Part 1

Covid-19, the SDGs, and the Recovery

The world is still in the early phase of the vast Covid-19 crisis. Deaths and infections continue to mount (JHU, 2020; Worldometer, 2020). Economies are in a deep and growing crisis. Inequalities within and among countries are rising, as the poorest suffer a disproportionate share of the infections and deaths, and struggle more to make ends meet. Poverty and hunger are soaring. And global tensions are rising. United Nations Secretary-General António Guterres has rightly called this crisis the worst since World War II. The economic ramifications could rival those of the Great Depression in the 1930s (IMF, 2020*a*).

The implications of the pandemic encompass public health, economics, social stability, politics, and geopolitics. The crisis is unprecedented in severity at least since the influenza epidemic at the end of World War I, and still very uncertain in its trajectory. The world will change markedly. However, if we take the right approach to crisis management, we may learn important positive lessons for the future – and if not, we may fall into a downward spiral of crisis.

The *Sustainable Development Report 2020* (SDR2020) presents some early thoughts on the Covid-19 crisis and the future of sustainable development.

This opening section is divided into two parts:

In the first part, we review early responses and identify short-term priorities for action by governments and their partners around the world, including the international community. We also describe how the Sustainable Development Goals (SDGs) can help chart medium-term and longer-term responses to recover from the health, economic, social, and environmental impacts of the pandemic. We believe that success will require deep changes to how countries and the international community operate, which we try to outline.

In the second part, we review how governments have responded to the immediate health crisis and describe emerging lessons for public health authorities, governments at large, and the public. The crisis has shown profound weaknesses in our public health systems, including in many of the richest countries that were deemed to be well prepared for such a pandemic. Meanwhile, some countries, particularly in the Asia-Pacific region, have (so far) been successful in containing Covid-19 and minimizing the damage to their societies. We present a novel approach and a pilot index to measure the effectiveness of the OECD countries' early responses to Covid-19 which integrates health and economic considerations.

Poor performance on this index does not necessarily mean that countries have not responded appropriately to the Covid-19 outbreak under the circumstances they were confronted with. In countries where personal protective equipment (PPE) (e.g. masks) and test kits were lacking and where capacities in intensive care units were more limited, a strict and prolonged lockdown was most probably required for containing the spread of the virus and reducing death rates. Yet, we also underline how some countries that were better prepared (e.g. South Korea) managed to deal with the disease outbreak more efficiently so far by testing, tracing, and isolating rapidly confirmed Covid-19 cases and through the immediate use of PPE among most of the population, which has greatly help in mitigating the negative economic impacts. Besides government actions, other factors can explain lower mortality rates from Covid-19 such as geography, demography, and other contextual factors including recent experiences with viruses' outbreaks.

1.1 Covid-19 and the future of sustainable development

Clearly, the pandemic will have profound implications on progress towards the SDGs, which this report has been tracking since 2016. The data we present in this 2020 report mostly dates from before the onset of the pandemic, so it does not account for the Covid-19 impact. For this reason, this section outlines likely implications on the SDGs by drawing on emerging data and findings from around the world. We underscore the preliminary and uncertain nature of these findings, but we hope they will help the global discussion on Covid-19 and the SDGs.

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This section also seeks to lay out a vision for the future of sustainable development and the SDGs. It is necessarily preliminary since we are only at what some have called the end of the beginning of Covid-19. Previous pandemics suggest that there may well be several new rounds of outbreaks, and the implications on economies, social cohesion, the environment, and international diplomacy are impossible to predict. As the UN Secretary-General (UN 2020) has reminded us, some of the worst can be avoided, but only if countries act decisively and in unison, with strong international solidarity.

The SDGs are the world's shared goals for sustainable development, and Covid-19 makes them more relevant than ever. It is critical that we "build back better," but the question is of course how to do so. In this section we outline some preliminary ideas for how the SDGs can provide the framework for national action and international cooperation in the wake of Covid-19.

We distinguish between short-run and longer-term priorities. In the short run, the absolute priority is to control the spread of the virus in every country, including the poorest ones. Countries and the international community also need to mitigate the impact on achievement of the SDGs, especially in vulnerable countries and population groups. International collaboration and partnerships are needed to speed the fight against the pandemic, support macroeconomic stability, and avoid a disastrous humanitarian crisis. In the longer term, we argue that the SDGs provide the framework to guide the recovery. Countries need to invest in stronger and more resilient health systems and pursue the other SDGs. We outline practical steps for how this might be achieved.

Short-term priorities

Control the disease

The good news is that, in principle, Covid-19 is controllable. The pandemic could be stopped in its tracks if every infected person were kept safely away from susceptible individuals during the period of infectiousness, which is roughly one to two weeks. If that were to happen, the vast majority of those currently infected would recover, while a small proportion, perhaps around 1%, would die from the illness. In a matter of just a few weeks the epidemic would end, since those infected today would not infect others.

Yet the pandemic is not being suppressed in this quick and orderly way. At the time of writing (late May 2020), the number of new cases continues to grow rapidly in many countries and regions, including Brazil, India, Russia, the United States, and several countries in South America and Africa. Infected individuals continue to infect susceptible individuals in large numbers. In many of these countries and regions, new infections are rising at a very fast pace. The virus has reached virtually every country on every continent.

Yet the news on suppressing the pandemic is not all bleak. Several countries, notably in the Asia-Pacific region – including Australia, New Zealand, South Korea, and Vietnam, among others – have shown that it is possible to stop the epidemic, or at least to reduce the number of new infections to small numbers. Success is based heavily on intensive public health services and good hygienic practices among the population. People in these countries who show symptoms are tested and isolated. If their home conditions are too crowded, they are quarantined in public facilities where they will not transmit the virus to family members or neighbors. Their close contacts are rigorously traced, tested, and isolated or quarantined if necessary. People are routinely monitored for symptoms (such as fever) when they move in public places. People wear face masks and regularly wash their hands to avoid spreading the virus, and they keep their physical distance from others when in shops, public places, or their workplaces. Businesses allow employees to work from home whenever possible, monitor their workforce for any symptoms of infection, and quickly isolate any who might be infected. In short, every effort is made to prevent infected individuals from infecting others.

Most countries around the world do not yet have such high-quality public health systems. They lack adequate testing, contact tracing, and quarantine facilities. They do not aggressively monitor public places for people with symptoms such as fever. Individuals do not always honor physical distancing. People take undue risks by meeting together in large groups, such as at beaches, sports events, restaurants, parties, religious services, funerals, and other

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group occasions. They also often do not, or cannot, adhere to strict hygiene measures, including hand-washing and the wearing of masks. The virus is then easily spread to large numbers of people.

The wealthy countries of Western Europe and North America were in fact among those with the greatest number of infected people and deaths in the first months of the pandemic. The United States alone was reporting 99,807 Covid-19 deaths as of May 26, or 29% of the world's 348,300 total reported Covid-19 deaths at the time, despite accounting for just 4% of the world's population. That comes to a death rate of 302 per million population in the United States, compared with just 3 per million in China, 4 per million in Australia and New Zealand, 5 per million in South Korea, and 7 per million in Japan. Well-financed healthcare systems did not spare the United States and many countries in Western Europe. These countries had hospitals but lacked testing capacities, contact tracers, and other control measures. Standard rankings of preparedness also gave the wrong message: The United States often topped these conventional rankings (box 1), yet the country failed to respond effectively when the virus arrived.

The pandemic especially ravages countries with poor leadership. Countries led by populists or strongmen who dismiss science, weaken public health institutions, or undermine transparency in the management of the disease are performing particularly poorly. The modeling has shown that even a few weeks' delay in response can mean the difference between suppressing the pandemic and suffering a mass outbreak with a vast loss of life. Each failure harms not only the country itself, but the rest of the world as well. It sets back the revival of trade, tourism, investment, higher education, and other global activities.

With widespread transmission of the virus and inadequate public health measures, most countries have resorted to temporary lockdowns of economic and social life. By cutting down sharply on daily contacts throughout society – in shops, restaurants, offices, public transport and public spaces, and at events – transmission of the virus is slowed. Yet lockdowns are very costly and inefficient. Instead of isolating only infected individuals and their contacts, everybody is isolated. The economy grinds to a halt, with very high costs in terms of mass unemployment, sudden poverty, a rise in hunger, rising domestic abuse, and other impacts of remaining at home.

Yet lifting lockdowns in the absence of adequate public health measures can simply allow the pandemic to return with full force. Every country therefore faces a grim reality. Either build up public-health capacity to contain the pandemic, as have those countries that have succeeded in containing Covid-19, or face the disastrous choice between an uncontained pandemic and economic collapse.

Clearly, the choice between death and economic collapse is really no choice. The only viable option for all societies is to build effective public health systems that can contain the pandemic, which could even allow businesses to operate at a level close to that of before the outbreak (Dorn et al., 2020). In fact, a synergetic relationship between public health and a prosperous economy seems possible even in times of Covid-19. According to illustrative calculations by Dorn et al., a favorable scenario may be one in which the virus's reproduction rate, or R-value, falls to 0.75 (based on data from Germany), which presents the best possible balance between new infections and economic costs due to shutdown measures. We will learn over the coming weeks whether countries that are currently reopening their economies have put in place the necessary public health interventions to monitor, trace, prevent, and treat infections, so as to prevent a second outbreak.

Even though it is possible to contain and even to stop the global pandemic through effective public-health measures, it is more likely that the virus will continue to spread widely and affect vast proportions of the world's population. This is the result of poor public leadership in many rich countries, combined with the lack of the means and financing to contain the epidemic in poorer countries. Poorer countries generally do not have large cadres of public-health officials, though such cadres are an excellent investment not only in pandemic control but also towards meeting other objectives of SDG 3 (Good Health and Well-Being). The poorer countries also do not have adequate testing facilities. It is also very difficult to keep impoverished populations at home even for short periods of time. Some leaders, such as Pakistan's Prime Minister Imran Khan (2020), have simply declared that they do not

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Figure 1

Short-term impacts of Covid-19 on the Sustainable Development Goals

- Mainly positive impact
- Mixed or moderately negative impact
- Highly negative impact
- Impact still unclear

SDG 1
No poverty

Highly negative impact

- Increased poverty due to job losses and economic lockdown
- Disproportionate impact on vulnerable groups (e.g., the poor)

SDG 2
Zero hunger

Highly negative impact

- Food insecurity due to reduction in global food supplies and trade
- Hunger due to fall in incomes and reduced food availability during lockdown
- Higher food loss and waste due to transportation challenges and reduced labor availability
- Poorer nutrition due to interruption of school meals

SDG 3
Good health and well-being

Highly negative impact

- Higher disease incidence and mortality from Covid 19
- Higher mortality from other causes because of overburdening of health systems
- Slight decline in mortality due to reduced economic and social activities (e.g., traffic accidents)
- Potential short-term health gains due to lower environmental pollution
- Negative impact of confinement and lockdown on mental health (e.g., anxiety and depression)

SDG 4
Quality education

Mixed or moderately negative impact

- School and day-care closures
- Loss in the development of human capital
- Poorer nutrition due to interruption of school meals

SDG 5
Gender equality

Mixed or moderately negative impact

- Possible disproportionate economic impacts on women (e.g., job losses, poverty)
- Other social impacts on women from the lockdown (e. g., domestic violence)
- Higher mortality rates from the virus among men (because they suffer from more chronic respiratory diseases due to higher smoking rate)

SDG 6
Clean water and sanitation

Mixed or moderately negative impact

- Limited access to clean water among disadvantaged groups limits possibility of adhering to strict hygiene guidelines

SDG 7
Affordable and clean energy

Mixed or moderately negative impact

- Slowdown in economic growth contributing to a reduction in energy prices (e.g., oil), which might increase access to energy but reduce incentives for renewables

SDG 8
Decent work and economic growth

Highly negative impact

- Economic crisis in virtually all parts of the world
- Trade disruption
- Mass unemployment
- Business closures / bankruptcies
- Sharp decline in tourism activities
- Massive public deficits

SDG 9
Industry, innovation and infrastructure

Mixed or moderately negative impact

- Decline in industrial outputs
- Possible nationalization of some industries, and bankruptcies and closures of others
- Scientific collaboration to find treatments and vaccine
- Accelerated uptake of digital technologies, for e-health, e-education, e-governance, and e-payments

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SDG 10
Reduced inequalities

Highly negative impact
- Disproportionate negative health and economic impacts on vulnerable groups (including refugees and migrants), especially in countries with low safety nets
- Loss of jobs of lower-skilled, lower-wage labor

SDG 11
Sustainable cities and communities

Mixed or moderately negative impact
- Rise in urban poverty and vulnerability
- Shut down of public transports
- Lower access to public / green spaces
- Movements of population that vary across countries
- Sharp short-term reduction in pollution levels

SDG 12
Responsible consumption and production

Impact still unclear
- Short-term reduction in natural resource use due to reduced economic activity and consumption
- Pressure to loosen up regulations on circular economy and postpone the adoption of new measures
- Increased plastic pollution (e.g., used to produce personal protective equipment)

SDG 13
Climate action

Impact still unclear
- Short-term reduction in global GHG emissions
- Pressure to reduce environmental safeguards
- Lack of clarity on environmental investments
- Slowdown in economic growth contributing to reduction in energy prices (e.g., oil), which might increase access to energy but reduce incentives for renewables

SDG 14
Life below water

Impact still unclear
- Short-term reduction in threats to marine biodiversity due to reduced global economic activity and consumption
- Pressure to reduce marine biodiversity and ecosystem safeguards

SDG 15
Life on land

Impact still unclear
- Short-term reduction in threats to terrestrial and freshwater biodiversity due to reduced global economic activity and consumption
- Pressure to reduce terrestrial and freshwater biodiversity and ecosystem safeguards, including biodiversity and ecosystem regulations conventions (for instance, on deforestation)

SDG 16
Peace, justice and strong institutions

Mixed or moderately negative impact
- Increased pressure on governments to mitigate the health and economic consequences of the pandemic
- Pressure to increase accessible health care in countries that have not yet achieved universal health coverage
- Increased public deficits and debt
- Disruption of legislative processes and public debates
- Suspension of freedom-of-information laws and transparency policies

SDG 17
Partnerships for the goals

Mixed or moderately negative impact
- Possible reduced responsiveness of international aid community to needs of the poorest countries
- Possible reduction in international remittances and cross-border financing
- Closing of borders
- Slowdown in international trade
- Debt crisis

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have the means to contain their county's pandemic. The consequences may well be horrendous for such countries. But they would also be horrendous for other countries, since the virus and the damage it wreaks would continue to spread across borders.

Therefore, the world as a whole is at a decisive moment. With serious public-health efforts in all parts of the world, containing the pandemic is feasible.

Mitigate negative impacts on the SDGs

Many fallouts from the Covid-19 crisis on the SDGs are direct and obvious. Figure 1 summarizes these short-term impacts. Some poor countries will face devastating poverty as they lose a high proportion of their incomes from commodity exports, tourism, and remittance flows. The terms of trade for many commodity exporters will fall sharply, as shown by the collapse in oil prices during the first months of 2020. Domestic lockdowns in the poor countries will deprive the poor of their meagre daily incomes. Poverty and hunger will rise.

Many food-importing developing countries could see plummeting currencies, steeply rising domestic (and real) prices of imported food, and thus growing hunger, both hidden and overt (FAO, 2020; IFPRI, 2020). Much of Africa in particular depends on food imports for staples, and these countries will likely lose a substantial proportion of their foreign-exchange income. The consequences could be dire and could translate into social and political instability, as well as hunger.

Many emerging economies and frontier economies could soon also face devastating challenges in refinancing their debts (Adrian and Natalucci, 2020). As the crisis unfolds, governments face an intense budget squeeze, as revenues decline while social spending rises. Moreover, many developing country currencies will depreciate against the dollar, raising the domestic currency costs of servicing foreign dollar-denominated debts. It would be possible in principle to refinance the debts falling due through new private borrowing, IMF credits, or systematic rollovers of principal and interest. In practice, the international financial system rarely works so systematically. It is more likely that one or more countries will default, pushing the bond-rating agencies to downgrade sovereign developing-country debts more generally, and leading to a freezing up of the system rather than a refinancing. The result would be a cascade of defaults and balance-of-payments crises that would also touch many countries that have hitherto managed their economies well.

Beyond the most direct impacts on poverty (SDG 1), food security (SDG 2), health (SDG 3), the economy (SDG 8), and multilateralism (SDG 17), Covid-19 has numerous other SDG impacts that are less widely discussed.

Vulnerable countries and population groups (including the elderly, people with pre-conditions, homeless people, low-skilled workers and refugees) are disproportionately affected by the short- and medium-term consequences of the Covid-19 crisis (United Nations, 2020). This can be expected to result in growing inequalities, undermining progress towards the achievement of SDG 10 (Reduced Inequalities). On SDG 5 (Gender Equality), early evidence suggests that women are disproportionally affected in many ways by the Covid-19 health and economic crises, including through their greater exposure to labor market disruptions and the increase in domestic violence stemming from the lockdowns (Inter-Agency Standing Committee, 2020; UNFPA, 2020; Wenham et al., 2020). Meanwhile, the mortality rate of Covid-19 is greater among men, due perhaps to greater pre-existing behavioral risk factors, such as higher smoking rates, other co-morbidities, or biological factors (Reeves and Ford, 2020). The crisis also has negative impacts on access to schools, especially for populations that are poorly equipped with digital technologies.

The crisis also affects the functioning of political and legislative systems and the rule of law (SDG 16). Some governments have introduced exceptional measures that increase their powers, allow them to rule by decree, and limit freedom of speech (Transparency International, 2020). As rightly emphasized by the UN Security Council (Council of Europe, 2020), the consequences of Covid-19 are exacerbated in fragile states, including in countries that face conflicts and civil wars.

At the same time, the crisis has brought about at least some temporary environmental benefits. Emissions of CO_2 around the world have dropped significantly due to

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reduced industrial activity, lower energy consumption, and reduced transportation of material and people (Le Quéré et al., 2020). CO_2 emissions and emissions of nitrogen dioxide, a major air pollutant, declined sharply in China during the early months of the pandemic (Ghosh, 2020; Myllyvirta, 2020), although they are now rebounding strongly (CREA, 2020). Yet, the virus may also have a negative impact on the enforcement of environmental laws, including on deforestation, as industrial lobbies put pressure on public authorities to loosen up restrictions or even postpone the adoption of new measures (Reuters, 2020). Meanwhile it is unclear what impact Covid-19 will have on investments, policies, and other short-term actions to tackle climate change. Overall, we believe the direction of short-term impacts on environmental and biodiversity goals (SDGs 12–15) is unclear. Most importantly, where Covid-19-related declines in economic activity have reduced environmental degradation, the restoration of economic activity should aim to protect these environmental gains.

While the global health situation remains gloomy, mortality rates due to traffic accidents (covered under SDG 3.6) have sharply declined in many parts of the world (Kopf, 2020). There might also be other short-term health gains due to lower pollution levels. These must be continued as the world recovers from Covid-19.

Medium- and long-term priorities

Guide the recovery with the six SDG Transformations

The SDGs provide an invaluable framework for recovery from Covid-19. The pandemic has laid bare the fragile economic, social, and environmental underpinnings of our world today. Despite the world's vast wealth, scientific and technological prowess, and supposed preparedness for disasters, and despite repeated specific warnings of the risks of pandemics, including many specific warnings of coronavirus pandemics, the world was not ready when the virus struck.

The SDGs were adopted to address unnecessary risks and fragilities across the economic, social, and environmental domains. These include poverty, widening inequalities in income and access to decent lives, continued high disease burdens, and of course massive environmental destruction. These warnings are today more pertinent than ever. If the Covid-19 disaster accomplishes anything good, it should be to shake the world from its complacency, so as seriously commit to the hard work of investing in a sustainable and inclusive future for humanity.

The six SDG Transformations (Sachs et al., 2019*a*) provide a detailed framework on which to construct integrated strategies to recover from Covid-19 and to build back better. They can be implemented in every country to help address trade-offs and synergies across the SDGs. We presented the SDG Transformations in last year's report and outline here how they will need to be rethought to help guide medium- and longer-term responses to Covid-19.

The core of the six Transformations is the recognition that all 17 SDGs can be achieved through six major societal transformations, focused on: (1) education and skills, (2) health and wellbeing, (3) clean energy and industry, (4) sustainable land use, (5) sustainable cities, and (6) digital technologies. All are guided by the twin principles of "leave no one behind" and "ensure circularity and decoupling" (See Sachs et al., 2019*a* for details, page 3). The six Transformations provide an action agenda for government ministries, businesses, and civil society. They help governments and the international community, as well as business and civil society, to frame actionable strategies to achieve the SDGs and thereby make our societies more prosperous, inclusive, and sustainable.

To implement these transformations, in the medium-run, relationship between markets and governments must be rebalanced, with governments playing a more central role in the economy through public investments, redistribution of incomes from rich to poor, and regulation of industry to ensure environmental and social sustainability. As a result of the pandemic, government spending will have to increase sharply over the coming one to three years, to mitigate the consequences of the health and economic crises. And at least some of this increase in spending, for example on health coverage and access to public services, should remain permanent.

Already, public workforces including healthcare workers and first responders such as the police force have been heavily mobilized to respond to the health emergency. Large-scale public-private partnerships are underway

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Figure 2

Six SDG Transformations

Source: Sachs, Jeffrey, G. Schmidt-Traub, M. Mazzucato, D. Messner, N. Nakicenovic, and J. Rockström (2019). "Six Transformations to achieve the Sustainable Development Goals," *Nature Sustainability,* 2(9), 805–14. Available at https://doi.org/10.1038/s41893-019-0352-9

– in transport for example – and the role of government in the health sector is expanding dramatically. Governments are also stepping in to distribute key medical supplies such as protective equipment and sanitizers, support research for treatments and vaccines, negotiate prices, and avert risks of food shortages (among other interventions). Massive fiscal packages, mainly to support the incomes of workers, combined with falls in GDPs will increase public spending as a share of GDP across the board.

The highest priority of every government must remain the suppression of the pandemic. There can be no economic recovery while the pandemic is raging.

Yet governments need to plan for the post Covid-19 economy. Unemployment will remain very high. Jobs lost in many sectors – retail, office support, construction, tourism, personal services, fossil-fuel energy – will not return, or at least not rapidly and robustly. Budget deficits and financial imbalances will persist. Many enterprises will go out of business. Non-government aggregate demand, including private consumption and investment, will most likely remain depressed.

There are many complex choices ahead, with financing at the core. In many countries, state and local governments provide healthcare, education, social services, and local

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infrastructure. But state and local governments will be strapped for cash. National governments, backed by their tax authority, their ability to borrow in capital markets, and their access to central bank financing (directly or through open-market operations), will urgently need to share revenues with state and local governments. Many national governments that borrow abroad in foreign currencies and require foreign exchange for vital imports such as food and basic capital equipment will suffer a balance-of-payments crisis. The G20 countries have already granted a debt-service moratorium to low-income countries (in April 2020). This will almost surely have to be extended to many emerging-market middle-income countries as well.

The length and depth of the global economic crisis will depend largely on when the pandemic is brought under control. If a vaccine proves to be successful on a rapid timeline, that is by late 2020 or during the first part of 2021, economic prospects will brighten dramatically – assuming that the vaccine can be manufactured at scale and deployed globally during 2021. Without a vaccine, all will depend on the success or failure of public health measures to suppress virus transmission: testing, isolating, contact-tracing, physical distancing, and safety in public spaces and work places through the use of face masks, sanitizers, and other hygienic measures (e.g., air circulation, UV lights).

As of this writing, in the late spring of 2020, the signs are very worrisome. Major outbreaks continue in large parts of the world, and public health containment and suppression approaches are not yet decisive in many major economies. The epidemic continues to spread rapidly in Brazil, India, Mexico, Russia, the United States, and several other countries in South America and Africa. The outlooks in many highly populous developing countries such as Ethiopia, Indonesia, Nigeria, Pakistan, and South Africa, remain guarded and tenuous.

As the epidemic itself is brought under control or eventually constrained by herd immunity once a large enough proportion of the population has been infected, the time for rebuilding the economy will be at hand. The sooner that moment arrives, the brighter will be the prospects for recovery. As of mid-2020, it seems likely that the Asia-Pacific region will start rebuilding first among the world's major regions.

Yet we will not go back to the pre-Covid-19 economy. Hundreds of millions of jobs will have been lost as a direct consequence of the pandemic. Many of these jobs will never return. E-commerce will boom, but in doing so will further displace the bricks-and-mortar retail sector. Offices will give way to increased teleworking from home. Education and healthcare will move increasingly online. The fossil-fuel industries will not recover, as the world rightly embraces renewable energy as a way out of the crisis. Countries such as Brazil, Indonesia, and Mexico that have recently banked heavily on their hydrocarbon sectors will face a need for deep economic restructuring. So too will traditional oil-exporting countries – including Angola, the Gulf States, Nigeria, and Russia.

In the rebuilding phase, governments should support their economic recovery with a strong focus on infrastructure investments that boost jobs and underpin the transition to a low-carbon economy, in line with the Paris Agreement. Tens of millions of jobs can be created directly by building new clean-energy systems based on solar and wind energy, long-distance power transmission, smart grids, electric vehicles, hydrogen and other synthetic fuels, and energy-efficient buildings. The European Green Deal, a United States "Green New Deal," a sustainable Belt and Road Initiative, and regional "green deals" in the ASEAN, South America, the Middle East, South Asia, and elsewhere, could provide the way forward to massive job creation, renewed economic growth, and environmental sustainability. In short, to the achievement of the SDGs and the objectives of the Paris Agreement.

The *Six Transformations Framework for the SDGs* can be a very useful guide for rebuilding:

Transformation 1 (Education, Gender and Inequality). Countries will need to invest more in their education systems to strengthen their resilience, particularly by drawing on modern communication technologies. The crisis is accelerating the rollout of digital tools in schools and in remote education and training – tools that have been used in many countries to strengthen the resilience of education systems in the midst of the crisis. Further investments in education in science, technology, engineering and mathematics (STEM) subjects and in life-long learning are needed to accompany these transformations and boost skills.

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Figure 3

An SDG framework to map out possible short-term and longer-term government responses to Covid-19

Whole-of-government response (transversal)

- Increased role of government in key sectors (economy, health, food, social security)
- Re-think global supply chains and dependence for strategic equipment and materials
- Strengthen development cooperation to support recovery plans in countries most hit and in least developed countries
- Strengthen statistical capacity, and the availability of timely data
- Strengthen government capacities to anticipate and manage unforeseen disruptive events
- Strengthen international platforms, exchanges and transparency among scientists/researchers (open science)

Transformation 1: Education, Gender, and Inequality

- Expand and strengthen public social security systems best suited to address the consequences of disruptive events
- Further investments in STEM education, digital skills, equity, and lifelong learning
- Further streamline basic health prevention measures in school programs (e.g., hand-washing) and provide adequate supplies for good hygiene
- Place women's needs and leadership at the heart of the response to the health and economic crises

Transformation 2: Health, Wellbeing, and Demography

- Strengthen the role of public health and disease prevention and surveillance (for both communicable and chronic diseases).
- Increase the role of public authorities in the research for treatment and vaccines, and in providing access to treatment and vaccines
- Accelerate efforts to achieve universal health care
- Strengthen public health emergency preparedness (including building stocks of essential equipment and increasing flexibility to mobilize staff to respond to emergencies)
- Reduce dependence on other countries for key health supplies and equipment
- Expand digital health solutions (e.g., telehealth) to reduce the burden on hospitals and increase access to care
- Increase the quality and timeliness of health statistics
- Increase the resilience of health systems to respond to shocks/crises (e.g., increase capacity to build hospitals and other infrastructures in record time)

Transformation 3: Energy Decarbonization and Sustainable Industry

- Use the Paris Climate Agreement as the vision for long-term change and to inform investment plans and bailouts
- Build on positive short-term prospects due to plummeting industrial output and further the roll out of digital services and e-commerce to accelerate the transition to climate neutrality
- Reduce international dependence for key industries and sectors in case of major disruptive events (e.g. protective masks, food supply)
- Pursue efforts to enforce environmental treaties and national regulations despite the lockdown and economic turmoil

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Transformation 4: Sustainable Food, Land, Water and Oceans

- Strengthen food security and hygiene, including the reduction of risks of zoonotic diseases
- Emphasize the resilience and sustainability of food systems
- Accelerate efforts to provide universal access to water and sanitation, and increase focus on hygiene and handwashing to help curb transmission of oral-fecal diseases
- Pursue efforts to reduce negative impacts on biodiversity and ecosystems to prevent future pandemics

Transformation 5: Sustainable Cities and Communities

- Address immediate threats to vulnerable groups in urban settlements (homeless, refugees), to avoid a deep worsening of their living conditions and to make confinement measures more effective
- Strengthen the territorial distribution of doctors and availability of care, including in rural areas
- Further integrate vulnerable groups in urban settlements, including homeless people, refugees, and migrants
- Adapt public transportation systems to the need for physical distancing and hygiene, and to changing patterns in working and commuting habits
- Develop integrated territorial strategies to address the impact of travel restrictions on business, exports, and tourism activities

Transformation 6: Harnessing the Digital Revolution for Sustainable Development

- Further expand digital health solutions to reduce the burden on hospitals and increase access
- Develop and use online education tools
- Further development of other digital government services and e-commerce
- Further investments in STEMS, digital skills, equity, and lifelong learning
- Accelerate the adoption of measures that support a fair transition for workers affected by the digital and technological revolution

Source: Authors' analysis

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The economic shocks from Covid-19 threaten to increase inequalities in all countries: the policy focus on lowering these inequalities will likely rise in importance. Countries will need to strengthen their social-protection systems (SDG 1.3 and SDG 10.4), including their ability to respond quickly to major crises. Gender-sensitive policies are also needed to mitigate risks of disproportionate economic and social impacts on women and girls.

Transformation 2 (Good Health and Well-Being) obviously has the most prominent implications right now. In the short- and medium-term, the role of public health systems in disease prevention and surveillance will need to increase to prevent further waves of Covid-19 and future health crises. Governments will play a key role in developing and distributing Covid-19 treatments and vaccines at global scale. As in the case of education, the crisis will likely accelerate the transformation towards digital healthcare and telemedicine to increase access to and efficiency of healthcare systems.

The Covid-19 crisis has made it very clear that countries equipped with effective social protection systems and universal health coverage are best equipped to respond to such crises. This is also less costly, and it is precisely for this reason that the SDGs call for countries to strengthen their social safety nets and move towards universal health coverage for key medical services. Meanwhile, nearly 40% of the world's population has no health insurance or access to national health services (ILO, 2020). Providing universal social-protection floors is within fiscal reach, although low-income countries might need financial support to close the fiscal gap. Another benefit of effective social safety nets is that they mitigate the consequences of lockdowns and thereby reduce the temptation to open up economies too early, risking a new Covid-19 wave.

Transformation 3 (Energy Decarbonization and Sustainable Industry) provides the long-term direction for a clean, green economy. This should guide government investment plans and support to companies and industries. Ironically, the crisis could lead to a decline in the enforcement of environmental laws and major international conventions in some parts of the world. Throughout, a major challenge during and post Covid-19 will be to direct the attention of senior policymakers to the climate crisis. The scientific community should be vocal on the need to connect the Covid-19 recovery to investments in clean energy.

Transformation 4 (Sustainable Food, Land, Water and Oceans) draws attention to the shorter-term risks of food shortages, especially in low-income countries, due to disruption in trade and supply chains and the sudden collapse of incomes. Vulnerable households, including in rich countries, will need financial support to mitigate the risks of food insecurity. In the medium and longer run, governments will need to accelerate the further integration of healthy diets, food security, agricultural systems, and natural resource management. This is becoming self-evident not only to respond to the increased percentage of undernourished people and obese people, but also to reduce the risks of future zoonotic diseases. Governments should seize the post Covid-19 recovery as an opportunity to accelerate the transition towards sustainable and resilient food systems.

Transformation 5 (Sustainable Cities and Communities). In the short run, there is an urgent need to meet the needs of vulnerable groups (including homeless people and refugees) in urban settlements. This is critical to avoid rapid deterioration of the living conditions of vulnerable people during the lockdown phase of pandemic control, but also to ensure that confinement measures are effective. This crisis will amplify inequalities in access to water, sanitation, and health services. Effective medium-term and long-term responses will therefore require increased investments to accelerate the provision of universal access to water, sanitation, and clean energy services. There will also be lasting implications of Covid-19 on territorial development, urban planning, and public transportation systems (OECD,2020). Regional and local policy leaders will need to guide the transformation of their territories in order to adapt to new realities including social distancing, changes in workplace practices and commuting patterns, and travel restrictions, which will impact business and tourism activities.

Transformation 6 (Harnessing the Digital Revolution for Sustainable Development) has been greatly accelerated by the Covid-19 epidemic. Countries that can afford it are accelerating the roll-out of digital technologies and services in response to the crisis. The

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digital technologies are playing an important role in sustaining social services, payments, schooling, and health care during the lockdowns, and in enabling working from home to be effective for many occupations. The importance of digital applications underscores the vital importance of universal access to broadband services as key to social inclusion, economic opportunity, and public health. Governments, businesses, schools, health facilities, and others will be turning increasingly to online service delivery as a vital part of their activities in the years ahead.

The urgent need for international cooperation

The current crisis, including hostilities among major powers, raises the specter of global conflict instead of global cooperation. We are reminded of the great work of economic historian Charles Kindleberger in *The World in Depression, 1929–1939*. It was Kindleberger's thesis that the Great Depression was so severe because there was no global leader (no "hegemon" in the language of international affairs) and no adequate cooperation among the major powers. The result was a breakdown of the global monetary and trading system that opened the way to Hitler in Germany in 1933, and then on to World War II.

The early signs of this crisis are not good. The United States is attacking the WHO as being too pro-Chinese, and is cutting off funding rather than supporting the WHO for its vital work in suppressing the pandemic. In general, the United States is intensifying its attacks on China and trying to divide the world between pro-US and pro-Chinese camps. The risk of a new Cold War is very grave and should be avoided by all nations.

The good news is that most of the world urgently wants multilateralism and cooperation. The bad news is that some countries do not, while others are paralyzed by their own crises, budget deficits, and divisions of local politics. The multilateral situation is therefore fraught and needs bolstering. A possible outcome is a kind of limping multilateralism, rather than strong and decisive cooperation, in which accomplishments on the ground are modest and countless opportunities to avoid hardships and suffering are lost.

International cooperation could speed a favorable and rapid resolution to the pandemic. Indeed, there is no other way to succeed. Global cooperation would include the following measures:

(1) Disseminate best practices rapidly.
The world needs urgently to learn from and to emulate the strategies for fighting Covid-19 adopted in the East Asia and the Pacific region. The WHO should urgently facilitate a rapid dissemination of best practices.

(2) Strengthen financing mechanisms for developing countries. The IMF was created for global crises like this one. It needs ample firepower, including far greater latitude to extend credits, either under existing facilities or through a new issuance of Special Drawing Rights (SDRs). Private creditors will need to refinance or capitalize debts falling due.

(3) Address hunger hotspots. We need global support for the lead United Nations agencies, including the Office for the Coordination of Humanitarian Affairs (OCHA), the Food and Agriculture Organization (FAO), and the World Food Program (WFP), so that they can head off impending hunger crises and food insecurity.

(4) Ensure social protection. As part of any comprehensive response to the pandemic, governments should promote new instruments of social protection, including a new Global Fund for Social Protection that was proposed to address SDG 1 (No Poverty) even before the pandemic, but which is even more urgently needed now in response to it.

(5) Promote new drugs and vaccines. Financing R&D for Covid-19 drugs and vaccines is an urgent global public good. Without global cooperation, R&D will be inadequate and duplicative. And when breakthroughs are achieved, they will in turn require global cooperation for their mass uptake. The Global Fund and Gavi, the Vaccine Alliance are two exemplary institutions that serve as historical precedents for what will be needed for the rapid uptake of new drugs and vaccines, and can lead the effort on the ground.

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Box 1. Lessons on preparedness

The risk of a pandemic – and specifically a coronavirus pandemic – has been widely forewarned year after year. Yet many regions, including the United States and Europe, have not taken heed of these warnings in any meaningful way. Countries failed to invest sufficiently in public health systems and now suffer the consequences.

The Covid-19 pandemic has highlighted the lack of preparedness of health systems to respond to such public-health emergencies, including those of many OECD countries that before the crisis were thought better prepared. As of June 20th, the United States had the highest number of reported cases and deaths due to Covid-19. As a share of their populations, apart from a few small city-states, it is the OECD countries Belgium, Spain, the United Kingdom, Italy and France that have reported the highest number of deaths per capita. By contrast, several countries located closer to China, where the disease outbreak started – notably South Korea – have managed the Covid-19 outbreak more effectively.

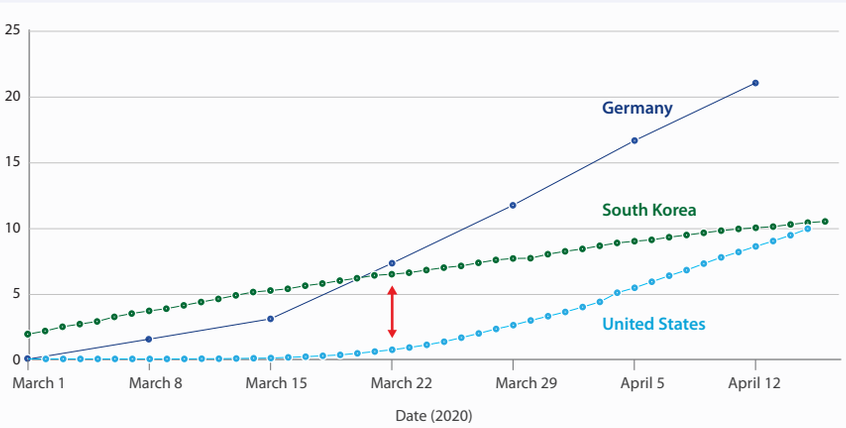
Before the Covid-19 outbreak, the United States and many Western European countries were rated highest for health preparedness. For example, the United States and the United Kingdom topped the Global Health Security Index released in November 2019, shortly before the first outbreak of Covid-19 (NTI, JHU, and EIU, 2019). President Trump cited this index early in the pandemic, in February 2020, to argue that the United States was rated "Number 1" in terms of preparedness (Hub staff report, 2020). But it quickly became obvious that the level of preparation was not particularly great in the United States and in many other OECD countries.

There does not seem to be anything wrong with the assessment framework for preparedness to health threats adopted by the researchers. Yet the Index seems to have overestimated the capacity of some countries, including the United States, the United Kingdom, and France, to implement widespread testing of suspected cases and to isolate them. For example, the United States scored better (98.2) than Germany (84.6) and South Korea (92.1) on the dimension "detection and reporting capacity," yet the United States took much more time than Germany and South Korea to test a significant proportion of its population (see figure 4, below).

Figure 4

Despite good performance in the 2019 Global Health Security Index on "Detection and Reporting," the United States took longer than Germany and South Korea to test its population during the Covid-19 pandemic.

Cumulative Covid-19 tests per 1,000 population



Performance in Global Health Security Index, November 2019
Category 2: Detection and Reporting

COUNTRY	RANK	SCORE
United States	1	98.2
South Korea	5	92.1
Germany	10	84.6

US gap in Covid-19 tests performed in March

Source: Official sources collected by Our World in Data

Another interpretation of the gap between predicted and actual responses to Covid-19 is that some countries *should have* been able to respond well to the Covid-19 health crisis but failed to do so because of a lack of information, poor political leadership, and other factors. These might be "omitted variables" in the Global Health Security assessment framework or variables that go beyond the scope of the GHS exercise (e.g. political leadership). As the world recovers from the Covid-19 crisis, it will be important to learn lessons from countries that were the most effective in dealing with the pandemic outbreak, but also to strengthen existing indicators and monitoring systems to track countries' preparedness and resilience capacities.

Source: Authors analysis. Based on Lafortune, G (2020). "How much do we know about countries' preparedness to respond to pandemics? Insights from two country-level indices." SDSN Blog Post. Paris. https://www.unsdsn.org/how-much-do-we-know-about-countries-preparedness-to-respond-to-pandemics-insights-from-two-country-level-indices

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1.2 Comparing early Covid-19 control in the OECD countries

It is important to understand why some of the richest countries have failed to contain mass deaths from Covid-19 even thought they had ample warning. This section presents a simple quantitative model of the emergency response and introduces an index to measure the effectiveness of early responses to Covid-19 in OECD countries.

There is an enormous variation in the early Covid-19 pandemic control measures taken across the OECD countries, covering the period March 4 through May 12. The most marked difference is in the Covid-19 death rate per 1 million population, even given that death rates are difficult to compare across countries owing to widely differing reporting standards. In some OECD countries, such as Australia, Japan, Korea, and New Zealand, reported Covid-19 deaths remain below than 10 per million population. In other OECD countries, including Belgium, France, Germany, Sweden, and the United States, deaths are above 100 per million population, and in some cases many times higher.

A second important difference lies in the overall extent to which the pandemic was suppressed during this early phase, which is measured by epidemiologists according to the effective reproduction rate (ERR). An ERR < 1 signifies effective suppression, while an ERR > 1 signifies ongoing epidemic conditions. Some OECD countries suppressed the transmission of the virus during March and April, for example South Korea and New Zealand. Other countries had epidemic conditions with ERRs averaging far above 1.0. These include France, Germany, the United Kingdom, and the United States, among many others.

A third difference lies in the efficiency with which the pandemic is controlled. One way to cut the ERR below 1 is to lock down the economy. This reduces the viral transmission but at the cost of an enormous disruption to the economy and to daily life. Another way to cut the ERR is through more focused strategies that emphasize the isolation or quarantine of infected individuals, contact tracing, quarantine of people exposed to carriers of the virus, and improved hygienic practices, such as wearing face masks. Through such targeted means, the pandemic can be suppressed at minimal economic cost. Some countries, such as South Korea, have succeeded in cutting their ERR through more targeted means, while others including Italy, Spain, and the United States have had to resort to the cruder and costlier approach of economic lockdowns. Strict and prolonged lockdowns, although costly, was most probably the right policy response for countries lacking PPE and with lower testing and hospital intensive care capacities. Strict and prolonged lockdowns contributed to saving many thousands of lives (Flaxman et al, 2020).

This section introduces a pilot index of Covid-19 control that summarizes each country's performance over the three dimensions (mortality rate, ERR, and efficiency of control). We study all OECD countries except for the three middle-income countries of Latin America (Chile, Colombia, and Mexico), where the virus came later, and Iceland due to the lack of relevant data on physical mobility, which we use to construct the efficiency index. We are therefore left with 33 OECD countries in our sample.

Mortality rate

The mortality rate per million population for the OECD countries as of May 12 is shown in table 1. We see that the mortality rate varies from a low value of 4 in Australia and New Zealand to a high of 762 in Belgium. It is important to emphasize that Covid-19 mortality rates are imperfectly measured, both within countries and across countries. Some countries count only the deaths of individuals who have tested positive for Covid-19, while others, such as Belgium, include deaths that were likely due to Covid-19, even if those deaths were not confirmed with a positive Covid-19 test. Many countries exclude deaths that occur at home or in nursing homes, which might account for some 40% of their total. Nonetheless, even taking into account the inevitable errors in the measurements, the actual differences in mortality rates are striking.

The high variation in mortality rates across the OECD countries reflects several factors. Perhaps most importantly, mortality per million depends on the infection rate per

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million. Unfortunately, insufficient testing and reporting in most countries mean that, at this stage, we lack accurate, comparable data on the infection rates of their populations.

The variation in the mortality rate across countries also reflects other structural factors, such as the intensive-care capacity of the hospital system; the population age structure (because of high mortality rates among the elderly); the burden of co-morbidities, such as obesity, respiratory infections, and hypertension in the population; and the protections given to vulnerable groups, especially in settings such as nursing homes, retirement homes, worker hostels, and prisons. Some also suspect that genetic differences might contribute to variations in mortality, but these issues are poorly understood at present.

Effective reproduction rate

The effective reproduction rate is defined as the average number of infections that an infectious individual transmits to susceptible individuals. In the most basic standard model of epidemics, the ERR(t) as of day *t* is given as follows:

(1) ERR(t) = N(t) x P(t) x D(t) x S(t)

In this equation, N(t) is the average number of contacts per day for an individual in the community; P(t) is the probability that a contact between an infectious individual and a susceptible individual actually transmits the virus; D(t) is the average number of days that an infectious individual is circulating in an infectious state in the community; and S(t) is the share of the population susceptible to infection as of day *t*. We see that N(t) x D(t) therefore is the average number of community contacts by an infectious person during the period of infectiousness. P(t) times the number of community contacts measures the number of times the virus will be transmitted. Since a fraction – S(t) – of those infectious contacts are susceptible to becoming infected, we have equation (1).

At the start of an epidemic – on day 0 – ERR is designated as R0, the basic reproduction rate. In the case of Covid-19, S(0) is assumed to be equal to 1, that is, the entire population is assumed to be susceptible, since there is no known intrinsic or acquired immunity. R0 is generally estimated to be between 2 and 3, with a typical estimate of around 2.4. D(0) is usually assumed to be around 6 days. Assuming these parameters (and acknowledging the many continuing uncertainties about the virus), we can surmise an average of 0.4 infections transmitted per day (= 2.4/6). If each individual plausibly has around 20 contacts per day, a typical assumption in the epidemiological literature, the probability of the virus being transmitted in any single contact (e.g., in a casual conversation, or interpersonal proximity in a retail shop, or sitting nearby an infected individual in a restaurant, theater, or sports event) can be calculated as 0.4 infections per day/20 contacts per day = 0.02 infections per contact, or a 2% risk of transmission in any single contact.

In the basic model, the daily change in the number of infected individuals I(t) as of day *t* is given by:

(2) I(t+1) – I(t) = N(t)*P(t)*I(t)*S(t) – [1/D(t)]*I(t)

N(t)*P(t)*I(t)*S(t) is the number of new infections in day *t*, while (1/D)*(t) is the number of currently infected individuals on day *t* who cease being infected, either because they die on day *t* or recover on day *t*. With a bit of simple algebraic rearrangement of equations (1) and (2), we can derive a basic relationship between the daily growth of new infections g(t) = [I(t+1) – I(t)]/I(t) and the ERR(t):

(3) ERR(t) = 1 + D(t)*g(t)

The relationship in equation (3) is helpful in two ways. First, we see that the growth of new infections g(t) is positive when ERR(t) > 1 and negative when ERR(t) < 1. Thus, the ERR(t) determines whether the epidemic is expanding or contracting. Second, since we observe (or at least can estimate) the growth of the epidemic day by day, we can also estimate ERR(t) for each day.

Several epidemiologists are now publishing estimates of ERR(t) on a daily basis. We use the estimates of Prof. Simas Kucinskas (2020) of Humboldt University of Berlin. The estimated ERR(t) averaged by day for the interval March 4 to May 12 is shown in table 1. We see that South Korea had the lowest average ERR in this period, at 0.76, while the United States, the United Kingdom, Turkey, Canada, France and Spain had the highest average values of ERR, above 1.5 for the period.

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Epidemic control efficiency

According to equation 3, the epidemic is suppressed by reducing ERR(t) to below 1.0. This can occur in four basic ways.

First, the average number of contacts per day N(t) in the population can be reduced sharply. This is the basic motivation of the "temporary lockdown" that was put in place in many parts of the world in mid-March. Second, the probability of transmitting the disease per each contact P(t) can be reduced by changes in personal behavior, such as by wearing face masks, using hand sanitizers, and observing social distancing. Third, the infectious individual himself or herself can stop circulating in the public very early in the course of the illness by self-isolating at home or through quarantine in a public facility. In this case, an infectious individual only circulates for one or two days before isolating. The number of days D(t) for which they are potentially spreading the infection is thereby cut sharply. Fourth, the proportion of the population susceptible to infection S(t) will fall over time, assuming that a bout of illness also confers persistent immunity. If the pandemic therefore infects enough of the population, S(t) will fall by enough to reduce ERR(t) to below 1.0. That is the painful way to stop the epidemic, which comes to a halt only after a substantial proportion of the population has fallen victim to the disease. Assuming an R0 of 2.4, and assuming no other behavioral changes that affect N(t), P(t), and D(t), we see that S(t) would have to decline to below 41.6% (= 1/2.4) in order for ERR to fall below 1.0. In other words, almost 60% of a population would need to incur the infection before "herd immunity" of the community is acquired.

A lockdown is an inefficient way to suppress the pandemic, and herd immunity is a deadly way to do so. In the case of a lockdown, daily contacts are slashed for everybody in the community across the board, whether or not they are infectious – putting aside the question of "essential workers" and partial lockdowns for the sake of the discussion. The economy declines sharply. In the case of herd immunity, more than half of the population incurs the infection, which if the infection mortality rate (IMR) is around 1%, as is generally believed, suggests that around 0.5% of the population would succumb to the disease, a horrendously high toll. In fact, in an uncontrolled pandemic the attack rate – meaning the proportion ever infected in the population – would be considerably above 1/2.4, with the mortality rate being commensurately higher as well.

It is far more efficient to cut ERR(t) by slashing P(t) through improved personal hygiene or by reducing D(t) through early isolation or quarantine in public facilities. Cutting D(t) efficiently limits the circulation of the few who are infected, rather than the many who are susceptible.

Thanks to Google Community Mobility Reports (2020), we have smartphone-based measurements for dozens of countries of daily mobility within the community, including visits to retail establishments, restaurants, grocery stores, pharmacies, transit stations and workplaces. The Google mobility measurements GM(t) therefore offer a useful proxy measurement of the decline in daily contacts N(t) in a community. The data show the decline in visits relative to a baseline GM(0) during the interval from January 3 to February 6, 2020.

Using the Google data, we show the proportionate decline in mobility, [GM(0) – GM(t)]/GM(0), in the final (sixth) column of table 1. To calculate the decline, we take the simple daily average of four of Google's community mobility measures: visits to retail outlets and recreation, visits to grocery stores and pharmacies, visits to transit stations, and visits to workplaces. In all cases, the variable is equal to the decline in visits relative to the baseline period.

The data show that visits among the community have declined relative to the baseline in all OECD countries, but by widely varying amounts. South Korea, which has not had a lockdown, shows a decline of 0.10, or 10%. On the other extreme, Italy and Spain show a decline in mobility of 62% and 60% respectively – the most extreme lockdowns in the OECD group. A few countries have reduced mobility by 25% or less – Australia, Japan, Latvia, South Korea, and Sweden – while several show reductions greater than 40%.

A useful measure of the *efficiency* of epidemic control is to compare the decline in ERR(t) with the decline in N(t), as proxied by the Google data. If most of the reduction in ERR(t) is brought about by a reduction in N(t), we can say that the epidemic control is inefficient. If most of the

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decline in ERR(t) is achieved not by a reduction of N(t), but (implicitly) by a reduction in P(t)*D(t), we can say that the epidemic control is efficient.

We therefore propose the following measure of epidemic control efficiency, ECE(t):

(4) $ECE(t) = [R0 - ERR(t)]/R0 - [GM(t) - GM(0)]/GM(0)$

The first term on the right-hand side measures the proportionate reduction in ERR(t), while the second term measures the proportion reduction in average daily contacts. When the proportionate reduction in ERR(t) exceeds the proportionate reduction of mobility, ECE(t) > 0, and we deem the epidemic control to be efficient. When ECE(t) ≤ 0, we deem epidemic control to be inefficient. The ECE Is shown in the fourth column of table 1, while its two right-hand-side components are shown in the fifth and sixth columns. We see that South Korea has demonstrated by far the most efficient epidemic control during the period of observation (March 4 to May 12), while Spain shows the least efficient control.

Index of epidemic control

We now create an overall index of epidemic control among the 33 OECD countries, by combining the data on Covid-19 mortality rates, effective reproduction rates, and epidemic control efficiency. To construct the index, we follow the usual procedure of the SDG Index described in this report. For each variable X_i for country i, we create a normalized variable X_i^N on a scale from 0 to 100, calculated as follows:

(5) $X_i^N = [X_i - X_{MIN}]/[X_{MAX} - X_{MIN}] \times 100$

X_{MIN} is the minimum value of X among the 33 OECD countries. X_{MAX} is the maximum value. Clearly, when $X_i = X_{MIN}$, then $X_i^N = 0$, and when $X_i = X_{MAX}$, then $X_i^N = 1$. For all other X_i, we have $\mathbf{0 < X_i^N < 1.}$

To construct the index, we use the mortality rate M (Column 1), the ERR (Column 2), and the ECE (Column 3). The final index score is denoted as the Covid Index of Epidemic Control (CIEC), and is calculated by averaging across the three variables:

(6) $CIEC_i = (1/3) * (M_i^N + ERR_i^N + ECE_i^N)$

According to this index, the top performing country is South Korea. Indeed, South Korea has excelled on all three dimensions of epidemic control. It has kept the death rate low, the ERR far below 1, and its economy has remained open during the entire epidemic. The worst performing economy is Spain, where the mortality rate is among the highest, its ERR averages far above 1, and the economy has been in substantial lockdown nonetheless. Some countries may have been artificially penalized in the data presented in this table due to their more-thorough reporting of Covid-19 deaths (counting probable cases as well as tested cases). Thus, we should also mention the five other very poor performers: Belgium, France, Italy, the United Kingdom and the United States.

Many governments, including Spain, have learned rapidly during the process and adapted policies accordingly. From April 6 onward, Spain has had an estimated R(t) less than 1, thereby dramatically curtailing the epidemic.

In general, South Korea owes its top ranking to its high-quality public health system. Its remarkable early efforts are described in an important report (Government of the Republic of Korea, 2020): not only did South Korea go into high alert upon the first news of the Covid-19 epidemic in China, its biotech companies moved rapidly to develop effective tests. By February 4, just three weeks after Chinese scientists had posted the genome of Covid-19, the company KogeneBiotech had developed an effective diagnostic kit (Lee, 2020). Five other companies followed soon after. ICTs were put to use in many ways: for emergency notifications from the government; in contact-tracing apps to let individuals know of virus "hotspots" visited by Covid-19-infected individuals; to develop distance-learning curricula and protocols; to provide advice for companies; and in many other applications that were developed and deployed within weeks.

It is useful to point out some other patterns among OECD countries in the early control period. First, the Asia-Pacific region in general has been high performing, exemplified in the following rankings on our index of epidemic control: South Korea, 1; Australia, 3; Japan, 6

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and New Zealand, 9. With the exception of Japan, OECD countries with a population of greater than 50 million people did quite poorly, however. Germany ranks highest among large OECD countries, at 19, followed by Turkey, 26; the United States, 28; Italy, 29; France, 30; the United Kingdom, 31; and Spain, 33. No doubt these large countries all received many infected travelers early in the pandemic, both visitors from China and residents returning from China. In this sense, the major countries, being the major travel hubs, were heavily "seeded" with Covid-19 early on. Yet they all evinced low levels of control, not only of their borders, but also of transmission within the community.

In general, Northern Europe has outperformed Southern Europe, and Eastern Europe has outperformed Western Europe. The Baltic states have all done well: Latvia, 2; Lithuania, 4; and Estonia, 5. Within the Nordic countries, Sweden is a distinctive outlier, not only in its policies, but also in its ranking, with Norway ranking 10; Denmark, 12; Finland, 14; and Sweden, 22. Sweden alone of these countries tried to avoid a shutdown. Mobility fell by only 19% in Sweden, compared with Denmark, 29%; Norway, 30%; and Finland, 32%. Yet the ERR remains much higher in Sweden, as does the mortality rate. Sweden has received little benefit from its heterodox stand, at least as of early May. Swedish public health officials claim that Sweden will be better able to weather a second wave in the fall, however, because of a higher level of acquired immunity. Time will tell whether this approach will prove to be correct in the long run, but it is more costly in the short run.

The United States has generally underperformed in its Covid-19 response in relation to the average of the OECD countries. In the United States too, there was no move to a nationwide lockdown. Decisions were left mainly to states and their governors. Most states introduced partial lockdowns in mid-March but began to lift these by early May. In any event, observance of the lockdowns was decidedly uneven. Mobility declined by a relatively modest 27%, and its ERR remains among the highest in the OECD. Mortality rates have also been high, although below that of the highest mortality rates of Western Europe.

Concluding thoughts

This section offers just a first attempt by the SDSN to compare responses across countries, and considers only the first months of the global pandemic. Yet even this first glimpse reveals stark differences in policies and outcomes across the OECD countries. Since it is vital for countries to learn from each other in this pandemic, the SDSN will continue to monitor and compare the public-health performance of nations in the coming years as part of our overall effort to measure progress towards the SDGs and to thereby foster best practices and accelerated learning among national and local policy makers.

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Table 1

Covid-19 pilot Index and performance indicators for the OECD countries

Rank	Country	Covid Index	Deaths Per Million	Effective Reproduction Rate (ERR)	Epidemic Control Efficiency (ECE)	ERR Decline	Mobility Decline
1	South Korea	0.90	5.00	0.76	0.63	0.36	0.10
2	Latvia	0.78	9.34	0.95	0.29	0.63	0.24
3	Australia	0.76	3.88	1.06	0.27	0.67	0.24
4	Lithuania	0.75	17.85	0.90	0.15	0.61	0.36
5	Estonia	0.75	46.14	0.94	0.21	0.73	0.31
6	Japan	0.73	5.08	1.25	0.29	0.70	0.16
7	Slovenia	0.72	49.18	0.83	0.07	0.78	0.46
8	Slovak Republic	0.72	4.77	0.96	0.07	0.74	0.42
9	New Zealand	0.71	4.34	0.80	-0.03	0.86	0.44
10	Norway	0.71	42.17	1.13	0.18	0.72	0.30
11	Greece	0.71	14.07	0.99	0.07	0.62	0.43
12	Denmark	0.70	92.00	1.11	0.19	0.73	0.29
13	Czech Republic	0.70	26.53	1.11	0.11	0.67	0.33
14	Finland	0.69	49.13	1.18	0.12	0.65	0.32
15	Hungary	0.68	43.48	1.14	0.06	0.63	0.32
16	Austria	0.65	70.13	1.16	0.00	0.58	0.44
17	Israel	0.64	29.04	1.22	-0.06	0.82	0.42
18	Luxembourg	0.64	166.13	0.95	-0.07	0.78	0.50
19	Germany	0.63	90.86	1.38	0.07	0.70	0.31
20	Switzerland	0.63	181.13	1.23	0.06	0.78	0.37
21	Poland	0.63	21.36	1.34	-0.05	0.52	0.38
22	Sweden	0.61	319.99	1.36	0.21	0.60	0.19
23	Netherlands	0.58	316.63	1.30	0.08	0.72	0.32
24	Canada	0.56	134.74	1.51	-0.10	0.63	0.37
25	Portugal	0.55	111.24	1.39	-0.21	0.65	0.49
26	Turkey	0.53	46.66	1.56	-0.25	0.65	0.38
27	Ireland	0.53	301.40	1.31	-0.14	0.73	0.44
28	United States	0.51	246.98	1.73	-0.05	0.63	0.27
29	Italy	0.49	508.74	1.19	-0.15	0.69	0.62
30	France	0.46	397.79	1.50	-0.21	0.68	0.54
31	United Kingdom	0.43	482.47	1.60	-0.15	0.60	0.43
32	Belgium	0.40	761.55	1.39	-0.10	0.67	0.45
33	Spain	0.39	575.26	1.50	-0.28	0.64	0.60

Source: Authors' analysis.
Deaths per million are for May 12, 2020. The effective reproduction rate (ERR), epidemic control efficiency (ECE), and mobility decline are all calculated for the period March 4 to May 12, 2020. ERR decline is calculated as (2.4 – ERR)/2.4, assuming R0 = 2.4.

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