States was the 24th country of the IMF35 for export growth with a contraction of 12.6%, while Canada was 25th with a 13% drop and the United Kingdom, 28th at −14.6%.

21. Guyana is an emerging-market country with an export sector characterized by primary commodities including sugar, gold, and bauxite.

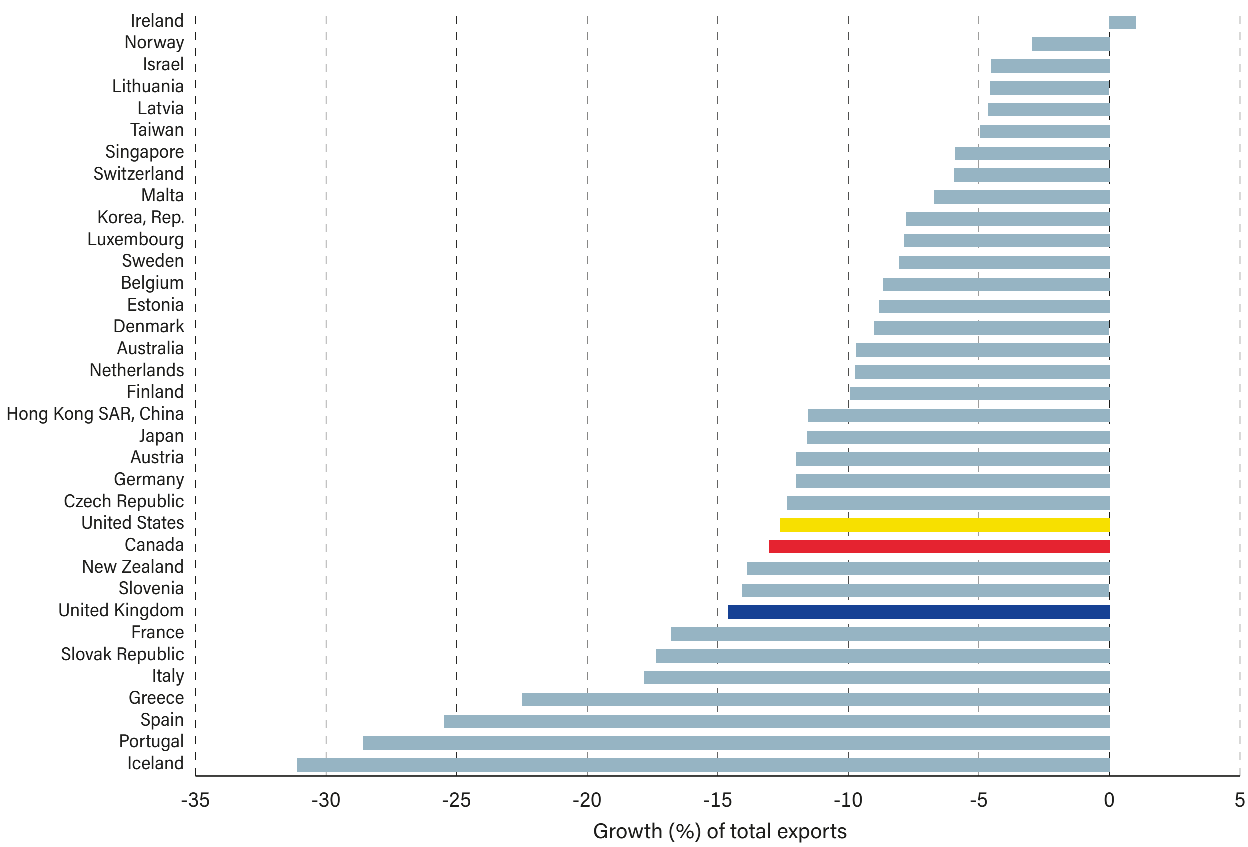
22. Incidentally, the worst performance in 2020 with a contraction in exports of 88% is that of Libya.

## Figure 16: Growth (%) of total exports of goods and services, top 30* countries, 2020




Note *: In 2020, Guyana actually had the highest growth in exports at nearly 80% but was omitted as an extreme outlier to facilitate visual presentation.

## Figure 17: Growth (%) of total exports of goods and services, IMF35 advanced economies, 2020

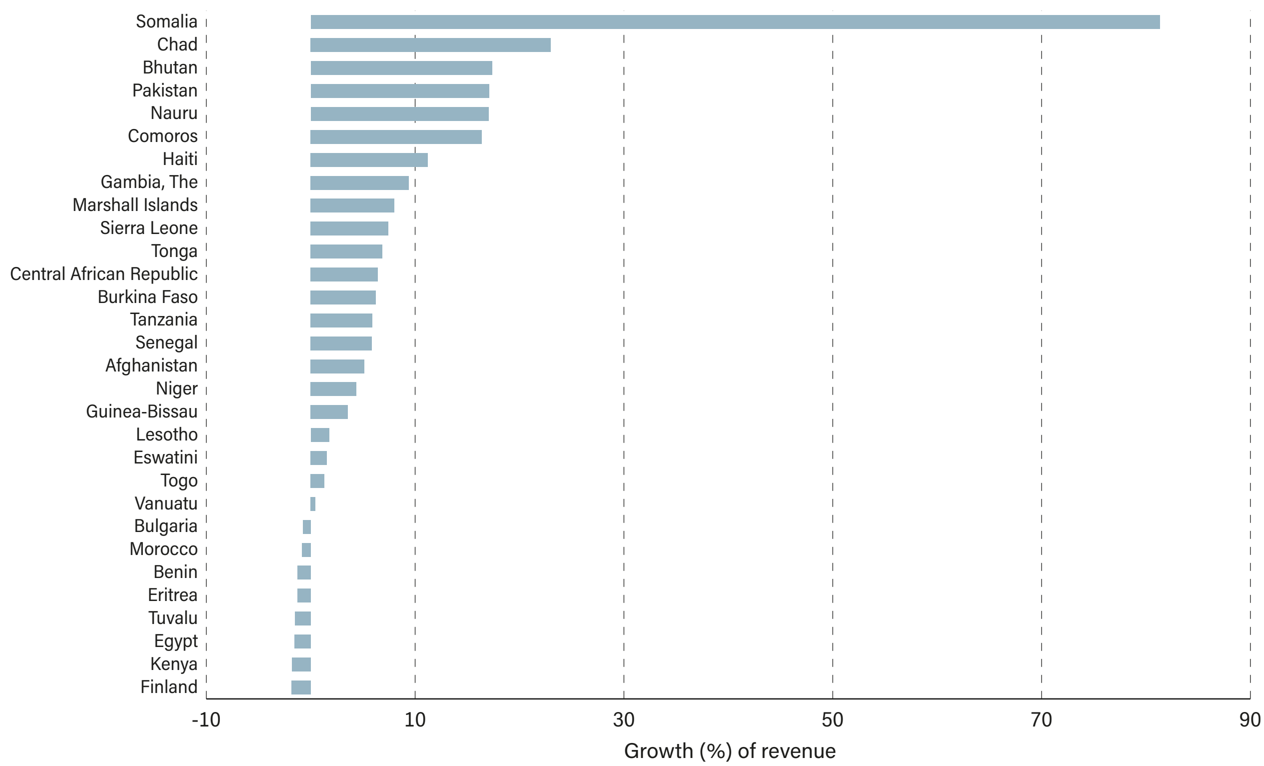



Source: International Monetary Fund, 2021c.

The economic impact, as one would expect, ultimately spilled over into the public finances in countries around the world as revenues dropped and pandemic-related spending soared, making for very large deficits indeed. The COVID-19 pandemic in particular resulted in a ramping up of government spending activities the world over as countries have introduced substantial fiscal packages encompassing assorted direct support for household income, loans, guarantees, tax deferrals, and other supports along with increased public-health spending to combat the pandemic (OECD, 2020). With a collapse in tax revenues, the spending is being financed by an expansion of government borrowing and, ultimately, public debt.

Figure 18 and figure 19 plot the growth rate of real general government revenue in 2020—first for the 30 countries with the largest positive revenue gains and then solely for the IMF35 advanced economies.[23] The countries that saw large increases in real government revenues during the pandemic include Somalia, Chad and Bhutan—jurisdictions generally not at the forefront of economic rankings. Indeed, nearly 80% of countries around the world saw declines in real general government revenues ranging from three

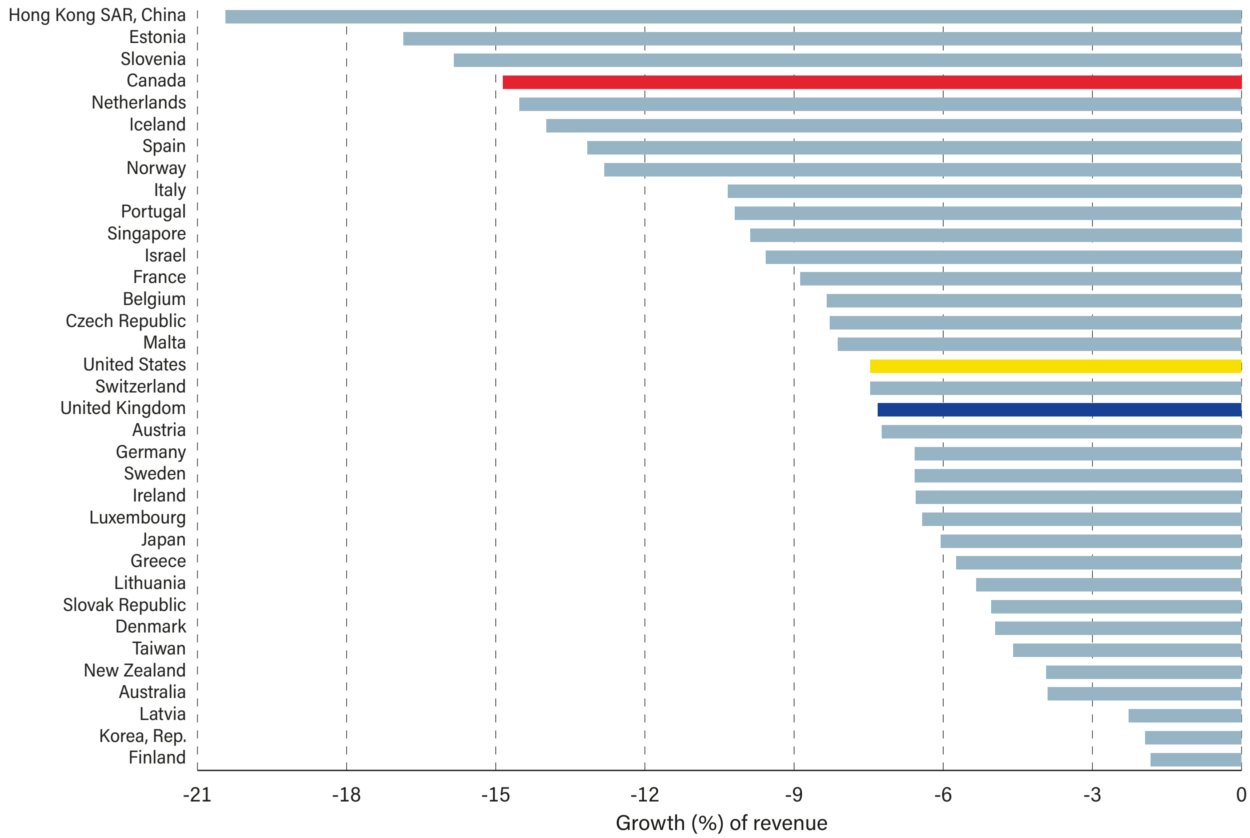
Figure 18: Growth rate (%) of real general government revenue, top 30 countries, 2020




Source: International Monetary Fund, 2021c; Statista, 2021 (for Somalia).

23. This was simply the percentage growth rate of general government revenue minus the inflation rate for 2020 as provided in data from International Monetary Fund, 2021c. For Somalia, the inflation rate for 2020 was obtained from Statista, 2021.

Figure 19: Growth rate (%) of real general government revenue, IMF35 advanced economies, 2020




Source: International Monetary Fund, 2021c.

quarters of one percent for Bulgaria to a 246% drop for Zimbabwe. As for the IMF35 advanced economies, they all saw real general government revenue drops ranging from the largest drop at just over 20% for Hong Kong to the smallest at nearly 2% for Finland. Of the IMF35 economies, the United States had the 17th worst drop in government revenue, the United Kingdom the 19th worst, and Canada the fourth worst—better than only Slovenia, Estonia, and Hong Kong.

On the other hand, general government expenditure—as illustrated in figure 20 and figure 21—increased in just over 80% of countries with the top ranks globally this time including some representation from the IMF35 advanced economies. Spending for the top 30 globally ranged from a high of 384% for inflation-afflicted Zimbabwe followed by Singapore at 83% to a low of 21% for Japan. Canada saw the 16th biggest spending increase in the world in 2020 at just over 30% while the United States came in 19th place at just over 28% and the United Kingdom 20th at just under 28%. IMF35 advanced economies made up over 20% of the top 30 spenders. Among the IMF35, Singapore was the top spender followed by second-place Canada, third-place United States and fourth-place United Kingdom. At the other end of the advanced-economy ranking was Estonia which at –1% was the only advanced economy to register a decrease in general government expenditure.

Figure 20: Growth rate (%) of general government expenditure, top 30 countries, 2020

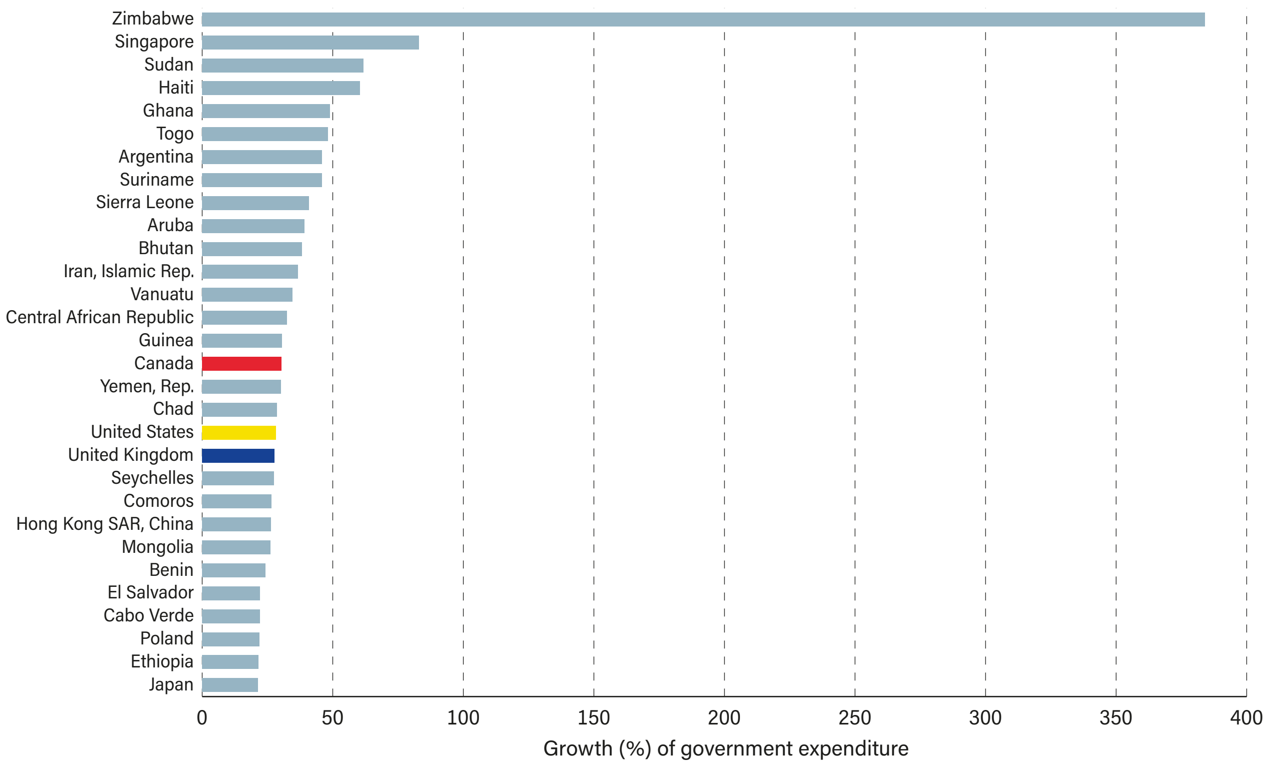
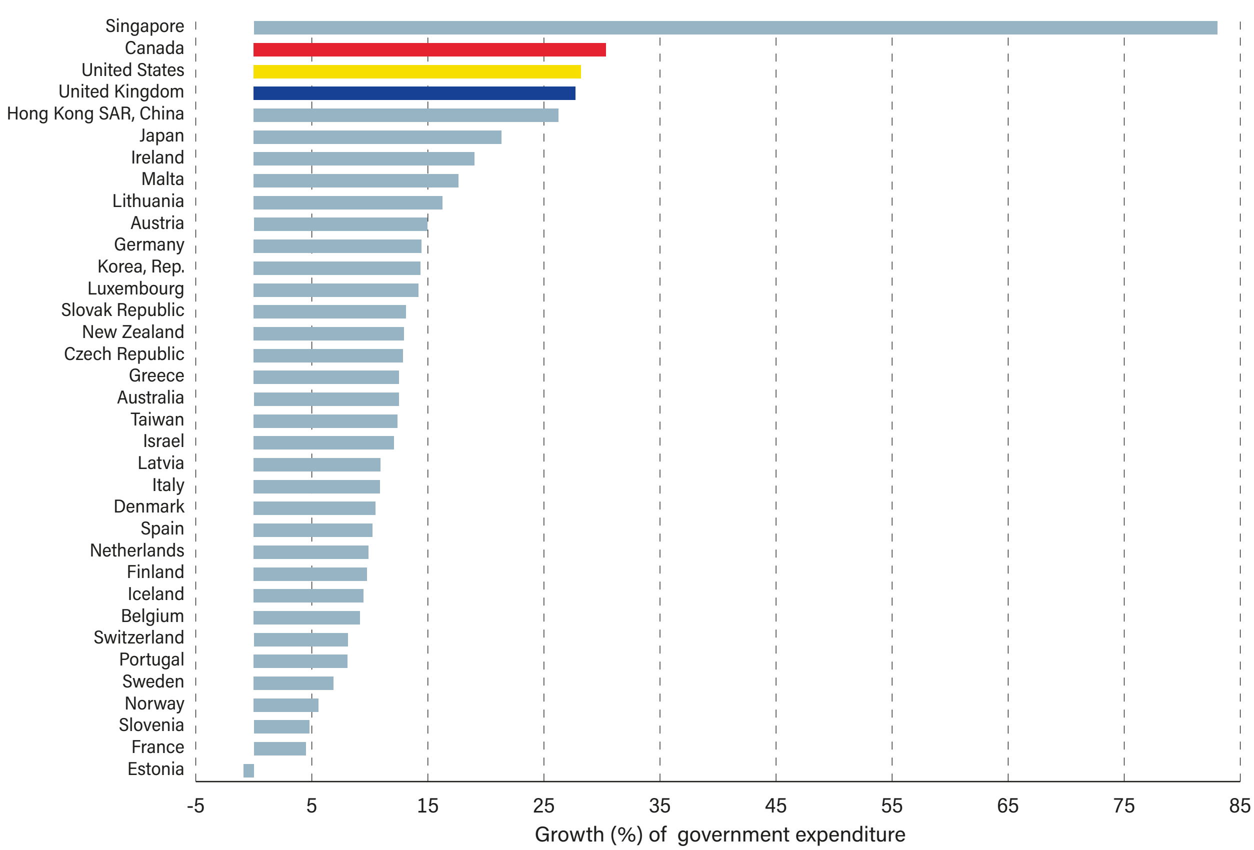


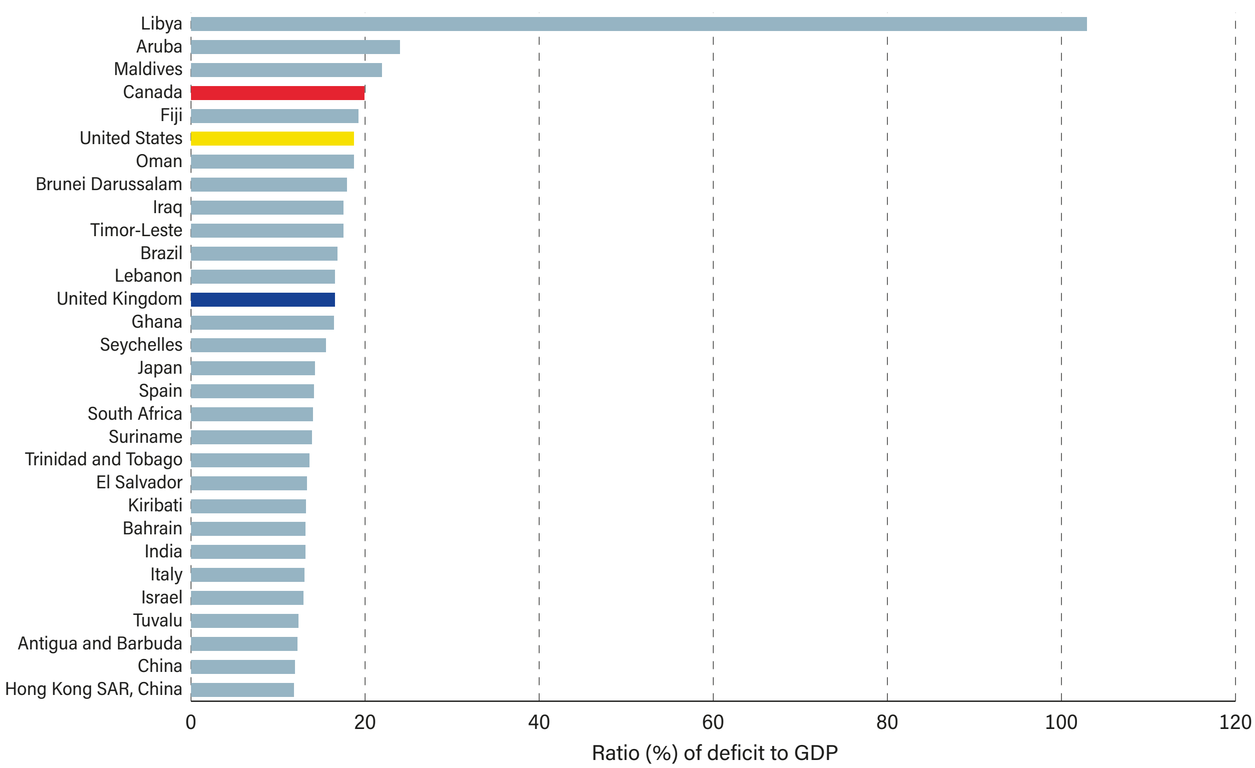

Figure 21: Growth rate (%) of general government expenditure, IMF35 advanced economies, 2020




Source: International Monetary Fund, 2021c.

Of course, revenues and expenditures are very much like two blades of a pair of scissors as they come together to determine the deficit. The size of the deficit is most usefully interpreted as a share of a country's GDP and figure 22 and figure 23 help complete the fiscal dimensions of the pandemic year by plotting deficit-to-GDP ratios for the top 30 countries globally and the IMF35 advanced economies available as of January 2021. Just about every country saw expenditures outpace their revenues in 2020 and only four countries—Macao, Qatar, Tonga, and Nauru—reported a surplus. Globally, the highest deficit-to-GDP ratio was Libya at 103% and it was joined at this lofty summit by Aruba (24%), Maldives (22%), and Canada (20%). The United States had the 6th highest deficit-to-GDP ratio globally at 19% while the United Kingdom came in 13th place at just under 17%. When only the IMF35 advanced economies are considered, Canada ranked first, followed by the United States and the United Kingdom. At the other end of the advanced-country ranking for deficits are Switzerland, Denmark, South Korea, and Norway.

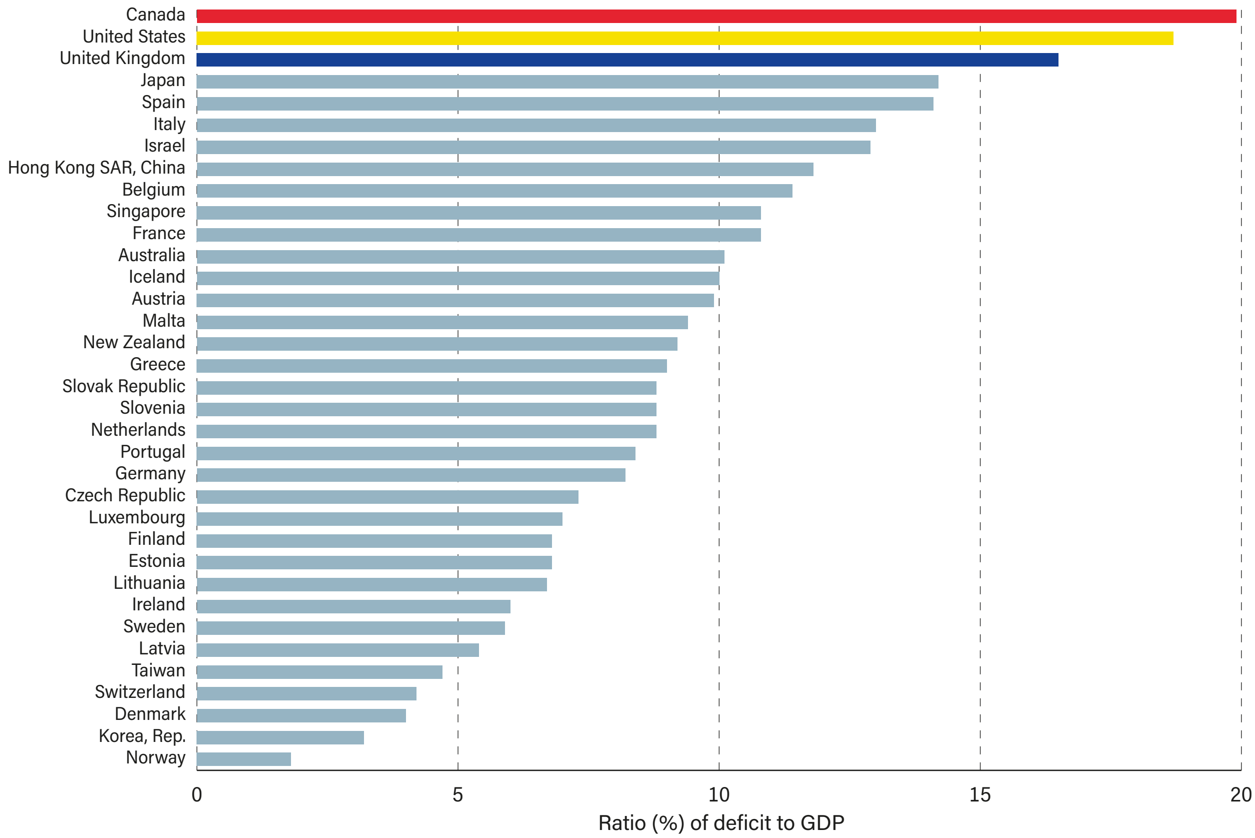
Figure 22: Ratio (%) of deficit to GDP, top 30 countries, 2020




Source: International Monetary Fund, 2021c.

Of course, these trends in the international incidence and extent of COVID-19, the economic impact, and the fiscal response need to be drawn together to illustrate the relationships among these variables. Figure 24 shows the relationship between the real GDP growth rate and COVID-19 cases per million of population for the countries in

Figure 23: Ratio (%) of deficit to GDP, IMF35 advanced economies, 2020



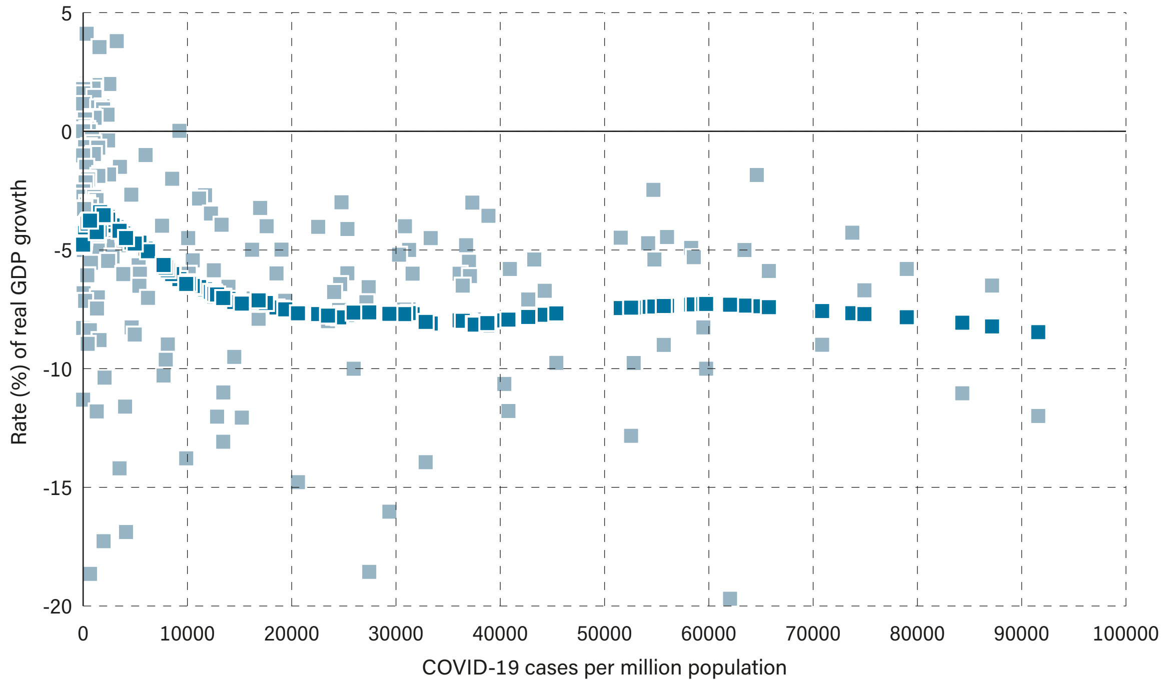

Source: International Monetary Fund, 2021c.

the data set. Figure 25 repeats the plot but this time providing the relationship between deaths from COVID-19 per million population and the real GDP growth rate. [24]

Cases per million rather than the total number of cases are used because the per-capita impact is a more in-depth indicator of the severity of the pandemic in each country. The smoothed plot suggests that more cases of COVID per million population are associated with the economic effect of a lower real GDP growth rate in 2020 but the effect levels off once 20,000 cases per million are reached. In other words, the impact of COVID-19 on the economy is most large at the outset and going from 0 cases to 20,000 cases per million is associated with a contraction of real GDP ranging from about 5% to 7.5%, after which the damage is done. A similar type of relationship also exists when deaths

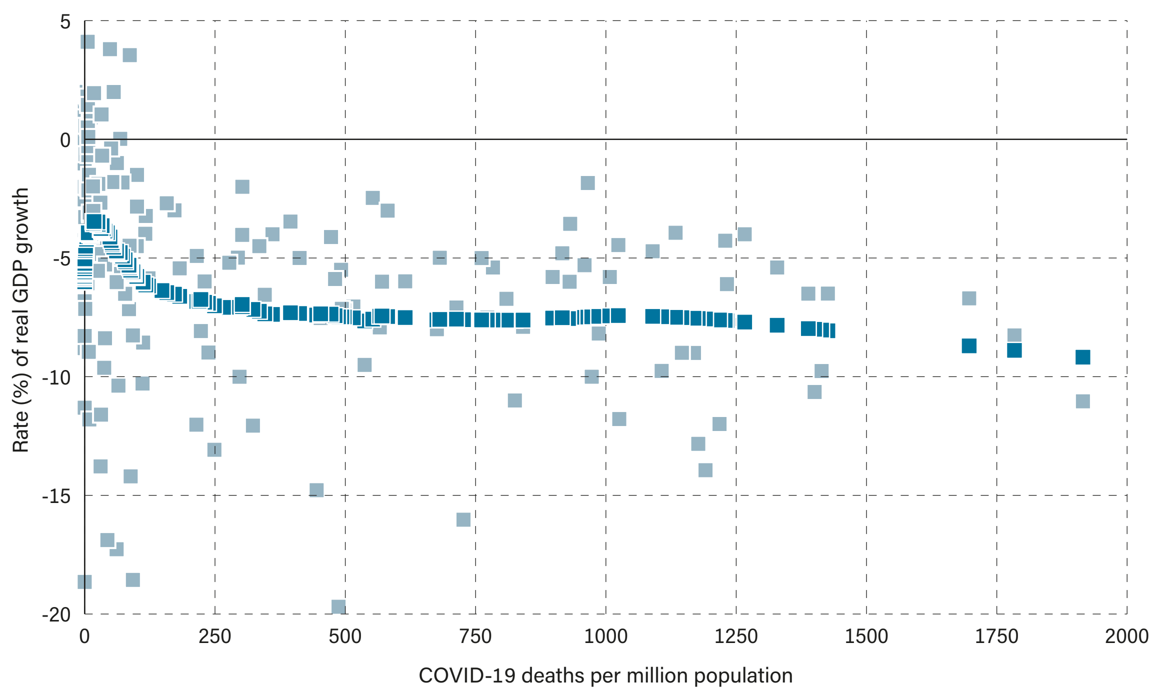
24. The plot in figure 24 is for 187 countries out of a total of 193 with available data as a result of an outlier adjustment eliminating those countries with real GDP growth rates in 2020 that were greater than 20% and smaller than −20%. In the IMF data, one country in 2020 had a positive growth rate of real GDP greater than 20% (Guyana) and four lower than −20% (Fiji, Lebanon, Macao SAR, and Libya). Figure 25 is also adjusted to eliminate outliers but deaths per million were available for fewer countries and the plot is for only 175 countries.

Figure 24: International relationship between growth rate (%) of real GDP and COVID-19 **cases** per million population, 2020; **187** countries, with LOWESS smooth (bandwidth = 0.5)




Note: Outlier adjusted—plotted only for rgdp growth rates between +20% and −20%.
Source: International Monetary Fund, 2021c; Worldometer, 2021b.

Figure 25: International relationship between growth rate (%) of real GDP and COVID-19 **deaths** per million population, 2020; **175** countries, with LOWESS smooth (bandwidth = 0.5)

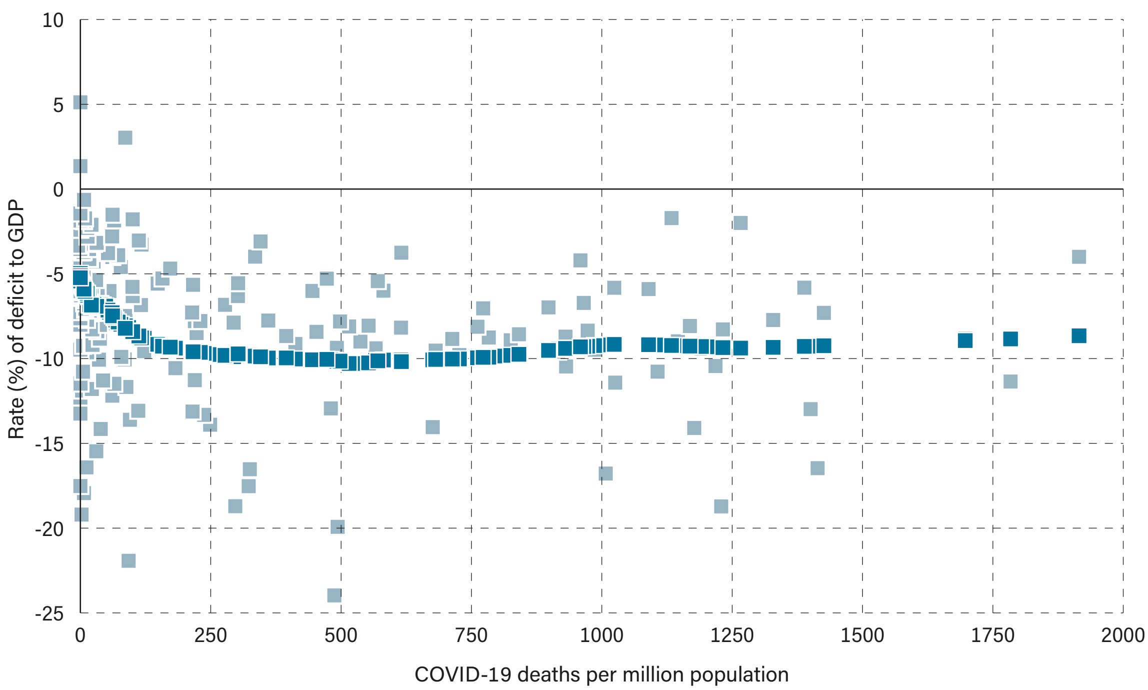



Note: Outlier adjusted—plotted only for rgdp growth rates between +20% and −20%.
Source: International Monetary Fund, 2021c; Worldometer, 2021b.

per million are plotted, with the same sized contraction of about 5% to 7.5% operating between 0 and 500 deaths per million. If anything, this suggests the importance of moving quickly to bring initial infections under control if one is to escape serious economic disruption.

Finally, the fiscal impact of the pandemic is also examined in figure 26 with a LOWESS smoothed plot[25] of the international relationship between deaths per million and the deficit-to-GDP ratio. Again, a pattern relating deaths per million and impact on the deficit-to-GDP ratio emerges. The range from 0 deaths per million and 500 deaths per million sees the ratio of deficits to GDP as depicted by the smoothed line go from −5 to −10%. Simply put, the onset of the pandemic, even with negligible mortality, caused sufficient economic and fiscal disruption to result in large deficit-to-GDP ratios. However, beyond 500 deaths per million, the smoothed relationship flattens out.

Figure 26: International relationship between ratio (%) of deficit to GDP and COVID-19 **deaths** per million population, 2020; **189** countries, with LOWESS smooth (bandwidth = 0.5)




Note: Outlier adjusted—plotted only for rgdp growth rates between +20% and −20%.
Source: International Monetary Fund, 2021c; Worldometer, 2021b.

25. LOWESS is a non-parametric regression smoothing technique that estimates a line of best-fit without assuming a specific functional form. In fitting LOWESS curves, the crucial decision involves the size of the smoothing parameter or bandwidth over which the locally weighted regressions used in the estimation process are estimated. Larger bandwidths provide greater degrees of smoothing while smaller bandwidths provide more variation in the final smoothed curve. For references on LOWESS, see Cleveland, 1979, 1985, and 1993).

In all three of these graphs, once an average smoothed relationship is estimated, it should be possible to look at specific countries in terms of their deaths or cases per million and compare them to where the average says they might be in terms of real GDP growth or a deficit-to-GDP ratio. For example, Canada had just under 500 deaths per million population by the close of 2020, which when compared the LOWESS smooth in figure 25 suggests a deficit of about 7.5% of GDP. At an estimated deficit-to-GDP ratio of 20% as of January 2021, Canada incurred a deficit over 2.5 times the size of what the smoothed relationship would suggest. However, such comparisons also require controlling for confounding factors and this is turn requires regression analysis to properly assess the determinants of COVID-19 rates of infection and death as well as the economic and fiscal effects.

# 4 Empirical Analysis

## 4.1 Estimating COVID-19 determinants and impacts—the literature

The literature on modelling and estimating the determinants of COVID-19 infection and mortality rates as well its impact upon social, health, economic, and fiscal policy is very recent, changing rapidly, and will continue to evolve in coming years. While these studies provide results that are often in some agreement as to determinants of infection and mortality rates, they also sometimes present differing results based on the assorted variables they have selected for analysis or emphasis. Many of them also used only data from the first wave of the pandemic, which amounts to several months of data.

Farzanegan, Gholipur, Feizi, Nunkoo, and Andargoli (2020) apply a cross-country regression model of 90 countries to examine the relationship between international tourism and COVID-19 cases and deaths up to April 30, 2020 to show that countries exposed to high flows of international tourism were more prone to cases and deaths caused by the COVID-19 outbreak. This association was robust even after controlling for other socio-economic determinants of the COVID-19 outbreak and regional dummies.

Meanwhile, Cao, Hiyoshi, and Montgomery (2020) use global country-level data to investigate the relationship between the COVID-19 case-fatality rate and demographic and socio-economic factors. They find a significant positive correlation between COVID-19 case fatality rates (CFR) and the population size of countries—especially in higher- and middle-income countries—as well as the proportion of female smokers in a country. There was a negative correlation between COVID-19 CFR and diabetes prevalence and also with the rate of death from cardiovascular disease. They also found that the COVID-19 Government Response Tracker (OxCGRT)—a composite measure based on nine indicators—was not a statistically significant determinant of Case Fatality Rates and even found some positive association in the higher-income countries.

Moosa and Khatatbeh (2021) identify the factors explaining inter-country differences in the severity of COVID-19 as measured by both infection and case fatality rates. They apply a technique known as extreme bounds analysis (EBA) to a cross-sectional sample of 154 countries and show that the infection and fatality rates depend on different factors across countries except for the number of tests, which is a robust determinant of both. As well, the infection rate depends on urban population rather than the overall population density and the fatality rate depends on the age structure of the population and population density, but not on the percentage of urban population.

Sannigrahi, Pilla, Basu, Basu, and Molter (2020) employ a spatial regression model to examine the association between key socio-economic variables and COVID-19 cases and deaths in European regions using data from 31 countries. They find that the impact of socio-demographic variables on COVID-19 incidence and mortality varied across countries with the highest effects in Germany, Austria, Slovenia, Switzerland, and Italy and the lowest impact in Ireland, Portugal, the United Kingdom, Spain, Cyprus, and Romania. The most important socio-economic variables explaining incidence and mortality were income, poverty rates, and total population size. The uneven distribution of cases and deaths amongst the European countries is attributable to other factors including cultural and societal factors and age distribution.

In a another working paper, Stojoski, Utkovski, Jolakoski, Tedovski, and Kocarev (2020) using data for 106 countries investigate the potential of 31 determinants describing a diverse set of socio-economic characteristics in explaining the outcome of the first wave of the coronavirus pandemic using a broad mix of variables. The general categories for the determinants are health-care infrastructure, health-status indicators, economic performance indicators, societal characteristics, demographic structure, and natural environment indicators. They show that the best empirical model behind the coronavirus outcome consists of only a few determinants. Their analysis suggests government policies in response to the pandemic, such as testing procedures, tracking of individuals, and physical-distancing measures, can explain the variety of outcomes across countries. Countries with a larger proportion of overweight population showed higher mortality. As well, along with the prevalence of overweight individuals, the population density and arrivals of international tourists were strong determinants of coronavirus cases per million population.

Pana *et al.* (2020) examine data for 37 countries to see the country-level determinants of the first wave of the COVID-19 pandemic using multivariable regression models that accounted for public health and economic measures. They also find international travel was directly associated with the mortality slope and thus potentially the spread of COVID-19 and conclude that, in future, early restrictions on international travel should be considered to control COVID-19 outbreaks and prevent related deaths.

In a somewhat different take on the pandemic, Hornung and Bandelow (2021) emphasize institutional factors and discuss the short-term health policies and public-health expenditures with which European countries responded to the COVID-19 crisis in the light of crisis-response evidence from the early 21$^{st}$-century financial crisis. They find left-wing governments and coordinated market economies tended to increase short-term public-health expenditures relative to others in response to crisis.

Summarizing, these studies suggest that age structure—namely the proportion of elderly in the population—was an important determinant of the severity of the COVID-19 pandemic with low income also being a factor. While none of these studies stressed income inequality as a factor in the severity of COVID-19, the issue has been raised in some literature along with the view that global income inequality has been made worse by the pandemic.[26] International travel also seems to have been a factor, but this result is usually from studies made early on in the pandemic and, given the travel shut-downs that also occurred within the first few months, a longer time series would likely see less emphasis from this effect. The proportion of smokers was of some significance but, of pre-existing conditions, only obesity seemed to be of some consequence in raising mortality while other conditions like diabetes or cardiovascular disease seemed to have mixed effects. As well, testing for the virus was seen to be important in reducing infection rates and mortality but the stringency measures in general were also more mixed in their effects on outcomes.

## 4.2 Model specification and estimation techniques

The models here estimate multivariate regressions using country-level international data for 2020 compiled from the International Monetary Fund, *World Economic Outlook Database*, as of January 2021 (IMF-WEO); the COVID-19 database of the World Health Organization; the Worldometer Corona Virus Data Base; Our World in Data; the COVID-19 Government Response Tracker (OxCGRT) at University of Oxford; and the World Bank. The variables used in the regression analysis are generally based on the use of variables in the literature to date. They are defined and sources provided in Appendix 1 with supplementary information on some of the key components used in the OxCGRT provided in Appendix 2. Summary statistics for these variables are provided in Appendix 3.

Of importance to note from the details provided in Appendix 3 (p. 62) is that, while there are 200 countries in the data set compiled, it remains that data is not complete for all the countries. For example, while data on COVID-19 cases and deaths per million population is available for 199 of the 200 countries, tests per million are only available for 177; similarly, data on the smoking rates of populations was only available for 138 countries. As a result, the regressions estimated will vary substantially in terms of the number of observations used depending on the composition of the independent variables used.

26. For some of these discussions, see Wildman, 2021 and Deaton, 2021.

There are four dependent variables used in the regressions:

1 the number of COVID-19 cases per million population for each country ($C_i$);

2 the death rate per million population from COVID-19 ($D_i$);

3 the real GDP growth rate ($R_i$); and

4 the ratio of deficit to GDP ($DFY_i$).

Deaths and cases per million are used to allow for inter-country comparisons of the intensity of the pandemic with total population accounted for by the use of weighted regression techniques.

The four dependent variables are regressed as a function of six sets of determinant variables:

1 COVID-19 variables ($CV_i$)—including cases, deaths, and tests per million population;

2 COVID-19 response variables ($CRV_i$)—the COVID-19 Government Response Tracker (OxCGRT) at points in the pandemic and the increase in the index over periods of time;

3 economic variables ($E_i$)—real GDP growth rates in 2020, real per-capita GDP in 2019, the export-to-GDP ratio in 2018, and the growth in total exports in 2020;

4 fiscal variables ($F_i$)—the general government expenditure-to-GDP ratio in 2019, growth of general government expenditure in 2020, and the deficit-to-GDP ratio in 2020;

5 health and demographic variables ($HD_i$)—including population density, population share aged more than 70 years, hospital beds per 1000 population, health spending as a share of GDP, and whether a country was heavily affected by SARS in 2002–2004;

6 a set of institutional characteristic variables ($I_i$)—including whether country is an IMF35 advanced economy, a federation, its ranking on the Fraser Institute's Economic Freedom Index, and world region fixed-effects variables.[27]

Again, the specific definition and sources for these variables are provided in Appendix 1.

27. Given that this study is based on an entire year's worth of data and international travel had essentially ground to a halt by April, international travel flows or tourist arrivals were not used as a variable even though several early studies have suggested that they were a significant determinant of COVID-19 infection and mortality rates. The early studies by Pana *et al*. (2020) and Stojoski, Utkovski, Jolakoski, Tedovski, and Kocarev (2020) used data from the first wave of the pandemic when travel was still a factor. International travel does appear to be a factor of some consequence in the recent spread of new variants in countries that have lagged in their border restrictions.

Some of these variables have been selected to provide evidence of the importance of issues that have been flagged in the coverage of the health and economic impacts of the pandemic in many countries. For example, the impact of the SARS outbreak between 2002 and 2004 affected some 30 countries with eight seeing more than 10 cases and just five (China, Hong Kong, Taiwan, Canada, and Singapore) seeing more than 100 cases. As noted in the earlier literature review, Taiwan in particular learned from the experience about necessary public-health planning and action and the variable is useful to see more generally if, after controlling for other factors, countries heavily affected by SARS2002-04 had fewer cases and lower mortality from COVID-19 as a result of lessons learned.

As another example, the IMF35 advanced economies appear to have been significantly hit by COVID-19 infection, mortality, and economic impacts both early and before other regions in the pandemic and it is useful to see if, after controlling for confounding factors, the impact using annual data is statistically significant. As well, some of the highest case counts and deaths rates appear to have hit countries with federal government structures—for example, the United States and Brazil. At the same time, federations like Australia seem to have done quite well in controlling spread and mortality. The coordination costs of more decentralized institutions with multiple jurisdictions having authority over health may have posed challenges in dealing with the COVID-19 pandemic or the economic fallout, making the inclusion of a dummy variable for federal countries useful to see if the effects are statistically significant.

The models estimated can be summarized in a general specification as:

1 $C_i = f(CV_i, CRV_i, E_i, F_i, HD_i, I_i)$

2 $D_i = f(CV_i, CRV_i, E_i, F_i, HD_i, I_i)$

3 $R_i = f(CV_i, CRV_i, E_i, F_i, HD_i, I_i)$

4 $DFY_i = f(CV_i, CRV_i, E_i, F_i, HD_i, I_i)$

Depending on variable availability and data span the models will present results for both narrow specifications with a few determinants and broader specifications using more variables. The estimation technique is Ordinary Least Squares and weighted regression with population size of the country as the weighting variable. This is done to provide greater weight to countries with larger populations as it is reasonable to assume that overall outcomes should be influenced more by countries with populations in the millions and billions rather than the hundreds of thousands. As well, the regressions for the determinants of the real GDP growth rate and the deficit-to-GDP ratio may suffer from the effects of endogeneity between deaths per million, income, and deficits. To deal with the potential bi-directionality between COVID-19 deaths per million and these variables, the coefficients of the deaths per million regression is used to estimate a "fitted" deaths per million variable that takes the bi-directionality into account.[28] Finally, all significances are reported at the 5% level unless otherwise specified.

It should be acknowledged that a key limitation of the econometric analysis is that COVID-19 and its total effects are still very much a work in progress and at best the estimates and results here will be but one snapshot measuring relationships and effects in the first year of the pandemic. As already noted at several points in this report, there are limitations as to the coverage of all variables as well as even the degree of reporting and accuracy for variables such as the cases and deaths from COVID-19. Furthermore, future research will add more data as well as consideration of different variables and effects as the shifting and changing research indicates, thereby resulting in different econometric approaches and specifications.

## 4.3 Regression results

Table 1 presents estimated results for two specifications of the determinants of COVID-19 cases per million population. The first specification is simply a regression of cases per million population on tests per million and tests per million squared and the level on the COVID-19 Government Response Tracker (OxCGRT) on April 1, 2020. The hump-shaped specification for testing is used because, initially, greater test intensity should result in more cases per million being discovered. At the same time, as testing ramps up, at some point one would expect that greater awareness of COVID-19 combined with follow-up such as isolation and tracing as cases are diagnosed should eventually begin to have an effect in reducing cases per million. The results for this first specification find that testing is statistically significant though the eventual rate of decline in cases while statistically significant is quantitatively small and only begins after 1.5 million tests per million population is reached. Going from 1.5 to 1.6 million tests—that is an additional 100,000 tests per million population—reduces the number of COVID-19 cases by 606 cases per million population, all other things given. As well, countries with a higher rating on the OxCGRT on April 1, 2020 had fewer COVID-19 cases per million but the result is not statistically significant.[29] This first regression explains about 68% of the variation in COVID-19 cases per million across countries.

28. More technically, this study uses a single equation technique known as Ordinary Least Squares. If there is simultaneity or bi-directionally between the variables in the model, the resulting estimates may be biased. That is, the estimated coefficients may not approach their true value. For an overview of these issues, see Kennedy, 1998.

29. It should be noted that testing policy is one of the components of the COVID-19 Government Response Tracker (OxCGRT). However, this stringency variable has been defined at points in time and changes over time while tests per million is an annual aggregate, which should limit any potential collinearity effects.

## Table 1: Regression results for COVID-19 cases per million

**Dependent variable: COVID-19 cases per million population**

| | Narrow Specification | | Broad Specification | |
|---|---|---|---|---|
| | Coefficient | t-statistic* | Coefficient | t-statistic* |
| **Independent variables** | | | | |
| COVID-19 tests per million population | 0.0966 | **14.46** | 0.0795 | **7.82** |
| COVID-19 tests per million population squared | 0.0000 | **−6.55** | 0.0000 | **−5.77** |
| COVID-19 Government Response Tracker (OxCGRT), April 1, 2020 | −8.0862 | −0.14 | 250.7499 | **2.11** |
| COVID-19 Government Response Tracker (OxCGRT), December 1, 2020 | | | −125.4795 | −1.58 |
| Change in OxCGRT, February 1 to April 1, 2020 | | | −116.1033 | −1.07 |
| Change in OxCGRT, May 1 to September 1, 2020 | | | 169.1039 | **2.18** |
| Change in OxCGRT, September 1 to December 1, 2020 | | | 142.1566 | 1.76 |
| Real GDP per capita, 2019 ($US PPP) | | | −0.0830 | −0.63 |
| Average of population share of males and females who smoke (%) | | | 24.9151 | 0.18 |
| 1 if a country had 100 or more cases of SARS in 2002-04, 0 otherwise | | | −18036.1000 | **−2.44** |
| IMF35 advanced economy (1 if IMF35 advanced economy, 0 otherwise) | | | 10024.9300 | **2.20** |
| Federation (1 if a federal country, 0 otherwise) | | | −1369.9810 | −0.67 |
| Europe (1 if European region, 0 otherwise) | | | −1203.7440 | −0.27 |
| Asia (1 if Asian region, 0 otherwise) | | | −3718.4380 | −1.46 |
| Pacific (1 if Pacific region, 0 otherwise) | | | 2379.2390 | 0.43 |
| North America (1 if North American region, 0 otherwise) | | | 11926.9500 | **2.51** |
| South American (1 if South American region, 0 otherwise) | | | 27222.5300 | **7.35** |
| Central America or Caribbean (1 if Central American or Caribbean region, 0 otherwise) | | | 11983.0600 | 1.39 |
| Middle East (1 if Middle Eastern Region, 0 otherwise) | | | 3114.3200 | 0.64 |
| Australia and New Zealand (1 if Australia and New Zealand, 0 otherwise) | | | −40139.7300 | **−3.88** |
| Constant | −1271.1600 | −0.27 | 895.3079 | 0.13 |
| N | 159 | | 128 | |
| F-statistic (3, 155) | 115.38 | | | |
| F-statistic (20, 107) | | | 43.52 | |
| Adjusted R-squared | 0.68 | | 0.87 | |

Note *: Bold denotes statistically significant at 5% level.

The second specification is broader, with more stringency variables including not only levels in April and December but also the change in the level of stringency during three periods—February to April, May to September, and September to December. As well, real per-capita GDP, the average smoking rate, and assorted institutional variables are included. The results again find a hump-shaped relationship between cases per million and tests per million with decline after 1.4 tests per million. The level of stringency in April as well as the increase in stringency between May and September are associated with statistically significant increases in cases per million—251 and 169 cases per million population, respectively—suggesting that stringency measures may change more in response to cases, thus being reactive rather than proactive. As a result, it is challenging to establish consistent relationships showing whether stringency increases in response to a rise in cases or cases fall in response to the increase in stringency.

Being a country with 100 or more cases of SARS in 2002-04 is negatively and significantly related to COVID-19 cases suggesting that on average those countries learned from their experience and probably applied it to COVID-19. Holding the other confounding variables constant, countries heavily affected by SARS saw about 18,000 fewer COVID-19 cases per million population relative to countries that did not have experience with SARS. The IMF35 advanced economies had significantly more cases than the non-advanced economies. In addition, relative to countries of the African continent (the omitted category), countries in North America and South America had significantly more cases per million, with other regions not statistically different. Finally, this second broad specification explains 87% of the variation on cases of COVID-19 per million across countries.

Table 2 presents estimated results for two specifications of the determinants of COVID-19 deaths per million population. The first specification is a regression of deaths per million population on COVID-19 cases per million and tests per million along with the level on the COVID-19 Government Response Tracker (OxCGRT) on April 1, June 1, and December 1 of 2020 and also the change in the level of the index over three periods: February to April, May to September, and September to December. The results from this narrower specification show that deaths are related to the number of infections as measured by cases per million but ramping up your testing serves to reduce the number of deaths per million. Indeed, the coefficient on tests per million population suggests that 100,000 tests per million population is associated with 21 fewer COVID-19 deaths per million population. Stringency measures early on in the pandemic appear to be associated with lower annual deaths per million population in 2020 given the negative coefficient on the value for April 1 value of the OxCGRT but not reduced with any of the other stringency measures. Indeed, there appears to be significant positive correlation. This again suggests that strong stringency measures may have been most effective early on in the pandemic. Continual stringency later on, that is, protracted lockdowns and

## Table 2: Weighted OLS regression results for COVID-19 deaths per million (population in 2020 weighting variable)

**Dependent variable: COVID-19 deaths per million population**

| | **Narrow Specification** | | **Broad Specification** | |
|---|---|---|---|---|
| | Coefficient | t-statistic* | Coefficient | t-statistic* |
| **Independent variables** | | | | |
| COVID-19 cases per million population | 0.0226 | **25.23** | 0.0164 | **10.87** |
| COVID-19 tests per million population | -0.0002 | **–3.25** | –0.0002 | –1.88 |
| | | | | |
| COVID-19 Government Response Tracker (OxCGRT), April 1, 2020 | –2.5704 | **–2.43** | 1.5842 | 0.76 |
| COVID-19 Government Response Tracker (OxCGRT), June 1, 2020 | 4.1562 | **3.72** | 3.5696 | 1.88 |
| COVID-19 Government Response Tracker (OxCGRT), December 1, 2020 | –0.5208 | –0.39 | –0.8236 | –0.44 |
| Change in OxCGRT, February 1 to April 1, 2020 | 1.7441 | **2.30** | 0.3098 | 0.17 |
| Change in (OxCGRT), May 1 to September 1, 2020 | 1.4652 | 1.17 | 3.1344 | 1.72 |
| Change in (OxCGRT), September 1 to December 1, 2020 | 4.4518 | **3.18** | 3.4215 | 1.75 |
| | | | | |
| Real GDP per capita, 2019 ($US PPP) | | | 0.0013 | 0.52 |
| | | | | |
| Population density (people per square km) | | | 0.0042 | 0.11 |
| Share of the population that is 70 years and older (%) | | | 36.9050 | **3.62** |
| Diabetes prevalence (% of population aged 20 to 79) | | | –10.9011 | **–2.04** |
| Hospital beds per 1,000 people | | | –31.5251 | **–3.38** |
| Current health expenditure as share of GDP (%) | | | 17.3300 | 1.6 |
| Average of population share of males and females who smoke (%) | | | –0.8606 | –0.35 |
| 1 if a country had 100 or more cases of SARS in 2002-04, 0 otherwise | | | –138.7031 | –1.17 |
| | | | | |
| IMF35 advanced economy (1 if IMF35 advanced economy, 0 otherwise) | | | –103.2996 | –0.99 |
| Federation (1 if a federal country, 0 otherwise) | | | –12.6796 | –0.37 |
| Europe (1 if European region, 0 otherwise) | | | 114.2047 | 1.35 |
| Asia (1 if Asian region, 0 otherwise) | | | –4.3737 | –0.07 |
| Pacific (1 if Pacific region, 0 otherwise) | | | 130.1240 | 1.16 |
| North America (1 if North American region, 0 otherwise) | | | 8.8933 | 0.11 |
| South American (1 if South American region, 0 otherwise) | | | 187.7272 | **2.50** |
| Central America or Caribbean (1 if Central American or Caribbean region, 0 otherwise) | | | –94.2391 | –0.72 |
| Middle East (1 if Middle Eastern Region, 0 otherwise) | | | 152.0748 | 1.62 |
| Australia and New Zealand (1 if Australia and New Zealand, 0 otherwise) | | | –47.9937 | –0.29 |
| Economic Freedom Index | | | –43.1050 | –1.35 |
| | | | | |
| Constant | –114.2506 | –1.66 | –54.1874 | –0.22 |
| | | | | |
| N | 159 | | 116 | |
| F-statistic (8, 150) | 189.32 | | | |
| F-statistic (27, 88) | | | 69.86 | |
| Adjusted R-squared | 0.91 | | 0.94 | |

Note *: Bold denotes statistically significant at 5% level.

other restrictions, do not appear to have been as effective.[30] Or, again it is also possible that higher stringency measures were reimposed at certain points as cases increased thereby resulting in the positive correlation. This first regression explains 91% of the international variation among countries in COVID-19 deaths per million.

However, when additional confounding factors are added to the broad specification regression, the stringency measures are all rendered insignificant in reducing deaths and even tests per million population becomes less significant (significant at the 10% level). Once a broader range of confounding factors are employed, the significant factors in raising the death rate are the level of infection (COVID-19 cases per million) and the percentage share of population aged greater than 70 years. On the other hand, the two significant factors in reducing the mortality from COVID-19 are the prevalence of diabetes in the population aged 20 to 79 and the number of hospital beds per 1,000 population. Each additional hospital bed per 1000 people was associated with 31.5 fewer COVID-19 deaths per million population. As well, after controlling for these assorted confounding factors, countries with high levels of economic freedom appear to have had fewer deaths per million than countries with less economic freedom though the result is not significant. This result may seem counterintuitive to some given the widespread perception that more authoritarian approaches might be better at controlling COVID-19. However, it could be opined that countries with high degrees of economic freedom also tend to be higher income, have better health infrastructure, and have citizens who are highly educated, well informed, and capable of making decisions on their own when dealing with problems and situations.[31] This second broader specification explains 94% of the variation in COVID-19 deaths per million population.[32]

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30. Of course, the large number of stringency variables may be correlated with one another. A correlation matrix of the stringency variables found both positive and negative correlations. Of the estimated correlation coefficients, only about one third had an absolute value greater than 0.3 suggesting there is not a high degree of collinearity between the stringency variables. In additional work (not reported here), the deaths per million variable in table 2 was regressed on the same variables except only the value for April 1 and then the change in stringency from May to September as the stringency variables. The results suggest high levels of stringency in April were correlated with high deaths per million while the change in stringency from May to September was not significant.

31. For discussion of the Fraser Institute's Economic Freedom Index and its relationship to economic growth and performance, see Di Matteo, 2013.

32. An additional unreported specification was estimated in the case of deaths per million in which annual deaths per million minus deaths per million at mid-year was regressed on the same variables in the deaths regression to see if there was a different response to these variables. Aging (percentage 70 years and older), cases, and tests per million were significant and the same sign as when the total year's observations were used. In this estimate, again none of the stringency variables were significant. As well, advanced economies had significantly lower deaths per million as did North America suggesting there was better pandemic response and management in the second half of 2020, which is captured when the entire year of data is used.

While one can intuitively see why more hospital beds per capita may make a difference in reducing the mortality from COVID-19, why higher rates of diabetes might do so, given that it is an underlying condition that should increase mortality from COVID-19, at first glance seems questionable (Riddle *et al.*, 2020). At the same time, Cao, Hiyoshi, and Montgomery (2020) also document a negative correlation between the prevalence of diabetes and COVID-19 case fatalities. One might hypothesize that, during the first waves of the pandemic, pre-existing conditions were indeed associated with greater mortality rates from COVID-19 but as knowledge increased people with underlying conditions were both being better monitored than the general population and also better protected because they took precautions such as wearing personal protective equipment (PPE) and practising physical distancing measures.

Table 3 moves us away from the determinants of COVID-19 infection rates and mortality and towards understanding the economic impacts of the pandemic. The table provides regression results looking at the determinants of real GDP growth in 2020 using three specifications: narrow, broad, and broad using the fitted values for deaths per million from the broad regression in table 2. Reiterating, the fitted values for death are used in one of the specifications to assist in accounting for the potential bi-directionality between COVID-19 deaths per million and variables that may determine both deaths per million and real GDP growth.

The narrow specification controls for COVID-19 deaths and tests per million population, assorted variables of the OxCGRT, and real per-capita GDP, and finds only the change in the level of stringency between February and April—the ramping up of restrictions during the first wave—to be negative and significant in its effects on real GDP growth. The broad specification and the broad specification with fitted deaths per million are extremely similar in terms of coefficient impact and significance, but the regression with fitted deaths per million explained 77% of the variation in real GDP growth as opposed to 70%.

Essentially, neither COVID-19 cases per million nor deaths per million had a statistically significant impact on the real GDP growth rate in 2020. The level of stringency in April and December was negative and insignificant but the ramping up of stringency from February to April and then from September to December appear to have been significantly associated with lower real GDP growth in 2020. According to the broad specification with fitted deaths, a one-unit increase in the OxCGRT from February 1 to April 1 in 2020 was associated with an approximate percentage-point drop in real GDP growth of 0.1%. The average increase internationally in the OxCGRT from February 1 to April 1 was 70 points, making for a 7 percentage-point drop in the real GDP growth rate after controlling for all other confounding variables.

## Table 3: Weighted OLS regression results for growth rate of real GDP (population in 2020 weighting variable)

**Dependent variable: growth rate of real GDP in 2020 (Constant prices national currency)**

| | Narrow Specification | | Broad Specification | | Broad Specification (with fitted deaths) | |
|---|---|---|---|---|---|---|
| | Coefficient | t-statistic* | Coefficient | t-statistic* | Coefficient | t-statistic* |
| **Independent variables** | | | | | | |
| COVID-19 deaths per million population | −0.0019 | −1.60 | −0.0004 | −0.28 | 0.0004 | 0.28 |
| COVID-19 tests per million population | 0.0000 | 0.10 | 0.0000 | 0.10 | 0.0000 | −0.24 |
| COVID-19 Government Response Tracker (OxCGRT), April 1, 2020 | −0.0337 | −1.04 | −0.0028 | −0.08 | 0.0233 | 0.65 |
| COVID-19 Government Response Tracker (OxCGRT), December 1, 2020 | −0.0610 | −1.78 | 0.0028 | 0.09 | −0.0066 | −0.21 |
| Change in OxCGRT, February 1 to April 1, 2020 | −0.0794 | **−3.82** | −0.0636 | **−2.90** | −0.0821 | **−3.65** |
| Change in OxCGRT, May 1 to September 1, 2020 | 0.0397 | 1.19 | 0.0061 | 0.21 | 0.0084 | 0.29 |
| Change in OxCGRT, September 1 to December 1, 2020 | −0.0074 | −0.21 | −0.0840 | **−2.72** | −0.0694 | **−2.08** |
| Real GDP per capita, 2019 ($US PPP) | 0.0000 | −0.89 | 0.0001 | 1.18 | 0.0001 | 1.63 |
| Percentage change in value of total exports of goods and services, 2020 | | | 0.2053 | **5.02** | 0.2043 | **4.56** |
| Export-to GDP ratio, 2018 | | | 0.0077 | 0.55 | 0.0022 | 0.16 |
| General government expenditure to GDP, 2019 (%) | | | −0.2357 | **−4.76** | −0.2982 | **−4.97** |
| IMF35 advanced economy (1 if IMF35 advanced economy, 0 otherwise) | | | −1.1025 | −0.61 | −0.9586 | −0.53 |
| Federation (1 if a federal country, 0 otherwise) | | | −4.3501 | **−5.57** | −3.7178 | **−4.40** |
| Europe (1 if European region, 0 otherwise) | | | 0.5038 | 0.32 | −1.7449 | −1.11 |
| Asia (1 if Asian region, 0 otherwise) | | | −2.1998 | **−2.39** | −4.7992 | **−4.62** |
| Pacific (1 if Pacific region, 0 otherwise) | | | −4.3018 | **−2.42** | −6.8294 | **−3.80** |
| North America (1 if North American region, 0 otherwise) | | | −0.2605 | −0.15 | −3.3086 | −1.88 |
| South American (1 if South American region, 0 otherwise) | | | −3.3366 | −1.76 | −4.8045 | **−2.46** |
| Central America or Caribbean (1 if Cent. Amer. or Carib. region, 0 otherwise) | | | −3.4836 | −1.30 | −5.2211 | −1.65 |
| Middle East (1 if Middle Eastern Region, 0 otherwise) | | | −7.6058 | **−4.02** | −10.2961 | **−4.83** |
| Australia and New Zealand (1 if Australia and New Zealand, 0 otherwise) | | | 0.0763 | 0.02 | −2.3359 | −0.62 |
| Constant | 8.645422 | **3.35** | 10.8202 | **4.53** | 14.1389 | **4.92** |
| N | 158 | | 147 | | 112 | |
| F-statistic (8, 149) | 16.04 | | | | | |
| F-statistic (21, 125) | | | 16.92 | | | |
| F-statistic (21, 90) | | | | | 19.06 | |
| Adjusted R-squared | 0.43 | | 0.70 | | 0.77 | |

Note *: Bold denotes statistically significant at 5% level.

Again, this suggests that protracted restrictions were of limited effectiveness in combatting the pandemic over the longer term but quite effective in reducing economic activity. Given that changes in restrictions are statistically significant variables but not the level of restrictions in specific months suggests that it may be abrupt stops and starts to restrictions that damage growth rather than extended but steady periods of restrictions. Indeed, the case has been made that short and very sharp lockdowns with clear directives work best in dealing with the pandemic rather than long lockdowns with porous restrictions enacted as a sort of political compromise between fighting the virus and keeping the public happy (*e.g.*, Sheikh and Sheikh, 2021; Fasani, 2020).

Countries that were able to ramp up their exports and keep exporting throughout the pandemic did significantly better than those that did not. Meanwhile, the size of the public sector as measured by the ratio of general government expenditure to GDP the year previous did not seem to offer any type of protection against the severity of the real GDP downturn. Indeed, countries with larger public sectors appear to have experienced significantly less growth in real GDP. All other things given, a one percentage-point larger ratio of government expenditure to GDP in 2019 was associated with one fifth to one third of a percentage point lower rate of real GDP growth in 2020. As well, federations appear to have experienced significantly lower real GDP growth after confounding factors were controlled for. Relative to non-federations, federations appear to have experienced real GDP growth rates ranging from 4.4 to 3.7 percentage-points lower. As for the world region variables, relative to countries on the African continent, countries in Europe, Asia, the Pacific, and South America all experienced significantly less real GDP growth in 2020. North America also experienced less real GDP growth, but it was only significant at the 10% level.

Finally, table 4 provides regressions looking at the determinants of the deficit-to-GDP ratios in 2020; positive ratios mean there is a surplus and negative ratios that there is a deficit. In interpreting coefficients, a negative coefficient means the variable is contributing to a more negative or larger deficit while a positive coefficient means it is contribution to a more positive ratio or smaller deficit (but larger surplus). There are again three specifications: a narrow, broad, and broad with fitted deaths per million in a manner akin to the previous real GDP growth regression.

The narrow specification shows deaths per million worsened the deficit-to-GDP ratio but not significantly while an increase in stringency in the period from May to September of 2020 resulted in significantly larger deficits. Not surprisingly, countries that had a high rate of real GDP growth in 2020 appear to have had smaller deficits. On the other hand, countries with larger public sectors in 2019 appear to have had larger deficits in 2020, suggesting that the pandemic's effects on economic growth and subsequent revenue drops hurt them more.

## Table 4: Weighted OLS regression results for ratio of deficit to GDP (population in 2020 weighting variable)

**Dependent variable: ratio (%) of deficit to GDP**

| | **Narrow Specification** | | **Broad Specification** | | **Broad Specification (with fitted deaths)** | |
|---|---|---|---|---|---|---|
| | Coefficient | t-statistic* | Coefficient | t-statistic* | Coefficient | t-statistic* |
| **Independent variables** | | | | | | |
| COVID-19 deaths per million population | –0.0013 | –1.34 | –0.0047 | **–3.96** | –0.0061 | **–5.24** |
| Change in OxCGRT, February 1 to April 1, 2020 | 0.0157 | 1.05 | 0.0048 | 0.34 | –0.0049 | –0.30 |
| Change in OxCGRT, May 1 to September 1, 2020 | –0.0985 | **–4.90** | –0.0540 | **–2.89** | –0.0504 | **–2.54** |
| Change in OxCGRT, September 1 to December 1, 2020 | 0.0128 | 0.59 | –0.0216 | –1.12 | –0.0141 | –0.67 |
| Real GDP per capita, 2019 ($US PPP) | 0.0000 | 0.38 | 0.0000 | 0.29 | 0.0000 | 0.55 |
| Growth rate of Real GDP, 2020 (constant prices national currency) | 0.5293 | **7.64** | 0.3817 | **5.83** | 0.1734 | **2.40** |
| Export-to GDP ratio, 2018 | | | 0.0188 | 1.61 | 0.0262 | **2.43** |
| General government expenditure to GDP, 2019 (%) | –0.1714 | **–4.11** | –0.3026 | **–7.34** | –0.2205 | **–4.38** |
| Growth (%) in general government expenditure, 2020 | 0.0092 | 0.67 | 0.0045 | 0.38 | 0.0055 | 0.53 |
| IMF35 advanced economy (1 if IMF35 advanced economy, 0 otherwise) | | | 0.0896 | 0.06 | –0.3855 | –0.30 |
| Federation (1 if a federal country, 0 otherwise) | | | –0.7519 | –1.14 | –0.8219 | –1.20 |
| Europe (1 if European region, 0 otherwise) | | | 8.5029 | **6.38** | 6.9268 | **5.55** |
| Asia (1 if Asian region, 0 otherwise) | | | –0.5520 | –0.82 | –1.7332 | **–2.14** |
| Pacific (1 if Pacific region, 0 otherwise) | | | –0.8020 | –0.60 | –0.7864 | –0.53 |
| North America (1 if North American region, 0 otherwise) | | | 0.7555 | 0.49 | 0.2796 | 0.20 |
| South American (1 if South American region, 0 otherwise) | | | 4.5551 | **2.92** | 3.3942 | **2.30** |
| Central America or Caribbean (1 if Cent. Amer. or Carib. region, 0 otherwise) | | | 0.8729 | 0.40 | –0.8657 | –0.34 |
| Middle East (1 if Middle Eastern Region, 0 otherwise) | | | 0.4840 | 0.34 | 0.6320 | 0.38 |
| Australia and New Zealand (1 if Australia and New Zealand, 0 otherwise) | | | 3.8839 | 1.09 | 2.0446 | 0.68 |
| Constant | –4.9763 | **–3.54** | –1.0093 | –0.67 | –2.5814 | –1.22 |
| N | 172 | | 170 | | 116 | |
| F-statistic (8, 163) | 27.73 | | | | | |
| F-statistic (19, 150) | | | 21.57 | | | |
| F-statistic (19, 96) | | | | | 17.32 | |
| Adjusted R-squared | 0.56 | | 0.70 | | 0.73 | |

Note *: Bold denotes statistically significant at 5% level.

The broader specifications show that the increase in stringency between May and September appears to have consistently and significantly contributed to greater deficits as does the size of the public sector. As well, deaths per million are also a significant contributor to larger deficits once a broader range of confounding factors is included. Relative to countries on the African continent, European and South American countries had significantly smaller deficits while Asian countries had significantly larger ones. Again, it should be noted that this is not a comparison of absolute deficit-to-GDP ratios but is after controlling for other confounding factors such as public-sector size and real GDP growth. Finally, federations did not have significantly different deficit performance than non-federations.

# 5 Discussion

Given that countries around the world continue to combat the health and economic effects of the pandemic, the constantly shifting analyses from experts and the on-going collection of pandemic data, and its economic and fiscal impacts, any conclusions are tentative and likely to be revised in the years to come as more evidence comes into place. At the same time, the evidence and results in this study can be used to offer some preliminary discussion and interpretations as to the effect of the pandemic, differences in international impacts and containment efforts, the effectiveness of responses, and the associated economic and fiscal impacts. On the other hand, the nature of some of the results may generate as many questions as answers as there is substantial variation in outcomes and performance across countries and therefore no one-size-fits-all policy conclusion that can be divined from the analysis.

In terms of general observations, it is important to note that the current pandemic is really only unprecedented and a surprise to many in the developed world because the technological and economic progress of the 21st century and resulting high material standards of living has been accompanied by a loss of our sense of history and historical perspective. Plague and pestilence have been features of the human experience since the start of recorded history. Pandemics have happened before and they will happen again. Nevertheless, many countries were caught unprepared for the pandemic even in cases where they had the experience of a more recent outbreak such as SARS, suggesting that lessons were not always learned.

Moreover, as the pandemic progressed it did not occur simultaneously across countries or proceed at the same rate everywhere and yet countries with the advantage of additional time seemed unable to see the warning signs and act quickly to implement control measures. Despite the marvels of instantaneous 21st-century communication and dissemination of information, it was as if each nation had to experience its own pandemic before it took the matter seriously. Learning behaviour was not guaranteed even amongst countries who had experienced infectious disease outbreaks in the recent past and might have been expected to learn something from the experience.

In terms of mortality, COVID-19 differs from historical pandemics in terms of the severity of its effects. To date, it is not the Black Death—which between 1347 and 1351 is estimated to have killed 25 to 50 million people, carrying off an estimated half of the European population—nor has it had the mortality impact of the Spanish flu, which is estimated to have killed anywhere from 20 to 100 million people. Moreover, the mortality effects have been more concentrated on the elderly rather than the working age population aged 20 to 65 years at least until recently. The spread of new variants does seem to be affecting younger demographics somewhat more in terms of severity of the illness and hospitalizations.

Nevertheless, to date the long-term economic effects of the COVID-19 pandemic should not be expected to involve large changes in capital-to-labour ratios and to have effects on interest rates. In the long run, one might expect a more serious effect on the acquisition of human capital given the many disruptions to schooling and education that have occurred, though these will only emerge over time. On the other hand, the short-term economic effects have been quite severe for two reasons: the disruption of modern economic production that involves highly integrated supply chains as well as an emphasis on personal services and the effect on economies of restrictions designed to limit the spread of the virus.

The pandemic's incidence during the first year was surprisingly severe amongst highly developed and economically advanced countries. While the IMF35 advanced economies account for 18% of the world's countries, they account for just over half of the 30 worst hit countries in world in terms of cases adjusted for population. This could be because the pandemic hit many of the advanced economies first, giving other countries more time to realize the severity of the pandemic and prepare. This may be the result of more complex, advanced, and interdependent economic systems being hit harder by the disruptive effects of the pandemic. Or, it could be the result of a weaker pandemic containment response by advanced countries with high degrees of economic freedom and personal liberty that may have generated more resistance to compliance. Or, it might partly reflect that advanced economies have better quality data and simply are more open about reporting the effects of the pandemic. These same points also apply to mortality from COVID-19, given that again the IMF35 advanced economies accounted for 40% of the top 30 countries ranked in terms of deaths per million but only 18% of the countries in this study. However, the fact that the advanced economies have much older population distributions than the developing and emerging world may also be a factor in the higher toll in advanced countries.[33]

The economic effects of the pandemic were substantial with an estimated drop in world real GDP in 2020 of 4.3%. Again, the IMF35 advanced economies were harder hit as they saw a 5.4% decline in real GDP while countries defined by the IMF as emerging markets and developing economies saw a 2.6% contraction. The implications for the

33. In this data set, the proportion of population aged 70 and over in the IMF35 advanced economies was 11.9%; in all other countries together it was 3.9%.

world economy are substantial, given that the IMF35 advanced economies account for 14% of world population but 40% of world GDP, making their recovery crucial to a complete global economic recovery and a full rebound in trade. The economic toll of the pandemic was not primarily driven by mortality as in past plagues and pandemics but resulted from the measures and restrictions enacted in an effort to control disease spread.

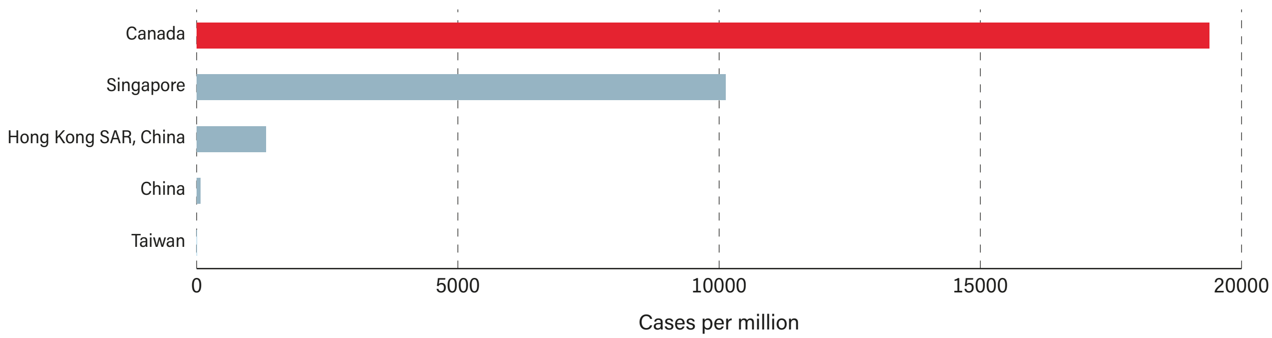
Lockdowns, quarantines, and travel restrictions have hurt the international travel industry and the labour-intensive personal services, food and accommodation, tourism, and arts and entertainment sectors as well as disrupted the global supply chain. The severity of containment measures and restrictions as measured by the OxCGRT varied across countries. Aside from measures enacted early on in the pandemic, levels of stringency or a ramping up of stringency do not appear to have significantly reduced COVID-19 cases per million population though high rates of testing do seem to have been a factor in eventually reducing the number of cases. Moreover, increased testing also appears a factor in mitigating the death toll.

However, stringency again does not appear to have been a major factor in curbing the death toll from COVID-19 aside from early on in the pandemic. This would suggest that the use of stringency measures such as lockdowns are best employed as short, sharp measures early on rather than as a protracted long-term tool. However, whether lockdowns are a substitute or complement for other comprehensive public-health measures such as case testing and tracking, wearing of masks, and general public compliance with rules is not possible to answer with this evidence. As well, the experience of individual countries like Taiwan, which stayed largely open for business during the pandemic, is worthy of further study.

An important factor raising mortality from COVID-19 appear to have been the population share of elderly while an important factor reducing the mortality was the number of hospital beds per 1,000 population. This latter variable is interesting because, while it was significant, the percentage share of GDP devoted to health spending was not. This suggests that in the end, even with abundant medical resources, it was probably not just how much you spent on dealing with COVID-19 but how it was spent and allocated in the recent past that mattered more. In the case of hospital beds, for example, even for the IMF35 advanced economies, hospital beds per 1,000 population ranged from a high of 13.1 in Japan, 12.2 in South Korea. and 8.0 in Germany to lows of 2.5 in Canada and Denmark, 2.4 in Singapore, and 2.2 in Sweden.

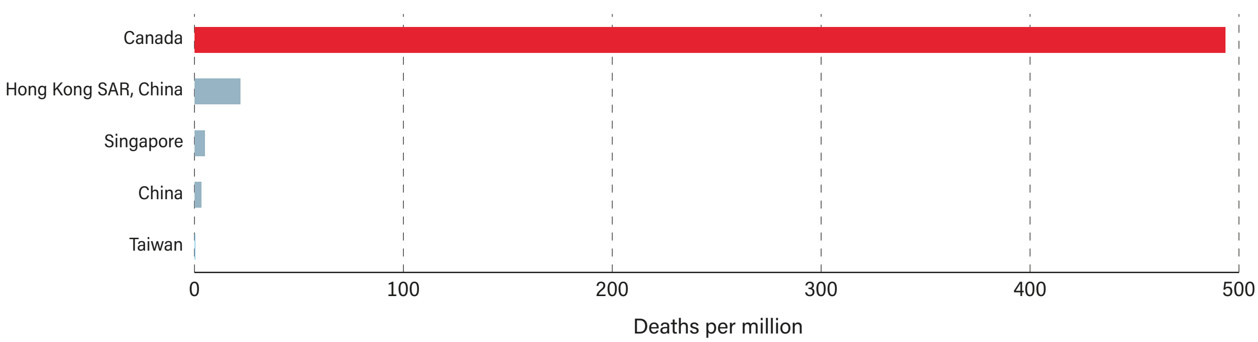
As a further point of interest, countries that were heavily affected by the SARS in 2004 collectively appear to have had significantly lower incidence of COVID-19 and fewer deaths, though even here the experience seems variable. Five countries experienced more than 100 cases during the SARS outbreak in the first decade of the 21st century—China, Taiwan, Singapore, Hong Kong, and Canada. However, as figures 27A and figure 27B illustrate, if there were any lessons to be learned from SARS about containing a pandemic and reducing the death rate, they do not appear to have been as well heeded in Canada, which during the COVID-19 pandemic had the highest numbers of cases and deaths per million of these five countries.

Figure 27A: COVID-19 cases per million in 2020, five countries most affected by SARS-2004




Source: World Health Organization, 2020b; Worldometer, 2021b.

Figure 27B: COVID-19 deaths per million in 2020, five countries most affected by SARS-2004




Source: : World Health Organization, 2020b; Worldometer, 2021b.

While stringency measures such as lockdowns had limits in dealing with either the spread or mortality from COVID-19, they certainly appear to have been effective in having a consistently negative impact on real GDP growth in 2020. In the end, it was not the deaths from COVID-19 *per se* that devastated economies, but more the restrictions and stringency measures enacted to reduce its spread. Exports were a particularly important variable and countries that managed to increase their exports during the pandemic did better. Oddly enough, economic growth in countries with larger public sectors appear to have done worse during the pandemic and it is not entirely clear as to why that might be. It may be that a large public sector was not as much of a stabilizing force during the pandemic given lockdowns and shutdowns were probably easier to implement on more centralized public-sector workers. Or, it may be that the short-term effects of the stimulus were not sufficient to overcome the longer-term productivity and growth-reducing effects of larger public sectors and accompanying higher rates of taxation.[34]

As for other institutional and regional factors, it would appear that federations had a particularly tough time when it came to economic performance during the pandemic, with significantly larger drops in real GDP compared to non-federations. Federalism is a system of government where units are able to be both independent and coordinate and should accommodate regional preferences within the economies of scale and political direction provided by a larger entity. It could be that, with their tiers of government and shared responsibilities, federations had more difficulty dealing with the pandemic and as a result suffered a worse economic impact. On the other hand, federations collectively do not appear to have had significantly higher cases and deaths per million so one wonders if there is some other undetermined institutional factor at play within the response of federations. However, given that advanced economies were also particularly hard hit it may be worth separating out the performance of advanced economies that were also federations.[35]

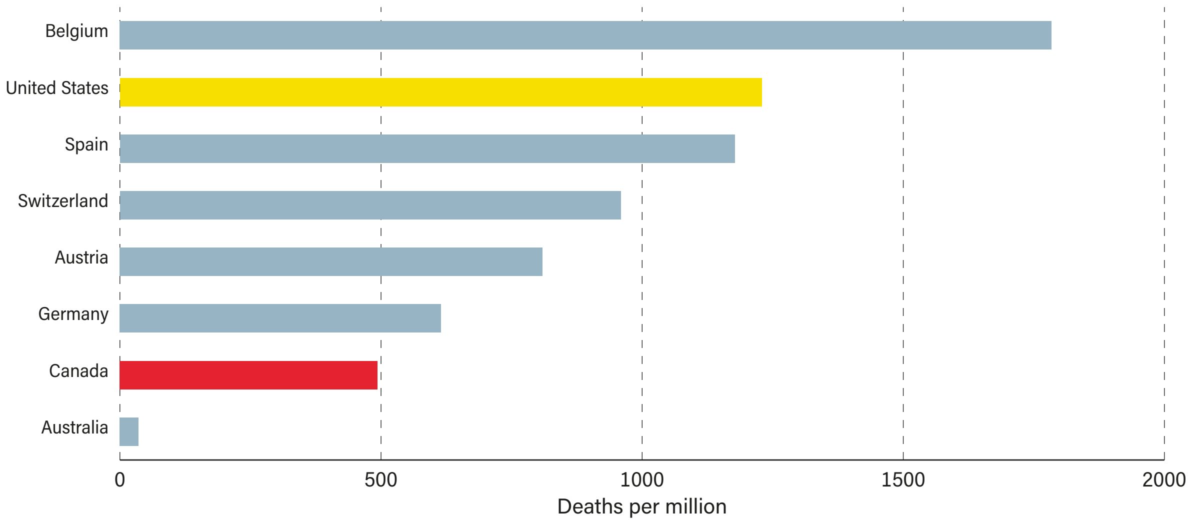
Figure 28A and figure 28B highlight the performance of federal countries that were also IMF35 advanced economies. The highest frequency of COVID-19 deaths per million among these eight countries was in Belgium (1,784), the United States (1,229), and Spain (1,177), while Australia (36), Canada (498), and Germany (615) fared the best. When it comes to real GDP growth, however, high death rates from COVID-19 again were not strictly correlated with economic performance. While all these federal advanced economies experienced contractions of real GDP, the smallest percentage reductions were in Australia, the United States, and Switzerland while the largest were in Spain, Belgium, and Canada. Canada and the United States were both outliers amongst these federal advanced economies in that Canada had relatively low death rates from COVID-19 but experienced a more severe economic contraction whereas the United States had relatively higher death rates but experienced a relatively milder contraction.

Of course, a major part of the economic effects was the fiscal response as countries around the world ran deficits to provide support for their economies as well as resources

34. For an examination of the relationship between the size of the public sector and economic growth, see Di Matteo, 2013.

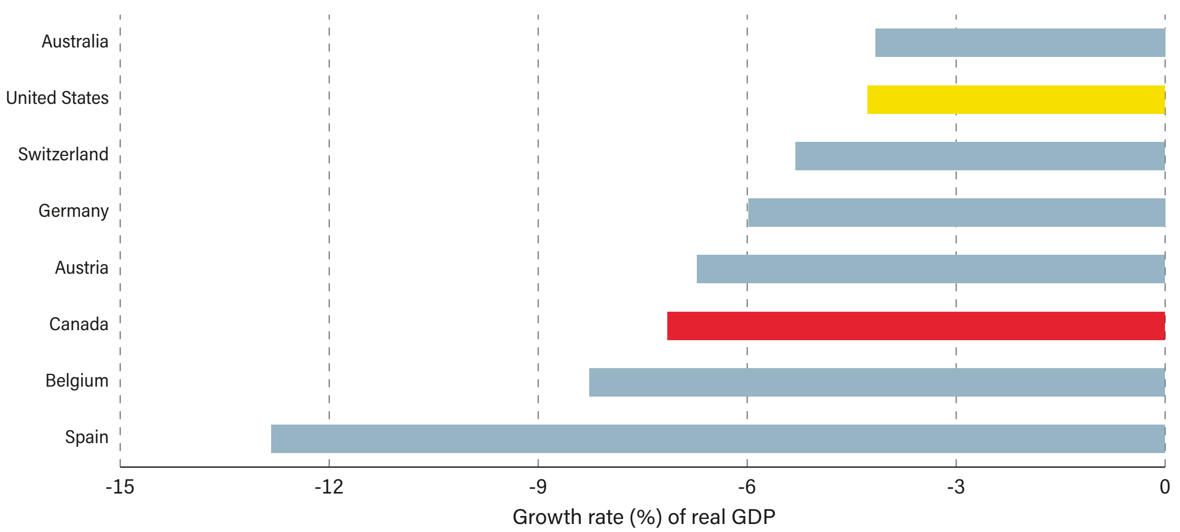
35. The list of countries that are federations in this data set reveals a rather diverse lot. They are: Australia, Austria, Belgium, Canada, Germany, Spain, Switzerland, and the United States (IMF35 advanced economies); plus Argentina, Bosnia and Herzegovina, Brazil, Ethiopia, India, Iraq, Malaysia, Mexico, Nepal, Nigeria, Pakistan, Russian Federation, South Africa, Sudan, United Arab Emirates, and Venezuela.

Figure 28A: COVID-19 deaths per million in 2020, IMF35 advanced economies with federal governments




Source: World Health Organization, 2020b; Worldometer, 2021b.

Figure 28B: Growth rate (%) of real GDP in 2020, IMF35 advanced economies with federal governments

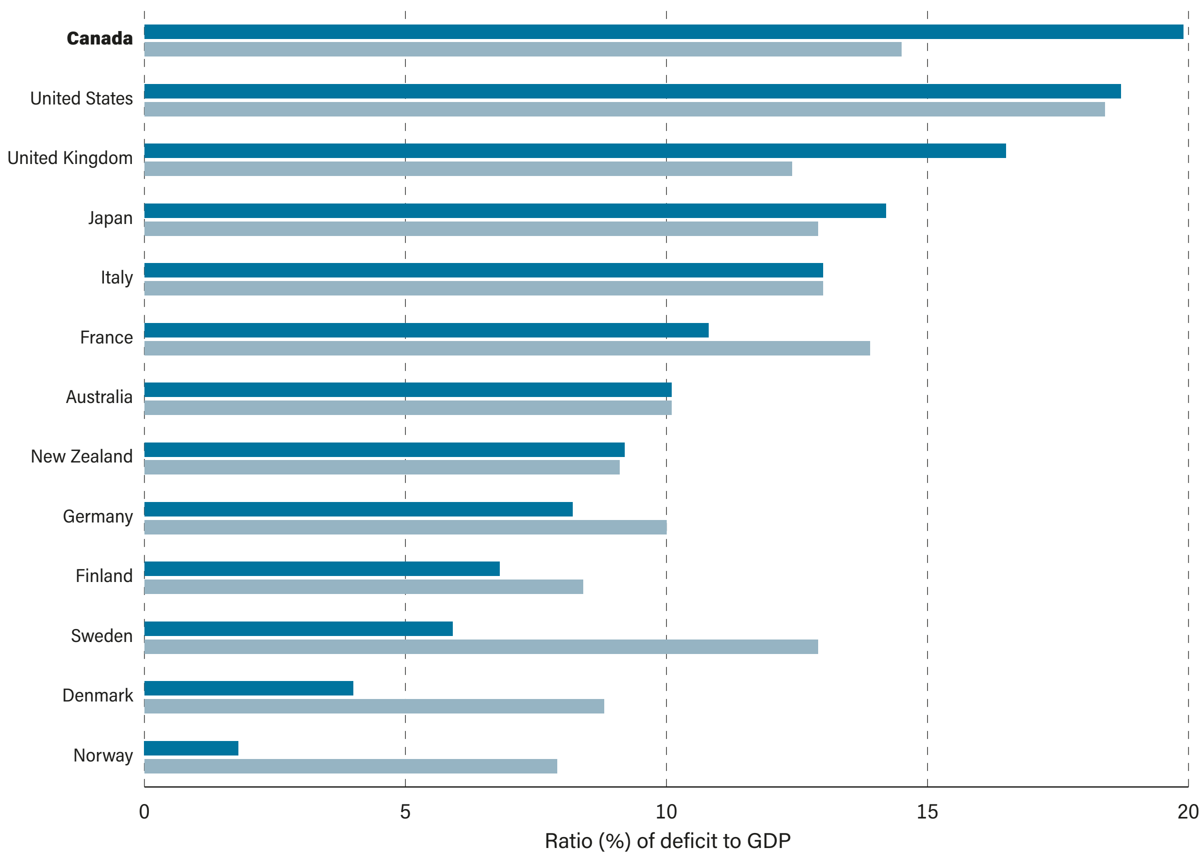



Source: World Health Organization, 2020b; Worldometer, 2021b.

to deal with the pandemic. Here, it would appear that countries with larger tallies of deaths from COVID-19 did run larger deficits. Stringency was also a factor of some significance in running a larger deficit, particularly in those countries that maintained higher levels of stringency during the late spring and summer of 2020. Given the negative impact of greater stringency on economic growth, it may be that prolonging restrictions resulted in a slower economy, undermining government revenues further. And, countries that had a larger public sector as a share of GDP to begin with appear to have suffered larger deficits in the pandemic year.

In the case of deficits, the results in this paper also afford an opportunity to compare countries in terms of their actual deficits relative to what the forecasted deficit might be given the determinants in the model. Figure 29A plots the actual deficit-to-GDP ratio, as available January 2021, and the predicted one from the broad regression with fitted deaths per million in table 3 for the G7 countries, plus Australia and New Zealand and the four Scandinavian countries. Figure 29B plots the difference between the percentage-point difference between the actual and predicted deficit-to-GDP ratio; a negative means that the actual deficit is larger than forecast and a positive that it is smaller than forecast. Of these countries, about half did better than expected while the other half did worse. Canada amongst this group did the worst with an estimated total government deficit-to-GDP ratio of 19.9% and a predicted one of 14.5%—over 5 percentage points worse than the model predicted.[36]

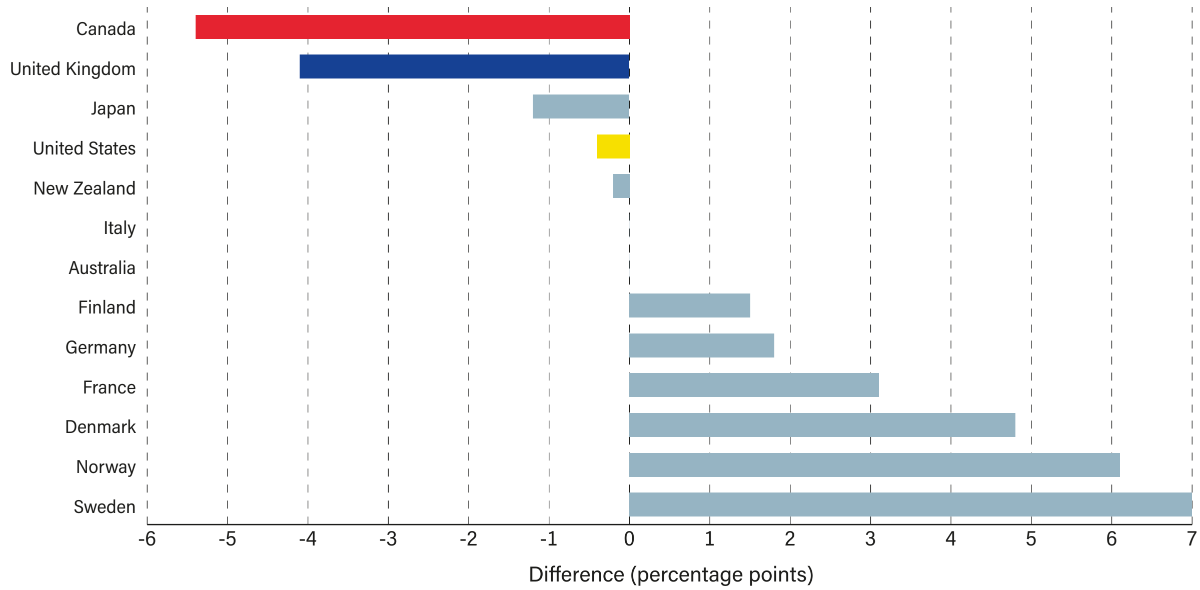
Figure 29A: Actual versus predicted ratio (%) of deficit to GDP, G-7 and Scandinavian countries, Australia, and New Zealand, 2020




Source: author's calculations.

36. Again, it should be noted that the data used was current as of January 2021. It is interesting to note that revised IMF fiscal monitor numbers for April 2021 now put the Canadian deficit-to-GDP ratio for 2020 at 11%. One imagines that these numbers will eventually change yet again (see IMF, 2021b).

Figure 29B: Actual minus predicted ratio of deficit to GDP (percentage points), GDP, G-7 and Scandinavian countries, Australia, and New Zealand, 2020




Source: author's calculations.

# 6 Conclusion

In the end, the most important feature of the pandemic is that there was no uniform pattern of the impact of the infection and spread across countries. Though all countries experienced the pandemic, its intensity and severity varied substantially across countries as did the economic impact, but there was not always a direct linear relationship between the intensity of the disease and the economic and fiscal impact. Indeed, countries that ran large deficits or had large public sectors to stabilize their economies did not generally do better either in restraining the spread of COVID-19 or protecting their economic performance. The advanced economies were hard hit by the pandemic in many regards, but they generally have older populations. Deaths from the disease varied across countries, with the availability of hospital beds and the share of elderly population important determinants. The economic impact was affected more by the intensity of restrictions and lockdowns as well as institutional features such as the size of the public sector and whether a country had a federal or unitary system—but not necessarily the number of cases or deaths. In the end, while there are common variables affecting the impact of COVID-19 on each country, how each country chose to play the cards that were dealt was likely an important determinant of outcomes for public health and the economy.

Of course, as the pandemic continues in 2021 and countries, one hopes, move towards controlling it, the surge of new variants in 2021 suggests that there are still twists and turns to come in the saga of the pandemic before it is ultimately brought under control. Key features will be the roll-out of vaccines around the world as well as the spread of the new and more transmissible variants such as those first identified in the United Kingdom, Brazil, South Africa, and now India. While key variables affecting mortality will continue to be the population share of the elderly as well as the infrastructure supplying hospital beds, to the mix will be added the mounting evidence that younger demographics appear to be more affected by the new variants. There will also be continuing economic and fiscal impacts as countries deal with new variants as well as repair economic damage and promote recovery. A key issue will be to what extent the large government intervention and fiscal response will persist and how much reorientation towards more activist and interventionist government—with its implications for economic growth—will remain in the wake of the pandemic. It remains to be seen if the pandemic with its era of large government spending ushers in a new era of higher taxes and more *dirigiste* government.

# Appendix 1: Variables Used in Study

| Variables | Description | Source |
|---|---|---|
| **COVID-19 variables** | | |
| covidcasespermillion | COVID-19 cases per million population | WHO COVID data and Worldometer as of January 23, 2021 |
| deathspermillion | COVID-19 deaths per million population | WHO COVID data and Worldometer as of January 23, 2021 |
| testspermillion | COVID-19 tests per million population | WHO COVID data and Worldometer as of January 23, 2021 |
| **COVID-19 response variables** | | |
| oxstringapril1 | COVID-19 Government Response Tracker, April 1, 2020 | Our World In Data |
| oxstringdec1 | COVID-19 Government Response Tracker, December 1, 2020 | Our World In Data |
| oxstringjune1 | COVID-19 Government Response Tracker, June 1, 2020 | Our World In Data |
| oxstringchfebapril | Change in OxCGRT, Feb. 1 to April 1 2020 | Our World In Data |
| oxstringchmaysept | Change in OxCGRT, May 1 to Sept 1 2020 | Our World In Data |
| oxstringchdecsept | Change in OxCGRT, Sept 1 to Dec 1 2020 | Our World In Data |
| **Economic variables** | | |
| rgdpgrowth2020 | Growth rate of real GDP, 2020 (constant prices national currency) | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |
| rgdpc2019 | Real GDP per capita, 2019 ($US PPP) | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |
| exportgrth2020 | Percentage change in value of total exports of goods and services, 2020 | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |
| exporttogdp | Export-to-GDP ratio, 2018 | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database; World Bank National Accounts Data; and OECD National Accounts data files. |
| **Fiscal variables** | | |
| gengovexpgdp2019 | General government expenditure to GDP, 2019 (%) | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |
| gengovexpgrth2020 | General government expenditure growth (%), 2020 | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |
| defgdp2020 | General government net lending/borrowing as share of GDP(%), 2020 | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |

| Variables | Description | Source |
|---|---|---|
| **Health and demographic variables** | | |
| pop2020 | Population in 2020 | IMF-WEO Variables, International Monetary Fund, World Economic Outlook Database |
| popdensity | Population density (people per square km) | World Bank World Development Indicators, sourced from Food and Agriculture Organization and World Bank estimates |
| perc70older | Share of the population that is 70 years and older (%) | United Nations, Department of Economic and Social Affairs, Population Division (2017), World Population Prospects 2017 Revision |
| diabetesprev | Diabetes prevalence (% of population aged 20 to 79) | World Bank World Development Indicators, sourced from International Diabetes Federation, Diabetes Atlas |
| hospbedper1000 | Hospital beds per 1,000 people | OECD, Eurostat, World Bank, national government records and other sources |
| hgdpperc2018 | Current health expenditure as share of GDP (%) | World Health Organization Global Health Expenditure Database |
| avgsmokerate | Average of population share of males and females who smoke (%) | World Bank World Development Indicators, sourced from World Health Organization, Global Health Observatory Data Repository |
| sars0204 | 1 if country had 10 or more cases of SARS in 2002-04 , 0 otherwise | SARS outbreak 2002-04. 30 countries affected for a total of 8,110 cases. However, 8 countries (China, Hong Kong, Taiwan, Canada, Singapore, Vietnam, United States, Phillipines) had 10 or more cases totaling 8,021. |
| sars0204plus100 | 1 if country had 100 or more cases of SARS in 2002-04, 0 otherwise | SARS outbreak 2002-04. 5 countries (China, Hong Kong, Taiwan, Singapore, Canada) had more than 100 cases |
| **Institutional Variables** | | |
| advancedecon | IMF35 advanced economy (1 if IMF35 advanced economy, 0 otherwise) | |
| federation | Federation (1 if a federal country, 0 otherwise) | |
| europe | Europe (1 if European region, 0 otherwise) | |
| asia | Asia (1 if Asian region, 0 otherwise) | |
| pacific | Pacific (1 if Pacific region, 0 otherwise) | |
| northamerica | North America (1 if North American region, 0 otherwise) | |
| southamerica | South American (1 if South American region, 0 otherwise) | |
| centralamandcaribb | Central America and Caribbean (1 if Central American or Caribbean region, 0 otherwise) | |
| middleeast | Middle East (1 if Middle Eastern Region, 0 otherwise) | |
| australianz | Australia and New Zealand (1 if Australia and New Zealand, 0 otherwise) | |
| africa | Africa (1 if Africa, 0 otherwise) | |
| econfreedom | Economic Freedom Index | Fraser Institute |

# Appendix 2: Select Components from the COVID-19 Government Response Tracker (OxCGRT) Stringency Index

**Face coverings**

0 – no policy

1 – recommended

2 – required in some specified shared/public spaces outside the home with other people present, or some situations when social distancing not possible

3 – required in all shared/public spaces outside the home with other people present or all situations when social distancing not possible

4 – required outside the home at all times regardless of location or presence of other people

**Stay at home**

0 – no measures

1 – recommend not leaving house

2 – require not leaving house with exceptions for daily exercise, grocery shopping, and 'essential' trips

3 – require not leaving house with minimal exceptions (e.g., allowed to leave only once every few days, or only one person can leave at a time, etc.)

blank – no data

**Testing policy**

0 – no testing policy

1 – only those who both (a) have symptoms and (b) meet specific criteria (e.g., key workers, admitted to hospital, came into contact with a known case, returned from overseas)

2 – testing of anyone showing COVID-19 symptoms

3 – open public testing (e.g., "drive through" testing available to asymptomatic people)

blank – no data

**Contract tracing**

0 – no contact tracing

1 – limited contact tracing—not done for all cases

2 – comprehensive contact tracing—done for all cases

blank – no data

**Restrictions on gatherings:**

0 – no restrictions

1 – restrictions on very large gatherings (the limit is above 1000 people)

2 – restrictions on gatherings between 100–1000 people

3 – restrictions on gatherings between 10–100 people

4 – restrictions on gatherings of less than 10 people

blank – no data

Source: Blavatnik School of Government, University of Oxford, 2021.

# Appendix 3: Summary Statistics

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **COVID-19 Variables** | | | | | |
| COVID-19 cases per million population | 199 | 18225.85 | 23133.43 | 0.00 | 122829.00 |
| COVID-19 deaths per million population | 199 | 327.11 | 446.96 | 0.00 | 1915.26 |
| COVID-19 tests per million population | 177 | 295203.70 | 446128.50 | 0.00 | 2906890.00 |
| **COVID-19 Response Variables** | | | | | |
| COVID-19 Government Response Tracker (OxCGRT), April 1, 2020 | 176 | 76.89 | 18.27 | 8.33 | 100.00 |
| COVID-19 Government Response Tracker (OxCGRT), December 1, 2020 | 176 | 67.92 | 18.15 | 13.89 | 100.00 |
| COVID-19 Government Response Tracker (OxCGRT), June 1, 2020 | 176 | 53.79 | 17.98 | 8.33 | 87.04 |
| Change in OxCGRT, February 1 to April 1, 2020 | 176 | 70.38 | 21.46 | −3.70 | 100.00 |
| Change in OxCGRT, May 1 to September 1, 2020 | 176 | −21.92 | 17.81 | −68.51 | 21.30 |
| Change in OxCGRT, Septerber 1 to December 1, 2020 | 176 | −2.75 | 17.74 | −49.07 | 47.22 |
| **Economic Variables** | | | | | |
| Growth rate of real GDP in 2020 (constant prices national currency) | 193 | −5.89 | 7.71 | −66.65 | 26.20 |
| Real GDP per capita, 2019 ($US PPP) | 193 | 21059.03 | 21862.48 | 788.10 | 116823.20 |
| Percentage change in value of total exports of goods and services, 2020 | 177 | −15.89 | 17.44 | −87.94 | 76.22 |
| Export-to-GDP ratio, 2018 | 191 | 84.07 | 521.41 | 0.00 | 7230.123* |
| | | | | | (* Marshall Islands) |
| **Fiscal Variables** | | | | | |
| General government expenditure to GDP, 2019 (%) | 193 | 32.52 | 16.63 | 12.62 | 125.90 |
| General government expenditure growth (%), 2020 | 192 | 12.72 | 30.50 | −22.46 | 383.95 |
| General government net lending/borrowing as share of GDP(%), 2020 | 192 | −8.15 | 8.66 | −102.94 | 31.50 |

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| **Health and Demographic Variables** | | | | | |
| Population, 2020 (millions) | 193 | 39.66 | 146.51 | 0.01 | 1404.33 |
| Population density (people per square km) | 182 | 347.30 | 1629.75 | 1.98 | 19347.50 |
| Share of the population that is 70 years and older (%) | 177 | 5.50 | 4.25 | 0.53 | 18.49 |
| Diabetes prevalence (% of population aged 20 to 79) | 182 | 7.68 | 3.81 | 0.99 | 22.02 |
| Hospital beds per 1,000 people | 164 | 3.01 | 2.46 | 0.10 | 13.80 |
| Current health expenditure as share of GDP (%) | 187 | 6.59 | 2.90 | 1.60 | 19.05 |
| Average of population share of males and females who smoke (%) | 138 | 21.58 | 9.44 | 4.00 | 45.95 |
| SARS0204 (1 if country had 10 or more cases of SARS in 2002-04 , 0 otherwise) | 200 | 0.04 | 0.20 | 0.00 | 1.00 |
| SARS0204plus100 (1 if a country had 100 or more cases of SARS in 2002-04, 0 otherwise) | 200 | 0.03 | 0.16 | 0.00 | 1.00 |
| **Institutional Variables** | | | | | |
| IMF35 advanced economy (1 if IMF35 advanced economy, 0 otherwise) | 200 | 0.18 | 0.38 | 0.00 | 1.00 |
| Federation (1 if a federal country, 0 otherwise) | 200 | 0.12 | 0.33 | 0.00 | 1.00 |
| Europe (1 if European region, 0 otherwise) | 200 | 0.24 | 0.43 | 0.00 | 1.00 |
| Asia (1 if Asian region, 0 otherwise) | 200 | 0.15 | 0.35 | 0.00 | 1.00 |
| Pacific (1 if Pacific region, 0 otherwise) | 200 | 0.08 | 0.27 | 0.00 | 1.00 |
| North America (1 if North American region, 0 otherwise) | 200 | 0.02 | 0.12 | 0.00 | 1.00 |
| South American (1 if South American region, 0 otherwise) | 200 | 0.06 | 0.23 | 0.00 | 1.00 |
| Central America and Caribbean (1 if Central American or Caribbean region, 0 otherwise) | 200 | 0.11 | 0.31 | 0.00 | 1.00 |
| Middle East (1 if Middle Eastern Region, 0 otherwise) | 200 | 0.08 | 0.27 | 0.00 | 1.00 |
| Australia and New Zealand (1 if Australia and New Zealand, 0 otherwise) | 200 | 0.02 | 0.12 | 0.00 | 1.00 |
| Africa (1 if Africa, 0 otherwise) | 200 | 0.27 | 0.45 | 0.00 | 1.00 |
| Economic Freedom Index | 162 | 6.86 | 0.95 | 3.34 | 8.94 |

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# About the author

## Livio Di Matteo

Livio Di Matteo is a Senior Fellow at the Fraser Institute and Professor of Economics at Lakehead University in Thunder Bay, Ontario, where he specializes in public policy and finance, health economics, and economic history. His most recent work examines value for money in health-care spending and the drivers and sustainability of health-care spending; fiscal economic history; and the historical evolution of economic inequality in Canada and internationally. Prof. Di Matteo is a member of the CIHI National Health Expenditure Advisory Panel and a contributor to *Fraser Forum*, the Fraser Institute's blog, as well as his own policy blog, *Northern Economist 2.0*. His op-eds have appeared frequently in many newspapers across Canada including the *Globe and Mail*, *National Post*, *Financial Post*, *Toronto Star*, *Winnipeg Free Press*, *Waterloo Region Record*, and *Hamilton Spectator*. He has been listed in Canada's *Who's Who* since 1995 and holds a Ph.D. from McMaster University, an M.A. from the University of Western Ontario, and a B.A. from Lakehead University.

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