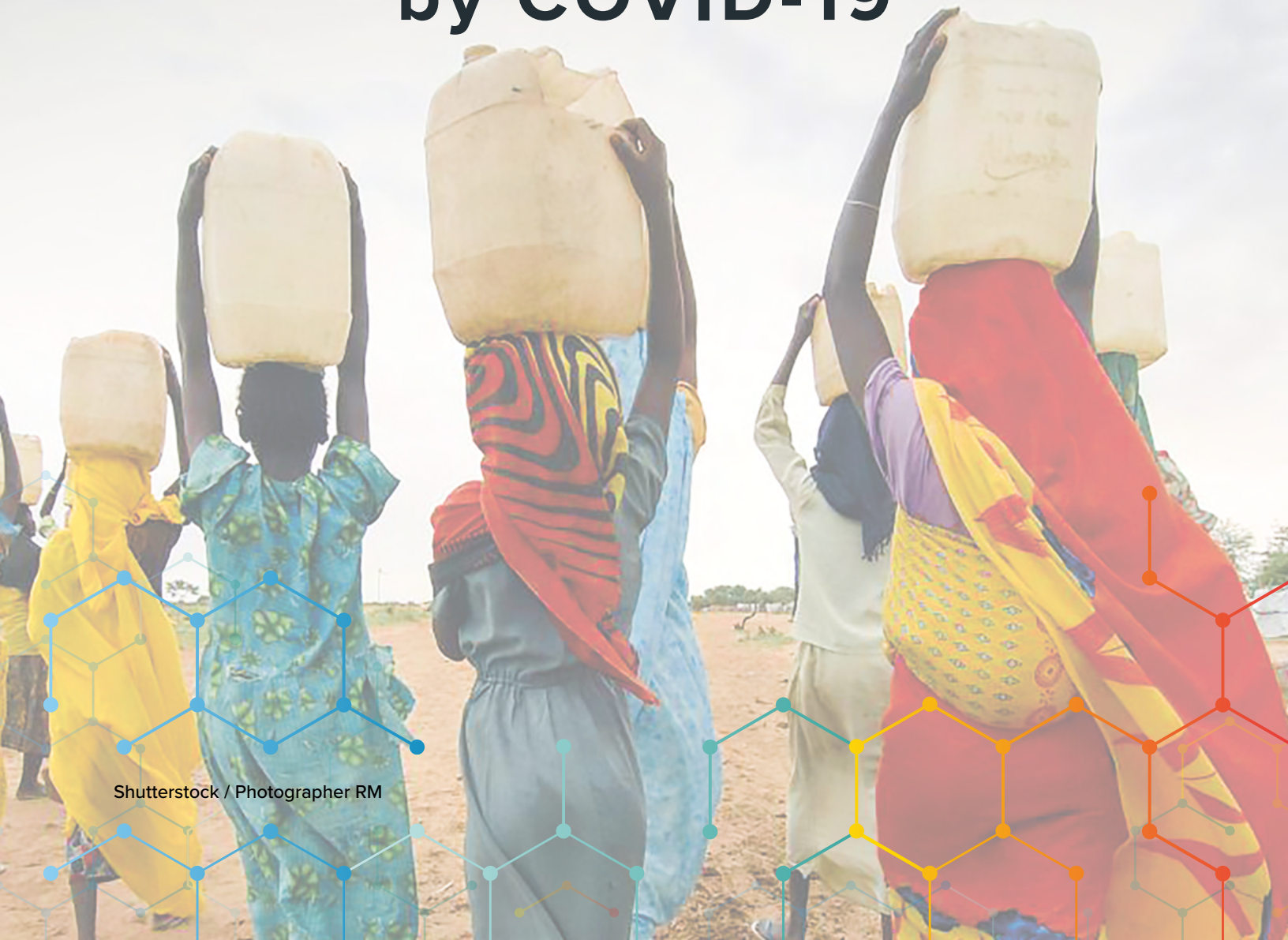
FREDERICK S. PARDEE CENTER FOR INTERNATIONAL FUTURES
JOSEF KORBEL SCHOOL OF INTERNATIONAL STUDIES
UNIVERSITY of DENVER

UNDP

FOUNDATIONAL RESEARCH REPORT

Pursuing the Sustainable Development Goals in a World Reshaped by COVID-19



Shutterstock / Photographer RM

Pursuing the Sustainable Development Goals in a World Reshaped by COVID-19

Foundational research report

Pardee Team (authors)

Barry B. Hughes
Taylor Hanna
Kaylin McNeil
David K. Bohl
Jonathan D. Moyer

UNDP Team

Babatunde Abidoye
Joanna Felix
Serge Kapto
Laurel Patterson

How to cite this report:

Hughes, B.B., Hanna, T., McNeil, K., Bohl, D.K., & Moyer, J.D. (2021). *Pursuing the Sustainable Development Goals in a World Reshaped by COVID-19*. Denver, CO and New York, NY: Frederick S. Pardee Center for International Futures and United Nations Development Programme.

See also the associated second flagship publication:

Abidoye, B., Felix, J., Kapto, S. & Patterson, L. (2021). *Leaving No One Behind: Impact of COVID-19 on the Sustainable Development Goals (SDGs).* New York, NY and Denver CO: United Nations Development Programme and Frederick S. Pardee Center for International Futures.

With generous support from the Republic of Korea

외교부
Ministry of Foreign Affairs

Table of Contents

Executive Summary

Report motivation and purpose

The Sustainable Development Goals (SDGs) enhance the efforts of the global community to monitor, forecast, and accelerate progress toward 169 targets across multiple dimensions of development represented by the 17 goals (Independent Group of Scientists appointed by the Secretary-General, 2019; UN, 2015). We are rapidly approaching the 2030 horizon for the goals. It is clear that we are not making adequate progress. Further, COVID-19 is setting us back. We need a better understanding of how well we are doing with respect to reaching the goals, how progress might be hindered by the pandemic, and how we might accelerate progress through and even beyond 2030. These needs frame this report.

Our central questions are:

1. How much progress will the world make toward the SDG targets by 2030? Although all five "Ps" of the SDGs — *People, Planet, Prosperity, Peace, and Partnership* — are important to us, we give primary but not exclusive attention to *People* and therefore to the first six goals.

2. How widespread will that progress be and how many countries may be left behind? An inevitable answer to that question is that not all targets will be reached by 2030 in aggregate globally and that many countries are not likely to reach them. Therefore, we add to that question: how much additional progress might be expected by 2050?

3. How much impact is COVID-19 likely to have on the prospects for reaching those goals? What if COVID-19 proves even more damaging to those prospects than we currently anticipate?

4. Recognizing the already substantial efforts that are being made to reach the goals, how much acceleration of progress might be possible with an even more ambitious SDG push by countries to reach them?

Challenges to addressing the report's questions and an approach to doing so

Increasingly better data help us understand historical trajectories and current conditions with respect to these questions. These include the metadata repository of the United Nations Department of Economic and Social Affairs and a very large number of more specialized and extensive data series from assorted intergovernmental organizations, nongovernmental organizations, and research projects. Yet, many targets are not adequately quantified and/or supported by data.

There are also increasingly extensive and high-quality forecasts or projections of progress toward the goals. Yet, some analyses largely extrapolate from historical data series, others are restricted to nexus studies of a few goals (especially with respect to sustainability studies for the *Planet*), and still other efforts rely upon expert assessment of relationships among goals and targets rather than on elaboration of the dynamics that create the synergies and trade-offs among them. Studies also often find themselves limited to selected countries or to broad aggregations at regional and global levels, even though it is important that progress toward the goals be assessed for all countries.

There is also widespread recognition that progress toward the goals is a matter of great uncertainty. Not least are the uncertainties flowing from the COVID-19 pandemic (not just during the pandemic period but for years and decades beyond it) and those related to the potential for extensive and intensive policy-driven action to facilitate goal attainment. In short, we need alternative scenarios.

This report addresses these challenges with two primary methodological supports. First, it uses the International Futures (IFs) model system. IFs aids the analysis here in several ways. It is an annually recursive model system that forecasts from its base year of 2015 through 2030 and on to 2050 (or even further). That helps us look beyond the current SDG horizon. Additionally, IFs represents 186 countries and facilitates aggregation to literally any desired grouping of countries including regions, income levels, and of course the world. Further and most important, IFs integrates distinct models across almost all the issue areas of the SDGs, including demographics, health, education, economics, governance, agriculture, energy, and the environment. This integration allows for exploration of dynamic connections across the SDGs. Those connections involve causal linkages that can be reinforcing or opposing. The connections also include representations of action-constraining accounting systems for finances (e.g. government revenues and expenditures) and physical resources (e.g. agricultural land and water limitations).

The second methodological support of this study is scenario analysis. Our forecasts or projections (terms that we use interchangeably) cannot be point predictions. Instead, scenarios help us think about the paths that countries and the world might follow and the factors that could shape the resultant alternative futures.

The first scenario is *No COVID*, an exploration of the development path that the world seemed to be on before the pandemic. Although now only theoretical, the scenario provides (1) a basis for consideration of how the world has changed; and (2) a basis for comparison of forecasts generated by IFs with those that other analysts were making prior to the pandemic (Appendix 3 provides comparison with other projections made prior to and after COVID onset).

The second scenario is *COVID*. This scenario incorporates analysis from the IMF concerning the impact that COVID-19 will likely have on gross domestic product (GDP) growth in 2020 and 2021 and projections from the Institute for Health Metrics and Evaluation (IHME) of possible mortality patterns. Within IFs, the global loss of GDP in 2020 relative to the *No COVID* scenario is about 6.6 percent in both market exchange rate (MER) and purchasing power parity

(PPP) terms. The scenario assumes a very considerable bounce back of economies after the pandemic, with loss of GDP at MER in 2030 being about 4.0 percent (3.5 percent at PPP). The scenario models the resultant global paths toward the SDGs.

The third scenario is *High Damage*. It assumes greater GDP losses in 2020-21 (about 8 percent in 2020 relative to *No COVID*), higher mortality, and less economic recovery (global GDP reduction of about 7 percent at MER in 2030 and a loss of about 13 percent in lower-income countries). Greater post-pandemic inequality and significant increases in national debt levels also help frame the scenario and contribute to the increased long-term economic loss.

The fourth scenario is *SDG Push*. Even as efforts to reach the goals have continued to increase around the world, there is potential for still more ambitious pursuit of them. The *Beyond Recovery* initiatives of United Nations Development Program exemplify the potential for building a new social contract, uprooting inequalities, rebalancing nature, climate, and the economy, and accelerating and scaling digital disruption and innovation. The IFs scenario analysis capability facilitates extensive representation of these initiatives in the *SDG Push* scenario.

Using the capabilities of IFs and the four scenarios, sections of this report focus in turn on poverty, nutrition, health, education, and safe water and sanitation. Gender equality is important across these issues. Although these goal issues (1 through 6) fall into the *People* dimension of the SDG structure, they require attention in the scenario framing also to *Prosperity*. Notably, that framing and especially the interventions of *SDG Push* (see Appendix 2 for detail on those) overlap with the objectives of Goal 8 to "Promote sustained, inclusive, and sustainable economic growth…," Goal 9 to "Build resilient infrastructure … and foster innovation," and Goal 10 to "Reduce inequality within and among countries". This report turns in its last substantive section to *Planet* and *Peace* by considering selected implications of all scenarios for the objectives of Goal 13 to "Take urgent action to combat climate change its impacts" and Goal 16 to "Promote peaceful and inclusive societies…"

Anyone wishing to explore the numerical forecasts from IFs for any of the SDG target variables addressed in this report, for any or all of the four scenarios, and for individual countries or groupings of them, can do so within this project's webpage inside the UNDP's COVID-19 Data Futures Platform.

Shutterstock / 2p2play

As much as we want a world in which no single human being suffers extreme poverty or hunger, dies during childbirth, or fails to complete education through the secondary level, we recognize truly universal success to be possibly beyond our reach. Instead, we operationalize numerical targets in this report from explicit statements of the SDGs when possible, from common practice when those do not exist, and sometimes from analogy or judgment. Among the numerical specifications are:

- Bringing extreme poverty, malnourished population, and malnourished children to or below 3 percent;
- Reducing maternal mortality to under 70 per 100,000 births, and neonatal and child (under 5) mortality to less than 12 and 25 per thousand live births, respectively;
- Raising completion of primary and upper secondary education to 97 and 90 percent or higher, respectively;
- Raising access to improved water and sanitation to 97 percent or higher.

Findings

Progress toward the SDGs can be assessed at global, regional, country, and subnational or subpopulation levels. In this report we focus primarily on the portions of the global population and the number of countries achieving them, with attention also to country groupings and gender subpopulations. There is very considerable variation in the stories of potential progress toward the SDGs across goals and targets, across scenarios, and across population groupings. Some general themes characterize those stories.

First, even in the *No COVID* world, we were not on track for attainment at the global level of any of the *People* targets by 2030. The top panel of Figure 1 shows the degree to which gaps between values attained in 2015 and the targets were likely to have been closed. Moreover, even by 2050 (bottom panel) many targets were unlikely to have been met.

Second, the story of progress before COVID was even less optimistic at the country level. Just 110 out of 186 countries represented in IFs would have achieved the SDG 1 goal of eliminating poverty by 2030 in a world without COVID-19 (Figure 2). By 2050 (bottom panel), we find that a total of 136 countries would have achieved the goal, but 50 countries would not have eliminated extreme poverty and more than 400 million people would still be living on less than $1.90 per day. Other goals were also not likely to have been met by large numbers of countries. By 2030 in the No COVID scenario, just 62 countries meet the target for malnutrition. Even though the targets for four of the goal variables appeared on track for attainment at the global level by 2050, only 128 countries were likely to fully attain target values for maternal, child, and neonatal mortality, and just 121 countries would reach the target for primary education completion.

Third, the COVID pandemic has added considerable additional challenge to SDG attainment by setting back development globally. It is widely acknowledged that the pandemic has in the short run resulted in increases in poverty and food insecurity, reduced access to healthcare, and interrupted educational attainment. We find that the pandemic's effects will linger for decades. COVID does not eliminate gains between 2015 and 2030 for any of the variables we examine, but it does consistently reduce them.

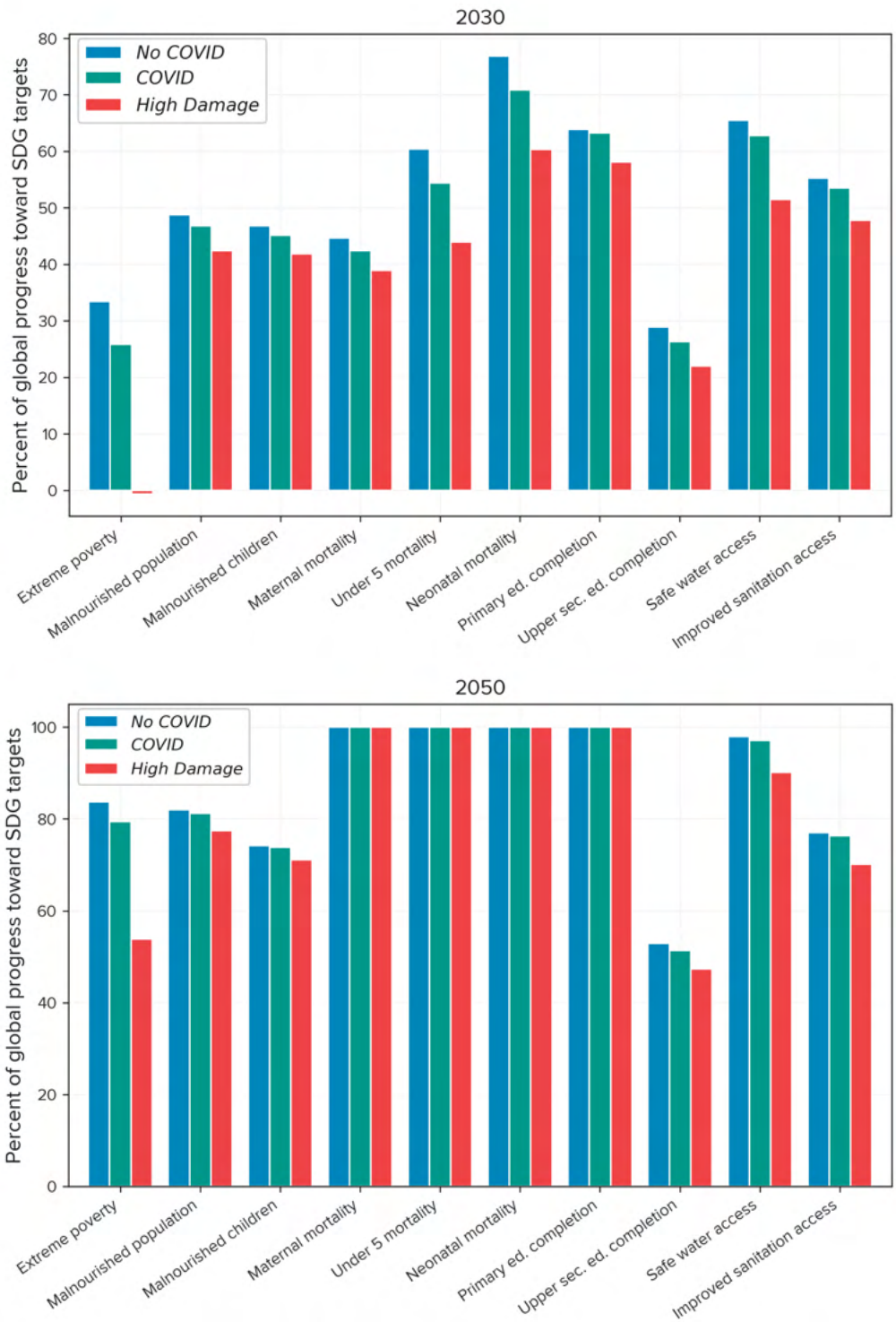


Figure 1 Impact of *COVID* on global progress toward SDG targets

Note: The top panel shows the global population's percentage progress toward the target value between 2015 and 2030 (the portion closed of the gap-to-target that existed in 2015); the bottom panel shows the global progress by 2050.

Source: IFs Version 7.61.

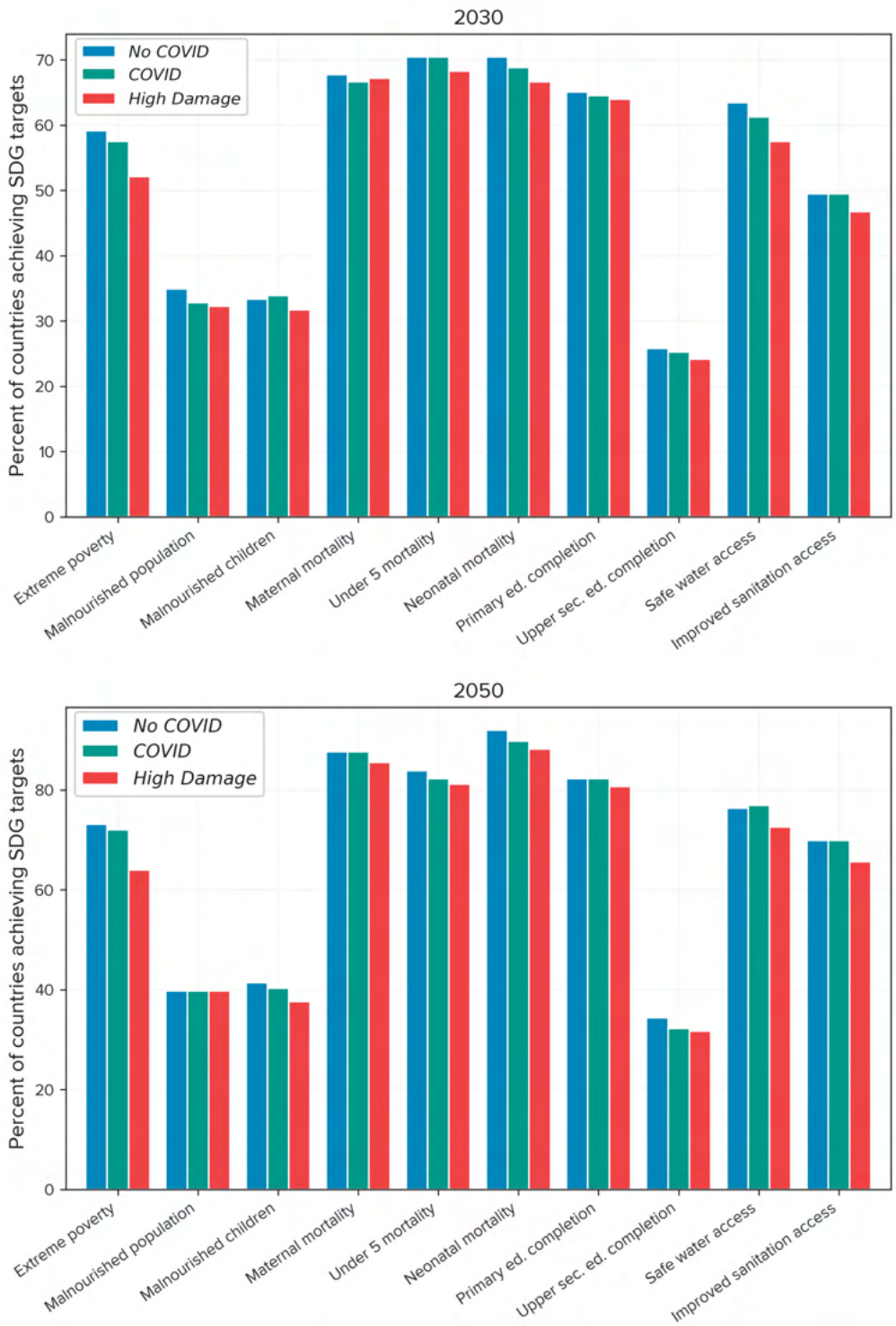


Figure 2 Impact of *COVID* on progress by countries toward SDG targets

Note: The top panel shows the percentage of countries reaching the target value by 2030; the bottom panel shows the percentage doing so by 2050.

Source: IFs Version 7.61.

Shutterstock / MIA Studio

In our *COVID* scenario, the pandemic results in 48 million more people in poverty in 2030 than projected in the *No COVID* scenario. By 2030, we project that three fewer countries will achieve the SDG 1 target in the *COVID* scenario than would have in the *No COVID* scenario. We also find nearly 12 million more people malnourished, higher rates of maternal, neonatal, and child mortality, and setbacks to education and water and sanitation access. In the *High Damage* scenario, these setbacks are considerably greater. In 2030, there are 213 million more people in poverty than in the *No COVID* scenario (an effect more than four times that of the *COVID* scenario). The years 2020 and 2021 are therefore changing the world from the one we once thought we knew.

Fourth, as important as it is to understand the costs of COVID, it is time to look beyond COVID and to ask what we can now accomplish in this changed world. The *SDG Push* scenario assumes the pandemic impacts of the *COVID* scenario but also represents an ambitious effort worldwide to advance human development. Figure 3 summarizes across the *COVID* and *SDG Push* scenarios the percentage progress of the global population toward the target values in 2030 (top panel) and 2050 (bottom panel) from the values in 2015; Figure 4 looks at the number of countries reaching target values.

Fifth, the *SDG Push* scenario results in significant acceleration toward achievement of the goals and targets examined in this report. It lifts 124 million more people out of poverty by 2030 than does the *COVID* scenario. It reduces total population malnutrition by 113 million people, improves health outcomes by reducing rates of maternal, neonatal, and child mortality, and improves educational completion and water and sanitation access.

By 2030, *SDG Push* results in 11 more countries achieving SDG 1 than projected with the *COVID* scenario (Figure 4 shows the percentage of countries reaching targets). Fourteen more countries meet the child malnutrition goal examined for SDG 2, 4, 2, and 9 more countries meet the maternal, neonatal, and child mortality targets, respectively, 9 more countries meet SDG 4 target for primary completion and 3 more countries meet the SDG 4 target for upper secondary completion. By 2050, *SDG Push* advancement is even more visible (Figure 4, bottom panel), with 24 more countries achieving the SDG 1 target than in the *COVID* scenario. 56 more countries achieve the target for reducing the malnourished population, 12, 17, and 14 more meet the SDG 3 targets for maternal, neonatal, and child mortality, and 32 additional countries meet the target for upper secondary education.

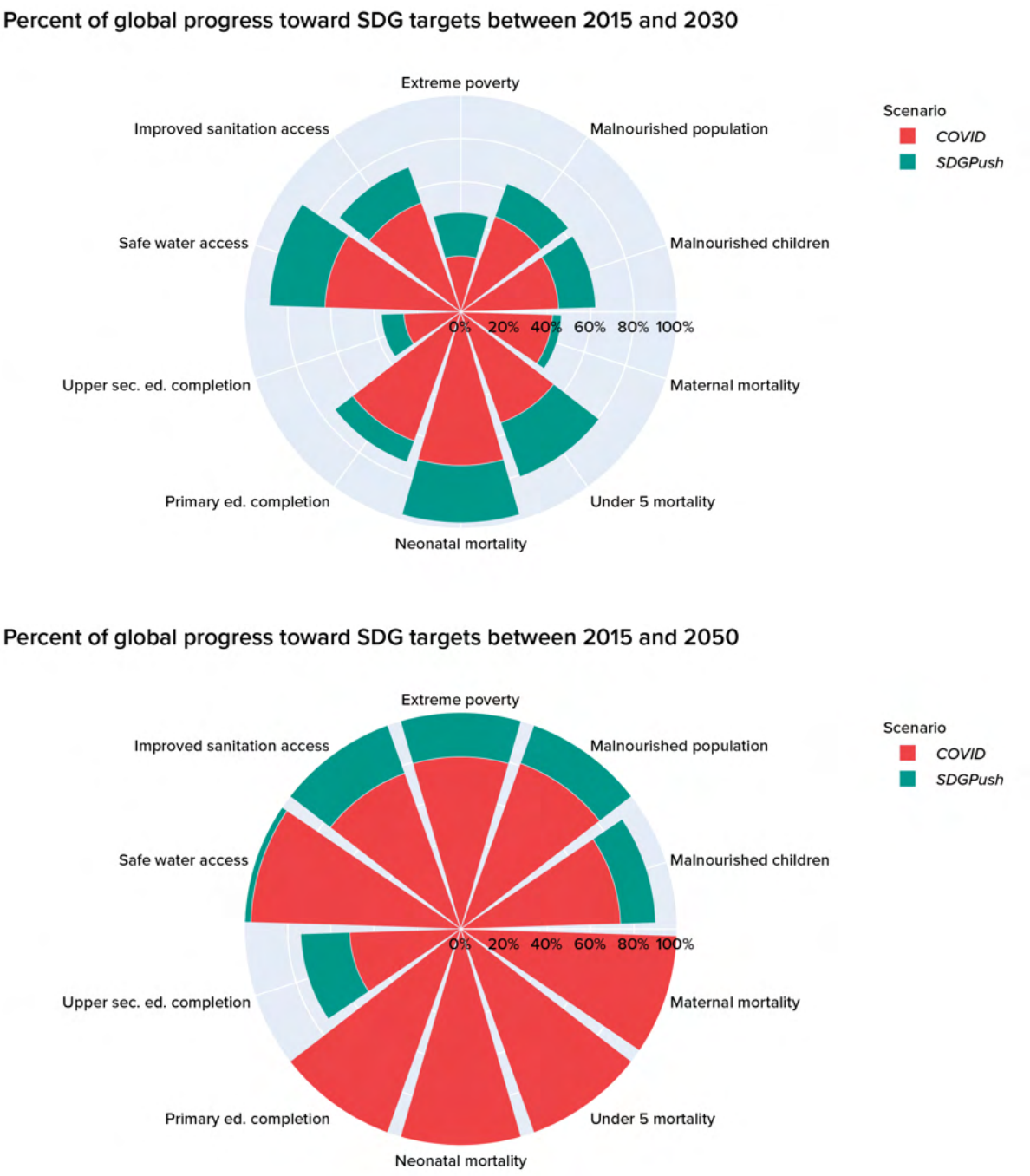


Figure 3 Impact of *SDG Push* on global progress toward SDG targets

Note: The top panel shows the global population's percentage progress toward the target value between 2015 and 2030 (the portion closed of the gap-to-target that existed in 2015); the bottom panel shows the global progress by 2050.

Source: IFs Version 7.61.

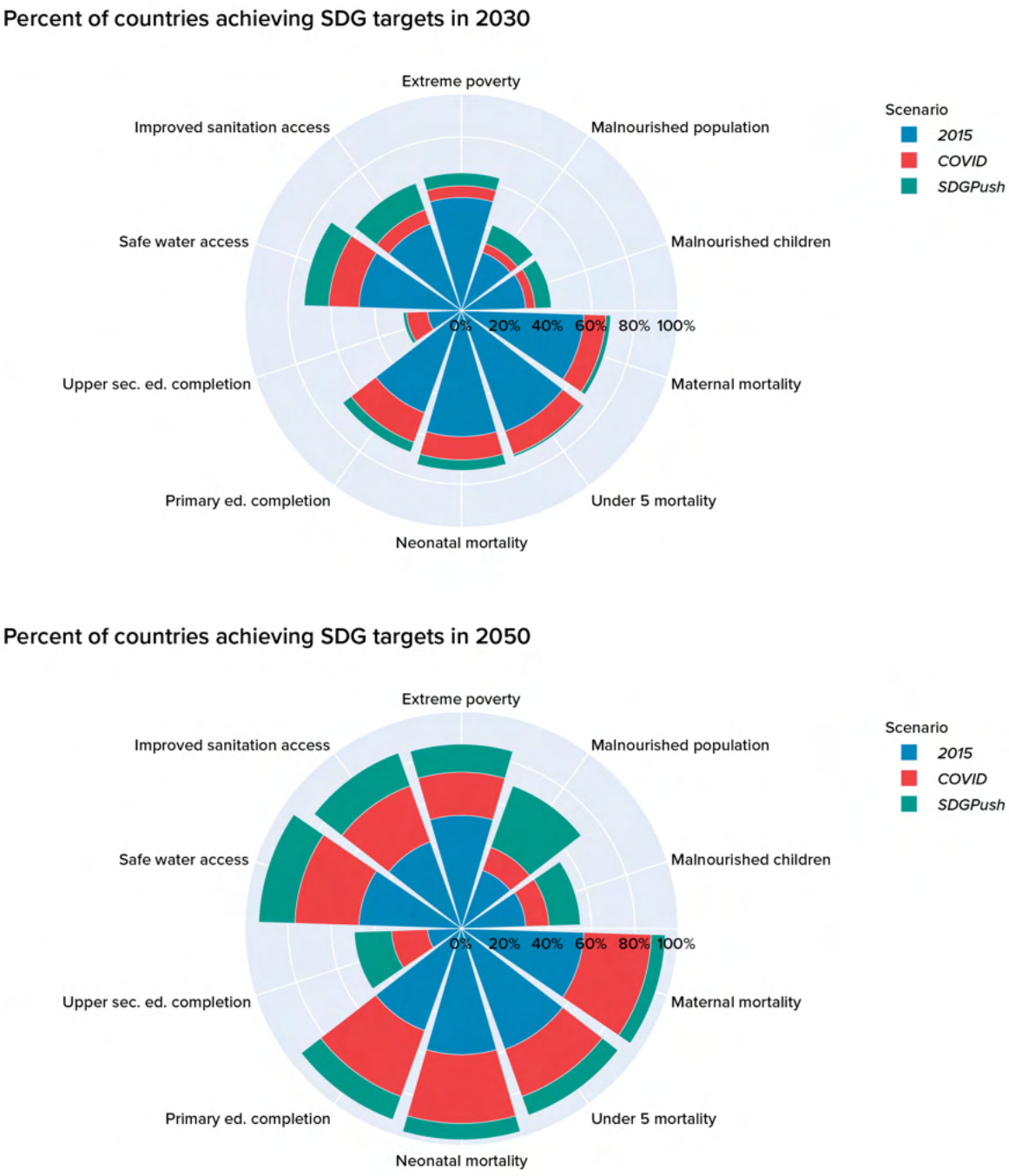


Figure 4 Impact of *SDG Push* on progress by countries toward SDG targets

Note: The top panel shows the percent of countries reaching the target value by 2030; the bottom panel shows the percentage doing so by 2050.

Source: IFs Version 7.61.

Sixth, even the *SDG Push* scenario cannot promise to fully and universally achieve the world we want. Although *SDG Push* can help the global population in total reach global target values for most of the indicator variables by 2050 – unfortunately, not by 2030 – there will be many countries that do not reach them even by mid-century (bottom panel of Figure 4).

Although countries and populations unlikely to reach the targets even with *SDG Push* will be located around the world, most will continue to be in Sub-Saharan Africa (SSA) and South Asia (SA). Still, geographic concentrations will change, and they will vary across SDG target variables. For instance, in 2019, 58 percent of the global population living on less than $1.90 per day lived in SSA and 29 percent lived in SA. The SSA share will grow in the COVID scenario to 71 percent in 2030 and 86 percent in 2050. Within SSA the share of those in extreme poverty in Central Africa will grow from 21 to 35 percent and that in East Africa will decline from 42 to 29 percent. The pattern is somewhat similar with respect to primary-aged children not enrolled; 58 percent are now in SSA and 78-79 percent may be in both 2030 and 2050. In contrast, in 2019 55 percent of undernourished children lived in SA and 29 percent in SSA. Even in 2050 more may be found in SA than in SSA (48 versus 29 percent).

Seventh, location-specific and policy-specific focus in SDG analysis will become increasingly important. The *SDG Push* scenario can be decomposed into its elements, and those can usefully be explored and tailored for individual countries. For instance, we know that improvements in governance, including its transparency, inclusiveness, and effectiveness, are important in themselves and as foundations upon which to structure and implement policies to accelerate progress toward the goals and their targets. Early exploration in this project suggests, for instance, that the governance interventions in the scenario account for about one-sixth of the reduction in poverty by 2030 that might be accomplished with *SDG Push* relative to *COVID* and nearly one-third by 2050. Future work building on this project will seek both to expand further our specification of tools available for reaching goals and to tailor intervention analysis to specific countries, giving special attention to the lowest income and most fragile countries.

Shutterstock / BELL KA PANG

Conclusion

The global community is faced with important choices as we continue to move through and beyond the COVID-19 pandemic. Prior to the pandemic, we were not on a development trajectory to achieve the Sustainable Development Goals and the pandemic has further hindered our ability to “leave no one behind”. This research shows, however, that a shift in development priorities is possible and can be very productive. With sufficiently strategic and bold investment in key drivers of development, the global community can move beyond a crisis and into opportunity. Investing in sustainable development must remain a global priority and, if done effectively, can help us achieve future development outcomes well beyond what was likely prior to COVID-19.

Acronyms

FAO	Food and Agriculture Organization
GEMR	Global Education Monitoring Report
GDP	Gross Domestic Product
IAM	Integrated Assessment Modeling
IFPRI	International Food Policy Research Institute
IFs	International Futures
IMF	International Monetary Fund
JMP	Joint Monitoring Programme
MAPS	Mainstreaming, Acceleration, and Policy Support
MMEIG	Maternal Mortality Estimation Inter-Agency Group
OECD	Organization for Economic Cooperation and Development
RBA	Regional Bureau Africa
RBAS	Regional Bureau for Arab States
RBEC	Regional Bureau for Europe and the Commonwealth of Independent States
RCPs	Representative Concentration Pathways
SSPs	Shared Socioeconomic Pathways
SA	South Asia
SSA	Sub-Saharan Africa
SDG	Sustainable Development Goal
UN	United Nations
UNICEF	United Nations Children's Fund
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USDA	United States Department of Agriculture
WDI	World Development Indicators
WHO	World Health Organization

1. Introduction

Since 2015 the Sustainable Development Goals (SDGs), successors to the Millennium Development Goals, have enhanced the efforts of the global community to monitor, forecast, and therefore undergird efforts to accelerate progress toward 169 targets across the 17 goals (Independent Group of Scientists appointed by the Secretary-General, 2019; UN, 2015).

Despite progress toward many SDG targets, the global community collectively and many individual countries are highly unlikely to reach the targets by 2030. Recognizing that the SDGs or their successors will continue to guide efforts beyond that horizon, this study looks additionally out to 2050 to identify the path we are on and a path that can accelerate our progress. It also seeks to identify some of the major sources of uncertainty and to communicate some of the principal dynamics that underly change and that shape the uncertainty.

This report advances existing monitoring and forecasting initiatives in three ways. First, it provides, for selected goals and targets, especially those related to human development, projections for the path of progress that the world seemed to be on prior to the outbreak of the COVID-19 pandemic. Second, despite the still very high levels of uncertainty around the ultimate course of the pandemic, it considers the possible impact on longer-term progress. Third, it explores the potential impact of a broad and integrated program of initiatives intended to move us more quickly toward achieving the goals.

Analysis of progress toward the SDGs often does so across the "5 Ps": People, Planet, Prosperity, Peace, and Partnership. Guided by what our tools allow, the results presented in this study focus especially on People. Individual report sections focus on Goals 1-4 (poverty, hunger, health, and education) and Goal 6 (access to water and sanitation). Across these as our data and tools allow there is attention to gender equality (Goal 5). More generally, the analysis imbeds attention also to Prosperity, especially to economic growth (Goal 8), which affects progress toward almost all other goals. The final section of the report extends analysis to Planet (notably Goal 13 and climate change) and Peace (Goal 16 and peace within countries).

The primary tools used for analysis are the International Futures (IFs) forecasting system and four scenarios explored with it. The next section of this report lays out the scenarios. The subsequent sections use IFs and the scenarios to explore possibilities for progress toward the SDGs. Appendix 1 provides information concerning IFs and Appendix 2 elaborates the interventions of the scenarios. Appendix 3 compares projections for progress toward each goal from other more issue-specific studies and the integrated IFs analysis. To explore the numerical forecasts from IFs for any of the SDG target variables addressed in subsequent sections of this report, for any or all of the four scenarios, and for individual countries or groupings of them, go to this project's webpage inside the UNDP's COVID-19 Data Futures Platform.

Shutterstock / View Apart

2. Uncertain Pathways to the SDGs

Global dynamics across multiple interacting issue areas, COVID-19, and the special efforts that national societies and the global community are making will interactively shape the progress of countries and the world toward the SDGs. A set of scenarios can help us explore the alternative possible paths of progress: the path we seemed to be on prior to COVID (the *No COVID* scenario), the impacts of COVID on that path as we now understand them (our *COVID* scenario), the possibility that COVID's impact will prove much worse than now anticipated (the *High Damage* scenario), and a new social contract underlying an integrated push toward the SDGs that combines increased efficiency of government, behavioral changes, and big investments (the *SDG Push* scenario). Table 2.1 summarizes the assumptions of the four scenarios.

Scenario name	Description
No COVID	A counterfactual scenario projecting the path the world was on prior to the COVID-19 outbreak, using growth rate projections from before the pandemic.
COVID	A scenario projecting a most likely path of development in light of the COVID pandemic, using the most recent projections of COVID-19's effects on economic growth and mortality.
High Damage	A scenario in which the COVID-19 pandemic has considerably greater negative effect on growth, inequality, and debt.
SDG Push	A scenario simulating an integrated push toward improved development and SDG achievement despite the pandemic, globally representing ambitious but achievable policies. This scenario includes the economic and health assumptions of the *COVID* scenario.

Table 2.1 Summary of scenario assumptions

2.1 The path we were on (*No COVID* scenario)

For most of human history, measurements and even conceptualization of the portion and numbers of people living in extreme poverty or suffering undernutrition did not exist. The *World Development Report 1990* introduced the dollar-per-day international poverty line using purchasing power parity across national currencies (Ravallion et al., 1991), a rate subsequently adjusted upward multiple times as analysis of purchasing power changed with the evolution of country- and goods/services-specific prices. The number of country-year measurements of poverty have increased steadily since that time, but they remain very limited relative to country-years without measurement (Hughes, 2016).

Roughly speaking (drawing upon the World Bank's PovcalNet data and estimates), nearly 2 billion people globally lived below the current $1.90 poverty line throughout the 1980s, a number that had fallen only below 1.7 billion by 2001 and then declined considerably more rapidly to fewer than 0.7 billion by 2017. Global percentage rates decreased from 43 percent in 1981 to 9.3 percent in 2017. Although East Asia and the Pacific, especially China, accounted for significant portions of the declines, poverty percentage reduction has occurred more generally around the world, especially since the turn of the century.

It is all but impossible to separate the contributions made by special efforts encouraged by the Millennium Development Goals announced in 2000 and the Sustainable Development Goals adopted in 2015 from the independent spread of economic growth globally. However, conscious attention to poverty eradication and other goals by national societies and the global community has undoubtedly accelerated progress.

That acceleration has characterized progress toward other goals also, especially the human development goals focused on, for example, nutrition, health, and education. The *No COVID* scenario represents a continuation of that progress. It will serve as a useful benchmark against which to assess both the possible setbacks from the pandemic and, more hopefully, accelerated progress and achievement despite the pandemic.

Shutterstock / Naypong Studio, Mariusz Szczygiel, Fulltimegipsy

2.2 COVID impacts on our progress (*COVID* and *High Damage* scenarios)

The outbreak of COVID and its spread around the world in 2020 led quickly to analysis about how recent decades of progress might immediately be disrupted. Studies have generally suggested the persistence of some or all of that disruption after 2021, but there remains great uncertainty surrounding the future of the pandemic and recovery. One way to deal with this uncertainty is to examine multiple scenarios; V, U, L, and K shaped descriptions of the immediate post-pandemic path have become common. Our *COVID* and *High Damage* scenarios build on assumptions about the pandemic and immediate post-pandemic period to support analysis of the longer-term pandemic impact.

2.2.1 Mortality and GDP costs during the pandemic

In elaborating the *COVID* scenario, we build on the work of analysts assessing the immediate and near-term mortality and economic costs of the pandemic. Two principal sources are the Institute for Health Metrics and Evaluation (IHME) and the International Monetary Fund, respectively.

We take country-level mortality estimates from the IHME for global deaths through February 2021. Those IHME estimates, when augmented by extrapolations for missing countries from data in the Johns Hopkins University database, range from 1.8 to 3.5 million. The central global estimate used in the *COVID* scenario is 2.7 million. The *High Damage* scenario assumes mortality totals 3.5 million.

On the economic side of the *COVID* scenario, we use the country-level growth rate projections through 2021 from the October 2020 release of the International Monetary Fund's (IMF) *World Economic Outlook*. The IMF estimate for global decline in GDP in 2020 is 4.6 percent in absolute terms (IMF, 2020), making it an approximately 7.5 percent drop relative to average annual global growth rates of recent years and a loss of about $6.7 trillion (in 2011 US dollars). The loss relative to 2020 in the *No COVID* scenario of IFs is about 6.6 percent. Global growth anticipated by the IMF for 2021 is 4.8 percent, suggesting that the global economy will begin 2022 with roughly the same size economy that it had at the end of 2019, a loss of about two years' growth.

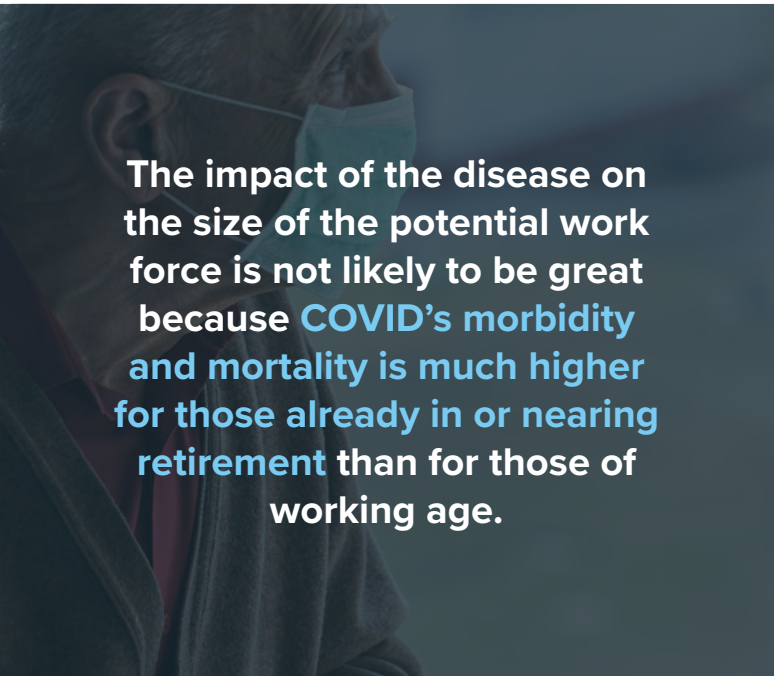
To simulate a greater economic impact of the pandemic, the *High Damage* scenario reduces country-level growth rates by an additional 1.5 percentage points in both 2020 and 2021.

Shutterstock / Narith Thongphasuk38

2.2.2 Uncertainties about the recovery and lasting impacts

Major uncertainties with respect to economic recovery can be framed in terms of the pandemic's longer-term implications for factors of production: labor, capital stock, and productivity. Distributional implications and demand patterns will also be important, as will be the potential for increased social fragility and conflict.

The impact of the disease on the size of the potential work force is not likely to be great because COVID's morbidity and mortality is much higher for those already in or nearing retirement than for those of working age. Approximately 5,000 million humans are aged 15-64 (compared with 735 million aged 65 and older); the deaths now expected during the pandemic period would therefore be a very small portion of that working-age population. A larger implication for the work force is a potential decline in participation rate associated with unemployment and disruption of skill acquisition during the pandemic, with a potential post-COVID offset from increased household needs for income due to asset losses during the pandemic.



Shutterstock / Bonsales

Similarly, pandemic-period forces affecting investment and capital stock may work in two directions, making some capital obsolete and encouraging increased investment in other areas. The shift of consumption from in-store purchases to on-line buying and of office work from dedicated space to home offices illustrate, but certainly do not exhaust, the implications for capital. Perhaps more important will be the acceleration of concerns about the reliability of regionally- and globally-scaled supply chains with limited redundancy.

Of great importance to analysis of implications is uncertainty about bounce back in utilization rates (and productivity) of production factors in 2022 and beyond. It is nearly certain that, rather than an indefinite idling or obsolescence of labor and capital, we will see significant rebound. The greater unknowns are the speed and ultimate extent of such rebound. Our *COVID* scenario assumes that 80 percent of the productivity losses in 2020 and 2021 relative to longer-term patterns are temporary, while 20 percent will persist. By comparison, the *High Damage* scenario assumes that roughly 80 percent of the decline will not be recovered.

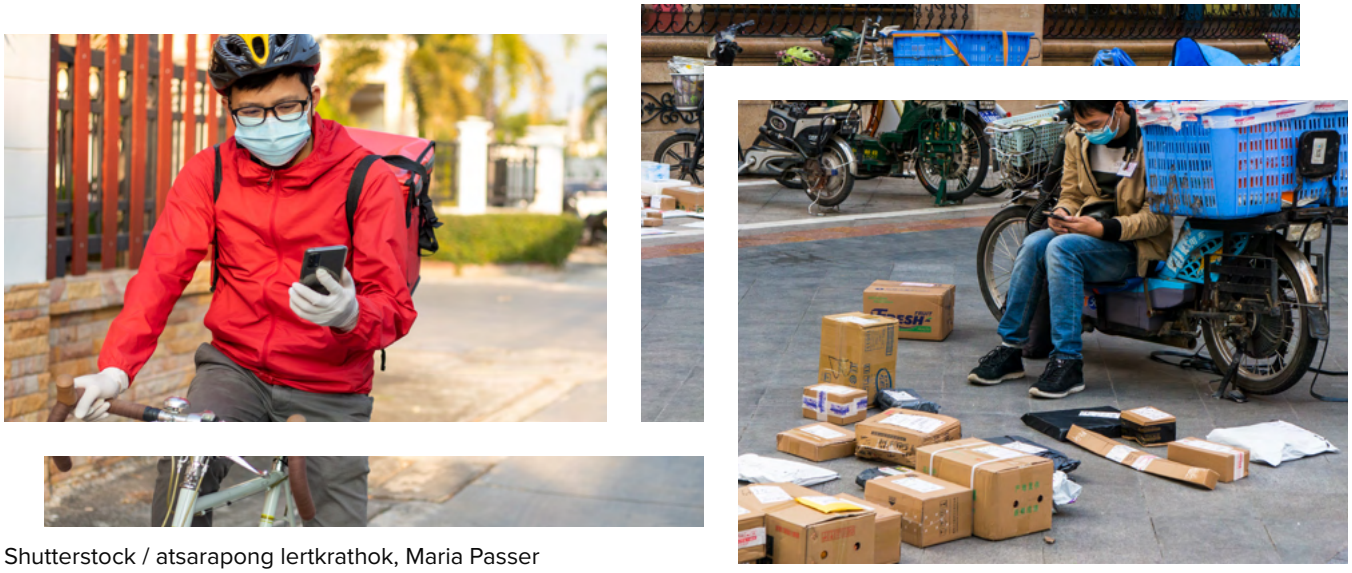
The *High Damage* scenario introduces two additional assumptions: increases in government debt and of economic inequality. Disruption of governmental revenue and expenditure patterns are influencing annual fiscal balances. Given exceptionally low interest rates and accommodative monetary policy currently, the longer-term implications of that for taxing and spending patterns post-pandemic and for monetary authority decisions, interest rates, and inflation are matters of considerable debate. The *High Damage* scenario assumes increased governmental debt to be 20 percent of GDP, which affects model forecasts of revenue and expenditure patterns. Further, the *High Damage* scenario increases Gini everywhere by 5 percent across the decade and thereafter (roughly 0.015 points on the 0-1 index basis), with direct implications for poverty rates.

The combined result of the IMF scenario assumptions for economic growth during 2020-2021, the pattern of bounce-back after the pandemic, and the larger dynamics of the IFs system (including feedback loops from growth loss to human development slow down and back to growth) determine the magnitudes of economic loss in 2030. In the *COVID* scenario that loss globally relative to *No COVID* is 4 percent at market exchange rates and 3.5 percent at purchasing power parity. For low-income countries it is 10 percent in *COVID* and nearly 14 percent in *High Damage*.

In thinking about the transition from pandemic period to the longer term, it helps to compare the current period with past economic crises, including the Great Depression of the 1930s, the (mostly) Asian financial crises of the late 1990s, and the financial crisis or Great Recession of 2007-2009. We have particular interest in the longer-term tail of economic loss and the division of that loss between capacity utilization bounce-back and long-term productivity loss. For instance, looking at the aftermath of both the Great Depression and the Great Recession, Kozlowkski, Veldkamp, and Ventateswaran (2020) model with an assumption of about 4/9 or 44 percent long-term loss, calculating that the discounted value of those losses across time could be 10 times that of the pandemic period. Other studies suggest financial balance sheet effects and the very long persistence post-crisis of low interest rates (Jordà et al., 2020).

These scenario assumptions and specifications, especially in the *High Damage* variant, deserve the kind of country-specific specification of pandemic period impact that post-pandemic data and analysis will eventually allow but which is currently not possible. Another important element of country specificity is, however, the broader national context of the pandemic's unfolding. This study takes advantage of elaborated 186-country representation of the IFs forecasting system (see Box 2.1 and Appendix 1 for model overviews and Appendix 2 for elaboration of the scenario interventions).

The country-specificity of IFs, combined with the extensive collection of development system models that it integrates, help in exploring important immediate and longer-term secondary effects. Most obviously, lower GDP levels during and after the pandemic generate lower income levels and therefore reduced consumption and savings/investment potential in ways that will play out differently with country context.

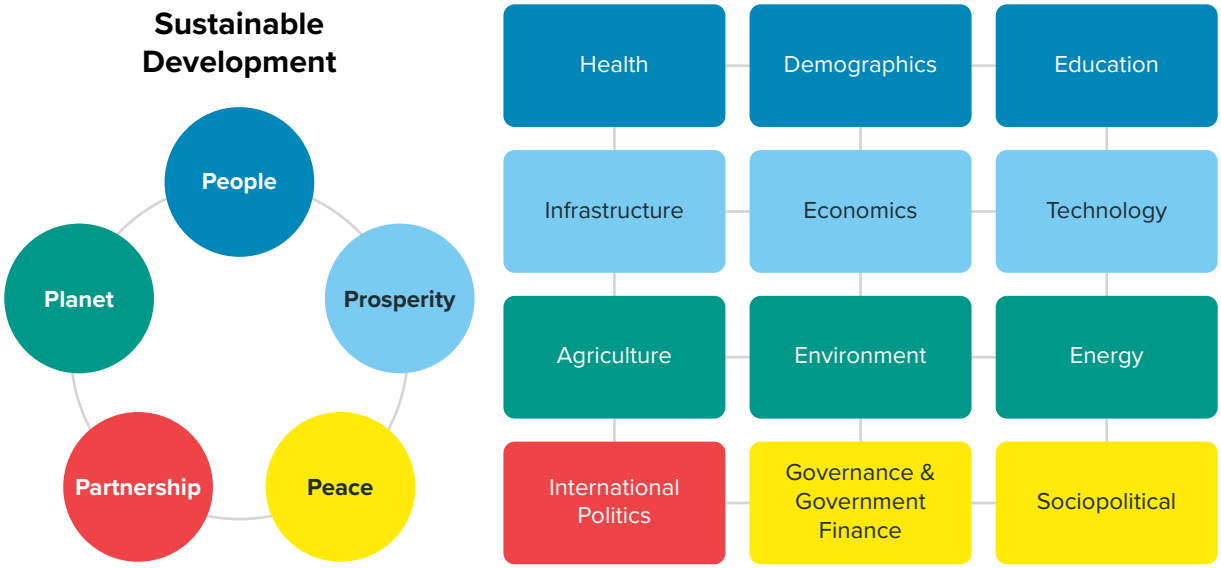


Shutterstock / atsarapong Iertkrathok, Maria Passer

Box 2.1. The International Futures (IFs) forecasting system

This study uses the IFs system to explore the long-term impacts of COVID on prospects for reaching the SDGs and of potential for extensive efforts to overcome pandemic damage and accelerate goal attainment. Representing 186 countries and their interactions, two features of the IFs structure enhance utility in such analysis (Hughes, 2019).

Comprehensive system representation with extensive causal linkage elaboration. The extensive framework of the SDGs calls for integrated model-based analysis across the issue domains of human development, socio-political change (including advance in the capabilities and outputs of government), and biophysical sustainability. Box Figure B2.1 shows how the models within IFs correspond to the 5 "Ps" and associated SDGs. Causal connections within and across component models, including endogenous representation of many drivers of economic productivity, facilitate consideration of variables and dynamics linking and underlying the SDGs and of policy orientations. Representation of temporal dynamics annually over the long-run facilitates understanding of lags in achieving change.



Box Figure B2.1. The Five "Ps" and the associated models of the IFs system
Note: The models of IFs are heavily interconnected.

Fiscal and physical resource competition accounting. Action trade-offs often lie in competition for resources. Governments (or households) cannot spend the same money on education, health, infrastructure, subsidies for renewable energy, and the military). The social accounting matrix structure within IFs manages fiscal accounting within and among governments, households, and firms. On the physical side IFs maintains accounting for land uses, fossil fuel resources, and age-sex specific demographics underlying labor supply.

2.3 Accelerating progress toward the SDGs (*SDG Push* scenario)

In the face of the pandemic, the United Nations system and the United Nations Development Programme (UNDP, 2020) have identified key elements of the wide-ranging initiatives required to move *Beyond Recovery* and to accelerate progress toward the SDGs. Also building on the four levers for action identified by the first quadrennial Global Sustainable Development Report (Independent Group of Scientists appointed by the Secretary-General, 2019), the *Beyond Recovery* program recognizes four areas of response needed to the pandemic and to the shortfalls in progress prior to it: Governance (building a new social contract), Social protection (uprooting inequalities), Green economy (rebalancing nature, climate, economy), and Digital disruption and innovation (for speed and scale).

The final scenario of this report is the big *SDG Push* needed across those arenas of action. It includes interventions across the four areas of action, many that apply to more than one. The scenario, built in part upon work by Moyer and Bohl (2019) and Moyer and Hedden (2020), integrates these scenarios into a single package rather than attempting sharp differentiation by areas. Still, they can be broadly grouped:

Governance (building a new social contract): Reduced corruption, increased government effectiveness, and increased democracy (thereby also inclusivity)

Social protection (uprooting inequalities): Increased enrollment into and completion of education at all levels, higher social transfers and increased protection of nutrition for less skilled and therefore lower income households for social transfers, higher societal focus on improving access to safe water and sanitation, electricity, and modern cookstoves, and increased supportive government expenditures on education and health

Green economy (rebalancing nature, climate, economy): Movement of calories consumed from meat to vegetable and fruits, reduction of agricultural waste in production, transport and processing, and consumption, increased agricultural yields allowing also increased forest area, reduced urban air pollution, increased efficiency of water and energy use, a carbon tax, accelerated technological advance, and a policy emphasis on renewable energy

Digital disruption and innovation (for speed and scale): Increased emphasis on tertiary education especially in science, increased governmental and societal spending on research and development, accelerated introduction of broadband technology including mobile forms

Shutterstock / LightField Studios

The representation of the *SDG Push* scenario is simultaneously facilitated by the structure of the IFs system used to manifest it and constrained by the limitations of both the model system and the goal/target/indicator specification of the SDGs.

With respect to the latter set of limitations, there are considerable differences between the human development goals, for which countries and the world have quantitative specificity of goals, targets, and indicators, and the environmental sustainability goals, where that often does not exist. For instance, the World Bank has defined a 3 percent threshold for the eradication of poverty and hunger (Ravallion, 2013), which has been widely accepted. In contrast, the quantification for combatting climate change, sustainably using the oceans, and reversing land degradation is much less clear. In part, that is because most human development goals can be pursued and reached within countries while many environmental sustainability goals cannot be met without action across countries and often only with country-specific levels of action–in the language of private and public goods, they are global public goods rather than nationally private ones. Although analysis with IFs can be undertaken across the goal set, the greater strengths of the system and the heavier focus here is on human development, for these reasons as well as because of the differential elaboration of the models within IFs.

Scenario building requires many choices and caveats. One broad choice is between developing a scenario that is structured to indicate the scope of action that would be required to achieve goals, with limited consideration of whether society and policy makers could realistically undertake such action, versus structuring a scenario with interventions scaled to be very ambitious but more definitively achievable.[1] *SDG Push* falls into the ambitious but achievable scenario category. Subjective judgment helps shape specifications of *SDG Push* intervention levels, but attention to successful country experience has been very helpful. Also, most major policy interventions require phasing in and the *SDG Push* scenario does that with initial steps introduced in 2021, again ambitiously. Further, even though the model system maintains financial and physical accounting as an aid to imposing reasonableness, societies would find it extremely challenging to pursue all such changes simultaneously, making the *SDG Push* scenario one intended to frame the limit of possibilities, and which hopefully can inspire and assist action.[2]

Appendix 2 shows the IFs parameter changes made to implement the *SDG Push* scenario in association with the four areas of action and indicates the magnitudes and geographic specification of the interventions.

Shutterstock / Patrick Foto

[1] Hughes (2013) similarly pointed to aggressive but reasonable levels.
[2] The *Sustainable Development Pathway* scenario of Soergel et al. (2021) is similarly characterized by the developers as "possible but challenging" in its pursuit of SDGs, but is considerably more aggressive in pushing beyond past practice of countries and the global system.

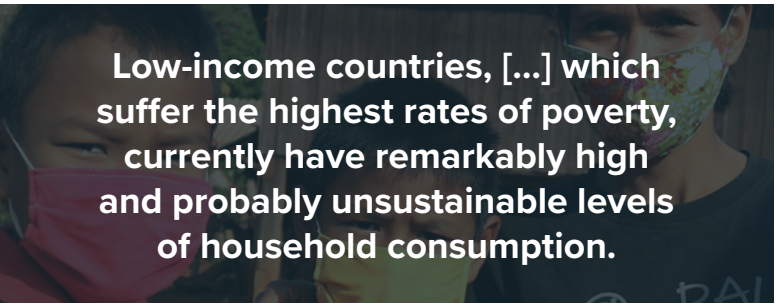
2.4 Challenges to goal attainment: Strong headwinds

Even without the pandemic, we were facing great challenges in reaching many of the SDGs. Those challenges still face even the *SDG Push* scenario. For instance, China has been a major part of poverty alleviation over the past several decades, accounting for 70 percent of the more than 1.1 billion people lifted out of poverty since 1990. Chinese domination of the global poverty reduction trend was driven by economic growth averaging 10 percent annually between 1990 and 2015 and by its demographic size. With its extreme poverty rate now below 1 percent, the global rate of poverty reduction has noticeably slowed.

Unfortunately, we cannot reasonably expect a similar pattern of poverty elimination within other countries in either rates or numbers. A variety of headwinds face the globe as we pursue poverty eradication (World Bank, 2020a) and other SDGs beyond the improbability that many other countries might experience such rapid economic growth. Two of the most significant are (1) challenges that households and governments face in protecting their consumption and expenditure shares of GDP and (2) the reality that many of the countries still far from the goals suffer considerable sociopolitical fragility.

2.4.1 Challenges to household and government consumption

The immediate determinants of poverty are (1) the level of household consumption and (2) the distribution of that consumption (as represented in a number like the Gini coefficient and the shape of the distribution, often roughly log-normal). Unfortunately, low-income countries and, to a lesser degree, lower-middle-income countries, which suffer the highest rates of poverty, currently have remarkably high and probably unsustainable levels of household consumption relative to their GDPs. Specifically, the household consumption share of GDP in low-income countries is about 70 percent and that in lower-middle-income countries is about 60 percent, compared to nearer 55 percent in upper-middle-income countries and high-income countries.



Shutterstock / Sunet Suesakunkhrit

There is reason to believe that the high share of consumption in the GDP of the low-income countries will decrease in coming years, namely the likely unsustainability of current support for it from deficits in trade balances and the offsetting financial flows from abroad. The low-income country group has been running trade deficits of approximately 15 percent of GDP across the last decade, about twice that of the previous decade and even of the late 1970s and early 1980s, a time when deficits ultimately contributed to financial crises.

Trade deficits and consumption shares of GDP are linked in national accounts. While GDP is a summation of value added across all producing sectors, there is another GDP identity on the demand side, which is also enforced in a model like IFs that represents social accounting:

GDP = Household consumption
+ Government consumption
+ Gross domestic fixed capital formation
+ Net trade

For most countries over time, net trade is in rough balance; if not, an accumulation of foreign debt becomes problematic. The low-income countries have been fortunate in having offsetting financial inflows including foreign aid and remittances, accounting for very roughly two-thirds and one-third of the trade deficits, respectively.

Fortunately for progress toward many of the SDGs, especially given significantly high population growth rates, lower-income countries have experienced faster GDP growth than have higher-income ones since approximately the turn of the century. Both the *No COVID* and *COVID* scenarios of IFs suggest that this pattern may well persist. If it does, however, and even if net foreign aid donations and remittance outflows from high income countries remain roughly constant as a portion of GDP, the net receipts of developing countries in the aggregate will decline as a portion of GDP. That would mean that trade would need move toward balance and that both household and government consumption could face increased restraints.

The combined implications of these patterns and trends is complicated, but the forecasts of IFs suggest that it is highly probable that household consumption shares of GDP in lower-income countries will decline several percentage points by 2030 and further by 2050.

Further, the support that foreign aid has been providing to government revenues in developing countries and therefore to their spending, including that on education, health, and infrastructure, will most likely decline if economic growth continues to exceed that of donor countries. Currently, the total government revenues of low-income countries are only about 22 percent of GDP. Raising those revenues and capacity for expenditure requires increasingly strong and capable governance, another challenge.

Shutterstock / Manoej Paateel

2.4.2 State fragility adds to challenges in reaching SDGs

The importance of enhancing governance to facilitate revenue raising and its use faces another head wind from state fragility, both a cause and effect of lower levels of human and socio-political development. Figure 2.2 shows the very strong current relationship among economic development level, government revenue as a percentage of GDP (omitting aid receipts), and the IFs index of state failure/fragility. The index for fragility is rooted in a database of internal conflicts across recent years from a project on state failure (Goldstone et al., 2010). As low levels of human development become increasingly concentrated in lower-income countries more prone to conflict, progress becomes more difficult.

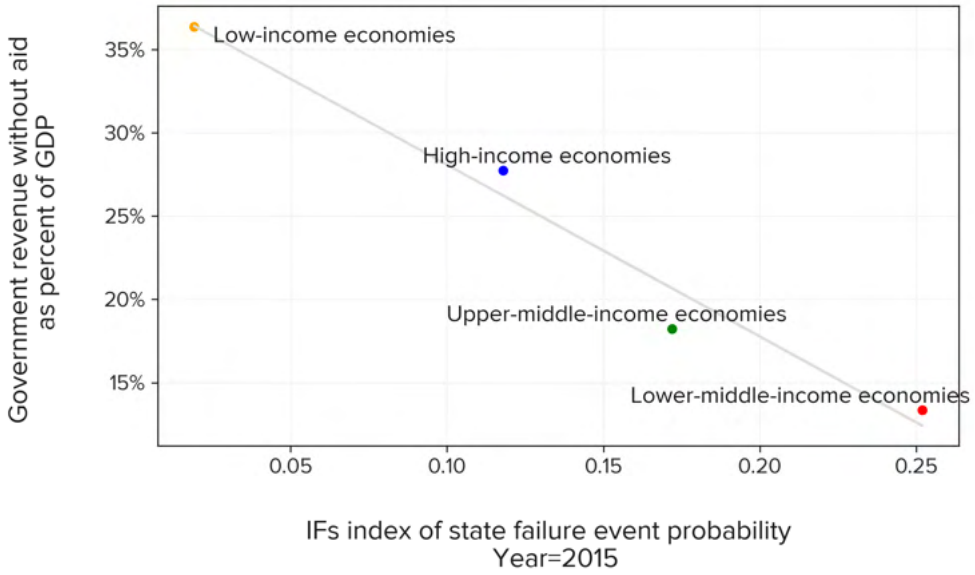


Figure 2.2 Government revenue as function of annual internal war probability
Note: R-squared=0.971
Source: IFs Version 7.61.

2.5 Headwinds are just one element of context

None of the headwinds sketched have prevented most countries and the world from making great progress toward the SDGs, especially since the adoption of the MDGs and SDGs. They do, however, supplement understanding of the tremendous efforts being put into reaching the SDGs with additional important context for the discussion to follow. They help explain why, even in the *No COVID* scenario, many countries and the world as a whole fail to meet the SDGs by 2030 and even 2050. They help put the *COVID* and *High Damage* scenarios in context. Finally, they provide some additional insight into the structuring of the *SDG Push* scenario and its great importance. We move now into discussion of prospects for attaining the SDGs.

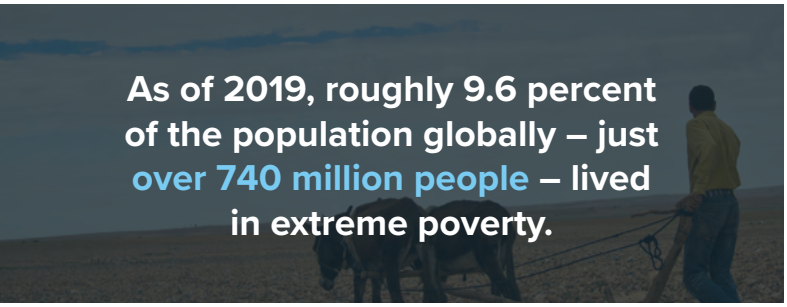
3. Poverty

Elimination of poverty is the first and most fundamental of the Sustainable Development Goals (SDGs). We therefore give it attention before moving to other goals, providing forecasts from International Futures (IFs) across groupings of countries and identifying numbers of countries reaching 3 percent or less in 2015, 2030, and 2050. We compare our forecasts with other pre-COVID and COVID period forecasts of poverty reduction globally, considering some of the key drivers of such forecasts and the uncertainties around them – with attention to the headwinds that are slowing down poverty reduction.

We assess poverty using the international extreme poverty line of $1.90/day, using 2011 US dollars at purchasing power parity (PPP). While the original SDG target used a poverty line of $1.25/day in 2005 US dollars, the World Bank updated the international poverty line in late 2015 to reflect changing costs of living and the movement to 2011 US dollars. The $1.90 line is now regularly used to assess SDG 1 progress, and use of the 3 percent target line is common.

3.1 The Path We Were On Before COVID

As of 2019, roughly 9.6 percent of the population globally – just over 740 million people – lived in extreme poverty. In the *No COVID* scenario the percentage rate declines modestly to 7.9 percent in 2030 before falling to 4.2 percent in 2050, still above the SDG target value. Poverty headcount is relatively stable over the next few years due to rapid population growth in many of the countries with high poverty rates, falling to 672 million by 2030 and to just over 400 million by mid-century.



Shutterstock / Sergei Kazakov

This forecast is somewhat higher than a recent pre-COVID projection from the World Bank (Lakner et al., 2019), which estimates both a lower poverty rate today (9 percent in 2018) and in 2030 (6.5 percent, or 550 million people). Our 0.6 percentage point higher calculation of global poverty in 2019 is related in part to our base year estimates of poverty levels for several countries such as Afghanistan and Eritrea, not included in the PovcalNet database that we and most other poverty studies rely upon.

Projections from other studies done over the last five years that include values for 2030 provide estimates ranging from 4 to 8 percent (Bill & Melinda Gates Foundation, 2019; Crespo Cuaresma et al., 2018; Lakner et al., 2019; Manuel et al., 2018; Reddy, 2020; Rozenberg & Hallegatte, 2015; World Bank, 2015). Our *No COVID* forecast is at the top of that range partly because of our higher initial condition. The headwinds discussion of Section 2.4 provides additional explanation. Elements

of that include attention in IFs to trade imbalances and consumption adjustment likelihood, the challenges facing lower-income societies in raising government revenues and expenditures, and the increasing concentration of poverty in more fragile societies.

The vast majority of the global poor (more than 90 percent) lives in low-income countries and lower-middle-income countries. As a group, high-income and upper-middle-income countries have already met the SDG target of reducing extreme poverty to less than 3 percent of the population, though many upper-middle-income countries have yet to meet the target at the country level. Poverty has been below 3 percent in high-income country group for decades and in the upper-middle-income grouping since roughly 2013. In lower-middle-income countries the poverty rate in 2019 was just under 12 percent of the population (358 million) and in low-income countries it was 45 percent (329 million).

Over the next decade, we project that the poverty rate will fall gradually in lower-middle-income countries, to 8 percent by 2030 (Figure 3.1). Though representing a one-third reduction in poverty rate and a removal of 80 million people from extreme poverty, this progress is far from what would be needed to meet the SDG target. Nearly 275 million people will remain in poverty (Figure 3.2). Even without the pandemic, progress would have been still slower in low-income countries, where the poverty rate could have fallen from 44 to 35 percent. Continued high levels of population growth mean that the poverty headcount would grow in that grouping, from 329 million in 2019 to peak at 351 million just before 2030. By 2022 there will be a higher headcount of poverty in low-income countries than in the lower-middle-income country group.

After 2030, poverty rates and numbers decline across all income groups in the *No COVID* scenario. But even after an additional 20 years, the scenario suggests that more than 400 million people could have been in poverty in 2050, including 210 million in low-income countries and 160 million in lower-middle-income countries.

Shutterstock / i_am_zews

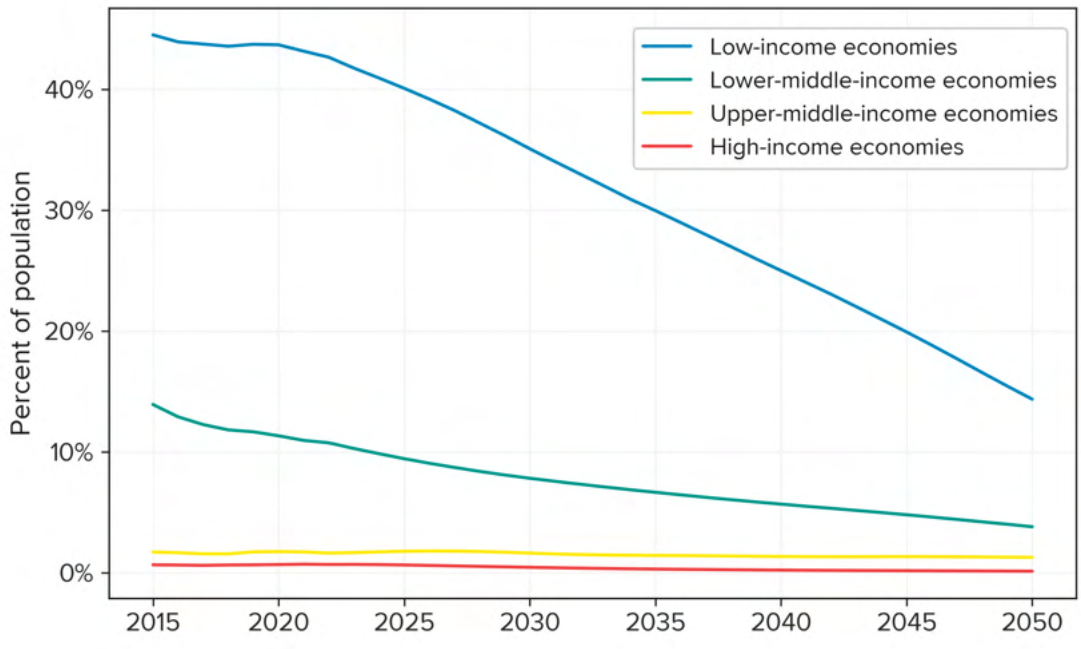


Figure 3.1 Extreme poverty rates in countries by income group, *No COVID* scenario
Source: IFs Version 7.61.

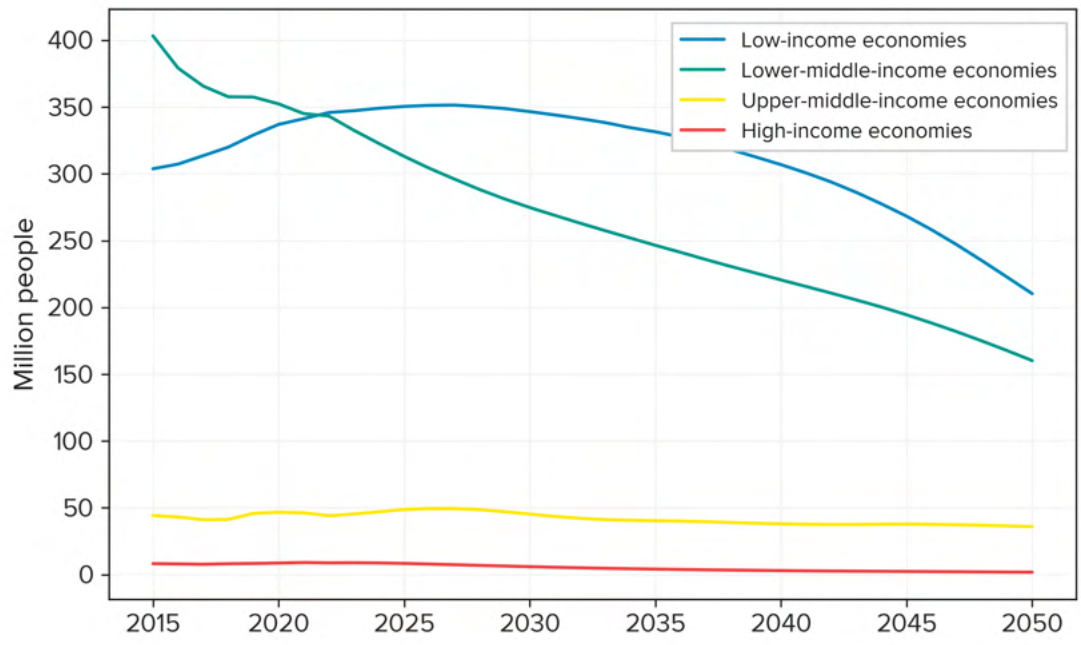


Figure 3.2 Extreme poverty headcount in countries by income group, *No COVID* scenario
Source: IFs Version 7.61.

The regional makeup of poverty has been undergoing a geographic shift for decades. In 1990, 80 percent of people in poverty worldwide lived in Asia, with 15 percent in Africa. Due to remarkable poverty reduction in Asia (notably in China) and rapid population growth in Africa, that composition has shifted dramatically. In 2019, 60 percent of people in poverty worldwide lived in sub-Saharan Africa. In a *No COVID* scenario, that would grow to 73 percent by 2030 and 85 percent by 2050.

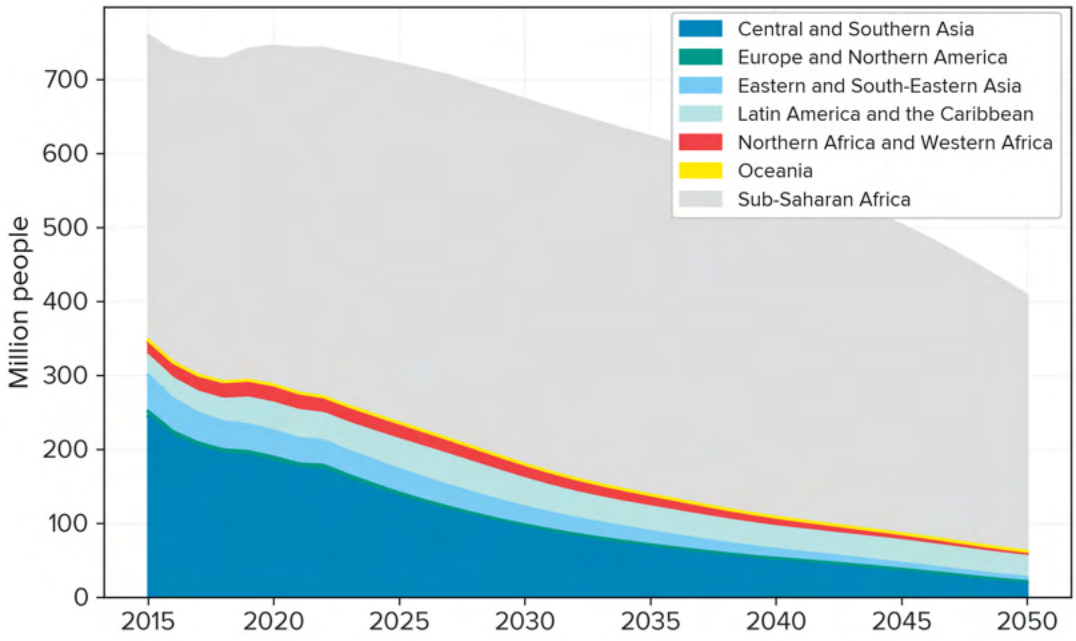


Figure 3.3 Extreme poverty headcount by UN SDG region, *No COVID* scenario
Source: IFs Version 7.61.

An important component of SDG 1 is that poverty is not only eliminated at the country level but that it is eliminated for all groups, including by gender. Poverty has differential patterns by age and gender. Women and girls are more likely to be in poverty than men and boys, a disparity that is especially pronounced for young working-age adults between 20 and 40 (Boudet et al., 2018).[3] As of 2019, nearly 5 million more women and girls lived in poverty than men and boys. Within a *No COVID* scenario, that gap would be halved by 2030, to 2.4 million.

In 2019, we estimate the global poverty rate was at 9.6 percent. At the national level, 102 out of 186 countries had met the target of reducing poverty to below 3 percent. By 2030, this group grows to 110 countries and by 2050 to 136 – an additional 34 countries would be projected to meet the target by 2050 in a *No COVID* world (Figure 3.4). But that still leaves 50 countries in which the target might well not have been met, even in the absence of the COVID pandemic.

[3] Poverty survey data are typically collected at the household level, so they cannot account for differential access to resources within households. For this reason, it is likely that existing data underestimate the poverty disparity by gender.

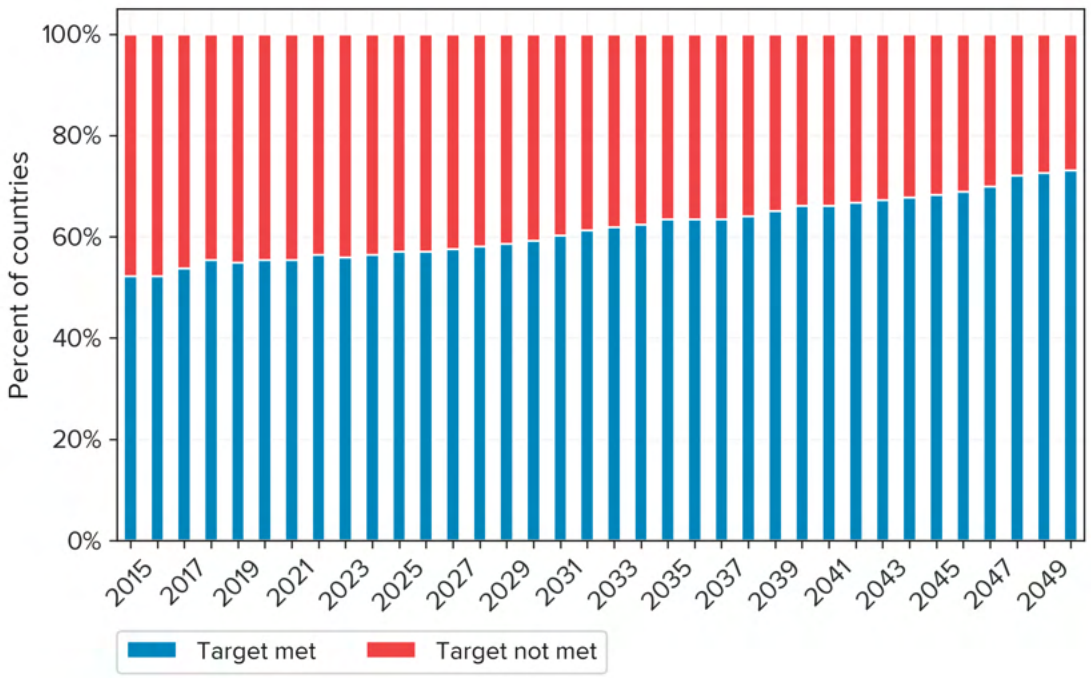


Figure 3.4 Percentage of countries reaching and not reaching the extreme poverty target, *No COVID* scenario
Source: IFs Version 7.61.

3.2 The Damage that COVID Inflicts

COVID-19 has killed more than 2 million people and left many more millions with still not well understood long-term morbidity. It has disrupted economies across the world and resulted in massive losses of employment and incomes (World Bank, 2020a). This has led to a historic reversal of the decades-long trend of poverty alleviation.

Poor and marginalized groups are especially vulnerable to COVID's impacts as they are more likely to have jobs that cannot be done from home or in compliance with social distancing requirements, lack access to savings and other coping mechanisms, and are less likely to live in places with adequate health care, social security programs and safety nets. Thus, the pandemic is deepening existing poverty while pushing additional people – vulnerable populations just emerging from or just above the international poverty threshold – into poverty.

COVID-19 has resulted in a sharp increase in the global poverty headcount and rate. We estimate that COVID increased the poverty headcount by 88 million people in both 2020 and 2021 (Figure 3.5). The increase is largest in the lower-middle-income country grouping, largely because of the increase in poverty in India. In the *COVID* scenario, this gap shrinks as the economy bounces back, but never recovers to the *No COVID* level. By 2030, an additional 48 million people remain in poverty due to the pandemic.

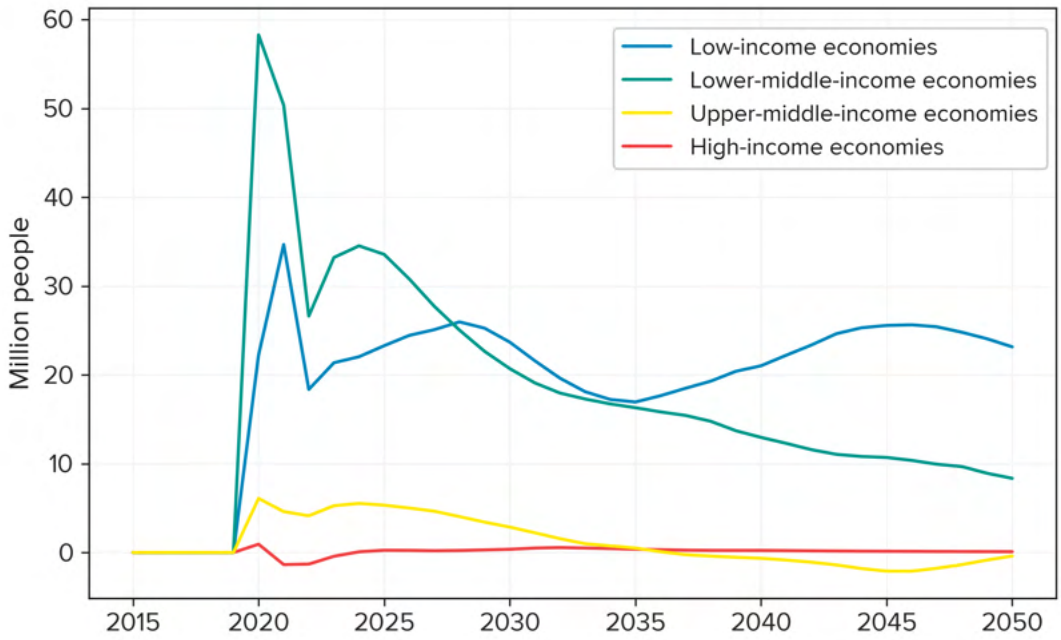


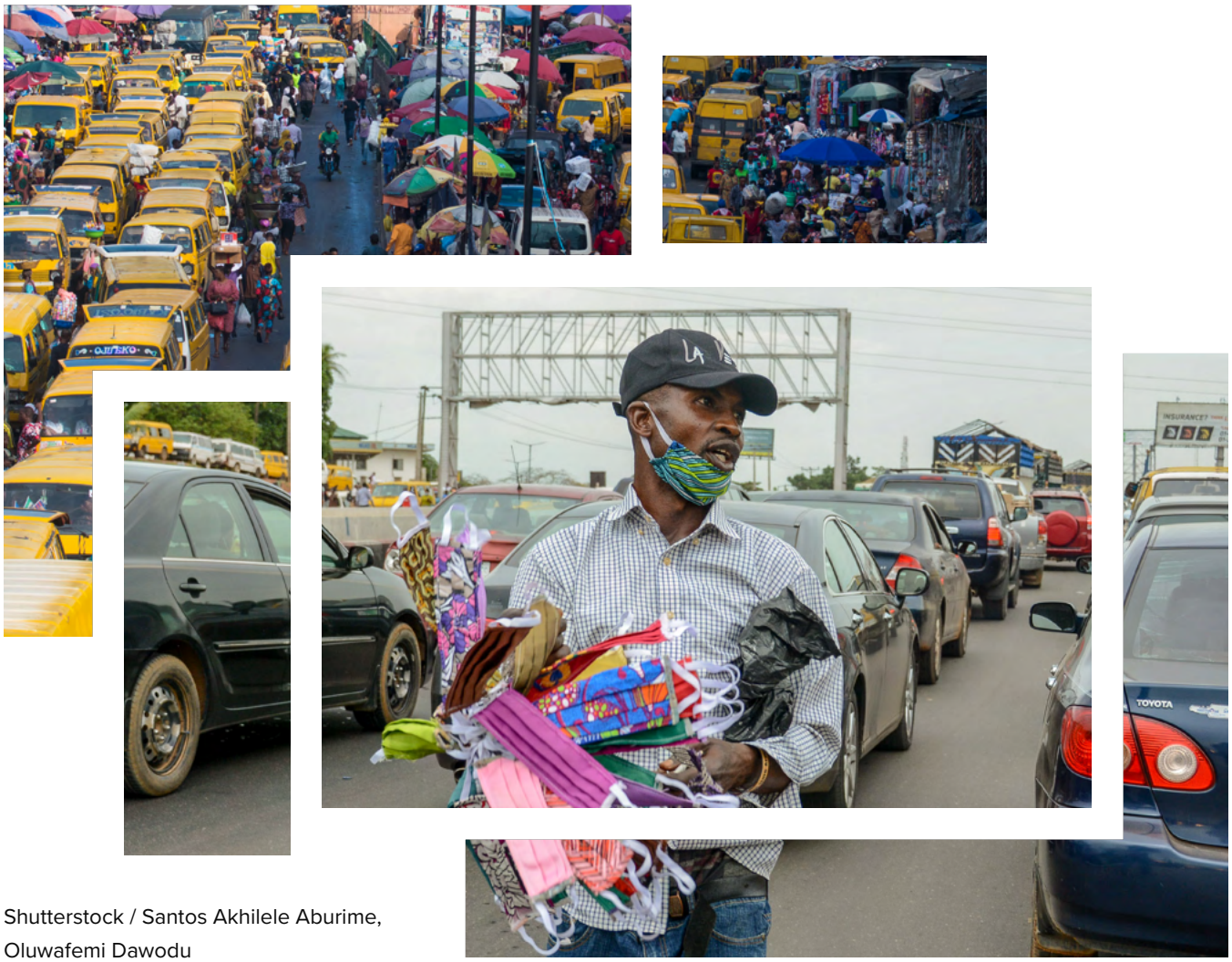
Figure 3.5 Additional people in extreme poverty in the *COVID* scenario relative to the *No COVID* scenario across World Bank income groups
Source: IFs Version 7.61.

In the *High Damage* scenario, the effect is considerably worse. Not only does this scenario result in 184 million more people in poverty on top of the *No COVID* scenario in 2020, the gap between the scenarios grows. By 2030, the pandemic and resultant economic damage are responsible for increasing the poverty headcount by 32 percent or 213 million over what is expected in a *No COVID* scenario. Even in 2050 the increment in poverty numbers is over 200 million.

Most other projections focus on the effect of COVID only in the short term, making estimations just for 2020 and 2021. Many of those produce results closer to the *High Damage* scenario than to the *COVID* baseline scenario. In April, Vos et al. (2020) estimated that COVID-19 could increase poverty by 140 million in the absence of strong interventions. Sumner et al. (2020) estimated the effect on poverty of an economic contraction of 5 to 20 percent, finding that COVID could increase poverty compared to 2018 levels by 85 million in a 5 percent contraction scenario, 181 million (10 percent) and 419 million (20 percent). Researchers at the World Bank have adjusted their projections upward from those made earlier in the year (Mahler et al., 2020) and now estimate that COVID is increasing poverty in 2020 by between 88 and 115 million (Lakner et al., 2020; World Bank, 2020a).

The World Bank (2020a) also projects that the COVID effect on poverty will have a lasting impact through 2030. Its analysis suggests a rate as much as one percentage point above the poverty rate forecast made in 2018 (World Bank, 2018). This increment, related at least in part to COVID, is nearly identical to the impact in 2030 from the *COVID* scenario and somewhat less than the 1.3 percentage point increase in the *High Damage* scenario. See Appendix 3 for quantitative comparison of recent projections with those from IFs.

Projections for the impact of COVID on poverty levels during and after the pandemic remain subject to great uncertainty and can change quite rapidly with new data and knowledge. For example, an earlier release of results from this project using version 7.58 of IFs suggested that global poverty numbers in 2030 in the *High Damage* scenario could reach 1,113 million, compared to 886 million from the model version 7.61 used for this report. In the past, IFs used poverty data from the World Bank's World Development Indicators, which does not include estimates for non-survey-years. For countries without a 2015 survey, IFs generated estimates which, in some cases, diverged considerably from estimates produced by Povcalnet. These countries included India and Nigeria, highly populous countries where a difference of a few percentage points translates to considerable difference in poverty headcount. This resulted in a poverty headcount difference between IFs estimates and World Bank/Povcalnet estimates of 143 million in 2017. Our movement to Povcalnet data for initializations has therefore reduced pre-pandemic poverty estimates. Also, movement toward somewhat higher estimates of post-pandemic economic growth rate potential, including for India, has further reduced estimates for future poverty in all scenarios. Continued change and refinement can be expected as our understanding grows.



Shutterstock / Santos Akhilele Aburime, Oluwafemi Dawodu

Box 3.1 The determinants in IFs of the impact of COVID on poverty rates

Poverty levels in IFs are initialized in 2015 using data from the World Bank's Povcalnet database. IFs uses a cross-sectional function with GDP per capita to estimate values for countries without values in that data. To forecast poverty, IFs uses average household consumption at purchasing power parity, an assumption of log-normal distribution of consumption power across national populations, and a Gini coefficient that determines the spread of the distribution. Within the broader IFs system around that formulation, a social accounting framework dynamically represents the shares of final demand components (household consumption, government consumption, gross capital formation, and net trade) within GDP. On the production side of the economy, value added in each of six economic sectors is divided among skilled labor, unskilled labor, and firms. Household income in the two categories is shaped by that labor income, firm distributions, and government taxation and (re)distribution patterns.

In 2020 and 2021, the years through the pandemic, the size and supply-side growth of value added and GDP is exogenously specified using values from the IMF's *World Economic Outlook* (most recently October 2020) (IMF, 2020). The passing through of those exogenous economic growth assumptions to production by sector, and on to household income and consumption, strongly shapes poverty levels during 2020 and 2021. The two different COVID-scenario sets of those exogenous growth assumptions, as described in Section 2, have different consequences for changes in poverty levels and most of the other target variables explored in this report. Although there are some changes in economic distribution patterns in those years as a direct result of the growth assumptions, they are relatively small compared to the changes post 2021.

In years after the pandemic the production and value added within each sector, and thus economy size and growth, are determined endogenously by capital stock, labor supply, and total factor productivity (in turn shaped by much else including education, health of workers, and infrastructure development). The labor income passes through the larger IFs model to household income, consumption (thus poverty), and savings (affected also by demand for investment capital), but in endogenous interaction with changing demographics, education levels and thus household category relative size and income distribution, economic structure (in less developed societies, for example, agriculture is a larger share but decreasing), and more. See Appendix 2 and Hughes (2019) for more information on IFs.

All these dynamics shape the projections of poverty in the baseline *COVID* scenario. As summarized in Section 2, the *High Damage* version of COVID's impact adds some additional exogenous assumptions including a larger carry-forward of productivity losses from the COVID years, an increase of inequality incremental to endogenous calculation of it, and an increased government debt burden that will affect its revenues and expenditures with additional implications for net household income available for consumption.

The impact of COVID is gendered, because its direct and indirect effects differ for men and women. Under the *COVID* scenario, IFs suggests that the pandemic is pushing 43 million women into poverty in 2020. By 2030, more than 23 million women will still be in poverty as a result of *COVID*, compared to the *No COVID* scenario. By 2030, the adult female poverty rate (15 and older) is at 6.5 percent, compared to 6 percent in the *No COVID* scenario and a total adult poverty rate of 6.3 percent. In the COVID *High Damage* scenario, the pandemic pushes 90 million women and girls into poverty in 2020, a figure that continues to grow, reaching 105.3 million by 2030.

The pandemic's lasting effect on poverty has implications for countries' abilities to meet SDG 1. In the *COVID* scenario, 107 countries meet the 3 percent target by 2030 (three fewer than in *No COVID*). In the *High Damage* scenario just 97 countries meet this target – 13 fewer than in the *No COVID* scenario and even five fewer than had already met that target in 2019.

One way to measure poverty over time is through poverty-years. A poverty-year represents a year spent in poverty by one individual. For example, if six people are in poverty one year and four are still in poverty the following year, the group has experienced 10 poverty-years over that time. Measuring poverty-years helps us take stock of not only the situation in any given year but the cumulative impact of COVID on poverty over time. By 2030, the *COVID* scenario results in 680 million additional poverty-years. By 2050, that figure doubles to 1.4 billion poverty-years (Figure 3.6). To give that 1.4 billion incremental poverty-years some context, it is approaching double the 760 million people in extreme poverty in 2015. And the cumulative extra poverty years through 2050 begins to approach 10 times the increment from COVID in 2020 (88 million).

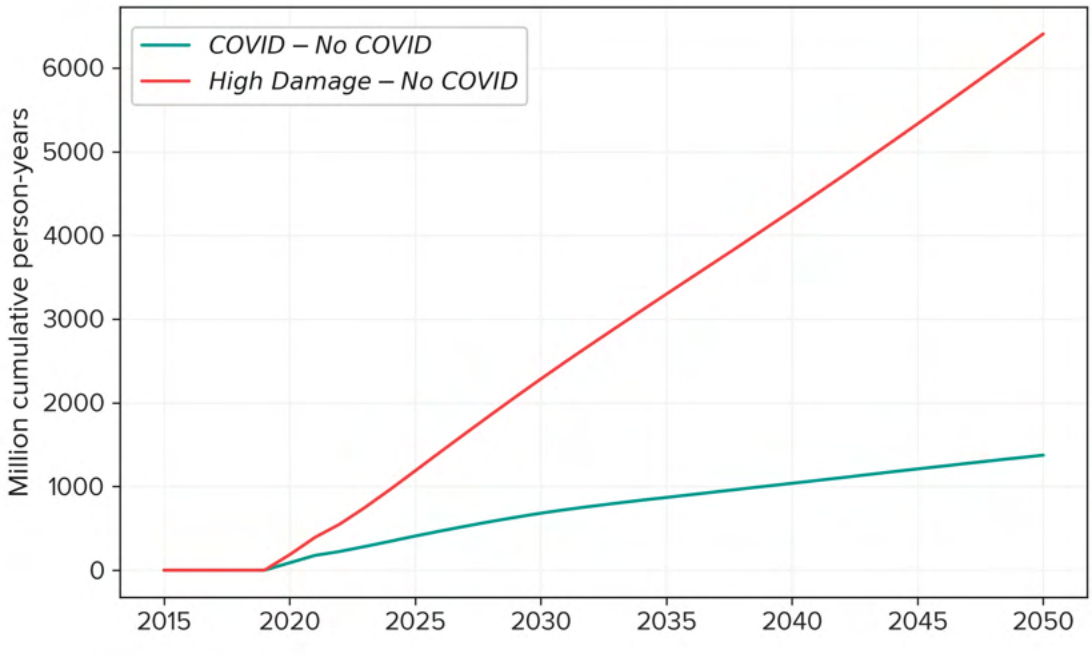


Figure 3.6 Incremental global poverty-years in the *COVID* scenarios relative to the *No COVID* scenario
Source: IFs Version 7.61.

3.3 Accelerating Progress

The *SDG Push* scenario models a massive global effort toward and investment in pushing forward the SDG agenda, including poverty alleviation. It provides a vision of a world in which concerted action is taken not only to mitigate the damage of the COVID pandemic but to push development trajectories beyond their *No COVID* pathway and make transformative progress.

In the *SDG Push* scenario, the world recovers from the pandemic-induced poverty spike to return to the *No COVID* path by 2025. After that, continued development lowers the poverty rate to 7.1 percent in 2030, 3.4 percentage points below the *COVID* scenario. In this scenario, the world meets the SDG target of a poverty rate below 3 percent at the global level in 2045. This translates to hundreds of millions of people lifted out of poverty. By 2030, *SDG Push* results in 125 million fewer people in poverty than the *COVID* baseline. By 2050, that figure grows to more than 260 million.

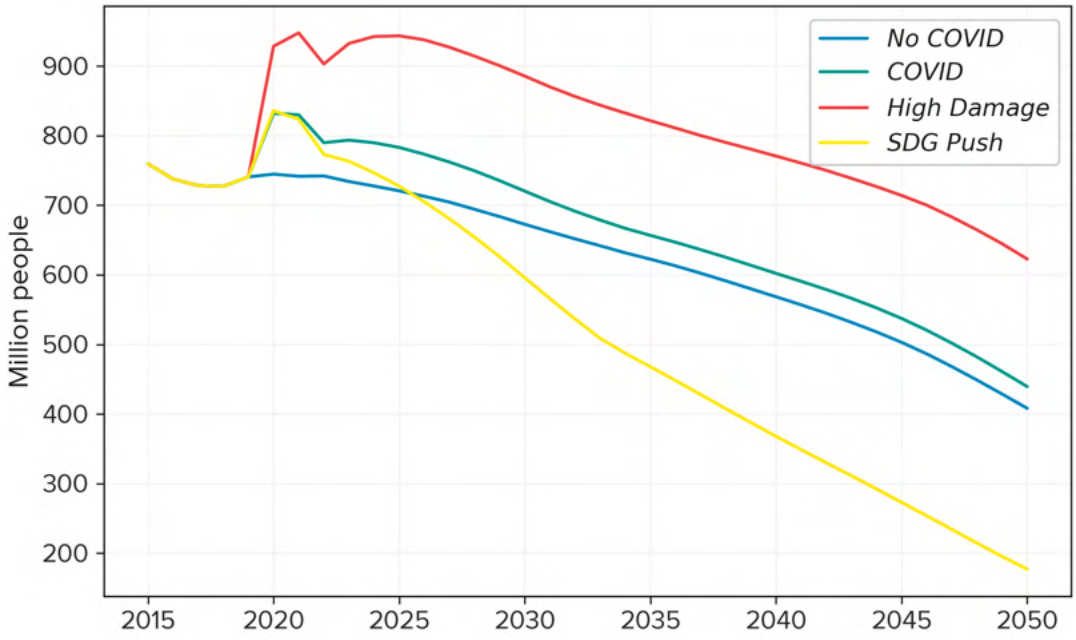


Figure 3.7 Global poverty headcount across scenarios
Source: IFs Version 7.61.

The *SDG Push* models a considerable acceleration toward gender wage parity, so it also moves to close the gender poverty gap. Compared to the *COVID* scenario, the *SDG Push* scenario lifts 64 million women out of poverty by 2030 and 133 million by 2050. It completely closes the gender gap in poverty headcount by 2037. The poverty rate difference between men and women is generally greatest from age 25 to 34. In 2019, the female poverty rate in this age group (9 percent) was 1.3 percentage points higher than the corresponding male poverty rate. Under the *SDG Push* scenario, that gap narrows to 1 percentage point by 2030 and less than one third of a percentage point by 2050.

This scenario leads to a considerable boost to the number of countries reaching the SDG 1 target. As a result of the *SDG Push*, 118 countries meet the SDG target, operationalized as 3 percent extreme poverty or less, by 2030 (11 more than in the *COVID* scenario) and 158 countries – all but 28 of those represented in IFs – reach the target by 2050.

The rapid alleviation of poverty is even more evident in terms of cumulative reduction in poverty-years. Relative to the *COVID* scenario, the *SDG Push* scenario results in more than 400 million fewer poverty-years by 2030 and 2.4 billion by 2050. Moreover, looking at poverty-years shows how much the *SDG Push* can accelerate development relative to its expected path before the pandemic. By 2050, the *SDG Push* results in 1.8 billion fewer poverty-years than even in the *No COVID* scenario.

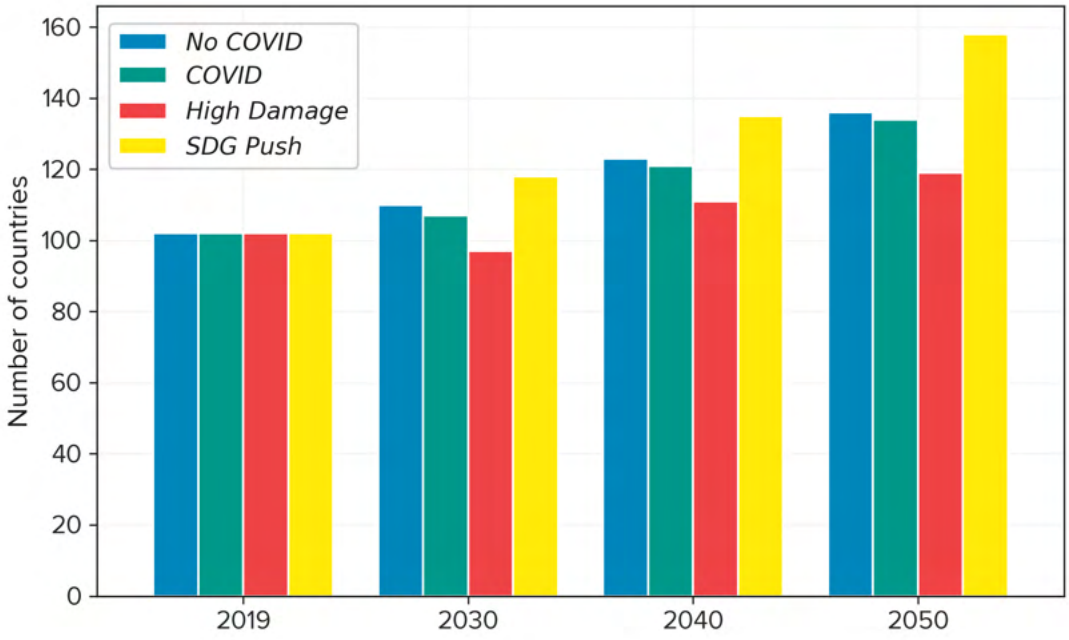


Figure 3.8 Number of countries projected to meet the 3 percent poverty target in select years by scenario
Source: IFs Version 7.61.

3.4 A Foundation for Acceleration: Governance

Many of the interventions in the *SDG Push* scenario involve or build on governmental action. Governments can learn, change policies, and develop new and innovative ones. The quality of governance–the relationship between government and society – is of fundamental importance in undergirding such learning and the shaping and implementation of policy. Thus, improvements in governance, including its transparency, effectiveness, and inclusiveness, are important in themselves and as foundations upon which to structure and implement the policies that will accelerate progress toward the goals and their targets.

Future work building upon this study will include decomposing the elements of *SDG Push* and exploring the appropriateness and scaling of its components for individual countries with special attention to the lowest income and most fragile countries. We can usefully illustrate the value of such decomposition by addressing a foundational question: "What portion of the impact of *SDG Push* might be attributable directly to change in governance quality?"

Three interventions in the much larger set of those for *SDG Push* relate directly to governance quality: reduced corruption (increased transparency), increased effectiveness, and enhanced inclusiveness (democracy). We find that these three interventions alone account for about one-sixth of the reduction in global poverty by 2030 in the *SDG Push* scenario (relative to *COVID*) and nearly one-third of that reduction by 2050. The primary path in IFs generating those results is the contribution of governance variables to total factor productivity in the economic model (Hughes & Narayan, in press) and the impacts of resultant acceleration of GDP growth for progress toward the SDG targets. Higher GDP per capita generally raises average household income and consumption, thereby reducing the share of population suffering from poverty. In many cases progress toward the SDG targets generates additional contributions to economic growth via the positive feedback loops linking growth and human development.

In short, governance improvements alone appear to be an important focal point for action in pursuit of the SDGs, as well as a foundation for a broad range of policy enhancements. Future work will further elaborate the direct impacts and extended dynamics around governance and other elements of an *SDG Push*.

Shutterstock / AleFron, Lidiya Ribakova

4. Nutrition

SDG 2 seeks to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture." Targets for this goal include ending hunger by ensuring access to safe, nutritious and sufficient food to all people and eliminating malnutrition. SDG 2 also seeks to reduce stunting and wasting in children under 5 years of age by 2025.

Undernourishment is a primary concept associated with hunger in a population; while definitionally it refers to a deficiency of nutrients, it is commonly considered to exist when caloric intake is below minimum requirements for life. Two concepts associated with undernourishment in children are stunting and wasting. Stunting is apparent when a child has height-for-age that is two or more standard deviations below standards for median values identified by the World Health Organization (WHO); wasting appears when weight-for-height is two or more standard deviations below WHO-identified median values and severe wasting appears at three standard deviations. IFs includes variables for population undernourishment, child stunting, and severe wasting; it also includes a child undernutrition variable that represents one or more standard deviations below weight-for-age. While recognizing that levels of zero are ultimate goals, as with extreme poverty we operationalize global and country success as bringing rates for total and child undernourishment and for child stunting below 3 percent. For child stunting we also look to the WHO/UNICEF (2018a) target of reducing numbers by 50 percent between 2012 and 2030.

Methodological issues take on special importance when we forecast undernutrition because of significant differences between forecasts from very reputable sources. Prior to COVID-19, the United States Department of Agriculture (USDA) forecast for 76 countries with significant prevalence of undernutrition, 761 million people would be food insecure in 2020 and 406 million would be food insecure by 2030 (Baquedano et al., 2020). According to the Food and Agriculture Organization (FAO), there were 690 million undernourished people in 2019 or 8.9 percent of the world's population. The FAO's 2019 values are lower than USDA estimates in large part due to downward revision by the FAO of numbers in China (FAO et al., 2020). Globally, the FAO found that since 2014, an additional 60 million people have become affected by hunger. Building significantly upon this recent upward trend, the FAO forecasts the number of undernourished people to exceed 840 million by 2030, even without COVID. This equates to an almost 1 percentage point increase in the prevalence of the undernourished between 2019 and 2030 (FAO et al., 2020), in marked contrast to the cutting of that rate globally by half between 1991 and 2010.

The significant difference in forecasts with respect to the pre-COVID trends in undernourishment by the FAO and USDA merits attention. Methodologies of both organizations incorporate attention to per capita caloric food demand, the distribution of calories across the population and the threshold below which an individual is considered food insecure (Naiken, 2002; Thome et al., 2019). While the USDA keeps the threshold for undernourishment and the distribution of calories across the population constant, the FAO values are tied to country-specific data and change over time. However, while these differences alter the specific undernourishment forecasts per country, they do not explain the difference in overall direction of undernourishment between the forecasts.

The key methodological difference is around the forecasts of mean caloric availability. The FAO separately forecasts population growth and an extrapolation of total calories available from the trend in the prevalence of undernutrition, weighting recent years heavily. This approach generates an expectation that the rise in total caloric availability (or potentially in effective demand) will be lower than population increase for some rapidly growing populations, resulting in a reduction in mean caloric availability for those countries. This decrease in mean food supply leads to projections of an increase in undernourishment. In contrast, the USDA forecasts mean caloric availability, driven by changes in GDP per capita and food prices. It is a demand-side driven model that assumes food supply can satisfy growing food demand. With rising levels of GDP per capita, the USDA forecasts a gradual increase in caloric demand and availability and a reduction in the prevalence of undernourishment.

The IFs system represents the agricultural production and trade subsystems underlying total caloric availability, as well as the food demand system driven by population, GDP per capita, and income distribution. In general, IFs projects mean caloric demand to increase, and that only in some specific instances will domestic supply and agricultural trade be insufficient to meet effective demand. The forecast drivers for child undernutrition also include access to improved sanitation and clean water, because that access reduces the incidence of diarrheal disease and facilitates nutrient utilization. Stunting of children in IFs reflects a combination of their general undernourishment rate and the extent of severe acute malnutrition (severe wasting), to which domestic instability and conflict also contributes.

4.1 The Path We Were On Before COVID

Although the world experienced marked improvement in undernourished numbers and prevalence rates of undernutrition across recent decades, much remained to be done to achieve the SDG 2 targets even before the onset of COVID-19. *No COVID* scenario forecasts of rates and numbers of undernutrition in IFs lie between the USDA and FAO studies. The FAO estimates a numerical increase in undernourished people of 22 percent between 2019 and 2030, quite far above the forecast reduction in IFs of around 16 percent and very far above the forecast reduction by the USDA of 46 percent for the 76 countries it studies between 2020 and 2030 (Baquedano et al., 2020; FAO et al., 2020). Between 2019 and 2030, IFs forecasts a decrease of more than two percentage points in the total global population that is undernourished to a rate of 7.2 percent in 2030 (see Figure 4.1). The *No COVID* rate declines further to 4.5 percent in 2050, but this is still well above the 3 percent target for ending hunger.

The values for child undernutrition using the weight-for-age measure are consistently higher than those of the general population. The rate declines only to 10.1 percent in 2030 and 6.4 percent in 2050. Wasting (height-for-age) is a more severe level of undernutrition than child undernutrition and afflicted 47 million children in 2019 (UNICEF et al., 2020) compared to about 97 million using the weight-for-age child undernutrition measure. The severe wasting number from IFs in 2019 is 28 million, 2.3 percent of the global population.

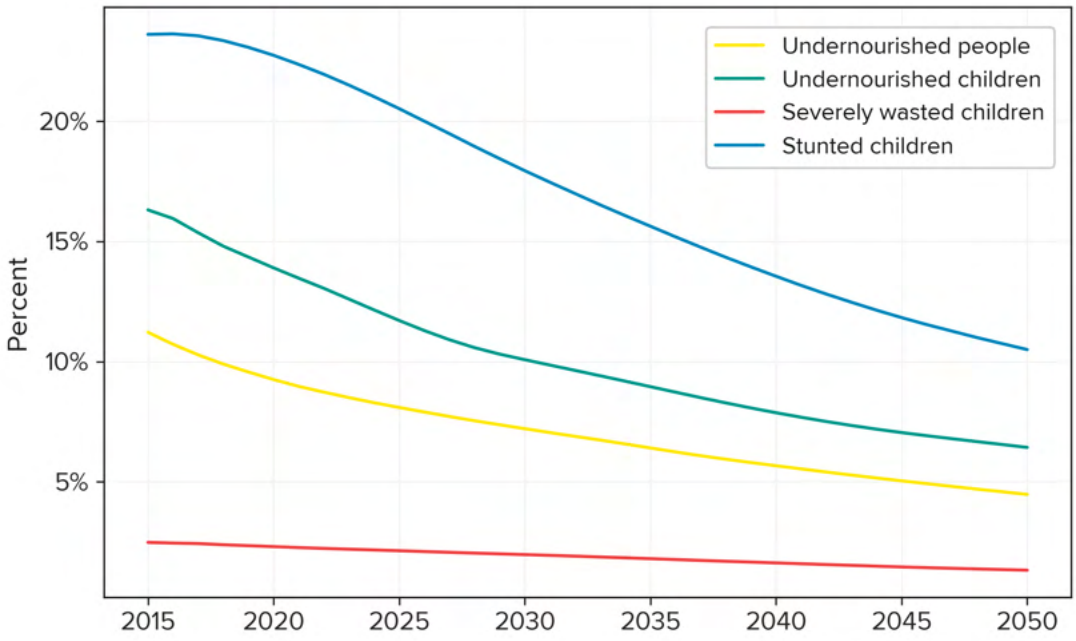


Figure 4.1 Percentages of undernourished people, undernourished children, severely wasted children, and stunted children, *No COVID* scenario
Source: IFs Version 7.61.

All four measures of undernourishment in Figure 4.1 decline through 2050 in the *No COVID* scenario. The highest rates are for stunting. Wasting and especially severe wasting, typically an intermittent impact of wars, droughts, and economic disruptions, often leave children with long-term stunting, as can more persistent but less severe undernourishment. According to UNICEF/WHO/WB Joint Child Malnutrition Estimates group (JME), 144 million children (21.3 percent) under 5 were afflicted with stunting in 2019 (UNICEF et al., 2020). Following current trends, JME forecasts stunting prevalence to decline to 19 percent of the child population in 2025. The IFs *No COVID* scenario produces 20.9 percent in that year and 17.9 percent in 2030 (122 million children). Stunting numbers not only fail to come at all close to a 3 percent level but remain well above the WHO/UNICEF target for 2030 of reducing the total by 50 percent relative to 176 million in 2012, a target reached only about mid-century in the *No COVID* forecast from IFs.

A 3 percent target might also be appropriate for wasting, but IFs does not forecast that variable. Severe wasting is so terrible that the target really must be zero; somewhat less than 3 percent of the child population suffers from it now, and very unfortunately the level does not reach zero even by 2050. All the other measures remain above a 3 percent target level even through 2050 (see Figure 4.1 again).

The situation is even worse in some subsets of global countries. Low-income countries (using the World Bank's classification) have the highest rates of undernourished population (Figure 4.2). In the *No COVID* scenario, 24 percent of the population across low-income countries would have been undernourished in 2020, 19 percent in 2030, and still 9 percent in 2050.

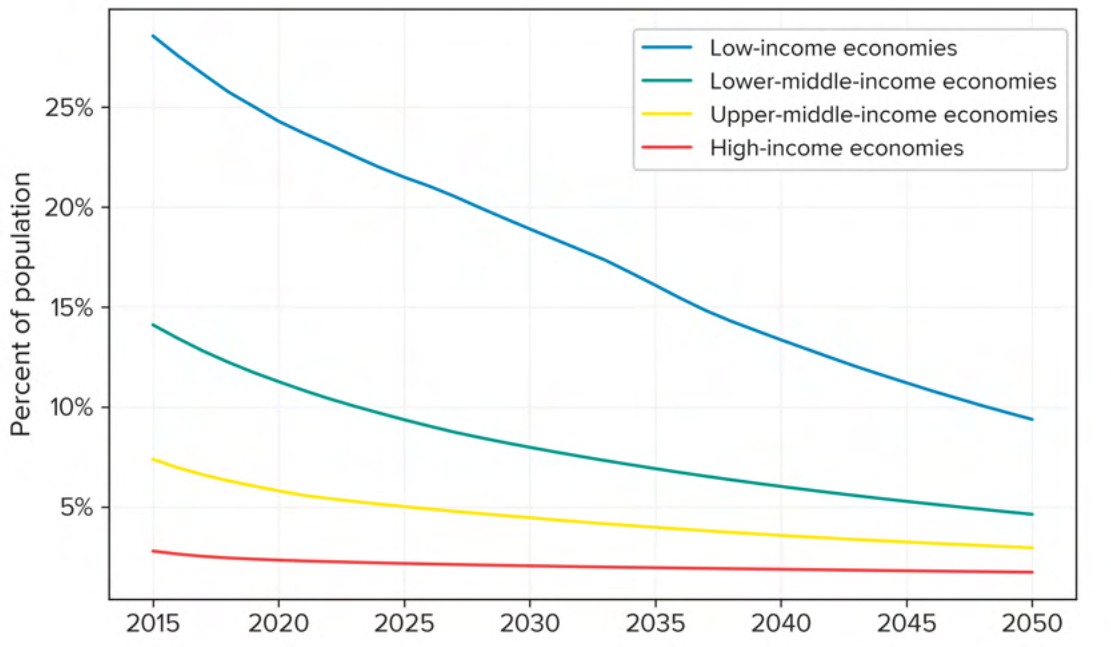


Figure 4.2 Percent of undernourished people across World Bank income groups, *No COVID* scenario
Source: IFs Version 7.61.

On a headcount basis, the largest number of the undernourished live in lower-middle-income countries, about 50 percent of those in India alone. While those numbers have been on a path to decline steadily toward mid-century, the numbers in low-income countries were unfortunately likely to remain quite stable in the *No COVID* world.

Regionally, Central and Southern Asia has suffered the largest portion of undernourished population globally and will likely continue to be in that position through 2050 (Figure 4.4). Not surprisingly, the patterns of Figures 4.3 and 4.4 are quite similar, given that a large share of low-income countries are Sub-Saharan (SS) African and a large number of Asian countries are in the lower-middle-income and upper-middle-income groupings. Currently, nearly 60 percent of the undernourished live in Central, Southern, Eastern and South-Eastern Asia and all but about 15 percent of the rest are in SS Africa. In 2050, the portions in Asia and SS-Africa will be 43 and 38 percent, respectively. Given population growth, the numbers in SS-Africa will have changed little across a third of the century.

In the *No COVID* world in 2020 only 56 of 186 countries in IFs would have achieved a 3 percent or lower target for the population that is undernourished (Figure 4.5). By 2030, this number grows to 65 countries and reaches 74 countries in 2050, leaving 112 countries in 2050 that will have not met that nutrition target operationalization.

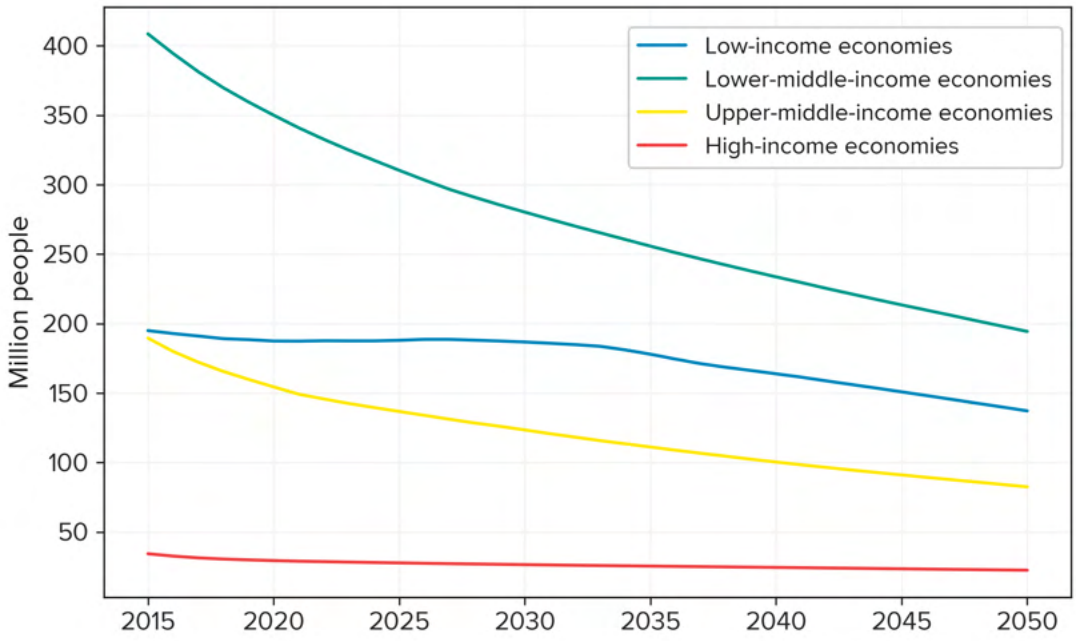


Figure 4.3 Undernourished population headcount in millions across World Bank income groups, *No COVID* scenario
Source: IFs Version 7.61.

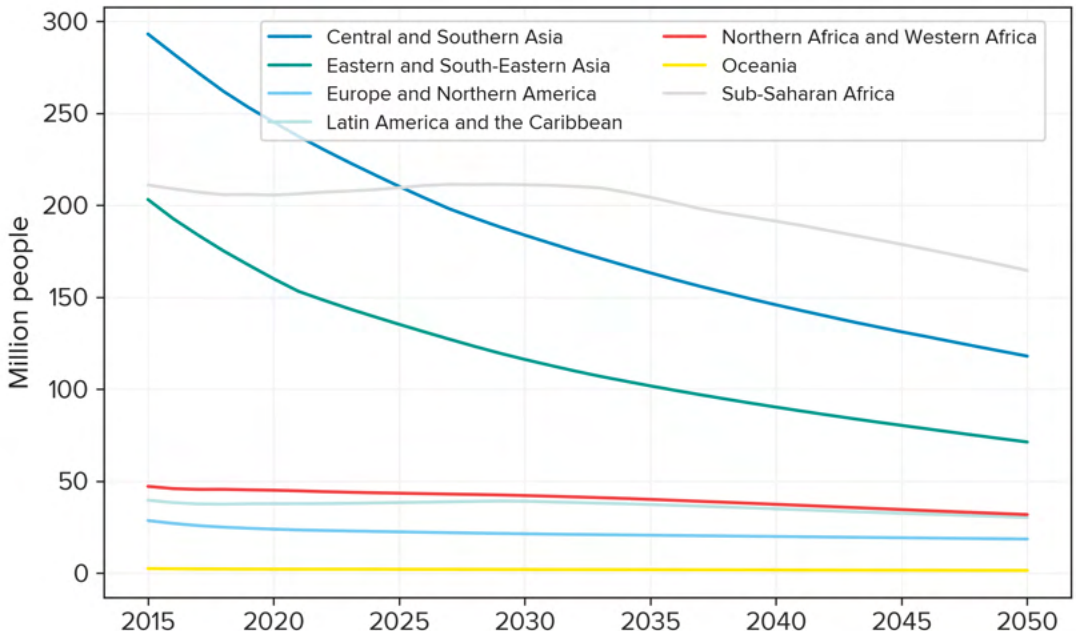


Figure 4.4 Undernourished headcount by UN SDG region, *No COVID* scenario
Source: IFs Version 7.61.

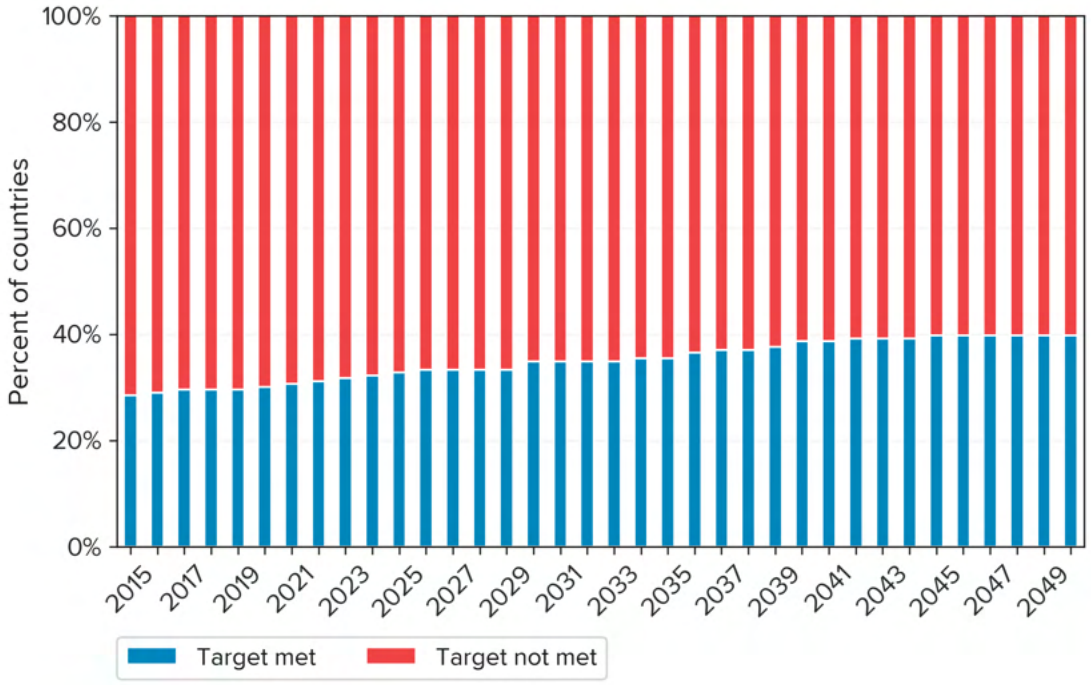


Figure 4.5 Numbers of countries bringing and not bringing undernourished population to three percent or less, *No COVID* scenario
Source: IFs Version 7.61.

As indicated in the earlier discussion of IFs projections relative to those from the USDA and FAO, the underlying driver of decreased rates of global and regional undernutrition anticipated in the *No COVID* and other scenarios of this analysis is growing mean values of calories per day available across most countries of the world. Figure 4.6 displays calories per capita available in the four global income categories and shows increasing calories to have been the pattern since 1995 and to continue in the *No COVID* scenario projection through 2050. Presently all income categories have more than 2,100 calories per capita available per day on average, the threshold USDA defines as the average value necessary for a healthy and active lifestyle (Baquedano et al., 2020). The issue has increasingly become adequately distributing calories across populations as well as the underlying quality (nutritional value) of those calories.

The likely continuation in the improvement of nutrition globally is very consistent with the near certain continuation of poverty reduction discussed in the previous section. Box 4.1 discusses the fundamentally close relationship between progress toward the twin goals of eradicating poverty and undernutrition.

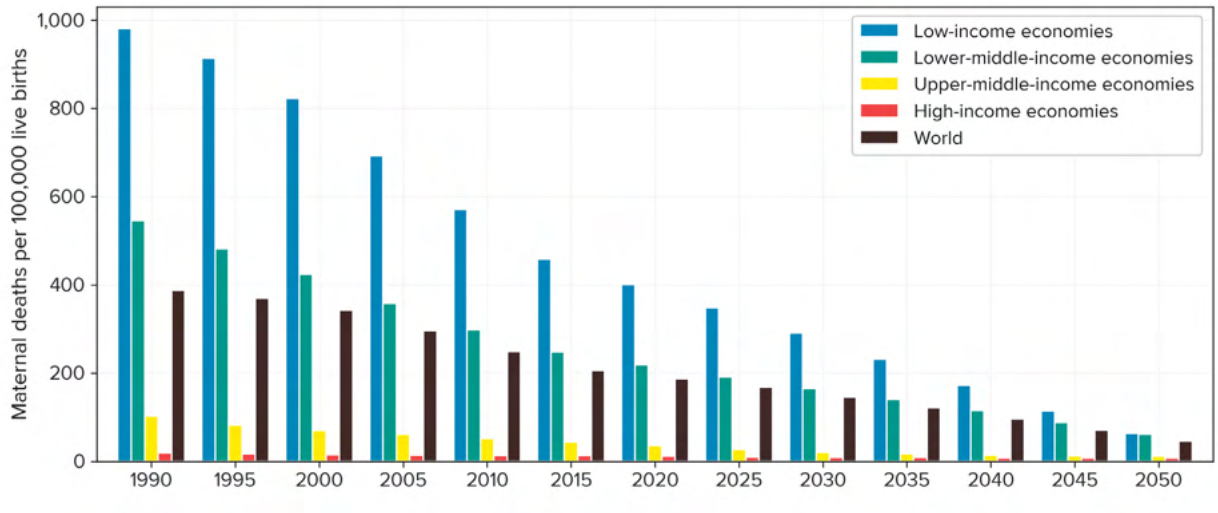
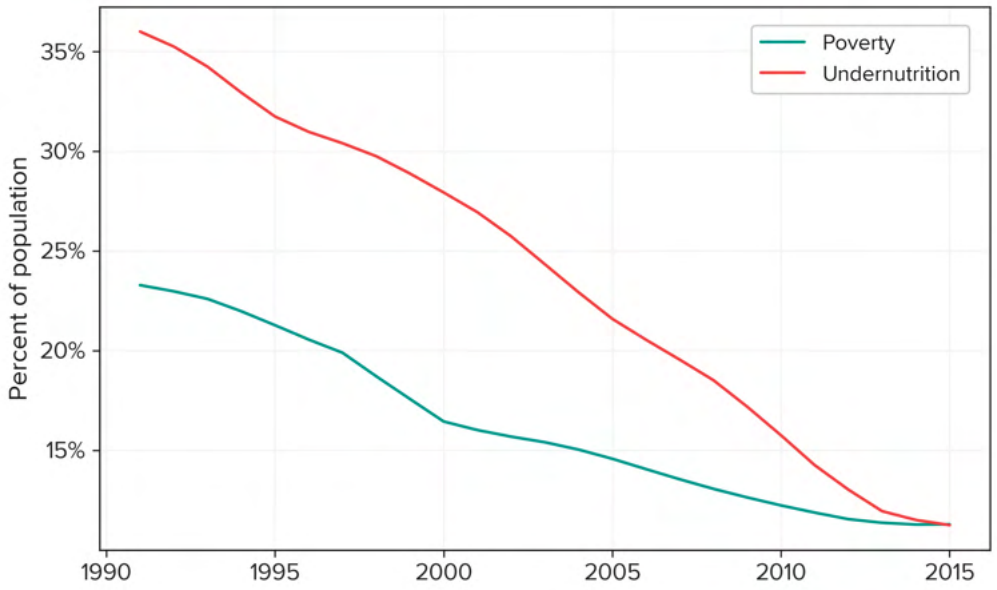


Figure 4.6 Calories per capita available for World Bank income groups 1970 to 2050, *No COVID* scenario
Note: FAO data through 2015 and IFs forecasts subsequently; country numbers in the FAO database increase across time and there is considerable year-to-year volatility in calories for many; the bar graphic visually smooths the patterns.
Source: IFs Version 7.61.

Box 4.1 What is the relationship between rates of extreme poverty and malnutrition?

The earliest work in identifying a universal extreme poverty line, including that of Ravallion, Datt, and van de Walle (1991), recognized the need to link its specification to consumption potential at purchasing power parity and to recognize the importance of distribution of that potential within and across societies. At low levels of income very large portions of it support food consumption, creating an automatic linkage between reduction in poverty and improvement in nutrition. Box Figure 4.1 shows that relationship over time.



Box Figure 4.1 Global poverty and undernutrition 1995 to 2050, *No COVID* scenario
Note: Data smoothed by filling country holes with interpolation and using a 5-year moving average.
Source: IFs Version 7.61.

At the same time, however, the somewhat faster decline historically in extreme poverty than in undernutrition suggests a less than perfect relationship between the two, most notably in the differing values of the 1990s and the subsequent convergence. The Human Development Report 2005 recognized other factors that interact with poverty decline in reducing undernutrition, including gender inequality like that in India that maintained gender gaps in primary education and boosted child underweight rates (Antony & Laxmaiah, 2008). Similarly, unsafe water and sanitation increase incidence of diarrhea and undernutrition in children; addressing that issue requires more than poverty reduction. Those poverty and nutrition differentiating factors related to infrastructure are part of the forecasting formulation for child undernutrition in IFs along with average calorie access; also, income distribution as represented by the level of income in unskilled-labor households interacts with calorie access for population undernutrition forecasting in IFs.

In general, however, we can normally expect the directions of change in percentages in extreme poverty and undernourishment to be the same across time.

4.2 The Damage that COVID Inflicts

COVID-19 has complicated the path to achievement of SDG 2 through its impact on food systems and poverty. COVID-19 has resulted in both supply and demand shocks to the food system as disruptions in the food supply chain including logistics, transportation and labor have led to some reductions in supply that, combined with a decline in household incomes and consumption, contributes to an overall decline in market access, especially for the most vulnerable. In the short-term, agricultural trade is being impacted; research points to around a 24 percent decline in agrifood exports from developed countries and over a 30 percent decline in agrifood exports from developing countries in 2020 as a result of COVID-19 demand and supply shocks (Laborde, Martin, et al., 2020). The International Food Policy Research Institute (IFPRI) estimates that agricultural and productivity declines due to COVID could lower global per capita calorie consumption by 5 percent in 2020. The pandemic is also anticipated to result in an increase in malnutrition due not only to decreasing market access but to an overall increase in food prices and decreased provision of state-sponsored meals due to school closures. Overall diet quality may also decline concurrent with declines in purchasing power as many individuals and families may shift towards purchasing less expensive or non-perishable food items with lower nutritional quality (FAO et al., 2020).

The extent to which these impacts will persist beyond the near-term remains uncertain. It is likely that the shocks to food supply will be relatively temporary because agricultural inputs including land, water availability, technology and labor availability will not be permanently damaged by the pandemic. From a demand perspective, although household incomes and purchasing power are reduced in the short-term, consumption should rebound. This is especially true because food is at the foundation of the consumption structure.

According to the USDA International Food Security Assessment Model, COVID-19 will result in an increase of 84 million food-insecure people in 2020, an increase of 11 percent over a *No COVID* scenario (Baquedano et al., 2020). This would imply that 22 percent of the population within the 76 countries that USDA focuses on in their analysis will be unable to consume 2100 calories a day. Looking out to 2030, the USDA forecasts a significant drop in food insecurity relative to 2020, despite the expectation that COVID-19 will result in almost a 13 percent (equating to 51 million people) increase in food insecurity in 2030 relative to a *No COVID* scenario. These forecasts are based on April 2020 IMF estimates for GDP growth rates. The FAO forecasts anticipate an additional 83 to 132 million undernourished people in 2020. This is affected by a range of loss in GDP growth of 4.9 to 10 percentage points due to the pandemic (FAO et al., 2020).

Shutterstock / Sergei Kazakov

The impacts of COVID-19 on global food security will of course have consequences for child undernourishment as well with von Braun (2020) from IFPRI estimating that 16 million more children will be malnourished in 2020. Projections based on IFPRI's MIRAGRODEP model suggest that there could be a 14.3 percent increase in the prevalence of moderate or severe wasting in children under 5, equating to 6.7 million additional children with wasting in 2020 as compared to a *No COVID* world (UNICEF et al., 2020).

IFs forecasts 38 million additional people undernourished globally in 2020 in the baseline *COVID* scenario versus the *No COVID* scenario. Figure 4.7 shows the breakdown by income-level grouping. The persistence of some portion of the rise in undernutrition through 2030 is tied to the *COVID* scenario assumption that some portion of the pandemic-period economic decline in GDP will not be recovered. In the *High Damage* scenario (see Figure 4.8), 45 million people additional people are undernourished as compared to the *No COVID* scenario. Persistence of the increase is greater with *High Damage* because the scenario posits greater persistence of the economic damage of the pandemic.

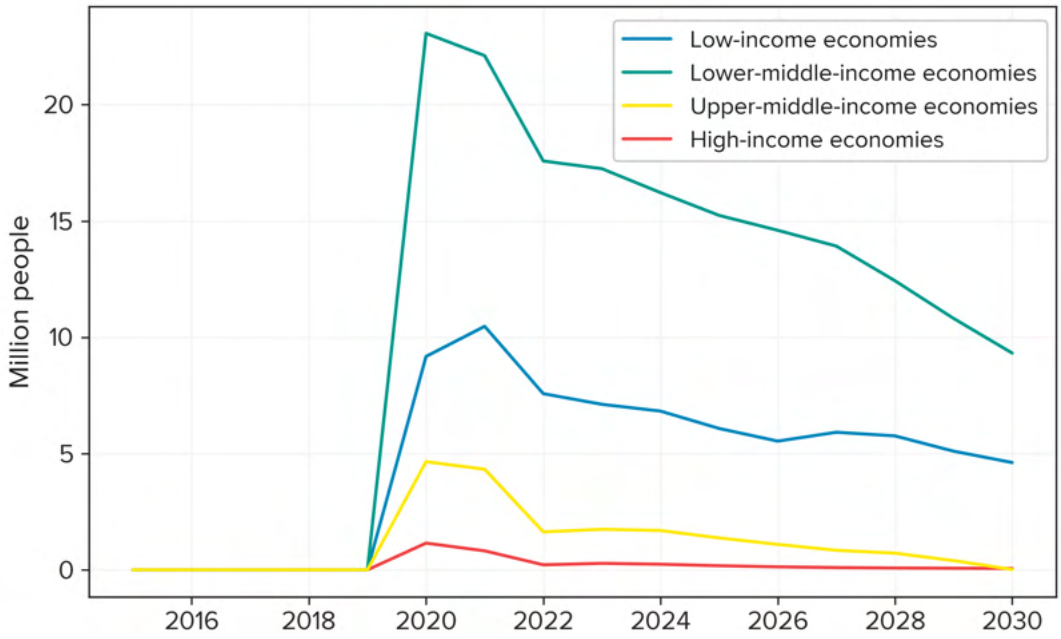


Figure 4.7 Change in number of undernourished people *COVID* vs *No COVID* scenarios for World Bank income groups
Source: IFs Version 7.61

In 2030 the *COVID* and *High Damage* scenarios leave an additional 2 million and 5 million children undernourished relative to *No COVID*, respectively. The numbers of additional stunted children are 3 and 7.5 million, with lifelong consequences for those children.

Each year that someone suffers undernutrition carries tremendous costs for them. COVID-19 will add many person-years of such costs to the already high burden of undernutrition we could have expected in the *No COVID* world. Figure 4.9 shows the cumulative difference in numbers of people undernourished in the *COVID* scenario versus *No COVID* and does the same for *High Damage* versus *No COVID*. This figure makes clear the impact of the possible persistence of economic damage and therefore undernutrition from the COVID years in the *High Damage* scenario. In *High Damage-No COVID* there are nearly 1.4 billion additional person-years of undernutrition through 2050.

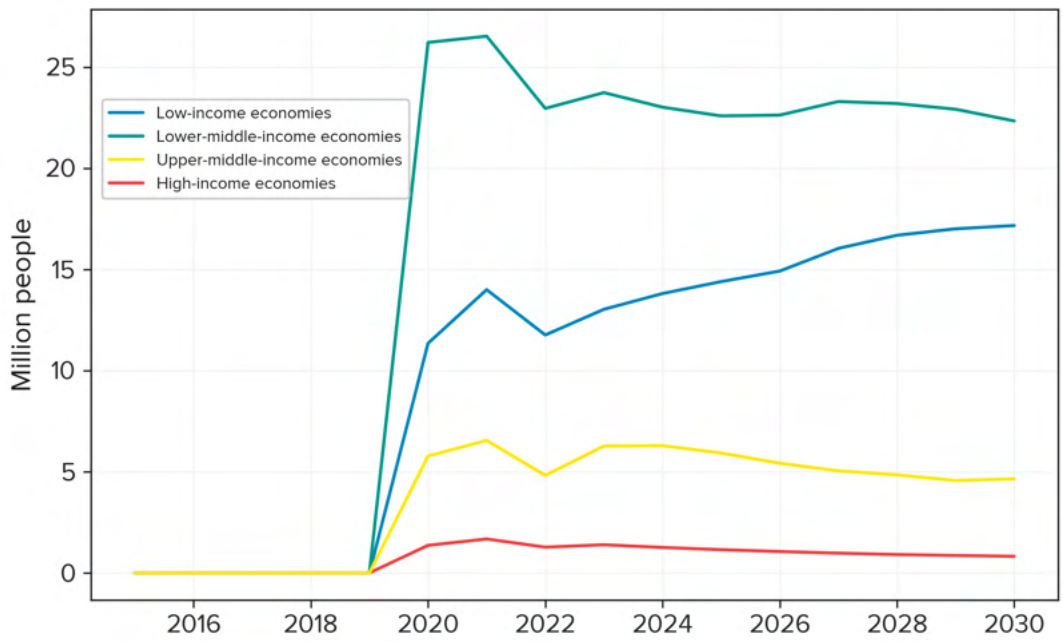


Figure 4.8 Change in number of undernourished people *High Damage* vs *No COVID* scenarios for World Bank income groups

Source: IFs Version 7.61.

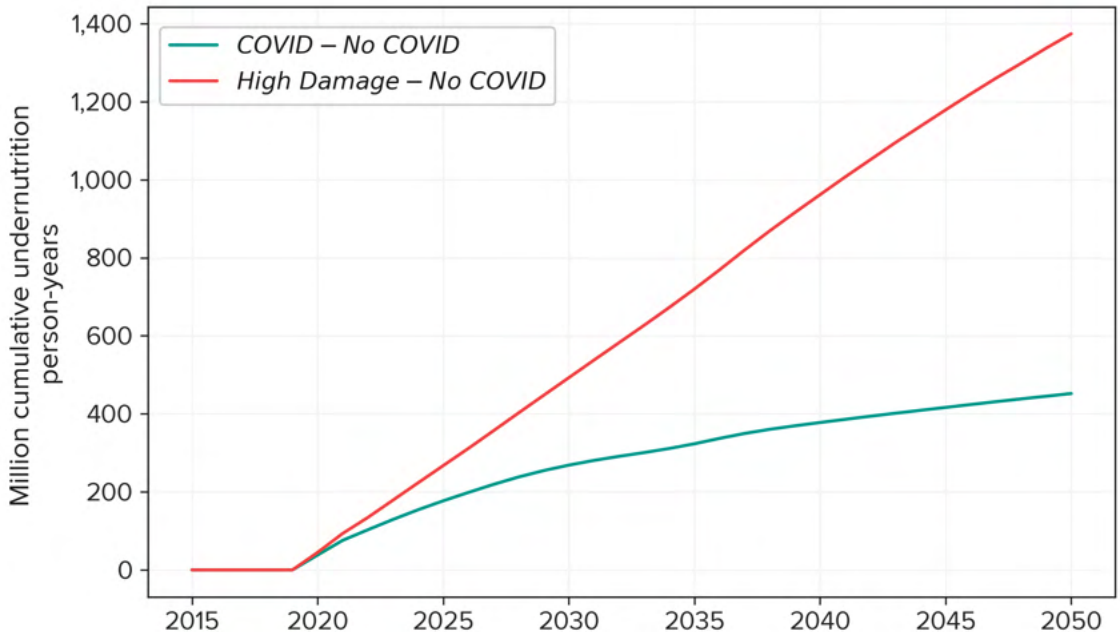


Figure 4.9 Cumulative additional person-years of undernutrition globally in *COVID* and *High Damage* scenarios vs *No COVID*

Source: IFs Version 7.61.

4.3 Accelerating Progress

Prior to the COVID-19 pandemic, the world was not on course to reach the SDG 2 nutrition targets. COVID-19 will almost certainly slow the progress that was being made, especially for those most vulnerable. The *SDG Push* scenario is designed to illustrate a world in which significant, coordinated and rapid action is taken to drive toward SDG achievement across all SDGs with a particular focus on achieving the SDGs through the four levers for action identified by the first quadrennial Global Sustainable Development Report (Independent Group of Scientists appointed by the Secretary-General, 2019). These are: Governance (building a new social contract), Social protection (uprooting inequalities), Green economy (rebalancing nature, climate, economy), and Digital disruption and innovation (for speed and scale).

Nutrition is influenced by many different factors. Decreasing global and country-level malnutrition requires simultaneously improving food availability, access and utilization (HLPF, 2020). In particular, issues like conflict and migration, climate change, and economic inequality significantly influence the provision of food. COVID-19 has tangibly disrupted agricultural trade and reduced incomes and consumption. Going forward, increased risk of conflict and geopolitical issues as well as growing inequality, may worsen COVID-19's impact on food security.

The *SDG Push* scenario reduces malnutrition for children and adults through interventions to improve water and sanitation access, education and governance transparency and effectiveness.

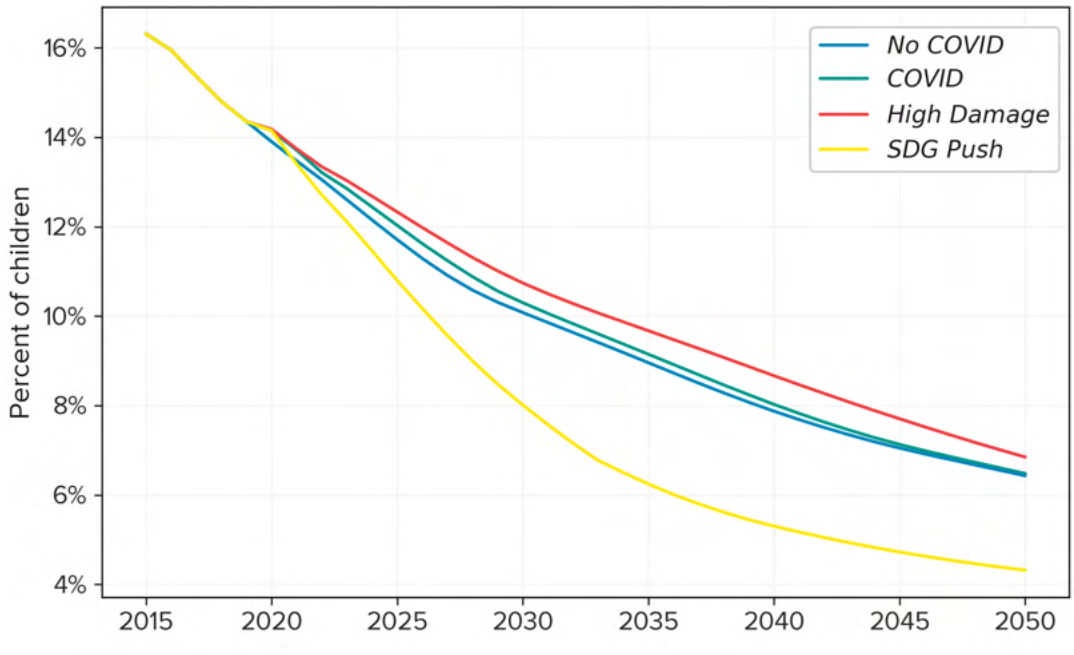


Figure 4.10 Undernourished children; *No COVID*, *COVID*, *High Damage* and *SDG Push* scenarios
Source: IFs Version 7.61.

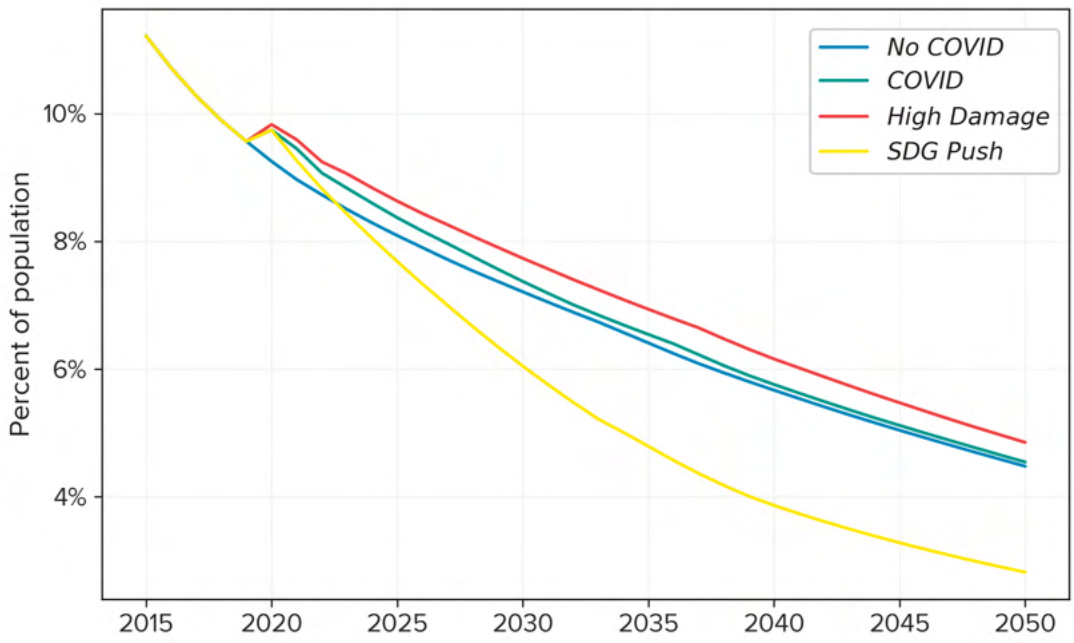


Figure 4.11 Undernourished people: *No COVID*, *COVID*, *High Damage* and *SDG Push* scenarios
Source: IFs Version 7.61.

The percentage of undernourished children decreases to 8.0 in 2030 and the percentage of undernourished people across the whole population declines to 6.0 in the *SDG Push scenario*. Progress continues out through 2050 with under 3 percent of the total population undernourished, an almost 2 percentage point reduction compared to the baseline *COVID* scenario. Unfortunately, just over 4 percent of children remain undernourished in 2050. The *SDG Push* scenario quite nearly reduces the number of stunted children by 50 percent in 2030 relative to the total in 2012; unfortunately, 7 percent remain stunted even in 2050.

Even with the *SDG Push*, 56 countries may not be able to reduce undernourishment below 3 percent of their populations by 2050 and an appalling 84 may not reduce the child weight-for-age measure below that level. The global fight to eliminate undernourishment is going to remain a very difficult one.

5. Health

SDG 3 is to "Ensure healthy lives and promote well-being for all at all ages." The first two targets associated with the goal involve (1) reduction of maternal mortality globally to below 70 per 100,000 live births and (2) reduction of neonatal mortality to or below 12 per 1,000 live births and under-5 mortality to or below 25 per 1,000. Neonatal mortality is generally understood to mean death within the first four weeks after birth and child mortality is that which occurs before age 5. Although it is not an explicit SDG target, we will also give some attention to infant mortality (death in the first year of life) because of its obvious importance and its representation in IFs.

Analysis of prospects for reaching any of the SDG targets obviously depends in part on identifying appropriate values for the model base year. In the case of maternal mortality, estimates in other studies are often acknowledged to be uncertain and vary from 196 (a range of 173-224) per 100,000 live births in 2019 using work by the Institute of Health Metrics and Evaluation or IHME (Kassebaum et al., 2016), to 211 in 2017 from the UN World Mortality 2019 report (UN DESA, 2020), to 216 (a range of 207-249) in 2015 from work drawing on the United Nations Maternal Mortality Estimation Inter-Agency Group (MMEIG) database Alkema et al. (2016, pp. 3–5). IFs takes its value of 206 in 2015 from the World Bank's World Development Indicators, which draws upon multiple sources including the World Health Organization, UNICEF and the United Nations Population Division. There is less variation across sources in values for child mortality (most are near the 40 per 1,000 live births used in IFs) or neonatal mortality (IFs specifies 19 per 1,000).

5.1 The Path We Were On Before COVID

Estimating reductions from the trajectories of each country, Alkema et al. (2016, p. 10) projected in their pre-COVID analysis a rate in 2030 of 161 deaths per 100,000. More optimistically, the Gates Foundation (2020, p. 27), even considering also the impact of COVID-19 in 2020 and 2021, projected a value of 144 in 2030, with a range across scenarios from 93-137. Thus, neither set of projections suggested that the world will reach the SDG 3.1 target level of 70 per 100,000 live births by 2030. Nor does the forecast from the *No COVID* scenario of IFs, which brings the value globally down to 145 in 2030.

Yet, by 2050 the IFs forecast for *No COVID* globally is a rate of 46 and even that for low-income countries reaches 63 on average, below the target of 70 per 100,000 live births. See Figure 5.1. Given that the value for low-income countries in 1990 was very nearly 1,000 (a maternal mortality rate of 1 percent at the time of every birth) the course of progress has been quite incredible.

Shutterstock / Dhwoj Gurung

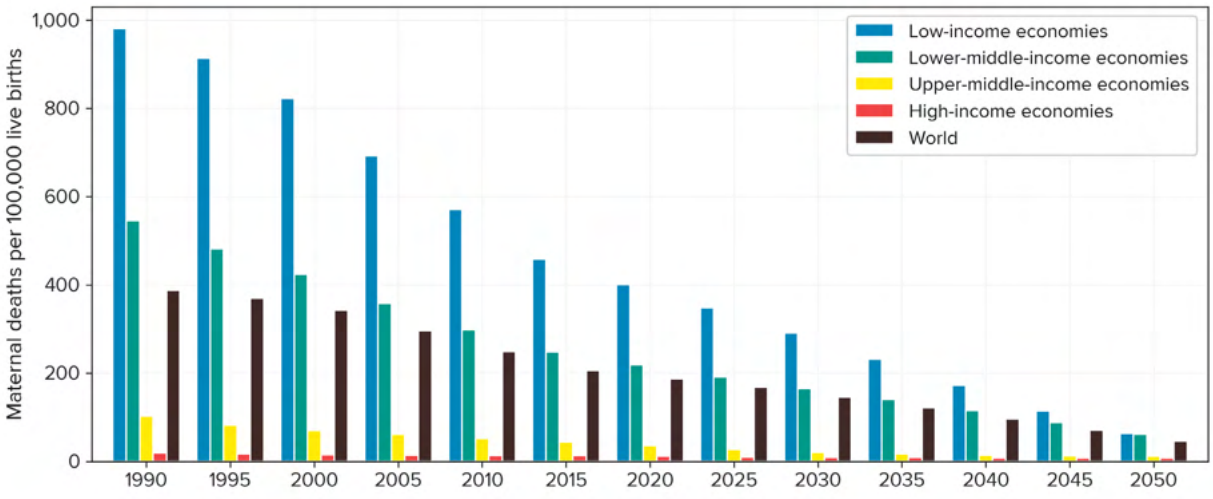


Figure 5.1 Maternal deaths per 100,000 births, history and *No COVID* scenario
Source: IFs Version 7.61.

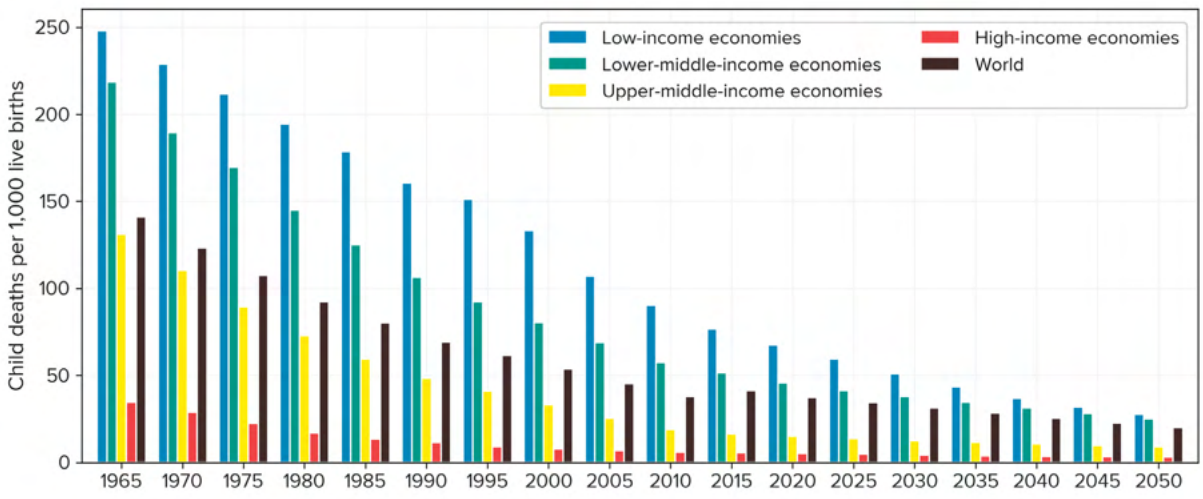


Figure 5.2 Child deaths per 1,000 births, history and *No COVID* scenario
Source: IFs Version 7.61.

To put the longer-horizon, target-reaching values from IFs into broader and unfortunately again less optimistic context, however, high-income countries had already reached a value below 12 per 100,000 births in 2019, a fraction of that expected for low-income countries even in 2050. Further, 23 countries could well still have not reached the SDG target or below by 2050, even had COVID not arrived.

With respect to IFs forecasts of under-5 mortality (Figure 5.2), a global reduction from 41 per 1,000 in 2015 to 31 in 2030 fails to reach the SDG 3.2 target value of 25 or fewer per 1,000 live births in the *No COVID* scenario. Globally, that goal is instead reached in about 2040. Once again, even the progress to 31 per 1,000 in 2030 is remarkable given a global rate of 244 per 1,000 as recently as 1960, when low-income countries were at 266 per 1,000 and even high-income countries were above the current global target with a value of 43 per 1,000. Again tempering that positive perspective, however, is the recognition that even by 2050, 30 countries could have been falling short of the SDG target value in the world prior to COVID.

Looking at neonatal mortality in IFs, the *No COVID* global forecast for 2030 is 13.6 per 1,000 and the target of 12 is reached in 2035. The target value in low-income and lower-middle-income categories is not, reached, however until the 2040s. In 2050, 15 countries appeared in this scenario unlikely to reach the target.

Although there is no SDG target for infant mortality, changes in this indicator over time and across scenarios are of interest. Before COVID, the global infant mortality rate was 149 per 1,000 in 1960 – an appalling 15 percent of all new-born humans died before age 1; it was on a path to reach 23 in 2030 and 14 in 2050.

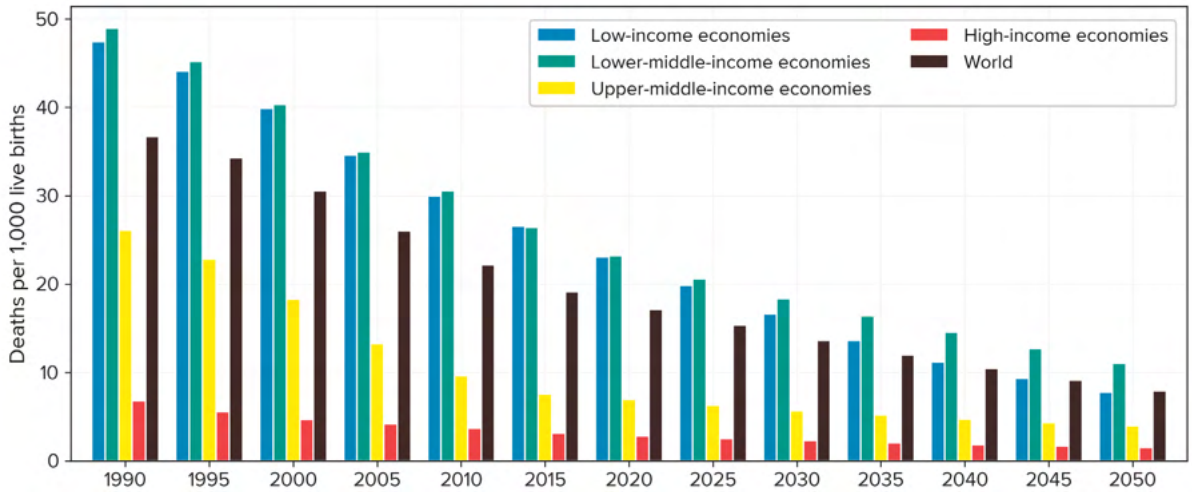


Figure 5.3 Neonatal deaths per 1,000 births, history and *No COVID* scenario
Source: IFs Version 7.61.

5.2 The Damage that COVID Inflicts

Research on the extent of direct increases in maternal, neonatal, infant, and child mortality as a result of COVID-19 is emerging and will become extensive across the pandemic's course. The early consensus (e.g. UNICEF[4]) appears to be that the direct mortality impact of the virus on those variables will not be terribly great; the greatest direct health effect is known to be mortality of the elderly. For instance, a study in Brazil suggested that as of very early June only 20 maternal deaths could be associated with COVID-19 and that this was the largest number in the world at that point (Takemoto et al., 2020, p. 2).

In contrast, indirect health impacts from factors including loss of income, poorer nutrition, and disruptions of seeking or receiving medical care could be very substantial. An early study of those impacts suggested that over 12 months there could be 24-113 thousand additional maternal deaths and 417 thousand to 1.8 million additional child deaths due to increased wasting (Roberton et al., 2020, p. e904). The study argued that within the 118 countries studied, in that project's high impact scenario, and over a six-month period, incremental maternal deaths could increase by 39 percent relative to normal numbers and additional child deaths could increase by 48 percent over typical levels (UNICEF, 2020c).

Further, changes in access to contraception and life patterns could have significant impacts on pregnancy numbers. Estimates of such indirect effects are highly uncertain. For instance, the Global Financing Facility has estimated that loss of access to contraception in the 36 countries where it operates could result in anywhere from 166 thousand to 8 million additional unintended pregnancies – the huge range was associated with length and intensity of the disruption of family planning services (Hayes et al., 2020).

IFs does not include an epidemiological modeling structure, nor does it explicitly represent some of the shorter-term impacts of COVID-19 such as disruption of access to medical care or family planning services resulting from either overloaded medical systems or reluctance by some to seek care during the pandemic. Instead, the focus of IFs is on the longer-term drivers of changes in health conditions including income and educational levels, and access to nutrition. Projections from IFs could therefore underestimate the shorter-term impacts of COVID, even while providing very useful alternative scenario forecasts concerning the longer-term consequences.

Subject to those caveats concerning the missing representation of short-term disruption dynamics, the longer-term drivers in IFs still generate some insight into immediate effects of COVID. Specifically, the rise in maternal mortality globally in 2020 relative to *No COVID* could be a very significant 4.6 percent in its base *COVID* scenario and 5.4 percent in the *High Damage* scenario. The impacts on child deaths are slightly greater (5.2 and 6.1 percent). Due largely to the greater reduction of GDP in 2020 anticipated by the IMF in middle-income countries than in low-income ones, the possible increases in maternal and child mortality in those countries is also greater.

Focusing on the longer-term impact, Figure 5.4 shows the differential rate of maternal mortality in the two *COVID* scenarios relative to a *No COVID* world. In the baseline *COVID* scenario of this study, the initial surge of maternal mortality largely erodes over time, whereas in the *High Damage* scenario it persists. (For context, the *No COVID* scenario produced values of 189 per 100,000 in 2019, 145 in 2030 and 46 in 2050.)

[4] https://data.unicef.org/topic/child-survival/covid-19/#status

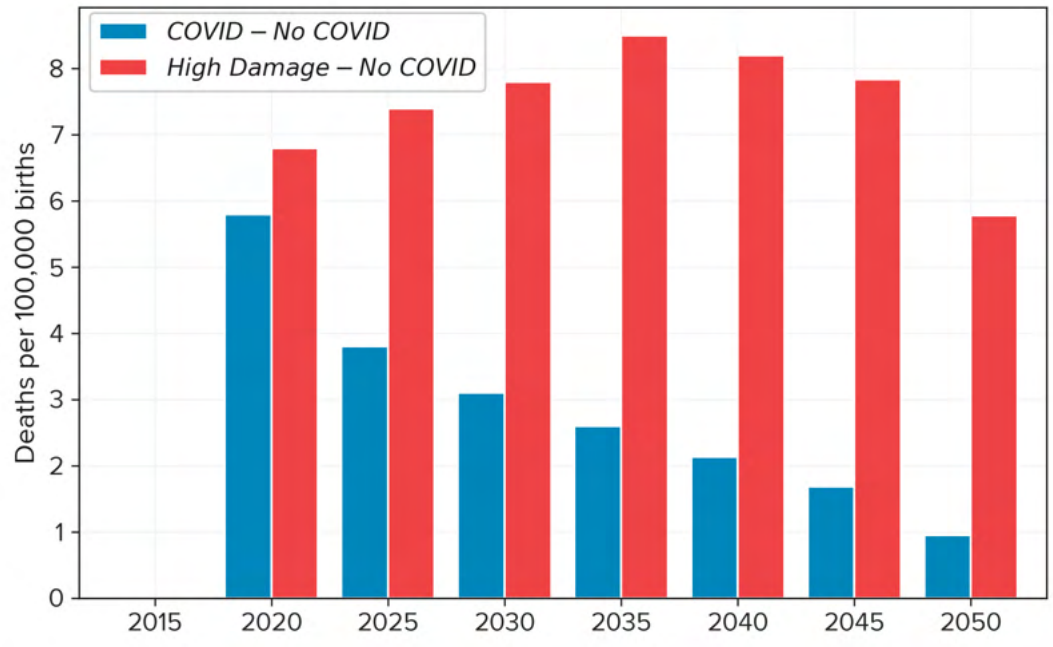


Figure 5.4 Rise in global maternal mortality in the *COVID* scenario relative to *No COVID*
Source: IFs Version 7.61.

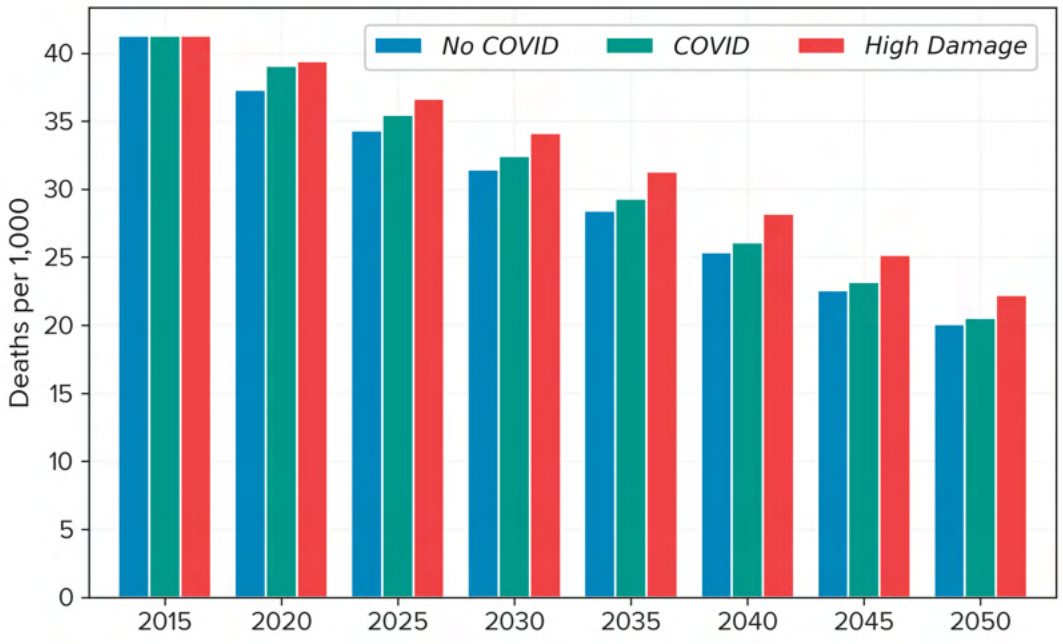


Figure 5.5 Global child mortality per 1,000 births, values across *COVID* scenarios
Source: IFs Version 7.61.

With respect to child mortality, the longer-term pattern of impact from the two *COVID* scenarios is similar (see Figure 5.5). In 2030 the increase in the *COVID* scenario relative to *No COVID* is about 1 per 1,000 and in the *High Damage* scenario it is nearly 3 per 1,000. Projections of global birth numbers through mid-century are remarkably stable at approximately 144 million annually; thus, each death per thousand is equivalent to 144,000 additional deaths. Each additional child death per thousand per year would therefore cost a cumulative total of 4.3 million child lives in the years between 2020 and 2050 – the impact from the *COVID* scenario is well above that number and that from *High Damage* is about six times higher.

We know of no other projection set against which we can compare this potential long-term COVID impact analysis. In the 2019 edition of Goalkeepers, however, the difference between the central and worst scenario in 2030 for under-5 mortality was 5 per thousand (Bill & Melinda Gates Foundation, 2019); in the 2020 edition it was 10 (Bill & Melinda Gates Foundation, 2020). The differences here between the *No COVID* and *COVID* scenarios are well within that range. The magnitude of differences between scenarios in both the Gates Foundation analysis and our own emphasize the incredible importance of reducing child mortality.

Figure 5.6 shows COVID's impact on neonatal morality by country income level. Despite generally lower assumptions by the IMF of economic damage from COVID in developing countries than in high-income ones, the differential cost of the pandemic in terms of neonatal mortality is much higher in the developing world. The explanation for greater increase in lower-middle-income countries than in low-income ones is largely the rise in India, which has been heavily hit by the pandemic and for which the IMF has projected a very high GDP decline (about 10 percent in 2020).

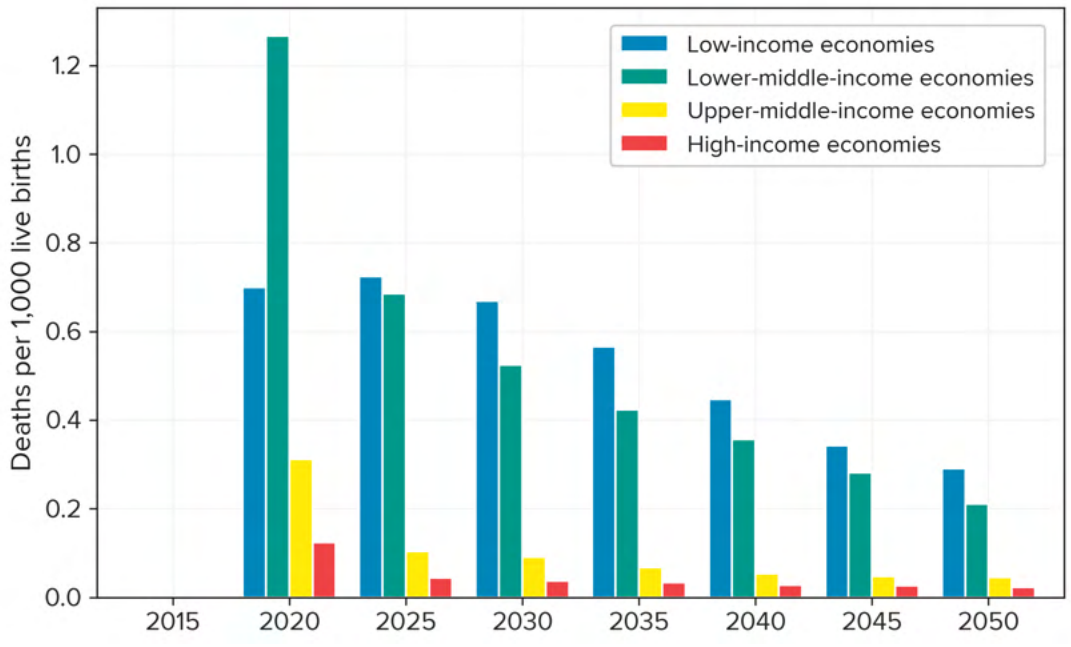


Figure 5.6 Rise in neonatal mortality in the *COVID* scenario relative to *No COVID*
Source: IFs Version 7.61.

5.3 Accelerating Progress

We have seen that the path the world was on prior to the COVID pandemic would have been unlikely to bring maternal mortality, child mortality, or neonatal mortality rates globally to the SDG target values for them by 2030. The three targets did appear reachable on a global average basis by 2050. Further we have seen that, even with the significant retardation of progress in the COVID *High Damage* scenario, the overall pattern would likely hold true.

Many countries, however, were not earlier on a path to reach any of the three targets, even by 2050, and COVID will likely slow their progress further. These analysis results and the importance of accelerating progress to the targets make the initiatives of the *SDG Push* scenario very important. That package of efforts would facilitate the world on average reaching each of the health goals already by 2030. At the country level, however, even *SDG Push* would struggle with the challenge of universal attainment. The challenge will remain especially great in the low-income countries of the world and the analysis here focuses on that set.

Figure 5.7 shows the full range of projections for maternal mortality in low-income countries across the scenarios of this study. It shows the COVID-related rise in maternal mortality in 2020 discussed above. The *SDG Push* scenario only begins to reshape future patterns in 2021. While *High Damage* maintains the rise in maternal mortality above the *No COVID* scenario through 2050, the *SDG Push* scenario shows a significant positive impact relative to *COVID* and *No COVID* scenarios already by 2030 (reductions of 6 and 3 per 100,000, respectively), and the benefit grows across time (to about 15 per 100,000 in 2050). In 2030, the maternal mortality rate for the low-income countries set in the *SDG Push* scenario has declined from 458 in 2015 to 287 per 100,000 live births. Unfortunately, even as aggressive as that scenario therefore is, the rate remains far above the SDG target of 70 per 100,000. Moreover, 58 countries would still find themselves above the target in 2030.

We are aware of no other projections against which to compare our analysis of possible longer-term *COVID* and *SDG Push* impacts on maternal mortality. The 2020 edition of the Goalkeepers report from the Gates Foundation showed a difference in 2030 of 29 per thousand between the *Reference* scenario and *Better* scenario. Those Gates Foundation scenarios reflect many more direct interventions on maternal mortality and the broader health environment than we do here in a study looking at interventions widely across the SDGs. Hence, the logic of their scenarios makes the differences between them greater than those shown in Figure 5.4. Both studies reinforce again the great human benefit of more ambitious interventions.

Shutterstock / Lidiya Ribakova

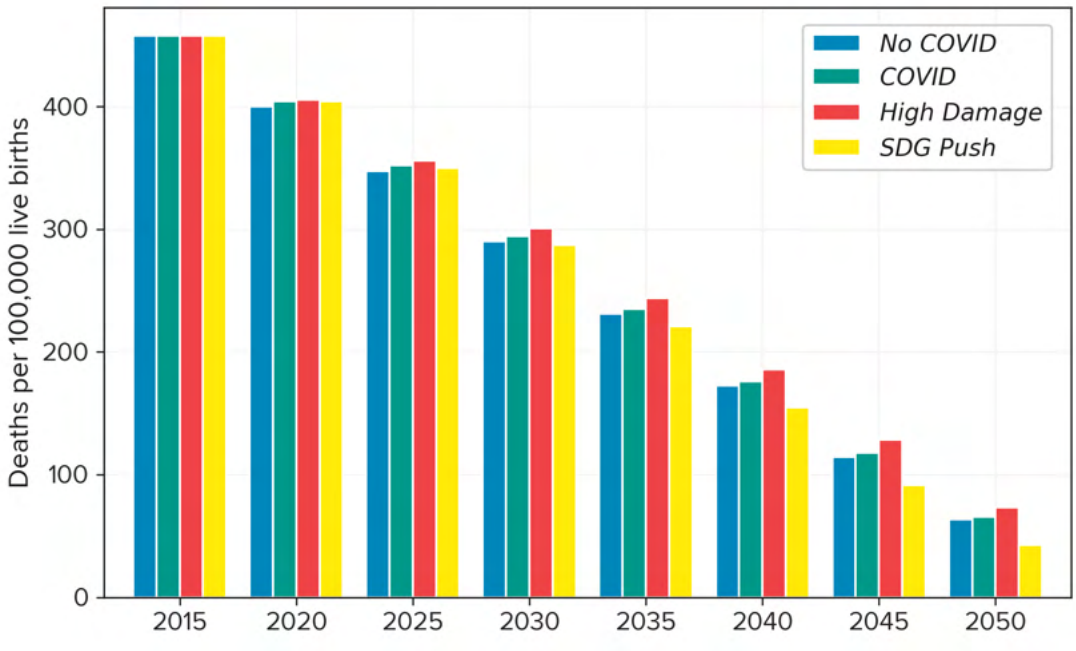


Figure 5.7 Maternal mortality per 100,000 births in low-income countries, comparative scenarios
Source: IFs Version 7.61.

One aspect of the good news from the *SDG Push* scenario is that the low-income set in aggregate does reach the global target by 2050. Even then, 11 countries globally could still be above the target value: Chad, South Sudan, Nigeria, Sierra Leone, Mauritania, the Central African Republic, Somalia, Equatorial Guinea, Afghanistan, Burundi, and Gambia.

With respect to child mortality (Figure 5.8), the pattern of scenario impacts is similar to that for maternal mortality. Even with the *SDG Push*, the low-income countries do not on average reach the global target of 25 per thousand by 2030 (instead the value is 46, compared to 77 in 2015). They do, however, reach it by 2046. By 2050 the value for the group falls to 21 with only 16 countries globally above the target value. While the average 2050 level for low-income countries is still well above the 6 of high-income countries in 2015, the possible progress is quite incredible relative to the *No COVID* path, which would leave the low-income country set still above the target value in 2050.

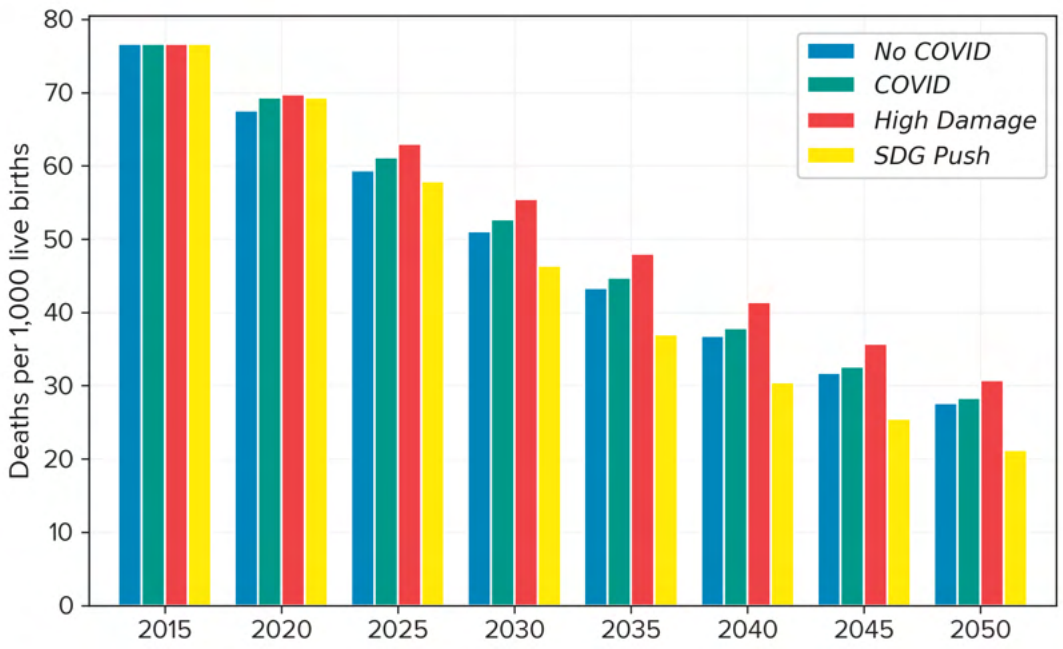


Figure 5.8 Child mortality per 1,000 births in low-income countries, comparative scenarios
Source: IFs Version 7.61.

Neonatal mortality again follows a similar trajectory across the scenarios in the low-income countries. While in the *No COVID* scenario low-income countries do not reach the target of 12 per 1,000 live births until nearly 2040, *SDG Push* enables them to reach the target by 2035. In 2050, only five countries globally have not met the goal in *SDG Push*: Equatorial Guinea, Angola, Pakistan, Chad, and Gabon. Patterns for infant mortality are again similar overall. In 2050, infant mortality rates are reduced to values less than one-fourth their 2015 levels and twice those of high-income countries in 2015.

Overall, the *SDG Push* scenario is, as Section 2 of this report indicated, very ambitious in its specification. The fact that even it does not bring global values for maternal, child, and neonatal mortality to those of the SDG targets for them in 2030 is somewhat discouraging and means that those targets are, indeed, themselves very aggressive. Nonetheless, the interventions of the scenario quite rapidly compensate for the impact of *COVID*, even the *High Damage* variation of it, and they do move the world strongly toward target values by 2050. If countries can move forward with some version of the *SDG Push*, the paths of historical progress can not only be maintained but significantly accelerated.

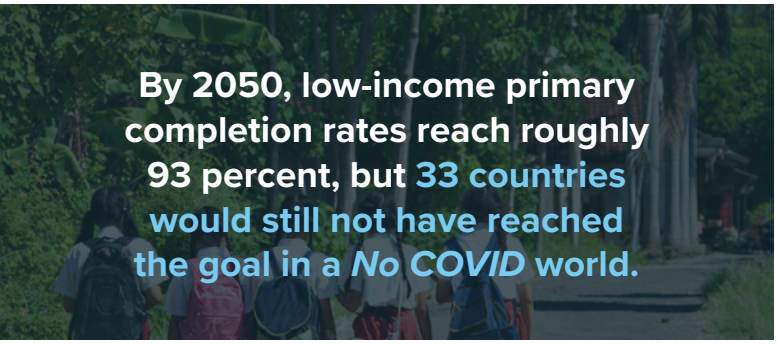
6. Education

SDG 4 seeks to "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all." The analysis here focuses on the first target for the goal, ensuring that all girls and boys complete free, equitable, and quality primary and secondary education.

Conceptually, the goal requires our attention to quantity (namely universality) of education at least through upper secondary levels, to the quality of education at all levels, and to assuring gender equality with respect to quantity and quality aspects of education. The UNESCO Institute of Statistics is the primary historical source in IFs for most analysis of student enrollment and completion patterns of boys and girls. Data measuring education quality can be sourced from the Global Data Set on Education Quality (Altinok et al., 2018) and the World Bank EdStats database. As with common use of the World Bank's 3 percent or lower target to indicate extreme poverty eradication, 97 percent is a useful operational benchmark for universality of education at the primary level (less than 3 percent not completing). Because even high-income countries have on average only reached about 90 percent completion rates for upper secondary education, however, that figure is a more useful target value for analysis of approach to universality at that educational level.

6.1 The Path We Were On Before COVID

IFs results show that the world is well on its way to achieving universal primary education for both girls and boys, with gross rates of completion (rates including both of-age and above-age students divided by the number of of-age children) at about 91 percent globally in 2019 and *No COVID* forecasts of 93 percent in 2030 and 98 percent in 2050. These current values and projections are on the high side of analyses using standard definitions of gross completion, which include children of as much as 3-5 years above normal primary completion age. They are closer to those that UNESCO and Global Education Monitoring Report (GEMR) (2019) provide when children up to 8 years above normal completion age are included; especially in low-income countries struggling to provide primary education to all, a great many students may be significantly overage. Over time and as universal net primary intake is approached and drop-out rates fall, the portion of children completing at higher than normal age decreases.



Shutterstock / Ros Fraser

Low-income countries lag significantly behind global levels of primary education, with gross completion nearer to 65 percent. In the *No COVID* scenario, the low-income country group reaches only 79 percent by 2030, and a total of 65 countries globally (many also at middle-income levels) fail to meet the target. By 2050, low-income primary completion rates reach roughly 93 percent, but 33 countries would still not have reached the goal in a *No COVID* world.

On another issue still needing much attention and central to SDG 4, while girls' primary completion rates in low-income countries are lower today than those for boys, they are projected to have caught up with and then surpassed those of boys by 2040 (Figure 6.1). This pattern is proving common with economic development across educational levels; for instance, women already outnumber men in tertiary enrollment in high-income countries.

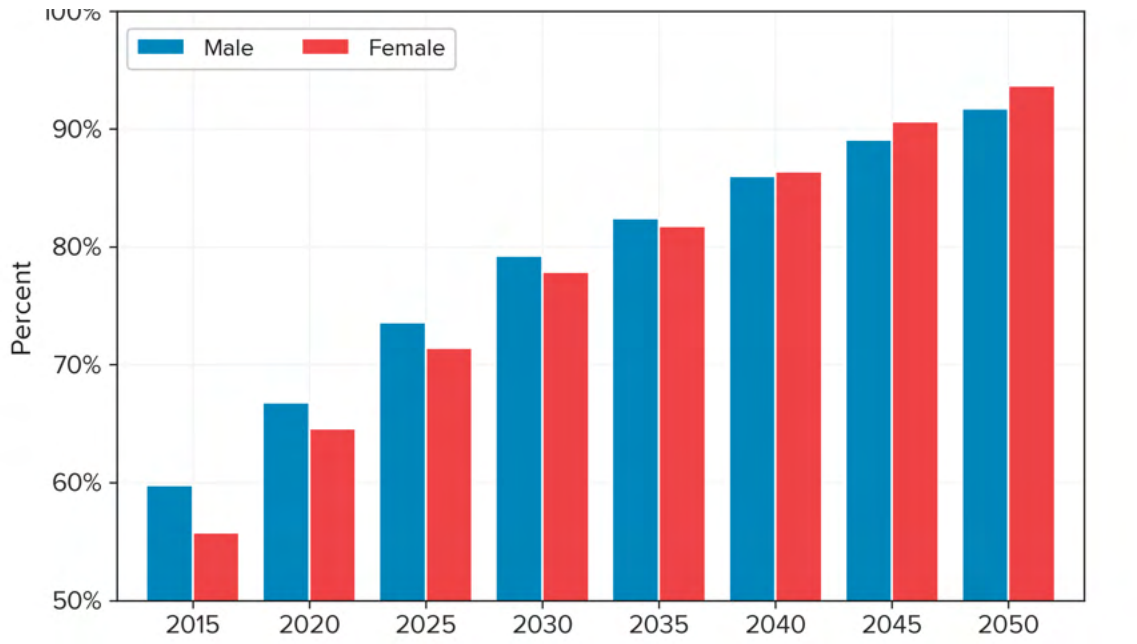


Figure 6.1 Primary education completion in low-income countries by of-age and overage students, *No COVID* scenario
Source: IFs Version 7.61.

Turning to lower secondary education, the current global rates of just below 70 percent would likely not have risen to reach a 97 percent gross completion rate by 2030 or even by 2050, instead reaching 76 and 81 percent, respectively. Only 69 countries appeared on track to reach 97 percent by 2030.

Evaluation of goal attainment at the upper secondary level is complicated. It appears that the 97 percent target used with other goals analyzed here would be inappropriate, especially when even many high-income countries fall short of that threshold (including those without large vocational or school-age apprenticeship systems that can reduce formal secondary education system numbers). In 2020 only 38 countries globally had secondary education completion rates above 90 percent. As Friedman et al. (2020, p. 636) point out, "no major world region has achieved near universal levels." We therefore consider 90 percent a more useful target for upper secondary completion. On a global level gross completion rates are approaching 54 percent and girls already have rates about 3 percentage points higher than boys (again, these numbers are somewhat higher than those in UNESCO and GEMR (2019)). In the *No COVID* scenario, the combined girl-boy rate increases to roughly 60 percent in 2030 and

70 percent by 2050 – still far short of the target level. Only 48 countries appeared likely to reach 90 percent by 2030 and 64 by 2050.

Appropriate target levels aside, major challenges to improving secondary education access and having children take advantage of it obviously exist, especially in developing countries. Figure 6.2 again focuses on low-income countries. It shows how incredibly far these countries are from any appropriate target rate for universal upper-secondary completion. It does indicate, however, that girls may nearly close the currently large gap with boys by mid-century – improvement, albeit far too slow in coming.

There are also great and likely persistent differences in education quality between lower and higher-income countries (Figure 6.3). Similarly, the Gates Foundation (2020, p. 38) suggests that, in sub-Saharan African countries, just 20 percent of students in grades 2 and 3 achieve minimum proficiency levels in reading and math. In high-income countries, this figure is closer to 90 percent.

Shutterstock / Kwame Amo

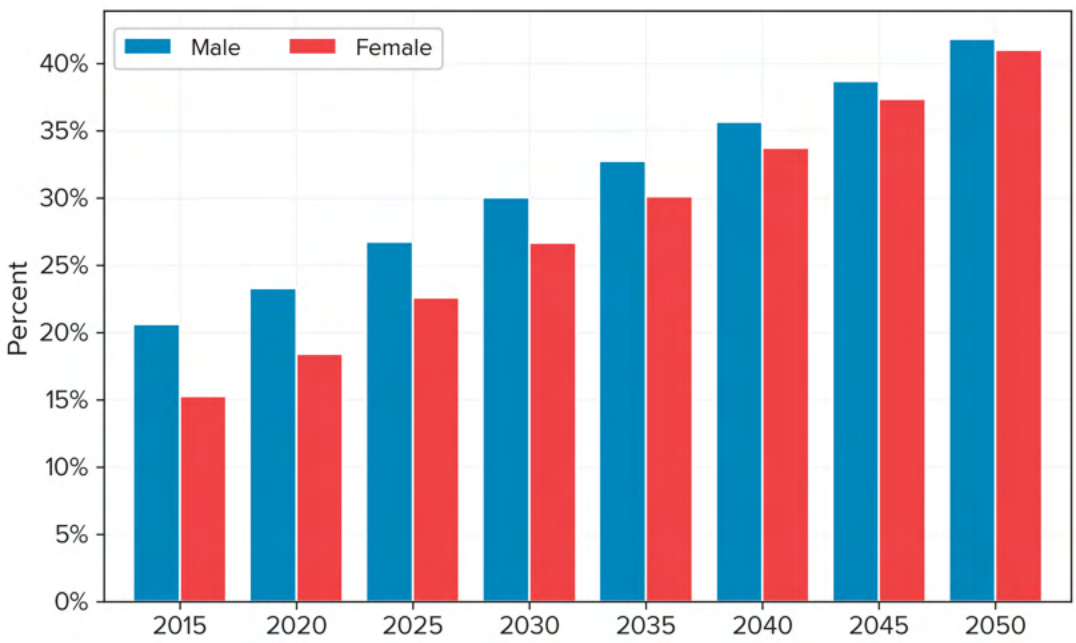


Figure 6.2 Upper secondary education completion in low-income countries by of-age and overage students, *No COVID* scenario
Source: IFs Version 7.61.

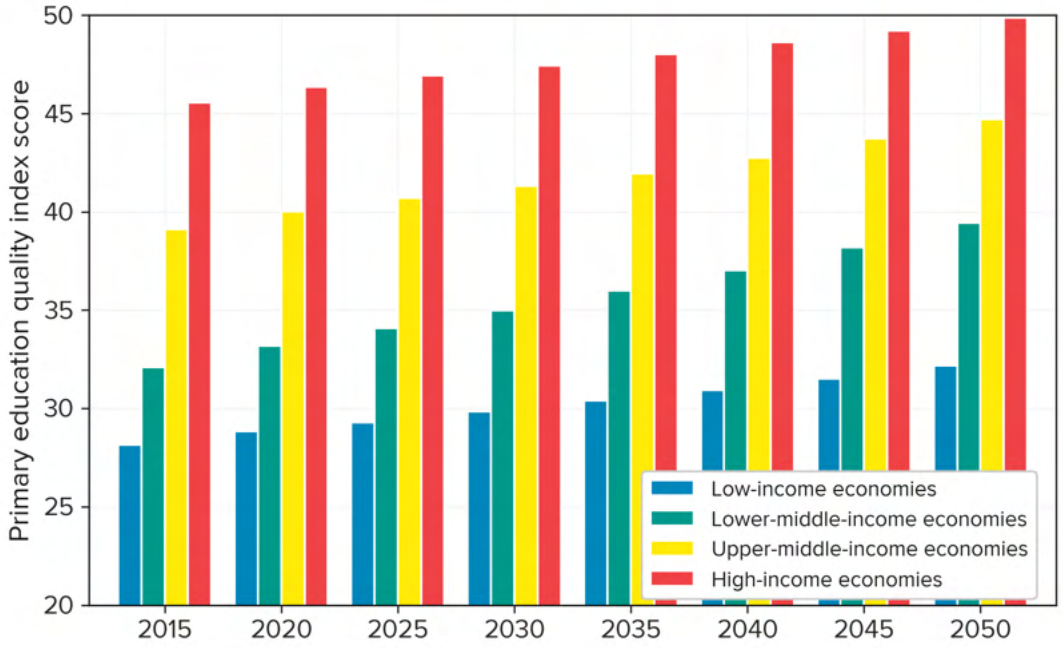


Figure 6.3 Primary education quality test scores across subject matter categories (males and females), *No COVID* scenario

Notes: The quality score is an average of those for reading, math, and science. Quality levels for females exceed those for males in each income category.

Source: IFs Version 7.61.

Targets for SDG 4 also refer to the importance of universal access to (rather than completion of) vocational and tertiary education (Target 4.3), to the development of relevant skills, *and (in Target 4.6) to ensuring that a substantial portion of adults achieve literacy and numeracy*. It takes considerable time for progress in educational systems to change the achievement characteristics of the adult population. This is because average years of schooling among older adults reflects their educational attainment several decades earlier (of course, many adults acquire literacy, numeracy, and other skills outside of formal education).

Figure 6.4 shows that lag pattern with respect to formal years of education. Even with the push toward universal primary education in developing countries well established and that toward universal secondary very much underway, in 2050 the average adult in low-income countries might have been able to only acquire fewer than 8 years of schooling. Lutz et al. (2018) prepared several projections of adult educational attainment in the project on Shared Socioeconomic Pathways (SSP) and the pattern of growth in Figure 6.4 is very comparable to the middle-of-the-road pathway (SSP2) in that set.

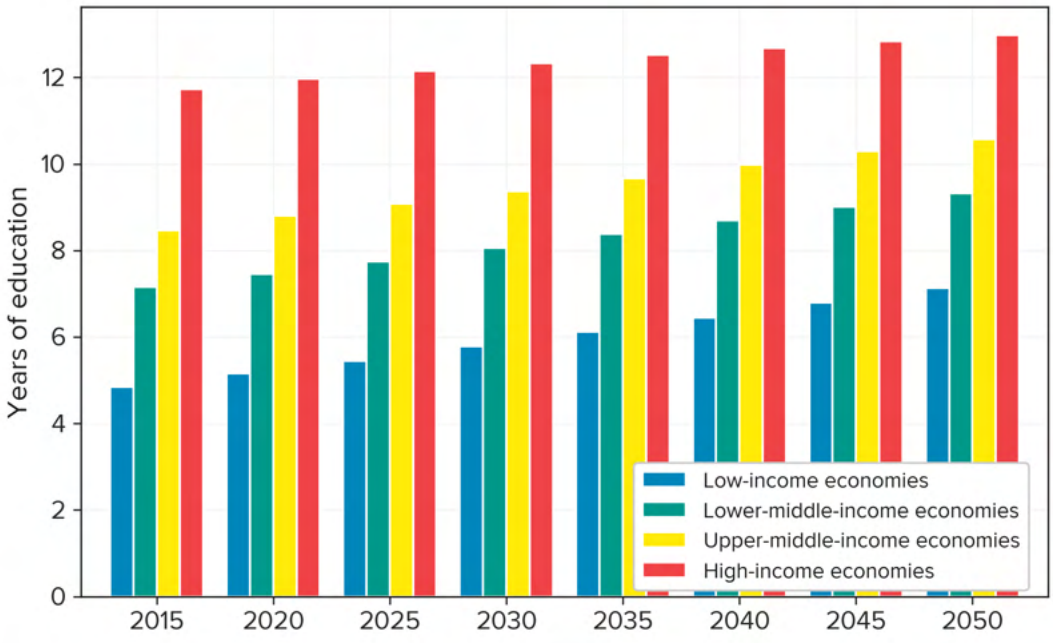


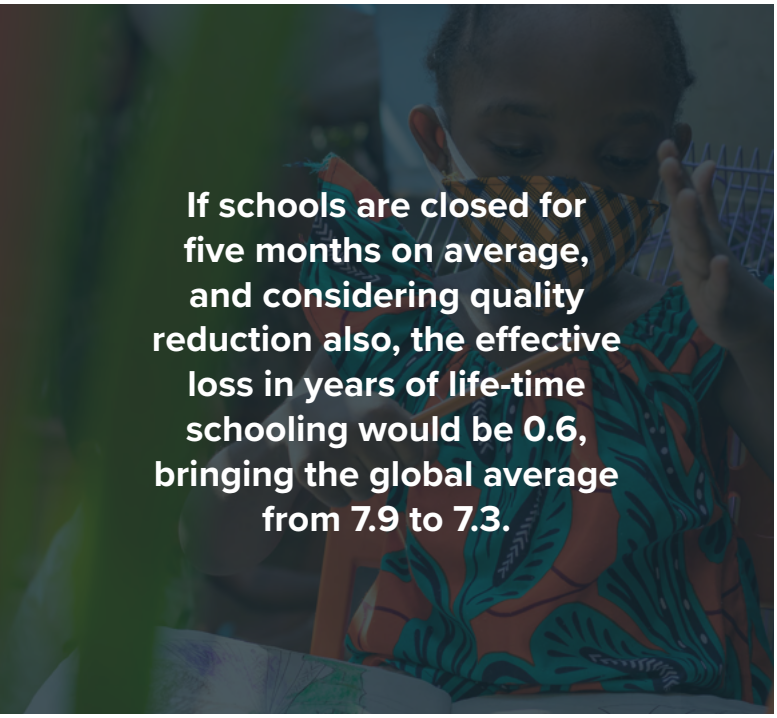
Figure 6.4 Average years of schooling of population 15 and older, *No COVID* scenario
Source: IFs Version 7.61.

6.2 The Damage that COVID Inflicts

Much of the anticipated and immediate negative impact of COVID on education results from missed enrollment and instructional opportunity during the pandemic, compounded by diminished quality when the character of teacher-student (and student-student) interaction changes. Widespread substitution of electronic for personal contact is occurring, especially in higher-income countries. Many students, including those already socially and educationally disadvantaged, are unable to effectively participate via virtual means. The movement to virtual education thus amplifies learning inequalities.

In developing countries, the technological capability for virtual education is extremely limited or nonexistent. In countries such as Côte d'Ivoire, the Gambia, Guinea-Bissau, Kiribati, Lesotho, Mauritania, and Sudan fewer than 10 percent of the poorest households have electricity (European Commission, 2020). Distance learning in high-income countries can reach roughly 80-85 percent of students, but less than 50 percent in low-income countries (UN, 2020). Educational impacts span all levels. According to one estimate from UNESCO (2020), forty million children have missed critical early childhood education – resulting in not only missed opportunities for learning and social interaction, but in some cases a decline in adequate nutrition as a result of missing meals provided at school. At this stage of the pandemic there is very limited actual data on either the extent or character of educational disruption, much less on the ability of educators and students to make up for losses in the long run.

While estimates exist for pandemic-period effects on GDP and mortality, we are unaware of available data or projections for 2020 and/or 2021 concerning the child-year losses of schooling by country. The World Bank (2020b) is attempting to track countries by school closure levels. Using such data for 157 countries, already by late June 2020 Azevedo et al. (2020) estimated that countries collectively had kept nearly 1.6 million students out of school. They further estimated that, if schools are closed for five months on average (they also did scenarios for 3 and 7 months), and considering quality reduction also, the effective loss in years of life-time schooling would be 0.6, bringing the global average from 7.9 to 7.3. They estimated also that the global share of students not acquiring minimum proficiency could rise from 40 to 50 percent and that 7 million students could drop out of school, with the greatest effects on girls and marginalized groups. Overall, they calculated the global lifetime loss of earnings at $10 trillion or one-tenth of one year of GDP.



Shutterstock / Etivaldo Marcolino

In addition to the complications resulting from unavailability of country-specific estimates of COVID's impact on enrollments, the IFs system is not structured to introduce exogenously such values in the pandemic years and then project educational recovery or lack thereof in subsequent years. Thus, none of the scenarios in this report include educational impacts from *COVID* as scenario assumptions. Instead, the IFs structure assists in exploring the immediate and longer-term consequences for educational outcomes in the face of the estimated GDP and mortality impacts of the pandemic years. Figure 6.5 shows the number of missing students globally across all educational levels (primary, lower secondary, upper secondary, and tertiary) in the *COVID* and *High Damage* scenarios. The *COVID* scenario results in nearly 8 million fewer enrollments in 2020 than in the *No COVID* scenario – an estimate based purely on the relationship with GDP. This figure is more than 9 million in the *High Damage* scenario. This full year estimate is four times that of Azevedo et al. (2020), which used partial, early-year data; it thus appears generally comparable. Longer-term losses in GDP per capita due to *High Damage* explain the sharp rise in the missing students in 2025 and beyond.

Enrollment rates underpin potential graduation rates. Figure 6.6 shows the impact of COVID in terms of the number of missing female graduates at the lower-secondary level, an educational frontier level for many girls in developing countries especially. Among other implications of acquiring lower secondary education for girls is a stronger position within family structures and lower fertility rates. Losses of hundreds of thousand lower secondary school female graduates year after year, as in the *COVID* scenario relative to *No COVID*, thus translate into very substantially lower progress for and status of women in the society more broadly. Between 2020 and 2050 in the *COVID* scenario relative to *No COVID*, the cumulative reduction in lower-secondary graduations of girls is 8.4 million.

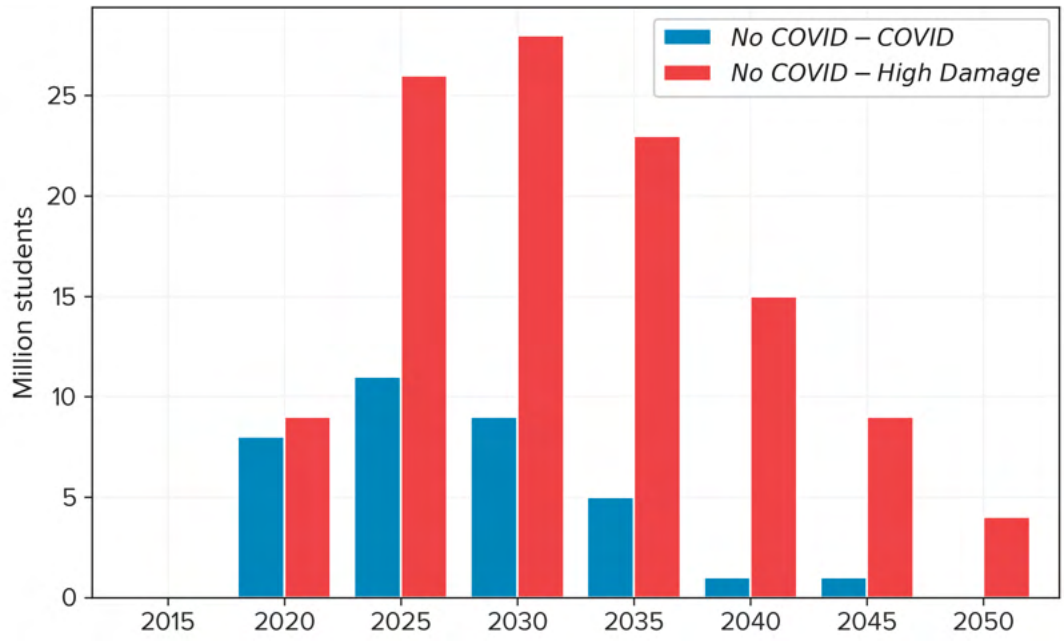


Figure 6.5 Missing students globally, all education levels, *COVID* scenarios relative to *No COVID* scenario
Note: Missing students is calculated as the difference between enrollment numbers in the *COVID* and *High Damage* scenarios and those in *No COVID*; the analysis does not account for small differences in population of student age.
Source: IFs Version 7.61.

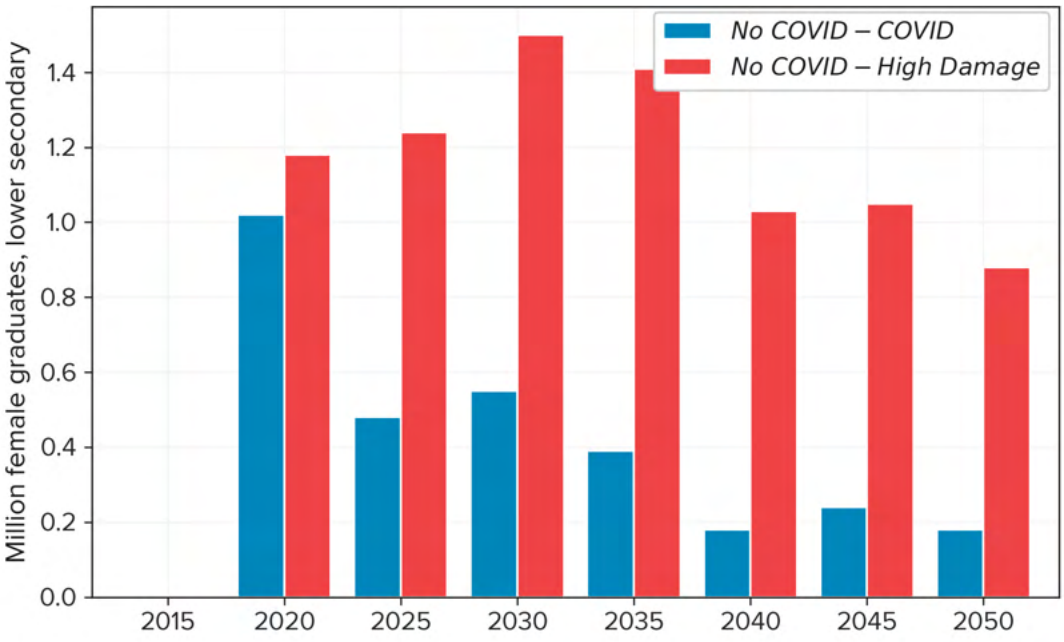


Figure 6.6 Missing female lower-secondary graduates relative to *No COVID* scenario
Source: IFs Version 7.61.

The figures on missing students, males and females across all levels of education, also show that while such impact in the baseline *COVID* scenario generally erodes over time, in the *High Damage* scenario it grows significantly in the middle years and continues to grow through 2050. There are structural reasons for this sustained educational impact. Not only does *High Damage* scenario GDP remain lower long-term than in the *No COVID* scenario, but so do government revenues and expenditures, including expenditures directed toward education. Further, the education model of IFs drives anticipated enrollments and completion not just by spending levels, but by the GDP per capita and its implicit relationships to structural development patterns more generally (including structural changes in the economy, ability of families to function economically with children in school, and societal willingness to educate girls). Figure 6.7 shows the cumulative student-years potentially lost through 2050 because of COVID: 170 million in the baseline *COVID* scenario and more than a half billion in *High Damage*.

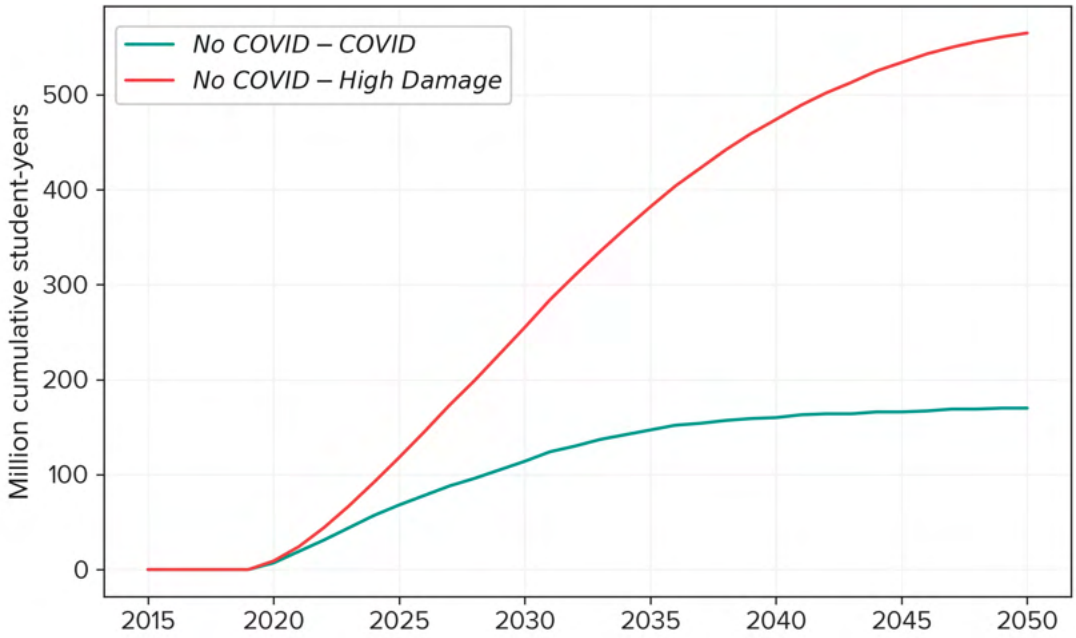


Figure 6.7 Cumulative missing student-years globally, all education levels, *COVID* scenarios relative to *No COVID* scenario
Source: IFs Version 7.61.

To put in broader context the World Bank's (2020b) global estimate of $10 trillion in lost earnings from education disruption reported earlier, the baseline *COVID* scenario results in a loss of GDP through 2050 relative to the *No COVID* scenario of $147 trillion ($363 trillion loss in *High Damage*). While the broader economic losses reflect many causal paths well beyond reduced educational opportunity, that reduction contributes significantly. Clearly, however, less education has costs well beyond loss of economic opportunity. Richness of lives and opportunities for progress toward gender equality cannot easily be monetized.

6.3 Accelerating Progress

As with other elements of human development and associated SDG target indicators, the *SDG Push* scenario not only offsets before 2030 the impacts of COVID, but greatly accelerates progress toward achieving the SDG targets. Figure 6.8 shows that gross upper-secondary enrollments could increase quite dramatically with an *SDG Push* effort. They still do not reach universality by 2030 or even by 2050 but are 11 percentage points higher than in the *No COVID* scenario by mid-century. Clearly low-income countries could not expect to do as well, and their enrollment rates reach 50 percent in 2030 and 72 percent in 2050, even with the big push. Universal lower secondary enrollment is a more achievable target and low-income countries could reach 80 percent by 2030 and 95 percent by 2050.

The number of children affected each year by such a big push scenario is very large. Figure 6.9 shows that at the peak an additional 40 million could be in school compared to the *No COVID* scenario, 27 million already in 2030.

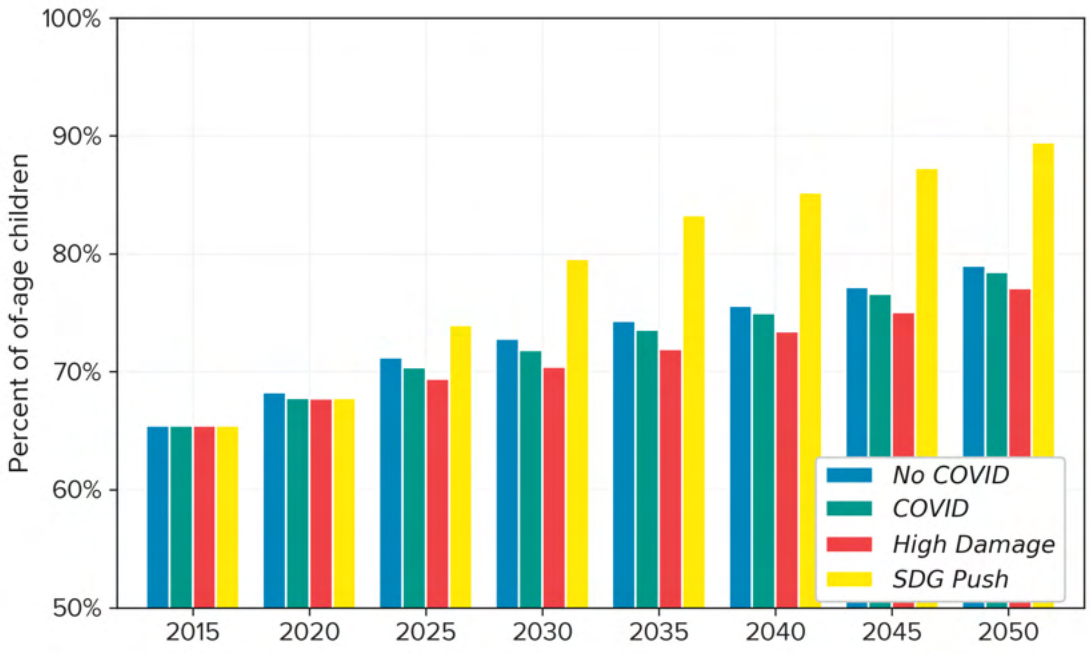


Figure 6.8 Global gross upper-secondary enrollment rate for of-age and over-age children across scenarios
Source: IFs Version 7.61.

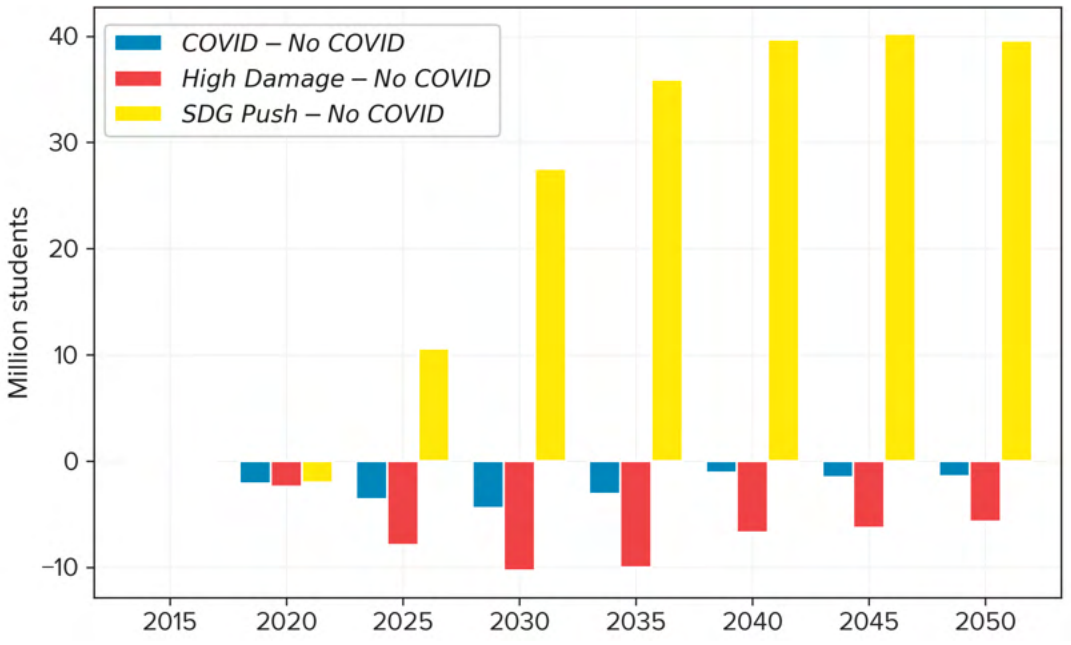


Figure 6.9 Incremental global gross upper-secondary enrollment: Scenarios versus *No COVID*
Source: IFs Version 7.61.

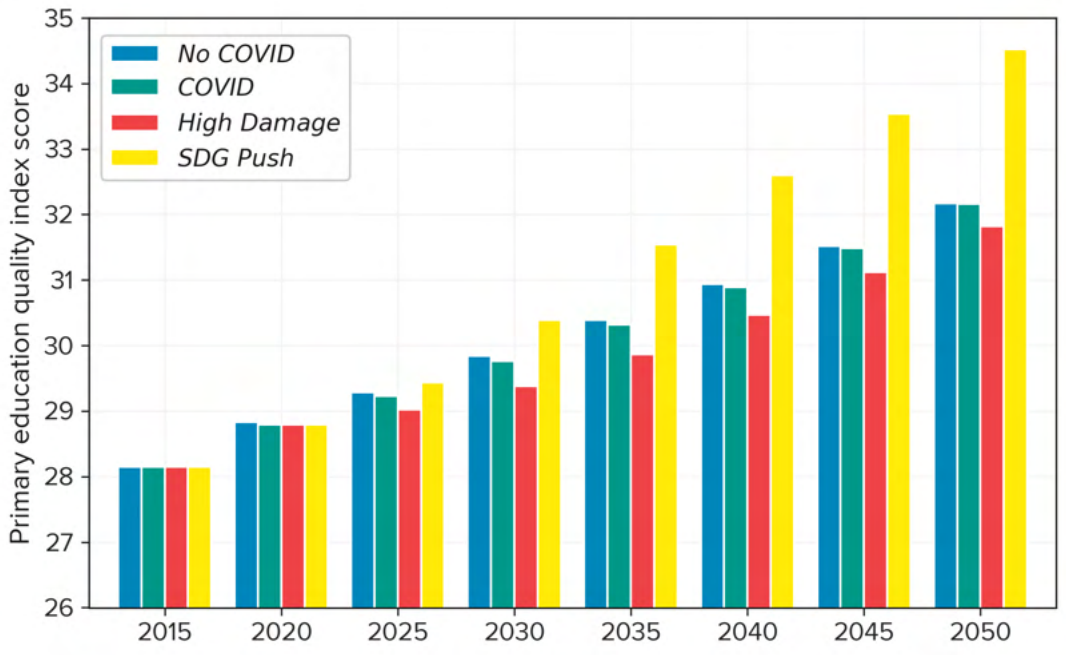


Figure 6.10 Primary education quality index in low-income countries across scenarios
Note: Education quality index is average across reading, mathematics, and science for males and females combined.
Source: IFs Version 7.61.

The *SDG Push* scenario not only increases the quantity of education achieved, it has implications for both quality and gender equality. Figure 6.10 shows that nearly an additional 2.5 points or 7 percent could be achieved by 2050 on the reading-math-science quality score at the primary level in low-income countries relative to the baseline *COVID* scenario. Gains at the secondary level would be roughly comparable.

Figure 6.11 shows the percentage by which male gross enrollment rates exceed female rates at the upper secondary level in low-income countries in both *COVID* and *SDG Push* scenarios. In the latter scenario, gender disparity falls to 2 percent by 2050, still too high, but almost cut in half relative to that in the *COVID* scenario. In all other country income groupings and in the world on average the gender gap is eliminated by 2030 with *SDG Push*, in fact very slightly reversed.

Overall, the global push to universal completion of equitable and high quality primary and secondary education was not on track prior to the pandemic. By mid-century the world on average could have attained universal primary education, but 33 countries would not have reached the goal. The world and two-thirds of countries appeared unlikely to reach a target of even 90 percent upper secondary completion. If no offsetting action is taken, COVID can set back even that progress quite substantially, increasing missed education-years by hundreds of millions. An *SDG Push* can not only offset the impacts of COVID, but help perhaps 25 million additional children obtain upper-secondary education every year by 2030 and 40 million do so by 2050. The opportunity should not be lost.

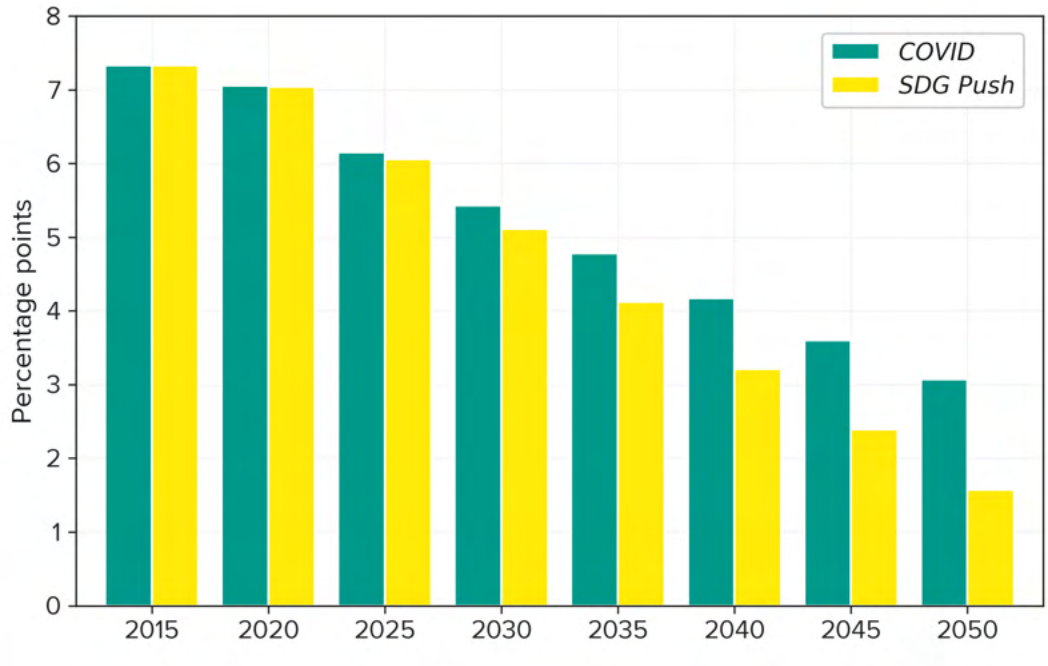


Figure 6.11 Percentage points by which male enrollment rates exceed female rates in upper secondary gross enrollment of low-income countries
Source: IFs Version 7.61.

7. Access to Safe Water and Sanitation

SDG 6 seeks to "Ensure availability and sustainable management of water and sanitation for all." The first two targets for this goal include achieving (1) universal and equitable access to safe and affordable drinking water for all and (2) adequate and equitable sanitation and hygiene for all.

The WHO/UNICEF Joint Monitoring Program (JMP) is the primary source for data on access to safe water and sanitation globally. In 2017, it somewhat revised its ladders for access types and now for both water and sanitation uses five categories of facilities aggregated into improved and unimproved facilities (WHO & UNICEF, 2017, 2018b). The IFs forecasting system was built with the tripartite classifications that preceded the revision; our analysis will therefore report from within that tripartite system. Table 7.1 shows the mapping of JMP and IFs categories.

	JMP Category	Value (% in 2015)	IFs Category	Value (% in 2015)
Water Access	At least basic (includes Safely managed)	88.7	Piped	62.9
	Limited	2.8	Other Improved	28.6
	Unimproved	6.3	Unimproved	8.6
	Surface Water	2.2		
	Total Improved (At least basic + Limited)	91.5	Total Improved (Piped + Other Improved)	91.5
Sanitation Access	At least basic (includes Safely managed)	71.5	Improved (At least basict)	71.5
	Limited (Shared)	8.0	Shared (Limited)	8.0
	Unimproved	10.1	Other Unimproved	20.5
	Open Defecation	10.3		
	Total Improved (At least basic + Limited)	79.5	Total Improved (Improved + Shared)	79.6

Table 7.1 Joint Monitoring Program and IFs categorizations of water and sanitation
Notes: Percentages show global provision levels in 2015; some small differences between JMP and IFs represent IFs treatment of 186 countries.

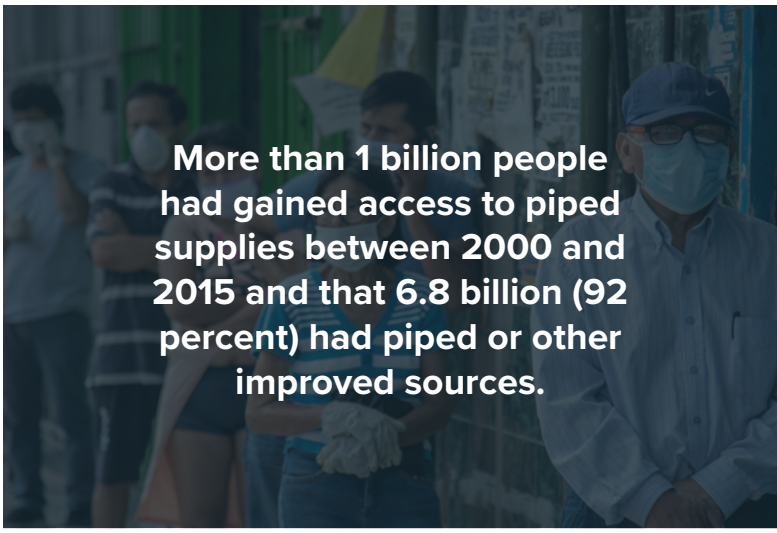
For water, which generally receives earlier priority attention in societies than sanitation, analysis here primarily focuses on the total level of improved water access, calculated as the sum of piped plus other improved. This corresponds to the improved grouping in the JMP revised system aggregating safely managed, basic, and limited. For sanitation, the three categories in IFs are improved, shared, and unimproved; the sum of the first two categories corresponds to the improved summing of safely managed, basic, and limited in JMP's revised classification system (excluding unimproved and open defecation from the improved grouping).

Access by every human to fully improved and safely managed water and sanitation, not shared by other households, remains our ideal. Nonetheless, in addition to focusing here on the somewhat broader concepts of improved water and sanitation access, we give attention to the number of countries reaching a rate of improved access (including shared) at or above 97 percent rather than 100 percent. In doing so we recognize how far the world is from our ideal, with only about 50 percent of countries now having even generally improved water facility access for 97 percent of their population and even fewer having generally improved sanitation access at that level. The emphasis here is on understanding how well we are doing, how COVID may hinder advance, and how significantly we can accelerate our progress.

7.1 The Path We Were On Before COVID

Although much progress had been made in achieving many of the SDG 6 targets prior to the COVID-19 pandemic, a great many countries and a large share of the global population were not on track to reach those targets by 2030.

With respect to water, UNICEF (2020a) estimated the number of people globally in 2017 lacking basic water services at 785 million and that on the current trajectory there would still be 340 million without a basic water service in 2030 and 1.8 billion (21 percent) without a safely managed water supply (the SDG specification, meaning free of contamination and available on premises when needed). Using the less demanding criterion of access to improved water sources, WHO/UNICEF (2017) noted that more than 1 billion people had gained access to piped supplies between 2000 and 2015 and that 6.8 billion (92 percent) had piped or other improved sources.



Shutterstock / Joel Salvador

Figure 7.1 shows the IFs forecast of improved water access in the *No COVID* scenario across World Bank income groups. The global percentage grows from 93 percent in 2020 to 95 percent in 2030 and then rises to just below 97 percent (our operational definition of universality) by 2050. However, low-income countries rise from 74 percent in 2020 to only 81 percent in 2030 and 93 percent in 2050.

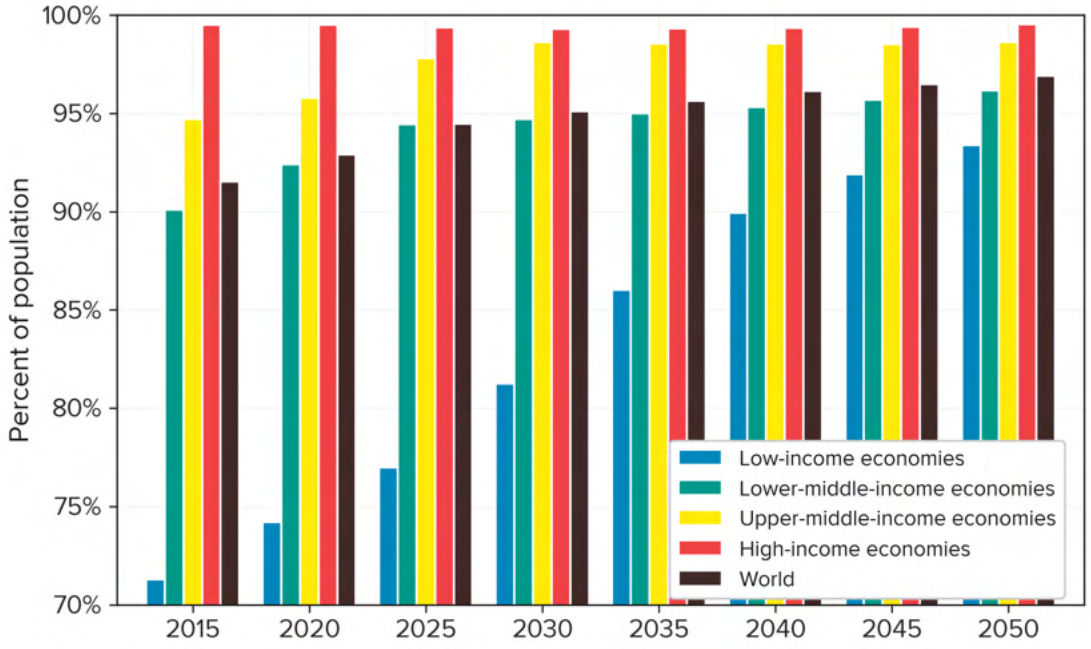


Figure 7.1 Percent of population with access to improved water facilities for World Bank income groups and world, *No COVID* scenario

Source: IFs Version 7.61.

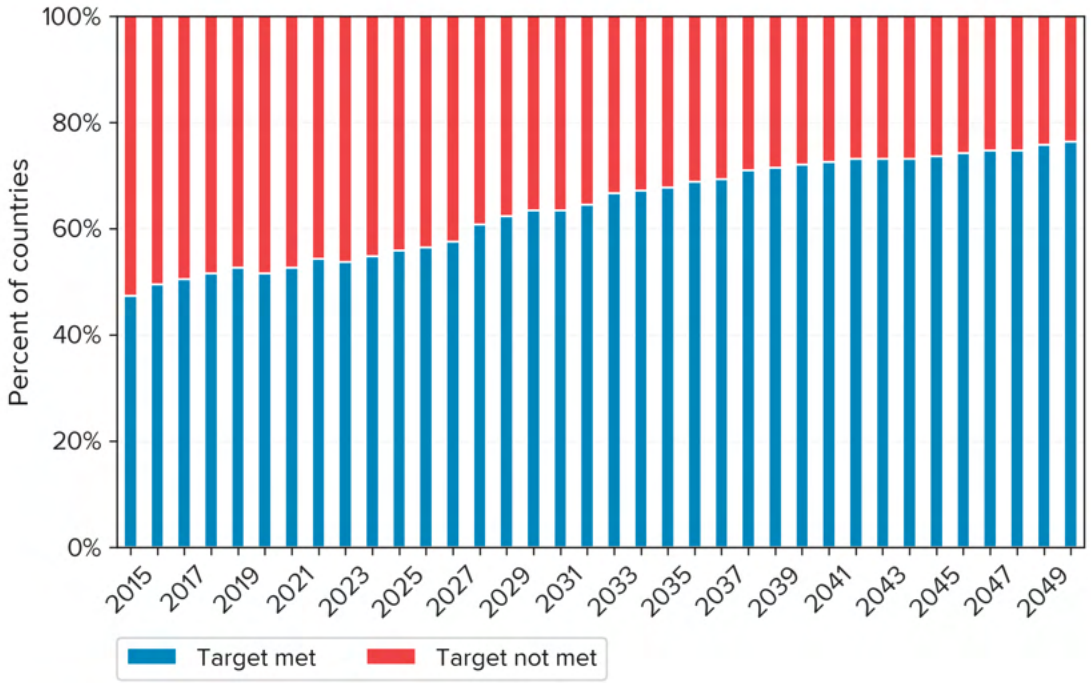


Figure 7.2 Numbers of countries reaching and not reaching 97 percent improved water access in each year, *No COVID* scenario

Source: IFs Version 7.61.

According to the *No COVID* scenario in IFs, only 96 countries would have achieved 97 percent improved water access in 2020. By 2030, the count would have reached 118, and 142 by 2050, leaving 44 countries in 2050 still below a 97 percent threshold.

According to the WHO/UNICEF Joint Monitoring Programme State of the World's Sanitation report, the population using safely managed sanitation services increased by 1.7 billion between 2000 and 2017. However, in 2017, 4.2 billion still lacked access to safely managed sanitation and 2 billion of those lacked access to basic sanitation services. According to the report, achieving universal access to safely managed sanitation by 2030 would necessitate a quadrupling in the current global rate of progress (WHO & UNICEF, 2020a).

Looking out to 2030, the Gates Foundation 2019 Goalkeepers Report forecast 22 percent of the population would still be using unsafe or unimproved sanitation in 2030 (Bill & Melinda Gates Foundation, 2019). This is a reduction from 29 percent as reported in 2018. These unsafe or unimproved numbers may be slightly overstated as they are based on access to sewer-connected toilets which may be too expensive for some countries to build and maintain. Properly managed pit latrines and septic tanks, which are less expensive, can also be safe.

Although much of the world may be on track to largely eliminate the use of unsafe or unimproved sanitation by 2030, there remains significant regional disparity. According to the 2020 Goalkeepers Report, for example, 66 percent of people living in sub-Saharan African and 37 percent of people in South Asia are using unsafe or unimproved sanitation in 2019 (in contrast to the 29 percent global average) (Bill & Melinda Gates Foundation, 2020).

According to the *No COVID* forecast in the IFs model, over 10 percent of the world's population would have lacked access to some form of improved sanitation in 2030 (Figure 7.3). When the forecast is extended to 2050, this figure decreases to about 7 percent. That is still below an operationalization of the SDG 6 goal as 97 percent of the population having access to improved sanitation.

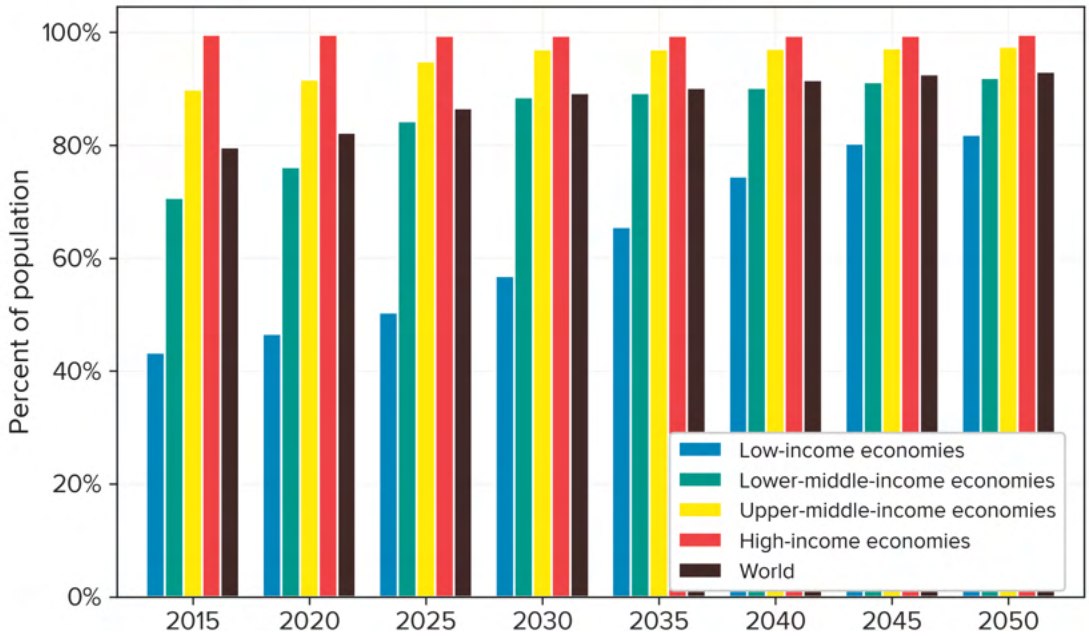


Figure 7.3 Percent of population with access to improved sanitation for World Bank income groups and world, *No COVID* scenario
Source: IFs Version 7.61.

When considering sanitation access at a regional level in IFs, only about 50 percent of people in Sub-Saharan Africa have access to improved sanitation in 2020 (Figure 7.4). This number grows to nearly 60 percent in 2030 and 80 percent in 2050 but this is still almost 9 percent lower than the next closest region (Oceania) in 2050. The Central and Southern Asia region meanwhile experiences a notable increase in access to improved sanitation with an improvement of over 17 percentage points between 2020 and 2030, reaching 96 percent access in 2050.

According to the *No COVID* scenario in IFs, only 79 countries would have achieved 97 percent improved sanitation access in 2020. By 2030, 92 countries were on track to reach 97 percent and 130 countries in 2050. Thus, even before COVID the battle for safe sanitation was looking far from being won.

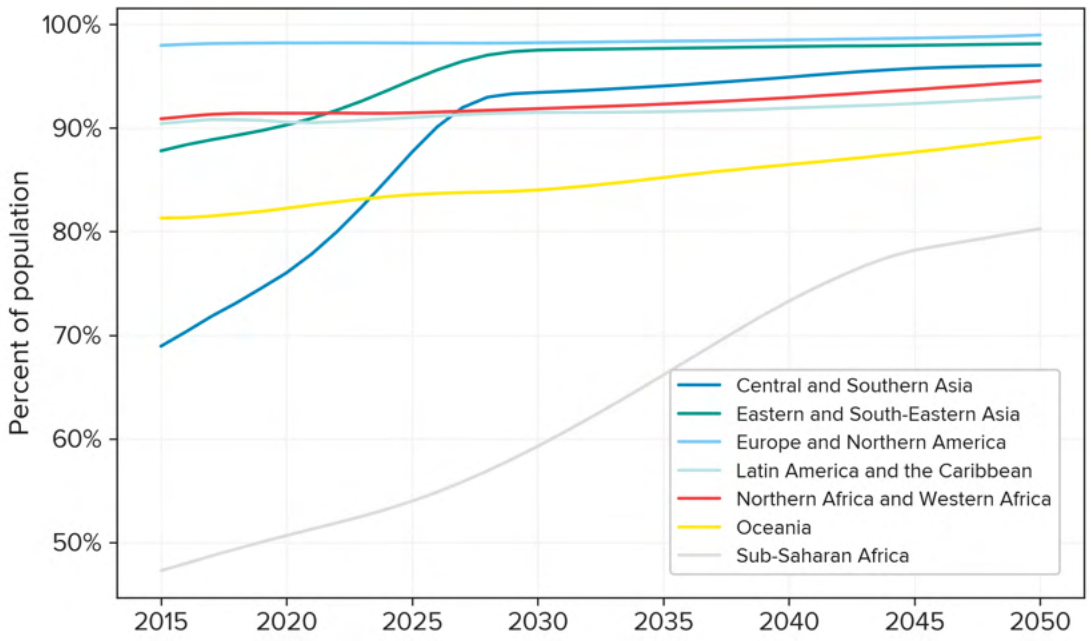


Figure 7.4 Percent of population with access to improved sanitation by UN SDG region, *No COVID* scenario
Source: IFs Version 7.61.

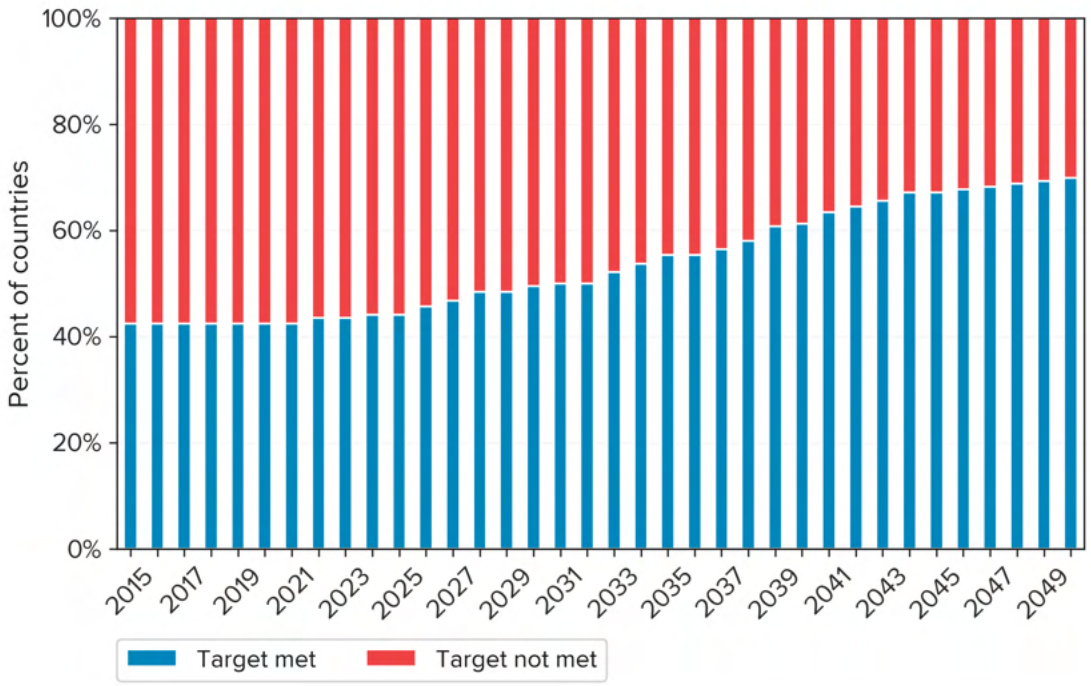
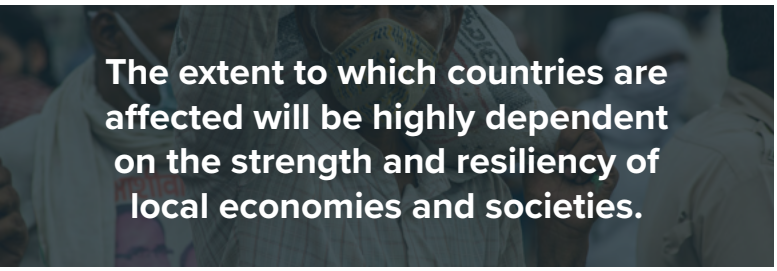


Figure 7.5 Numbers of countries reaching and not reaching 97 percent improved sanitation access in each year, *No COVID* scenario
Source: IFs Version 7.61.

7.2 The Damage that COVID Inflicts



Shutterstock / PradeepGaurs

COVID-19 has made the path to achievement of SDG 6 targets even more difficult. There will be impacts on water and sanitation including reduced access to water and sanitation services due to quarantine, diminished maintenance of water and sanitation infrastructure, and reduced service provision (UNICEF, 2020b). In the longer run, the pandemic is expected to slow investments in the water sector worldwide (IFC, 2020), an effect related in IFs to slower economic growth. The extent to which countries are affected will be highly dependent on the strength and resiliency of local economies and societies.

In 2030 about 12 million who would likely have had access to safe water in the *No COVID* world will lack it in the baseline *COVID* scenario (Figure 7.6). The *High Damage* scenario reduces the number with access in 2030 by 65 million (almost half in low-income countries) and even by 2050 the additional number of those without improved access is 18 million. Interestingly, in 2050 the *COVID* scenario suggests that 3.5 million more people could have improved water access than in *No COVID*. Among the dynamics in IFs that can generate such a result is a reduction in infrastructure costs that can allow even somewhat less spending to benefit more people.

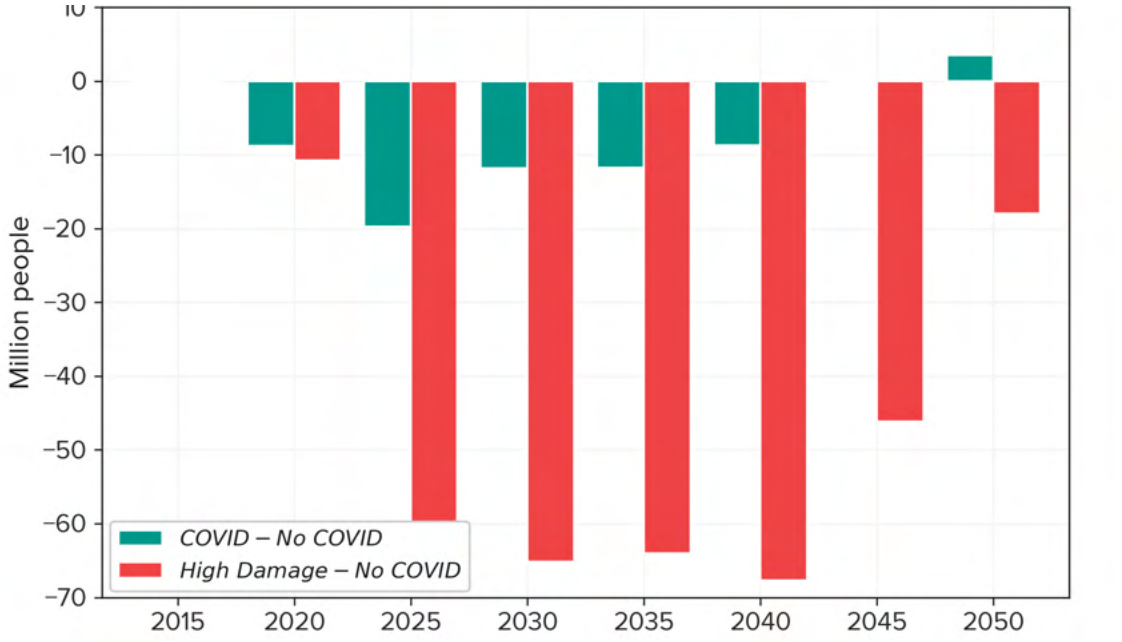


Figure 7.6 Million people globally losing access to improved water in *COVID* and *High Damage* Scenarios compared to *No COVID*

Source: IFs Version 7.61.

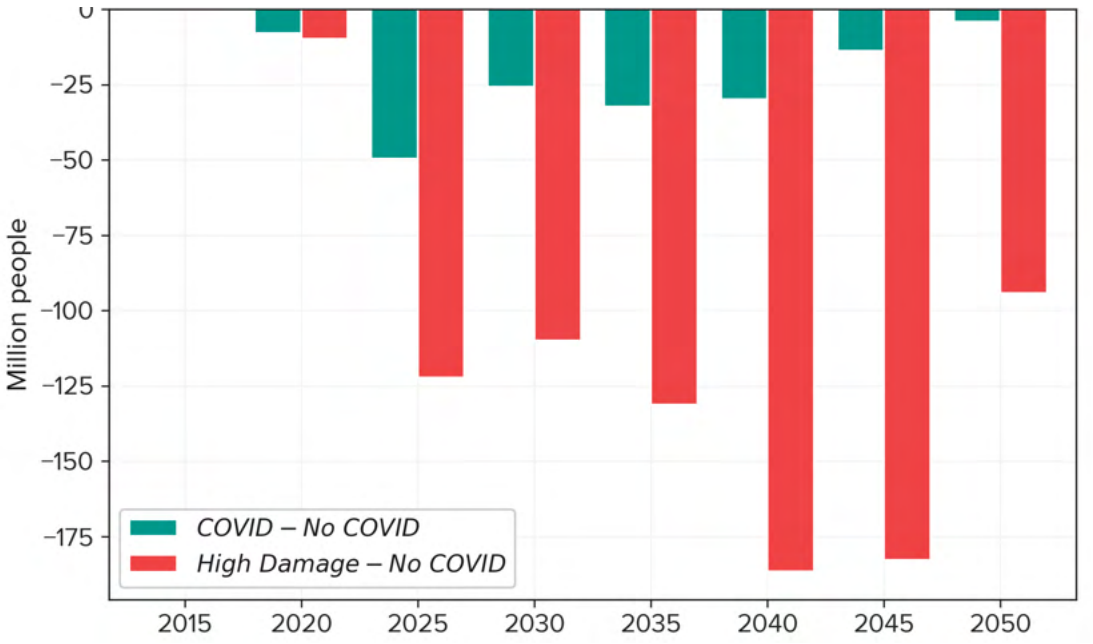


Figure 7.7 Million people globally losing access to improved sanitation as a result of *COVID* and *High Damage* Scenarios

Source: IFs Version 7.61.

In the baseline *COVID* scenario, the number of people without access to improved sanitation in 2030 is 26 million more than in the *No COVID* scenario (see Figure 7.7). In *High Damage*, 110 million suffer that loss and even in 2050 there are 94 million fewer people with improved sanitation than in the *No COVID* world. The losses of potential access are especially great for low-income countries. Again, the higher priority of most societies is on water access, so the greater losses from COVID in access to safe sanitation compared to safe water might be expected.

The human cost of having totally unimproved sanitation (neither improved nor shared) because of COVID could be very great. And Figure 7.8 shows that even in the baseline *COVID* scenario there could be almost 900 million person-years of additional human life burdened with unimproved sanitation (mostly relying on open defecation) through 2050. The *High Damage* scenario would increase that impact to more than 4 billion person-years.

Shutterstock / MA ANDYANTO

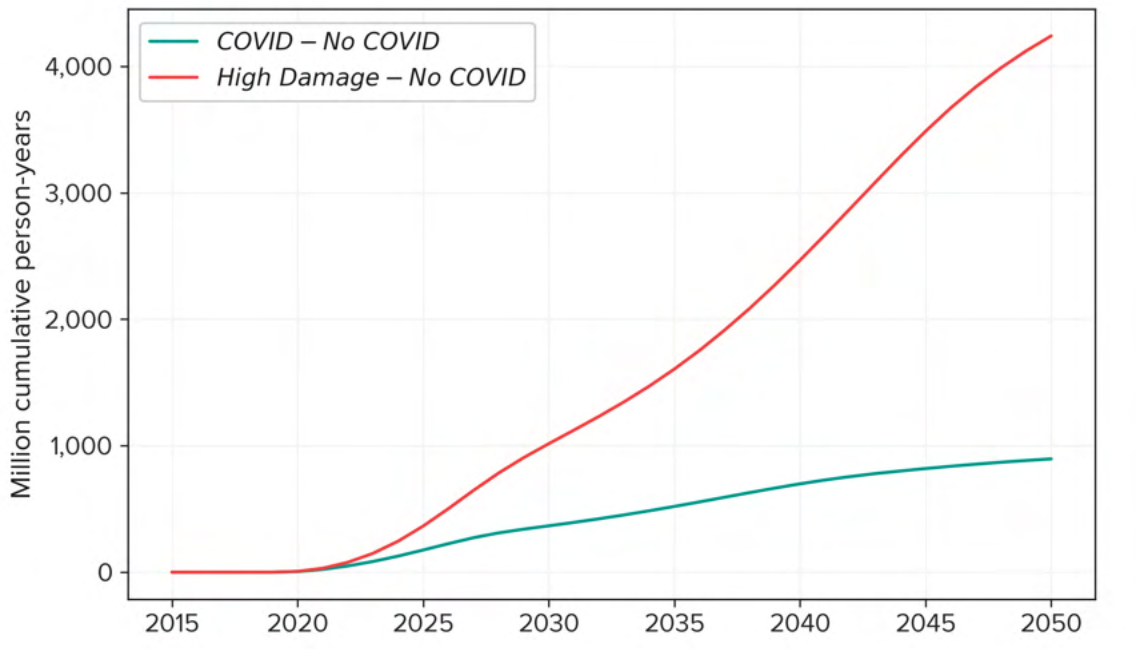


Figure 7.8 Cumulative person-years of unimproved sanitation globally as a result of *COVID* and *High Damage* Scenarios

Source: IFs Version 7.61.

7.3 Accelerating Progress

Although COVID-19 is anticipated to reduce access to water and sanitation globally, the pandemic also provides an impetus for strategic and collective action that could have long-term ramifications for the achievement of SDG 6 targets. The *SDG Push* scenario depicts a world in which this action is taken. The scenario introduces patterns of change in access to improved sanitation and safe water that appear feasible on the basis of at least some country experiences historically (see Appendix 2).

The *SDG Push* scenario is introduced into the baseline *COVID* world. Progress toward the SDG targets improves significantly under this scenario. Access to safe water globally is nearly 1.5 percent higher in 2030 than in *No COVID* and more than 2 percent higher in 2050 than in the *COVID* scenario. This equates to nearly 200 million additional people with access to improved water in 2050 under the *SDG Push* scenario relative to the *COVID* scenario. Access to improved sanitation globally is 3 percent higher in 2030 than in *COVID* and nearly 5 percent higher in 2050. The increases lead to values also well above those in the *No COVID* scenario, more than offsetting the impact of COVID.

Populations in high-income countries as a grouping already have universal access to safe water. The push is much more important in non-OECD countries and Figure 7.9 compares progress toward universality for these countries across the four scenarios of the project. *SDG Push* does not quite take those countries to universal access (using 97 percent as operationalization of that) by 2030, but it takes them to 99 percent in 2050. Already in 2022 access levels exceed those of *No COVID*.

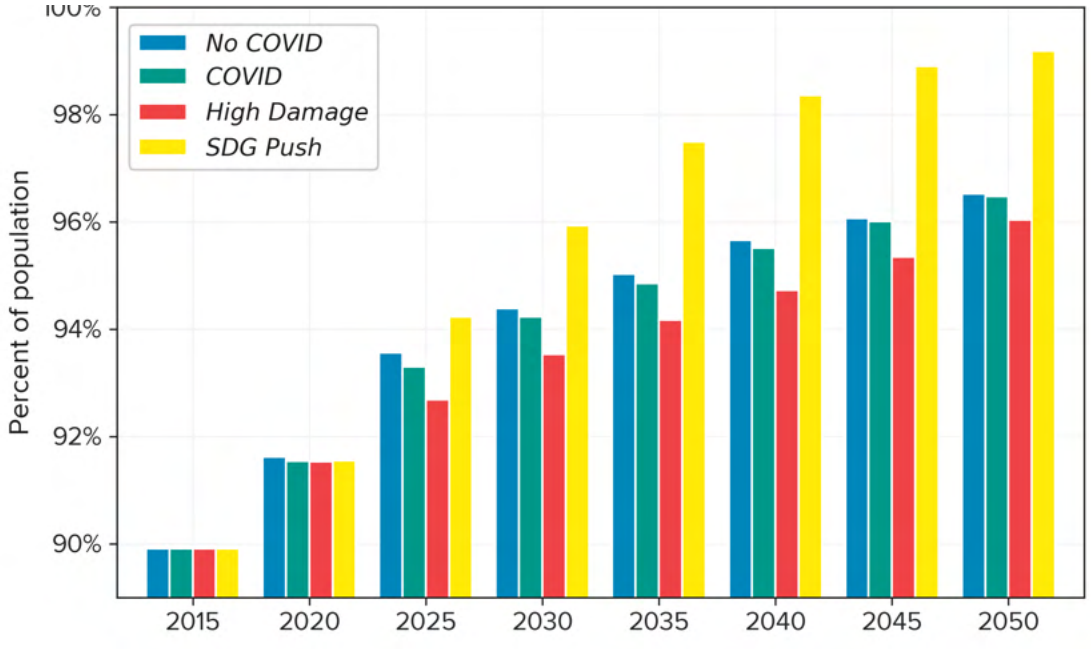


Figure 7.9 Percent of population in non-OECD countries with improved water access: *No COVID*, *COVID*, *High Damage*, and *SDG Push* scenarios
Source: IFs Version 7.61.

Challenges are greater for progress toward universally safe sanitation. Figure 7.10 shows that even with the *SDG Push* only 90 percent of population in non-OECD countries are likely to have improved sanitation access in 2030. This value, however, rises to over 97 percent in 2050. For low-income countries the numbers are 61 percent in 2030 and 89 percent in 2050.

Thus, the news with respect to sanitation, especially in the *SDG Push* scenario, is a mixture of good and bad. On the good side, by 2030 an additional 2 billion people could have improved sanitation relative to the number in 2015, 264 million more than in the *No COVID* scenario. The bad news is that even by 2050 there could still be 230 million people globally without improved or shared sanitation (thus most often relying upon open defecation).

COVID-19 has itself demonstrated how critically important sanitation, hygiene, and access to clean water are to the prevention and containment of disease. Hand-washing, for example, has been identified as an important element of strategy for protecting against infection from the virus (WHO & UNICEF, 2020b). The value of sanitation and safe water for improved health reaches, of course, far beyond any impact it might have on future protection against corona viruses. One critically important contribution they make is protecting children against diarrheal disease, thereby significantly reducing child mortality and increasing time exposed to schooling. Perhaps improving access to safe water and sanitation will be understood to be an even higher priority in the post-COVID world than it was before the pandemic.

Shutterstock / Lidiya Ribakova

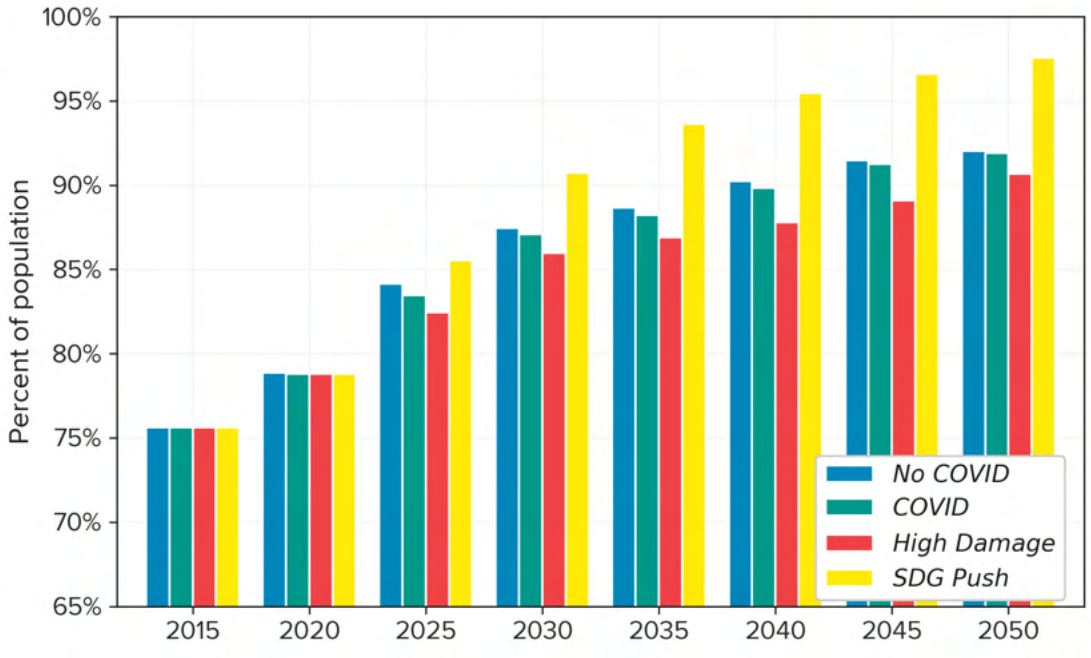


Figure 7.10 Percent of population in non-OECD countries with improved sanitation access: *No COVID*, *COVID*, *High Damage*, and *SDG Push* scenarios
Source: IFs Version 7.61.

8. Beyond People and Prosperity to Planet and Peace

Pursuit of sustainable development requires attention to five dimensions or pillars, the "5 Ps": *People*, *Prosperity*, *Planet*, *Peace*, and *Partnerships*. This report focuses heavily on people and prosperity and therefore the SDGs concerning poverty, hunger, health, education, gender equality, and access to safe water and sanitation. However, this project fully recognizes the critical importance of the other three pillars in themselves and in close interaction with people and prosperity.

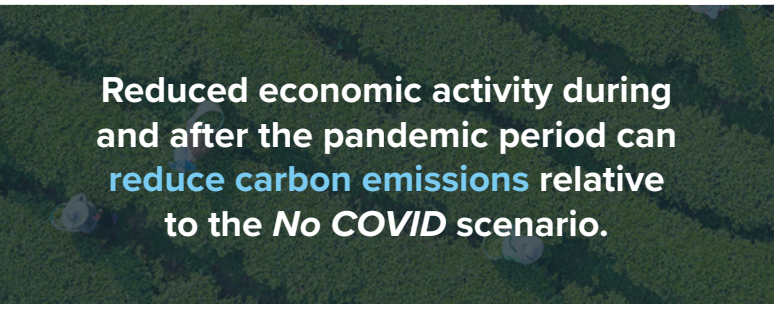
Quantitative analysis of progress toward a protected planet and toward peaceful and inclusive societies is even more challenging for us than that for people and prosperity for three reasons. First, many of the SDGs pertaining to planet, peace and partnerships were not originally given associated quantitative targets; even now appropriate quantifications are often somewhat uncertain. Second, planetary environmental sustainability, including limiting climate change and addressing fishery damage, requires planetary target specification and cooperative action by countries starting from very different points with respect to their current (and historical) contributions to globally unsustainable patterns. Determining appropriate country-specific action is challenging.

Third, and related to the first two, modeling of environmental and socio-political change dynamics in the International Futures (IFs) system is not as extensively elaborated as that for dynamics related to people and prosperity. Two planet and peace issue areas for which IFs does include significant representation are climate change and state failure. Specifically, the energy and agricultural models of IFs provide a basis for analysis of carbon emissions and atmospheric concentrations. And extensive modeling in IFs of issues and variables on the people and prosperity dimensions provides the basis for representing changing probability of domestic unrest and likelihood of state failure. We therefore look here at future potential for limiting climate change and building peaceful societies.

Shutterstock / Gorkhe1980, NOWAK LUKASZ

8.1 Limiting climate change

SDG 13 is to "Take urgent action to combat climate change and its impacts." The *COVID* and *SDG Push* scenarios have important implications for pursuit of that goal.



Shutterstock / Thailand Travel Lover

Reduced economic activity during and after the pandemic period can reduce carbon emissions relative to the *No COVID* scenario. Research finds a significant pandemic-period reduction in carbon emissions (for example, an 8.8% reduction in CO2 emissions in the first half of 2020 (Liu et al., 2020)) as a result of decreased economic activity. This mitigation of contributions to climate change may be one of few silver linings of the current COVID-19 crisis. But the effects of this on long-term build-up of greenhouse gas in the atmosphere is likely to be "insignificant" with respect to meeting the Paris Agreement goal of limiting global warming to well below 2˚C in the absence of its helping to motivate major effort toward green recovery (UNEP, 2020, p. xiii). Although some evidence is emerging to contradict the concern, the benefit of pandemic-period reductions in emissions might even be offset by slowing investment in renewable energy sources due to reduced economic activity.

In sharp contrast to the almost certainly limited effect of COVID upon atmospheric carbon concentrations even in the *High Damage* scenario, the *SDG Push* scenario contains interventions that could have quite positive effects on annual carbon emissions and therefore atmospheric concentrations of carbon dioxide. These include both greater efficiency in the use of energy as a result of accelerated technological advance and a carbon tax and enhanced development of renewable supplies (see Appendix 2).

Because the concentration of carbon dioxide in the atmosphere changes very slowly in response to changes in annual emissions and because of attention to those concentrations across the full century by almost all climate-focused integrated assessment modeling, Figure 8.1 extends our attention to 2100, well beyond the SDG horizon. It shows that, indeed, the *COVID* scenarios have limited implications for atmospheric concentrations across that horizon. In fairly sharp contrast, the Green Economy interventions of *SDG Push*, while changing atmospheric levels by only about 5 parts per million in 2030, generate a more significant reduction of nearly 25 parts per million by 2050, increasing to 80 parts per million in 2100.

Shutterstock / Alexandros Michailidis

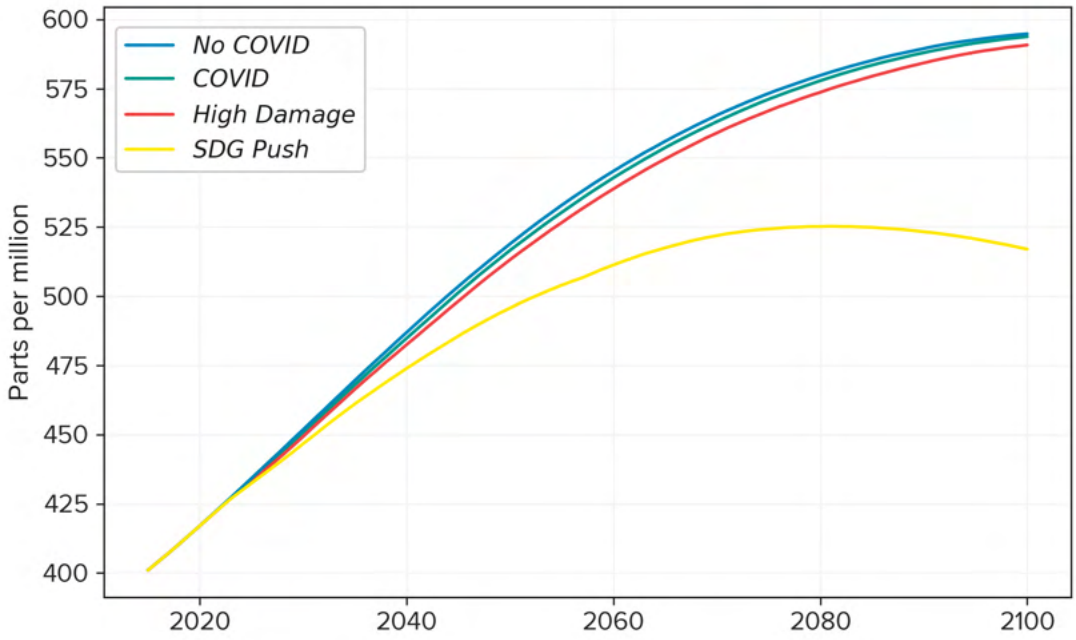


Figure 8.1. Atmospheric carbon dioxide concentration: *No COVID*, *COVID*, *High Damage* and *SDG Push* scenarios
Source: IFs Version 7.61.

Analyses in the climate-change oriented Integrated Assessment Modeling (IAM) community can put the figure's scenario results in context. That community developed a set of scenarios called Representative Concentration Pathways (RCPs) to serve the Intergovernmental Panel on Climate Change's Firth Assessment Report. They continue to be widely used as a bridge between analysis of greenhouse gas emissions and likely extent of global warming (van Vuuren et al., 2011).[5] The four RCP scenarios, designated by radiative forcing numbers in W/m-2 are RCP2.6, RCP4.5, RCP6.0, and RC8.5. The highest pathway is roughly associated with atmospheric concentrations of carbon-dioxide-equivalent greenhouse gas levels exceeding 1,200 parts per million in 2100.

The values in Figure 8.1 for three of the four scenarios of this project fall between expectations of RCP4.5 and RCP6.0, closer to the latter (once estimates for other greenhouse gas emissions are added to the carbon dioxide alone modeled by IFs in Figure 8.1). In sharp contrast, *SDG Push* holds levels to those close to RCP4.5, often associated with expectations for global temperature change above but close to 2 degrees Celsius. In short, the benefits of *SDG Push* for limiting climate change are very significant.

Shutterstock / TheEverywhereMan

[5] See also https://iiasa.ac.at/web/home/research/researchPrograms/Energy/RCP.en.html

8.2 Building peaceful and inclusive societies

SDG 16 is to "Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels." Again, *COVID* and *SDG Push* scenarios have different implications for attaining these goals. We look here at one key aspect of peaceful and inclusive societies, the level of conflict within them.

The COVID-19 pandemic has affected factors that can both signal and contribute to increased probability of internal conflict, such as increases in infant mortality rates and sudden drops in GDP. Negative implications of conflict for people and prosperity can further increase the probability of conflict, generating a vicious feedback loop, often with devastating consequences in the form of significant violent internal conflict.

While it is possible for models to represent an increase or decrease in the likelihood of state failure driven by structural factors, it is difficult or impossible to accurately anticipate when a state will fail (experience significant internal conflict). Because of this the IFs system represents an index of state failure. That index (0-1) is related historically to probability of failure but is not intended to be a country-year forecast of such probability. Figure 8.2 shows a sharp increase in the index during the pandemic period – such increased risk of failures, especially in fragile and less resilient states, is not surprising (and there may yet be a lag between the impetus for such failure as shown in the figure and manifestation of conflict). The figure also shows, however, a very slow decrease in index values in the *No COVID* scenario, and even in the *COVID* scenarios, due to ongoing global development and improvement on the people and prosperity dimensions. The *SDG Push* scenario can accelerate that rate of improvement.

Putting into context both the possible COVID-period surge and the longer-term pattern of slowly decreasing likelihood of domestic conflict are pre-COVID period studies of civil conflict by Hegre et al. (2016) and Hughes (2019, pp. 176–178). Both projects drew upon historical data from the Political Instability Task Force (Goldstone et al., 2010), identifying conflicts resulting in more than 1,000 deaths across their duration and at least 100 in one of the conflict years. Both used the Shared Socioeconomic Pathway (SSP) scenarios (O'Neill et al., 2014, 2017) to frame broad alternative futures for domestic conflict potential globally.

Shutterstock / YT HUI

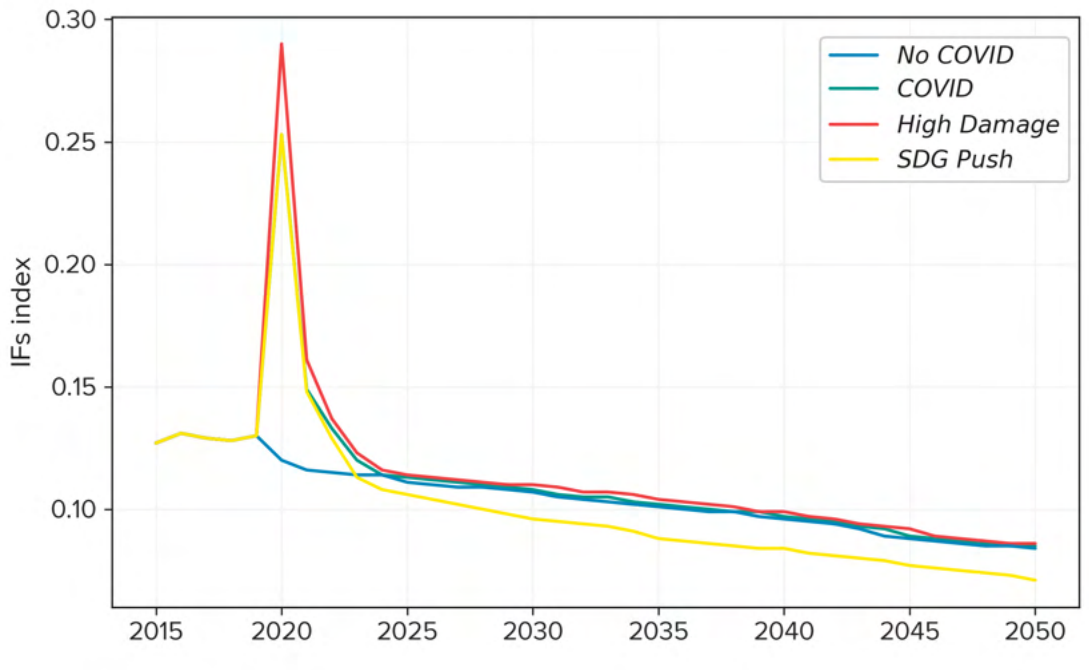


Figure 8.2. State failure internal war event index: *No COVID*, *COVID*, *High Damage* and *SDG Push* scenarios
Source: IFs Version 7.61.

Since 1960 there has been great volatility in the portion of countries suffering at least some civil violence. A peak of 23 percent was reached in 1992 (35 percent in Africa) as the Cold War's ending generated great disruption in many societies. Globally, the sharp and widespread losses of GDP in 2020-2021 considerably exceed those of that earlier period. Other factors, including improvements in governance and higher economic development levels, appear to be dampening any immediate surge in conflict during the pandemic, holding levels of it well below the potential suggested by Figure 8.2. Only after some time will we know whether the aftermath of the immediate pandemic impacts generates increases in conflict.

Following the global turmoil and increased levels of civil conflict in the 1980s and early 1990s, the longer-term trend turned downward. The SSP2 scenario is often characterized as "Middle of the Road" in the SSP set. Both the Uppsala Conflict Data Program or UCDP (Hegre et al., 2016) and the IFs project (Hughes, 2019) suggest a continued long-term decrease of civil conflict in their representation of the SSP2 scenario, a decrease like that shown in Figure 8.2 for the *No COVID*, *COVID*, and even *High Damage* scenarios. In comparison, the SSP1 scenario is named "Sustainability" and has many of the characteristics of *SDG Push*. Again, both UCDP and IFs analysis have suggested paths for civil conflict in SSP1 that decline somewhat more than in SSP.

Historically, civil conflict has been much more likely within countries and sets of them that have made less progress on the variables that this report has examined related to the *People* dimension of the SDGs. There can be little doubt that an effort to look beyond the pandemic and push forward ambitiously toward the targets of the SDGs will further the cause of bringing *Peace* to more of the world.

9. Summary and Conclusions

General insights

Prior to the COVID-19 pandemic we were not on a path that would globally reach any of the specified quantitative targets for poverty, hunger, health, or education by 2030. Although it appeared likely that on global average we would reach several human development targets by 2050, many of the most socio-politically vulnerable countries would have reached few even by then.

Uncertainties surrounding the persistence and magnitude of post-COVID impacts that will slow progress toward SDG targets relative to the *No COVID* world are very great. The *COVID* and *High Damage* scenarios of this report have reflected this via very different assumptions with respect to magnitude of GDP impact during the pandemic, extent of economic bounce-back after it, impacts on inequality, and increased government indebtedness. The scenarios generate very different long-term impacts on potential progress toward the targets. Even the considerably more probable baseline *COVID* scenario suggests high human costs of the pandemic. For instance, through 2050 it could result in 1.4 billion additional person-years of extreme poverty and about 400 million person-years of undernutrition.

The *SDG Push* scenario successfully increases the rate of progress toward the targets sufficiently to overcome the global losses of even the *High Damage* COVID scenario before 2030 for most target variables. On top of the baseline *COVID* scenario it greatly increases the number of countries reaching target levels by 2030 and 2050.

Additional insights concerning the *No COVID* world

Some strong headwinds were already facing future rates of progress toward the goals before the pandemic. Those include:

- The very rapid and significant progress made globally toward the targets during the period of the MDGs and to date with the impetus of the SDGs, as illustrated and often heavily driven by the rapid progress in China, is now largely behind us. Few additional countries are likely to experience such rapid progress.

- Many low-income and lower-middle-income countries have been able to offset large trade deficits with foreign aid and remittances; if GDP growth in developing economies continues to outstrip that of high-income economies, such financial inflows will be less able to offset those trade deficits, which have supported household consumption shares of GDP well above those in higher-income countries.

- A large number of lower-income countries have not developed governance capacity to acquire and efficiently use domestic economic resources on behalf of progress toward human development goals. Many of those countries have experienced significant state fragility in the recent past.

Additional insights concerning the baseline *COVID* and *High Damage* COVID worlds relative to *No COVID*

Uncertainties surrounding the persistence of post-COVID impacts that will potentially slow progress toward SDG targets relative to the *No COVID* world are very great and include:

- How much of the COVID-period GDP declines reflects temporary idling of capacity in sectors such as hospitality and tourism and how much might represent longer-term loss of productivity?
- How will the persistent socio-economic impact of the economic declines be distributed across sectors and sub-populations? How will that distribution affect income distribution?
- How great will be the additional governmental debt burdens and how will those increments affect revenue raising and expenditure patterns across time?
- How might financial and emotional insecurities incurred during the pandemic and the recovery periods affect consumer and investor behavior and thereby propagate through economic growth?

The two *COVID* scenarios differ significantly with respect to representation of these post-pandemic unfoldings and therefore also in the magnitude and pattern of impacts on progress toward the SDG targets. In the most general terms, the baseline *COVID* scenario represents a pattern of impact that is quite severe during the pandemic period; post pandemic the damages done to GDP and progress toward targets relative to the *No COVID* world are addressed quite rapidly and significantly, although some residual effects persist through 2030 and onward. In contrast, *High Damage* shows still more impact during the pandemic and considerably less post pandemic recovery toward *No COVID* levels.

Additional insights concerning the *SDG Push* world relative to the *No COVID* and *COVID* worlds

The *SDG Push* scenario contains a wide range of interventions that reflect the UNDP's proposed initiatives to advance governance (building a new social contract), enhance social protection (uprooting inequalities), move to a green economy (rebalancing nature, climate, and the economy), and benefit from digital disruption and innovation (embracing speed and scale). While representation of each intervention is intended to be ambitious but achievable for countries pushing toward the SDG targets, it would be very difficult for individual countries to simultaneously undertake all the efforts required. Unfortunately, it is nearly impossible to imagine a world in which all countries do so. Nonetheless, the scenario, in comparison with the *No COVID*, *COVID*, and *High Damage* worlds helps us understand the range of futures that we could possibly face. Explorations in future projects of the value-added by individual interventions and clusters of them, tailored to specific countries, can further enhance global efforts to move the world toward the frontiers of the possible.

Most important, within the contexts of the world as we understand it and the greatly varied conditions of countries, the *SDG Push* scenario helps us think seriously about what is possible. And to recognize and manifest the great potential that we possess to accelerate progress toward the Sustainable Development Goals and all that they represent for the future of humanity.

About the Study

Scenarios and analysis were developed through collaboration of the Frederick S. Pardee Center for International Futures and economists and policy experts from UNDP's SDG Integration, Strategic Policy and Engagement Team, and Human Development Report Office. The tool supporting the analysis is the International Futures (IFs) forecasting system. The models and data in IFs have been validated with many countries through training exercises and collaboration with governments and international organizations.

IFs is the product of more than 40 years of peer-reviewed and ongoing academic research at the University of Denver. The component models have been developed by trained modelers and researchers, and they have been the subject of peer-reviewed academic publications — https://pardee.du.edu/node/483.

IFs uses publicly available historical datasets from reputable sources such as UN agencies, IMF, World Bank, OECD, other academic research programs (for example Global Trade Analysis Project from Purdue University, Environmental Performance Index from Yale University and Columbia University), inter-governmental data (Eurostats), and other non-governmental institutions (such as the Economist Intelligence Unit). The full list of data sources included in IFs is available here: https://pardee.du.edu/database-international-futures-ifs. It must be noted that as a data-driven tool, IFs is affected by the well-known limitations in data availability and data quality from international sources. The tool applies statistical methods to estimate missing data from historical datasets.

UNDP has significantly invested in the IFs tool, supporting enhancements in the models and an alignment of the IFs tool to the SDGs. The IFs system has supported other flagship reports in UNDP including the report on the Impact of War in Yemen. It underpinned analysis of potential policy choices in RBEC, RBA and RBAS country offices, as well as in several MAPS engagements, providing an evidence-base for recommendations of SDG accelerators through policy simulations. UN-Women and UNDP have collaborated with the Pardee Center on a new module to forecast the gender gap in poverty. In July 2020, the SDG Integration Team launched a training, attended by 125 staff from 48 country offices in all regions, regional hubs and central bureaus, on how to use IFs to assess the medium to long term impact of COVID-19 on the SDGs. The Pardee Centre is currently utilizing the IFs model to assess COVID impact in Africa as part of a collaboration with RBA. This project is part of the continuing collaboration between the United Nations Development Programme and the Frederick S. Pardee Center for International Futures, Joseph Korbel School of International Studies, University of Denver.

The core authoring team for this report consisted of Barry B. Hughes, Taylor Hanna, Kaylin McNeil, David K. Bohl, and Jonathan D. Moyer of the Frederick S. Pardee Center for International Futures. Assistance for the Pardee Center team was provided by Beth Anne Card, Cade Carter, Caio Pereira, Andres Pulido, Barbara Stone, Adam Szymanski-Burgos, Suraj Thapa, and Andrew Woodward. José Roberto Solórzano and Mohammod Irfan provided modeling support, while Yutang Xiong led data support. From the UNDP, the collaborating team was led by Laurel Patterson, Babatunde Abidoye, Serge Kapto, Joanna Felix, Lars Jensen, Maria Marta Rey Malca De Habich, Youngeun Kang, Tasneem Mirza and Catharina Klingspor.

References

Alkema, L., Chou, D., Hogan, D., Zhang, S., Moller, A.-B., Gemmill, A., Fat, D. M., Boerma, T., Temmerman, M., Mathers, C., & Say, L. (2016). Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. *The Lancet*, 387(10017), 462–474. https://doi.org/10.1016/S0140-6736(15)00838-7

Altinok, N., Angrist, N., & Patrinos, H. A. (2018). *Global Data Set on Education Quality* (1965-2015) (Policy Research Working Paper No. 8314). The World Bank. https://doi.org/10.1596/1813-9450-8314

Antony, G., & Laxmaiah, A. (2008). Human development, poverty, health & nutrition situation in India. *The Indian Journal of Medical Research*, 128, 198–205.

Azevedo, J. P., Hasan, A., Goldemberg, D., Iqbal, S. A., & Geven, K. (2020). *Simulating the Potential Impacts of COVID-19 School Closures on Schooling and Learning Outcomes: A Set of Global Estimates* (Policy Research Working Paper No. 9284). The World Bank. https://doi.org/10.1596/1813-9450-9284

Baquedano, F., Christensen, C., Ajewole, K., & Beckman, J. (2020). *International Food Security Assessment*, 2020-2030 [GFA-31]. U.S. Department of Agriculture, Economic Research Service.

Bill & Melinda Gates Foundation. (2018). *Goalkeepers: The Stories Behind the Data 2018*. Bill and Melinda Gates Foundation and IHME, University of Washington. https://www.gatesfoundation.org/goalkeepers/report/2018-report/

Bill & Melinda Gates Foundation. (2019). *The Goalkeepers Report 2019: Examining Inequality*. Bill and Melinda Gates Foundation. https://www.gatesfoundation.org/goalkeepers/report/2019-report/

Bill & Melinda Gates Foundation. (2020). *COVID-19 A Global Perspective: 2020 Goalkeepers Report*. Bill and Melinda Gates Foundation. https://www.gatesfoundation.org/goalkeepers/report/2020-report/#GlobalPerspective

Boudet, A. M. M., Buitrago, P., de la Briere, B. L., Newhouse, D., Matulevich, E. R., Scott, K., & Suarez-Becerra, P. (2018). *Gender Differences in Poverty and Household Composition through the Life-cycle: A Global Perspective* (Policy Research Working Paper No. 8360). World Bank.

Crespo Cuaresma, J., Fengler, W., Kharas, H., Bekhtiar, K., Brottrager, M., & Hofer, M. (2018). Will the Sustainable Development Goals be fulfilled? Assessing present and future global poverty. *Palgrave Communications*, 4(1), 1–8. https://doi.org/10.1057/s41599-018-0083-y

European Commission. (2020). *Educational inequalities in Europe and physical school closures during Covid-19* (Fairness Policy Brief Series No. 04/2020). European Commission. https://ec.europa.eu/jrc/sites/jrcsh/files/fairness_pb2020_wave04_covid_education_jrc_i1_19jun2020.pdf

FAO, IFAD, UNICEF, WFP, & WHO. (2020). *The State of Food Security and Nutrition in the World 2020: Transforming food systems for affordable healthy diets*. FAO, IFAD, UNICEF, WFP and WHO. https://doi.org/10.4060/ca9692en

Friedman, J., York, H., Graetz, N., Woyczynski, L., Whisnant, J., Hay, S. I., & Gakidou, E. (2020). Measuring and forecasting progress towards the education-related SDG targets. *Nature, 580*(7805), 636–639. https://doi.org/10.1038/s41586-020-2198-8

Goldstone, J. A., Bates, R. H., Epstein, D. L., Gurr, T. R., Lustik, M. B., Marshall, M. G., Ulfelder, J., & Woodward, M. (2010). A Global Model for Forecasting Political Instability. *American Journal of Political Science*, 54(1), 190–208. https://doi.org/10.1111/j.1540-5907.2009.00426.x

Hayes, B., Weinberger, M., White, J., & Skibiak, J. (2020, June 25). Are we ready to mitigate the impacts of COVID-19 on family planning and contraceptives? | *Global Financing Facility*. Global Financing Facility. https://www.globalfinancingfacility.org/are-we-ready-mitigate-impacts-covid-19-family-planning-and-contraceptives

Hegre, H., Buhaug, H., Calvin, K. V., Nordkvelle, J., Waldhoff, S. T., & Gilmore, E. (2016). Forecasting civil conflict along the shared socioeconomic pathways. *Environmental Research Letters*, 11(5), 054002. https://doi.org/10.1088/1748-9326/11/5/054002

HLPF. (2020). *Food security and nutrition: Building a global narrative towards 2030* (p. 112).

Hug, L., Alexander, M., You, D., & Alkema, L. (2019). National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: A systematic analysis. *The Lancet Global Health*, 7(6), e710–e720. https://doi.org/10.1016/S2214-109X(19)30163-9

Hughes, B. B. (2013). *Development-Oriented Policies and Alternative Human Development Paths: Aggressive But Reasonable Interventions* (SSRN Scholarly Paper ID 2344474). Social Science Research Network. https://papers.ssrn.com/abstract=2344474

Hughes, B. B. (2016). International Futures (IFs) and integrated, long-term forecasting of global transformations. *Futures*, 81, 98–118. https://doi.org/10.1016/j.futures.2015.07.007

Hughes, B. B. (2019). *International Futures: Building and Using Global Models*. Elsevier Academic Press. https://doi.org/10.1016/C2014-0-04231-1

Hughes, B. B., & Narayan, K. (in press). Enhancing integrated analysis of national and global goal pursuit by endogenizing economic productivity. *PLOS ONE*.

ICSU. (2017). *A guide to SDG interactions: From science to implementation*. International Council for Science (ICSU). https://dx.doi.org/10.24948/2017.01

ICSU & ISSC. (2015). *Review of Targets for the Sustainable Development Goals: The Science Perspective*. International Council for Science and International Social Science Council. https://council.science/wp-content/uploads/2017/05/SDG-Report.pdf

IFC. (2020). *The impact of COVID-19 on the water and sanitation sector*. International Finance Corporation, World Bank Group. https://www.ifc.org/wps/wcm/connect/industry_ext_content/ifc_external_corporate_site/infrastructure/resources/the+impact+of+covid-19+on+water+and+sanitation

IMF. (2020). *World Economic Outlook, October 2020: A Long and Difficult Ascent*. International Monetary Fund. https://www.imf.org/en/Publications/WEO/Issues/2020/09/30/world-economic-outlook-october-2020

Independent Group of Scientists appointed by the Secretary-General. (2019). *Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development*. United Nations. http://pure.iiasa.ac.at/id/eprint/16067/1/24797GSDR_report_2019.pdf

Jordà, Ò., Singh, S. R., & Taylor, A. M. (2020, April 8). The longer-run economic consequences of pandemics. *VoxEU.Org*. https://voxeu.org/article/longer-run-economic-consequences-pandemics

Kassebaum, N. J., Barber, R. M., Bhutta, Z. A., Dandona, L., Gething, P. W., Hay, S. I., Kinfu, Y., Larson, H. J., Liang, X., Lim, S. S., Lopez, A. D., Lozano, R., Mensah, G. A., Mokdad, A. H., Naghavi, M., Pinho, C., Salomon, J. A., Steiner, C., Vos, T., … Murray, C. J. L. (2016). Global, regional, and national levels of maternal mortality, 1990–2015: A systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, 388(10053), 1775–1812. https://doi.org/10.1016/S0140-6736(16)31470-2

Kozlowski, J., Veldkamp, L., & Venkateswaran, V. (2020). *Scarring Body and Mind: The Long-Term Belief-Scarring Effects of Covid-19* (FRB St. Louis Working Paper No. 2020–009). https://doi.org/10.20955/wp.2020.009

Kriegler, E., O'Neill, B. C., Hallegatte, S., Kram, T., Lempert, R. J., Moss, R. H., & Wilbanks, T. (2012). The need for and use of socio-economic scenarios for climate change analysis: A new approach based on shared socio-economic pathways. *Global Environmental Change*, 22(4), 807–822. https://doi.org/10.1016/j.gloenvcha.2012.05.005

Laborde, D., Martin, W., & Vos, R. (2020). Poverty and food insecurity could grow dramatically as COVID-19 spreads. In J. Swinnen & J. McDermott (Eds.), *COVID-19 and global food security* (0 ed., pp. 16–19). International Food Policy Research Institute. https://doi.org/10.2499/p15738coll2.133762

Laborde, D., Parent, M., & Smaller, C. (2020). Ending Hunger, *Increasing Incomes, and Protecting the Climate*: Ceres2030, International Institute for Sustainable Development (IISD) and International Food Policy Research Institute (IFPRI).

Lakner, C., Mahler, D. G., Negre, M., & Prydz, E. B. (2019). *How Much Does Reducing Inequality Matter for Global Poverty?* (Policy Research Working Paper No. 8869). World Bank.

Lakner, C., Yonzan, N., Mahler, D. G., Aguilar, A. C., Wu, H., & Fleury, M. (2020, October 7). Updated estimates of the impact of COVID-19 on global poverty: The effect of new data. *World Bank Data Blog*. https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty-effect-new-data

Liu, Z., Ciais, P., Deng, Z., Lei, R., Davis, S. J., Feng, S., Zheng, B., Cui, D., Dou, X., Zhu, B., Guo, R., Ke, P., Sun, T., Lu, C., He, P., Wang, Y., Yue, X., Wang, Y., Lei, Y., … Schellnhuber, H. J. (2020). Near-real-time monitoring of global CO2 emissions reveals the effects of the COVID-19 pandemic. *Nature Communications*, 11. https://doi.org/10.1038/s41467-020-18922-7

Lucas, P. L., Hilderink, H. B. M., Janssen, P. H. M., Kc, S., van Vuuren, D. P., & Niessen, L. (2019). Future impacts of environmental factors on achieving the SDG target on child mortality—A synergistic assessment. *Global Environmental Change, 57*, 101925. https://doi.org/10.1016/j.gloenvcha.2019.05.009

Lutz, W., Goujon, A., KC, S., Stonawski, M., & Stilianakis, N. (Eds.). (2018). *Demographic and human capital scenarios for the 21st century*. European Union.

Mahler, D., Lakner, C., Aguilar, R., & Wu, H. (2020, June 8). Updated estimates of the impact of COVID-19 on global poverty. *World Bank Blogs*. https://blogs.worldbank.org/opendata/updated-estimates-impact-covid-19-global-poverty

Manuel, M., Desai, H., Samman, E., & Evans, M. (2018). *Financing the end of extreme poverty*. Overseas Development Institute.

McArthur, J. W., Rasmussen, K., & Yamey, G. (2018). How many lives are at stake? Assessing 2030 sustainable development goal trajectories for maternal and child health. *BMJ : British Medical Journal (Online); London, 360*. http://dx.doi.org.du.idm.oclc.org/10.1136/bmj.k373

Moyer, J. D., & Bohl, D. K. (2019). Alternative pathways to human development: Assessing trade-offs and synergies in achieving the Sustainable Development Goals. *Futures*, 105, 199–210. https://doi.org/10.1016/j.futures.2018.10.007

Moyer, J. D., & Hedden, S. (2020). Are we on the right path to achieve the sustainable development goals? *World Development*, 127, 104749. https://doi.org/10.1016/j.worlddev.2019.104749

Naiken, L. (2002, June). Keynote Paper: FAO methodology for estimating the prevalence of undernourishment. *Measurement and Assessment of Food Deprivation and Undernutrition*. International Scientific Symposium, Rome, Italy. http://www.fao.org/3/Y4249E/y4249e06.htm#bm06

Nilsson, M., Griggs, D., & Visbeck, M. (2016). Policy: Map the interactions between Sustainable Development Goals. *Nature News*, 534(7607), 320. https://doi.org/10.1038/534320a

Obersteiner, M., Walsh, B., Frank, S., Havlík, P., Cantele, M., Liu, J., Palazzo, A., Herrero, M., Lu, Y., Mosnier, A., Valin, H., Riahi, K., Kraxner, F., Fritz, S., & Vuuren, D. van. (2016). Assessing the land resource–food price nexus of the Sustainable Development Goals. *Science Advances*, 2(9), e1501499. https://doi.org/10.1126/sciadv.1501499

O'Neill, B. C., Kriegler, E., Ebi, K. L., Kemp-Benedict, E., Riahi, K., Rothman, D. S., van Ruijven, B. J., van Vuuren, D. P., Birkmann, J., Kok, K., Levy, M., & Solecki, W. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. *Global Environmental Change*, 42, 169–180. https://doi.org/10.1016/j.gloenvcha.2015.01.004

O'Neill, B. C., Kriegler, E., Riahi, K., Ebi, K. L., Hallegatte, S., Carter, T. R., Mathur, R., & van Vuuren, D. P. (2014). A new scenario framework for climate change research: The concept of shared socioeconomic pathways. *Climatic Change*, 122(3), 387–400. https://doi.org/10.1007/s10584-013-0905-2

Pradhan, P., Costa, L., Rybski, D., Lucht, W., & Kropp, J. P. (2017). A Systematic Study of Sustainable Development Goal (SDG) Interactions. *Earth's Future*, 5(11), 1169–1179. https://doi.org/10.1002/2017EF000632

Ravallion, M. (2013). How Long Will It Take to Lift One Billion People Out of Poverty? *The World Bank Research Observer*, 28(2), 139–158. https://doi.org/10.1093/wbro/lkt003

Ravallion, M., Datt, G., & van de Walle, D. (1991). Quantifying Absolute Poverty in the Developing World. *Review of Income & Wealth*, 37(4), 345–361. https://doi.org/10.1111/j.1475-4991.1991.tb00378.x

Reddy, S. G. (2020). *Global Absolute Poverty: The Beginning of the End?* (SSRN Scholarly Paper ID 3537705). Social Science Research Network. https://doi.org/10.2139/ssrn.3537705

Roberton, T., Carter, E. D., Chou, V. B., Stegmuller, A. R., Jackson, B. D., Tam, Y., Sawadogo-Lewis, T., & Walker, N. (2020). Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: A modelling study. *The Lancet Global Health, 8*(7), e901–e908. https://doi.org/10.1016/S2214-109X(20)30229-1

Rozenberg, J., & Hallegatte, S. (2015). *The Impacts of Climate Change on Poverty in 2030 and the Potential from Rapid, Inclusive, and Climate-Informed Development* (Policy Research Working Paper No. 7483; Shock Waves: Managing the Impacts of Climate Change on Poverty Background Paper). World Bank. https://doi.org/10.1596/1813-9450-7483

Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., & Fuller, G. (2018). *Global Responsibilities. Implementing the Goals: SDG Index and Dashboards Report 2018*. Bertelsmann Stiftung and Sustainable Development Solutions Network (SDSN). https://sdgindex.org/reports/sdg-index-and-dashboards-2018/

Sellers, S., & Ebi, K. L. (2018). Climate Change and Health under the Shared Socioeconomic Pathway Framework. *International Journal of Environmental Research and Public Health*, 15(1), 3. https://doi.org/10.3390/ijerph15010003

Soergel, B., Kriegler, E., Weindl, I., Rauner, S., Dirnaichner, A., Ruhe, C., Hofmann, M., Bauer, N., Bertram, C., Bodirsky, B. L., Leimbach, M., Leininger, J., Levesque, A., Luderer, G., Pehl, M., Wingens, C., Baumstark, L., Beier, F., Dietrich, J. P., … Popp, A. (2021). *Climate action within the 2030 Agenda: A holistic sustainable development pathway* [Manuscript submitted for publication].

Sumner, A., Hoy, C., & Ortiz-Juarez, E. (2020). *Estimates of the impact of COVID-19 on global poverty*. UNU-WIDER. https://doi.org/10.35188/UNU-WIDER/2020/800-9

Takemoto, M. L. S., Menezes, M. O., Andreucci, C. B., Knobel, R., Sousa, L. A. R., Katz, L., Fonseca, E. B., Magalhães, C. G., Oliveira, W. K., Rezende-Filho, J., Melo, A. S. O., & Amorim, M. M. R. (2020). Maternal mortality and COVID-19. *The Journal of Maternal-Fetal & Neonatal Medicine*, 0(0), 1–7. https://doi.org/10.1080/14767058.2020.1786056

Thome, K., Smith, M. D., Daugherty, K., Rada, N., Christensen, C., & Meade, B. (2019). I*nternational Food Security Assessment*, 2019-2029. 65.

UN. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development* (A/RES/70/1). United Nations. https://doi.org/10.1891/9780826190123.ap02

UN. (2020). *Education during COVID-19 and beyond* [Policy Brief]. United Nations. https://www.un.org/development/desa/dspd/wp-content/uploads/sites/22/2020/08/sg_policy_brief_covid-19_and_education_august_2020.pdf

UN DESA. (2020). *World Mortality 2019* (ST/EAS/SER.A/437). United Nations. https://www.un.org/en/development/desa/population/publications/pdf/mortality/WMR2019/World_Mortality_2019.pdf

UNDP. (2020). *Beyond Recovery: Towards 2030*. United Nations Development Programme. https://www.undp.org/content/undp/en/home/librarypage/hiv-aids/beyond-recovery--towards-2030.html

UNEP. (2020). *Emissions Gap Report 2020*. United Nations Environmental Programme. http://www.unenvironment.org/emissions-gap-report-2020

UNESCO. (2020). *Global education monitoring report, 2020: Inclusion and education: All means all*. UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000373718

UNESCO & GEMR. (2019). *Meeting commitments: Are countries on track to achieve SDG 4?* UNESCO Institute for Statistics and Global Education Monitoring Report Team. https://unesdoc.unesco.org/ark:/48223/pf0000369009

UNICEF. (2020a). *UNICEF's Water Game Plan: Universal safe and sustainable water services for all by 2030*. United Nations Children's Fund. https://www.unicef.org/media/73146/file/UNICEF-Water-Game-Plan.pdf

UNICEF. (2020b). *Monitoring and mitigating the secondary impacts of the coronavirus disease (COVID-19) pandemic on WASH services availability and access*. United Nations Children's Fund. https://www.unicef.org/documents/monitoring-and-mitigating-secondary-impacts-coronavirus-disease-covid-19-pandemic-wash

UNICEF. (2020c). *As COVID-19 devastates already fragile health systems, over 6,000 additional children under five could die a day, without urgent action* [Press Release]. United Nations Children's Fund. https://www.unicef.org/press-releases/covid-19-devastates-already-fragile-health-systems-over-6000-additional-children

UNICEF, WHO, & World Bank. (2020). *Levels and trends in child malnutrition*. United Nations Children's Fund, World Health Organization, and World Bank.

van Soest, H. L., van Vuuren, D. P., Hilaire, J., Minx, J. C., Harmsen, M. J. H. M., Krey, V., Popp, A., Riahi, K., & Luderer, G. (2019). Analysing interactions among Sustainable Development Goals with Integrated Assessment Models. *Global Transitions*, 1, 210–225. https://doi.org/10.1016/j.glt.2019.10.004

van Vuuren, D. P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G. C., Kram, T., Krey, V., Lamarque, J.-F., Masui, T., Meinshausen, M., Nakicenovic, N., Smith, S. J., & Rose, S. K. (2011). The representative concentration pathways: An overview. *Climatic Change, 109*(1), 5. https://doi.org/10.1007/s10584-011-0148-z

von Braun, J. (2020). *Forecast 2020: Financial Meltdown and Malnutrition*. United Nations; United Nations. https://www.un.org/en/chronicle/article/forecast-2020-financial-meltdown-and-malnutrition

Vos, R., Martin, W., & Laborde, D. (2020, April 16). Poverty and food insecurity could grow dramatically as COVID-19 spreads [Research Post]. *IFPRI Blog*. https://www.ifpri.org/blog/poverty-and-food-insecurity-could-grow-dramatically-covid-19-spreads

Weitz, N., Carlsen, H., Nilsson, M., & Skånberg, K. (2018). Towards systemic and contextual priority setting for implementing the 2030 Agenda. *Sustainability Science*, 13(2), 531–548. https://doi.org/10.1007/s11625-017-0470-0

Weitz, N., Nilsson, M., & Davis, M. (2014). A Nexus Approach to the Post-2015 Agenda: Formulating Integrated Water, Energy, and Food SDGs. *SAIS Review of International Affairs*, 34(2), 37–49.

WHO & UNICEF. (2017). *Progress on drinking water, sanitation and hygiene. 2017 update and SDG baselines*. World Health Organization and United Nations Children's Fund. https://www.who.int/mediacentre/news/releases/2017/launch-version-report-jmp-water-sanitation-hygiene.pdf

WHO & UNICEF. (2018a). *The extension of the 2025 Maternal, Infant and Young Child nutrition targets to 2030*. World Health Organization and United Nations Children's Fund. https://www.who.int/nutrition/global-target-2025/discussion-paper-extension-targets-2030.pdf?ua=1

WHO & UNICEF. (2018b). *JMP Methodology: 2017 update & SDG baselines*. World Health Organization and United Nations Children's Fund. https://washdata.org/report/jmp-methodology-2017-update

WHO & UNICEF. (2020a). *State of the world's sanitation*. World Health Organization and United Nations Children's Fund. https://washdata.org/sites/default/files/2020-11/UNICEF-WHO-state-of-the-worlds-sanitation-2020.pdf

WHO & UNICEF. (2020b). *Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19* [Interim guidance]. World Health Organization and United Nations Children's Fund. https://www.who.int/publications/i/item/WHO-2019-nCoV-IPC-WASH-2020.4

World Bank. (2015). *A measured approach to ending poverty and boosting shared prosperity: Concepts, data, and the twin goals*. World Bank.

World Bank. (2018). *Poverty and Shared Prosperity 2018: Piecing Together the Poverty Puzzle*. World Bank. https://www.worldbank.org/en/publication/poverty-and-shared-prosperity-2018

World Bank. (2020a). *Poverty and Shared Prosperity 2020: Reversals of Fortune*. World Bank. https://openknowledge.worldbank.org/bitstream/handle/10986/34496/9781464816024.pdf

World Bank. (2020b, April 30). *World Bank Education and COVID-19* [Text/HTML]. World Bank. https://www.worldbank.org/en/data/interactive/2020/03/24/world-bank-education-and-covid-19

You, D., Hug, L., Ejdemyr, S., Idele, P., Hogan, D., Mathers, C., Gerland, P., New, J. R., & Alkema, L. (2015). Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *The Lancet*, 386(10010), 2275–2286. https://doi.org/10.1016/S0140-6736(15)00120-8

Appendix 1: The International Futures (IFs) Forecasting system

Approaches to forecasting progress on the SDGs

There remains less understanding than desired of how policy interventions dynamically and interactively affect the simultaneous pursuit of multiple SDGs by very disparate countries, the interacting methodological and substantive research frontiers that motivate this project. Some studies have primarily extrapolated historical trends in target and indicator variables with little or no attention to the drivers of that progress (Sachs et al., 2018). Other work has given more attention to a selected set of drivers, generally still related to individual goals/indicator variables (e.g., Bill and Melinda Gates Foundation (2018) with respect to poverty and health; Cuaresma et al. (2018) on poverty; Lucas et al. (2019) on child mortality).

Many studies identify a significant nexus of interrelated goals and possible interventions. Weitz, et al. (2014, p. 43) examined the water, energy, and food nexus, giving particular attention to natural resources as enablers of development. Obersteiner, et al. (2016) dug into the land resource and food price nexus. Sellers and Ebi (2018) elaborated narratives on the linkages of climate change and health. The CD-LINKS project identified the development-energy-climate nexus and recognized the special attention given by integrated assessment models (IAMs) to the impact on broader development goals of action to limit climate change (van Soest et al., 2019). Moyer and Bohl (2019) and Moyer and Hedden (2020) studied multiple human development goals. Nexus work often uses alternative scenarios in computer models. Obersteiner et al. (2016) drew upon three of the five Shared Socioeconomic Pathways or SSP scenario set (Kriegler et al., 2012; O'Neill et al., 2014, 2017) and explored 14 policy strategies using runs of GLOBIOM (Global Biosphere Management Model).

Another set of studies turns directly to connections across the full SDG set, drawing on expert analysis. Nilsson et al. (2016) proposed a 7-point (-3 to +3) scale to assess relationship strength. See ICSU (2017; 2015) for applications to goal subsets. Weitz, et al. (2018) built a cross-impact matrix across 34 targets (two per each of the 17 goals) for Sweden. Relevant also to this work, they found that effective institutions had the highest summed relationship with other targets. Pradhan, et al. (2017) statistically examined the intercorrelation of 122 indicators across SDG targets for 227 countries from 1983 to 2016.

Shutterstock / photo-lime

The methodological advantages of International Futures (IFs)

This study uses the International Futures (IFs) system to explore the long-term impacts of COVID on prospects for reaching the SDGs and the potential for extensive efforts to overcome the pandemic's damage and accelerate progress toward the goals. Three aspects of the IFs structure facilitate such analysis of the SDGs, adding to the contributions of earlier work: its country-specific representation, its comprehensive system representation, and its treatment of fiscal and physical resource constraints (Hughes 2019; pardee.du.edu/wiki/Main_Page).

Country specificity. Representing 186 countries and their interactions, the IFs structure enhances its utility in analysis of important immediate and longer-term secondary effects of scenario interventions. Results of this project provide information on global progress toward the goals, on progress across the World Bank country income categories, and by UN region. They further provide insight into the numbers of countries attaining goals in 2030 and 2050 and into the relationship of attainment failure to state fragility.

Comprehensive system representation with extensive causal linkage elaboration. The extensive framework of the SDGs calls for integrated model-based analysis across the issue domains of human development, socio-political change (including advance in the capabilities and outputs of government), and biophysical sustainability. Figure 1 shows how the models within IFs correspond to the SDGs. Causal connections within and across component models, including endogenous representation of many drivers of economic productivity, facilitate consideration of variables and dynamics linking and underlying the SDGs and of policy orientations. Representation of temporal dynamics annually over the long-run facilitates understanding of lags in achieving change.

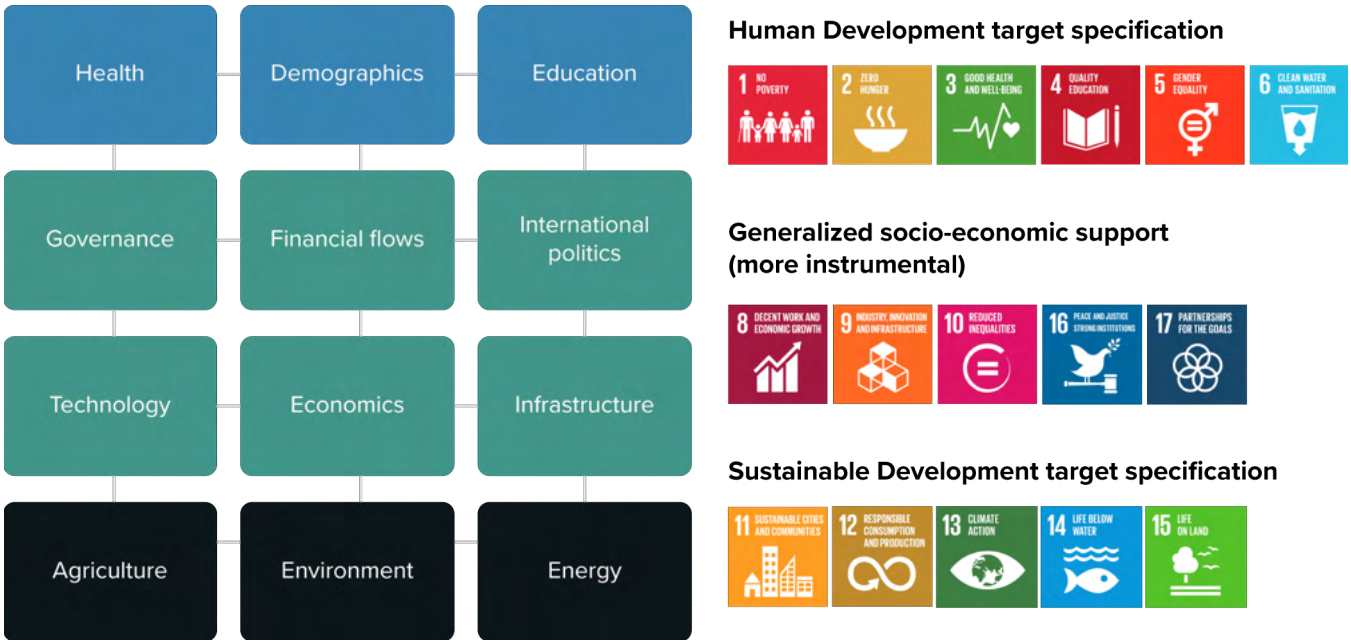


Figure 1. The models of the International Futures (IFs) system and related SDGs

Note: Blue indicates models in IFs primarily focused on human development; green represents socioeconomic development; black shows models especially important to sustainable development

Fiscal and physical resource competition accounting. Trade-offs often lie in competition for resources. Governments (or households) cannot spend the same money on education, health, infrastructure, subsidies for renewable energy, and the military. Social accounting matrices (SAMs) like that within IFs represent fiscal accounting within and among governments, households, and firms. On the physical side, IFs maintains accounting for land uses, fossil fuel resources, and age-sex specific demographics underlying labor supply.

Most obviously, lower GDP levels during and after the pandemic generate lower income levels and reduce consumption and savings potential. Reduced consumption directly affects poverty and nutrition levels. Reduced savings can affect investment and capital formation across issue areas as diverse as education, water and sanitation, and the broader economy and its future growth. All of these accounting-constrained dynamics shape the impacts of COVID on progress toward the SDGs.

The majority of the studies on the impact of COVID-19 are relatively short-term in nature, looking at the immediate effect in 2020/2021. This study is one of the few model-based studies looking at the possible impact on the longer-term progress of the SDGs to 2050. Given that COVID is deeply impacting all aspects of livelihood and society, it is important to explore not just the apparent linkages between poverty and its proximate drivers of economic and population growth and distribution but also drill down into the deep drivers, including the development of human capital (education and health), the character and effectiveness of governance, and knowledge extension and diffusion (Hughes & Narayan, in press).

Poverty calculations within International Futures (IFs)

Elimination of poverty is the first and most fundamental of the SDGs. Review of its treatment within IFs can illustrate the benefits of the system's country specificity, integrated system representation, and fiscal accounting.

Forecasts of poverty rates and numbers in alternative IFs scenarios are produced within a dynamically recursive general equilibrium economic model that utilizes a social accounting matrix (SAM) structure to represent financial flows within and among households, government, and firm agent categories. The economic model is bi-directionally hard-linked to a demographic model representing population by age and sex, and to a set of other models including education, health, governance, agriculture, and energy. The 186 countries of IFs are linked via trade, investment, migration, and remittance flows.

Poverty calculations in each annual time step most directly use the variables household consumption per capita at purchasing power parity per capita, a Gini coefficient, and an assumption of log-normal income distribution. The resultant poverty rates applied to population totals determine numbers in extreme poverty.

Gini can change in IFs with exogenous assumptions or in response to the relative population shares of and changing income shares of skilled and unskilled households (affected, for instance, by educational attainment within households). Household consumption levels are determined within the SAM and therefore are affected by household shares of value added (GDP in the aggregate) and its division between net savings and consumption, as well as by net flows to or from government. GDP growth can be driven exogenously or determined endogenously.

When endogenous (beyond the first few model years for which GDP data or good estimates are available), the production side uses a Cobb-Douglas production function, drawing labor from the demographic model and endogenously representing productivity change as

a function of variables from other models in IFs including education, health, infrastructure, and governance quality. Assisting in the representation of short-term dynamics and the impacts of disruptions like the pandemic to economic equilibration, a capacity utilization variable augments the endogenous production calculation. For more detail on the poverty calculations and broader model see Hughes et al. (2009), Hughes (2019), and https://pardee.du.edu/wiki/.

Within this UNDP/Pardee Center project on Pursuing the SDGs in a World Reshaped by COVID, GDP growth in all scenarios is represented exogenously through 2021. In the *COVID* scenarios, the basis for those growth rates are values from the IMF's *World Economic Outlook* (October 2020), modified by a reduction of 1.5% in the *High Damage* scenario during the pandemic years. In the *No COVID* scenario, the exogenous growth rate values through 2021 come from the IMF's World Economic Outlook prior to the pandemic. From 2022 through the forecast horizons, the endogenous calculations of IFs determine economic growth rates. The estimates of household income and consumption in all years use the SAM structure and are endogenous. The basic Gini calculation for all years and scenarios is endogenous, but in the *High Damage* scenario, an exogenous factor increases Gini by 5% in the years following the pandemic.

Appendix 2: Parametric interventions in the scenarios

Scenarios in IFs represent the interaction of the highly integrated models with parametric interventions. Because of the structures of IFs outlined earlier (notably country-specificity, extensive representation of interacting systems in component models, and fiscal and resource accounting constraints), parametric interventions have complicated relationships with model forecasts or projections (terms used interchangeably in this project), even for the variables most directly affected by the interventions. Most interventions involve multipliers on the underlying endogenous variable calculations within IFs, not overriding specifications of values for those variables. Thus, as the dynamics of the model unfold and the set of interventions within any scenario have their impacts, the underlying endogenous calculations will be affected; the impacts of the multipliers can be reduced or increased by the endogenous dynamics.

One important example of this relates to interventions directed at increasing governmental expenditures in targeted areas such as education and health. As indicated in textual body description, the social accounting matrix structure of IFs assures a relationship between governmental spending and revenues. Although the model realistically allows some deficit spending, it also tracks the accumulation of governmental debt across time and represents the necessity for governments to address fiscal deficit increases and debt growth via reduced spending (which occurs partially in issue areas targeted for growth as well as others) and increased revenues (which then affect finances of firms and households, including their savings, investment, and consumption). Flows of resources from abroad, including foreign aid and remittances, also affect the finances of governments and households. In short, the accounting system often means that the model "fights" specific intervention specifications, and that it especially constrains attempts, as in the *SDG Push* scenario, to increase spending in multiple arenas. Country specificity, such as initial government debt levels and fiscal balances, will also add to the complexity of scenario impact unfolding.

This example illustrates only one of the constraints that the model imposes on intervention efforts. Those also occur around land use, household food consumption patterns, energy production and consumption character, and much more. Even interventions in health can produce complex results because reductions or increases in some forms of mortality (not least COVID-induced) can be offset in part by changing mortality rates elsewhere (e.g., fewer deaths from heath disease among the elderly population, which is most severely impacted by COVID).

On the flip side of the coin, many interventions affect the dynamics of positive feedback loops rather than the negative loop constraints from accounting systems. For instance, improvements in education, health, and infrastructure can each or all contribute to acceleration of improvements in economic productivity, growth in economies and government revenues, improved prospects for further investment in the area(s) targeted, and therefore further acceleration of progress.

The scenario descriptions below, with their indications of magnitudes of change in specific parameters (mostly phased in over time starting in 2021), must therefore be understood as directional intentions of change and indications of priority levels, not as exactly reflecting the magnitude of direct results. The reports of this project on the progress of SDG-related variable change will indicate the resultant magnitudes of that progress, often quite different from the magnitude of the interventions. While the intervention magnitudes are individually scaled to be ambitious but potentially achievable (given historical experience of at least some high performing countries), the model helps us understand the potential effects of pursuing them in combination across the areas of intervention.

Description of scenarios and scenario interventions used in this report

No COVID: This scenario represents the path the world was on before the COVID pandemic. Patterns of development within each country in demographics, economics, and across all SDG variables reflect model structures and parametric specifications that generate not simple extrapolations of patterns prior to 2019, but the results of dynamic change building on historical patterns.

COVID: The *COVID* scenario includes a set of changes to parameters in the IFs model on top of the *No COVID* scenario:

- The most recent country-specific GDP growth projections made by the IMF (2020) to reflect the economic impact of COVID.
- A total factor productivity shock adjustment parameter is set at 0.2 throughout the horizon to represent the 20% portion of pandemic-era GDP loss that has a long-term effect on productivity; the other 80% of GDP is assumed to represent shorter-term decline in capacity utilization the rebounds after 2021; the division is informed very generally by the experience of previous crises.
- Increased communicable disease mortality rate to account for COVID-19 deaths by country: data on COVID-19 deaths from IHME were converted to a population-wide mortality rate. Mortality interventions affect the population the year after they are introduced, which is why this intervention is made in 2019 to take effect in 2020.
- Increased mortality from communicable diseases by age group, normalized to the population-wide rate noted above. (This parameter tells IFs how to distribute increased mortality by age group).
    - The youngest cohorts (0-9 and 10-19) have the lowest mortality rate per infection, which increases by age group as follows:
        - Ages 20-29 at 0.003
        - Ages 30-39 and 40-49 at 0.005
        - Ages 50-59 at 0.013
        - Ages 60-69 at 0.04
        - Ages 70-79 at 0.125
        - Ages 80+ at 0.22

High Damage: This scenario represents a future in which the recovery trend is slower, and the economic damage is greater than the estimates provided by the IMF in October. In this scenario:

- A further reduction of 1.5% is introduced in the projected growth rate from the IMF October WEO report by country (for 2020- 2021).
- 80% of the COVID-induced GDP shock will persist as a loss in productivity throughout the period, preventing a full recovery to the pre-COVID growth trajectory.
- Inequality (measured by a domestic Gini coefficient) is increased by 5% from the initial shock and throughout the model forecast horizon.
- Government debt as a portion of GDP is increased by 20% in the initial shock (2020), simulating the additional debt countries will take on.
- The increased mortality from communicable diseases remains the same as in the *COVID* scenario.

SDG Push: Includes a set of interventions to simulate the impact that focused investments on social protection, promoting a green economy, strengthening governance structures, and digital disruption may have on our road not just to recovery but to accelerated progress thereafter:

- Social Protection
    - Improved diets via additional calorie allocation to those most in need.
    - Increased numbers of improved modern cookstoves by 500 million units over a 12-year period.
    - A targeted doubling of the public health budget.
    - Increase welfare transfers from governments to households for unskilled workers by 50% in a 13-year period for the whole world; and doubling government to household welfare transfers for unskilled workers in the WB low-income group over a 13-year period.
    - Increased access to water and sanitation:
        - Percentage of population with access to piped water doubles over 30 years (world) and increases by 50% over 30 years (WB low-income countries). The more substantial intervention outside of low-income countries is because the intervention works on closing the remaining gap with universal access, a process that becomes more demanding as it progresses.
        - Percent of population with access to improved sanitation doubles over 30 years (world) and increases by 50% over 30 years (WB low-income countries).
    - Ratio of female to male wages by country reaches 1 by 2050 (simulates all countries reaching wage parity over 30 years; ratio left alone if it already exceeds 1).
- Governance
    - The scenario simulates improved governance participation by 30% over a 13-year period via Polity project index.
    - Improves governance effectiveness (quality) by 30% over 13-year period — World Bank's governance effectiveness index.
    - Reduces government corruption by 30% over 15-year period Transparency International index.
- Green economy
    - Water demand is reduced by 30% over 32 years in the world.
    - Electricity transmission and distribution loss (as a percent of production) drops by 40% over 13 years in the world.
    - Reduction of particulate matter in urban air (urban air pollution) of 30% over 35 years in the world.
    - Increase in forested land area — simulating impact of reforestation in the world.
    - A carbon tax is introduced at $200 per ton over 13 years for OECD countries; and at

$50 per ton for non-OECD countries in a 13-year period.

- Energy demand per unit of GDP decreases by 1.4% annually, slowly declining to a rate of 1.3% by 2050, reducing the energy intensity of the economy.
- Simulating increased cleaner and more sustainable energy production sources by:
    - Annual rate of energy production cost reduction for coal set to 0.002, reflecting recognition of the external costs of coal in its true total cost
    - Annual rate of energy production cost reduction for nuclear set at 0.0035, assuming new and safer nuclear technologies will continue to emerge
    - Annual rate of energy production cost reduction for other renewable energy set to 0.01 (continued encouragement of technological progress)
- Energy demand in OECD countries falls a further 10% over 68 years, relative to endogenous calculation.
- Energy demand in non-OECD countries falls a further 38% over 78 years, relative to endogenous calculation.
- Increased electricity access, tripling the upward push in the percentage of the world population with access to electricity over a 12-year period.
- Increasing electricity access in low-income countries by 50% over a 12-year period.
- World agricultural production loss of crops, meat, ocean fish catch, and aquaculture is reduced by 30% over 30 years.
- World agricultural transportation and processing loss is reduced by 30% over 30 years.
- World agricultural food loss at the consumption stage is reduced by 30% over 30 years.
- High-income economies increase their agricultural yields by 20% over 15 years.
    - Upper-middle-income economies increase their agricultural yields by 20% over 15 years.
    - Lower-middle-income economies increase agricultural yields by 50% over 50 years.
    - Low-income economies double agricultural yields over 50 years. This intervention results in yields that follow historical patterns. This, in combination with improved diets/calories intervention (incentive), results in yields that grow more rapidly.
    - Countries currently catching more than 2 mmt of fish annually reduce their fish catch by 25% over 50 years.
- Digital disruption/innovation — Relies on improved education, human capital, and access to digital technologies
    - Lower secondary graduation rates are tripled in a 12-year period starting in 2021.
    - Targets a 5% annual increase in lower secondary graduation starting in 2021.
    - The rate of science and engineering graduates in increased by 10 percentage points over a 13-year period.
    - Doubles the total of lower secondary graduation rates over a 13-year period starting in 2021.
    - Targeting a doubling of budgetary allocation to education.
    - Targeting a doubling of budgetary allocation to research and development.
    - Targeting a doubling of budgetary allocation to infrastructure.
    - Private research and development spending as a percent of GDP increased by 20% over 13-year period.
    - Access to broadband grows 50% over 19 years.
    - Access to mobile broadband grows 50% over 19 years.

Appendix 3: Comparison of IFs and Other Forecasts

Comparison of IFs forecasts across the four scenarios with those from other studies helps place this study in a broader context. Such comparison is done frequently in the IFs project as an aid to analysis of how and why forecasts differ. That analysis in turn assists both in thinking about how forecasts of the project might be improved and how those from the Pardee Center add value to the broader global enterprise of better understanding alternative planetary futures.

Poverty rate, *No COVID* projections

Source	Value (Year)	Scenario	2030 headcount (millions)	2030 rate (percent)
IFs v. 7.61	9.6% or 741m (2019)	No COVID	673	7.9
Bill & Melinda Gates Foundation. (2019). The Goalkeepers Report 2019: Examining Inequality. Bill and Melinda Gates Foundation.	8% (2018)	Baseline	-	7
		If we progress	-	6
		If we regress	-	7
Lakner, C., Mahler, D. G., Negre, M., & Prydz, E. B. (2019). How Much Does Reducing Inequality Matter for Global Poverty? (Policy Research Working Paper No. 8869). World Bank.	9% (2018)	Growth according to WEO forecasts, constant country-level Gini	550	6.5
		Growth according to WEO forecasts, country-level Gini reduces 1% annually	450	5.4
Manuel, M., Desai, H., Samman, E., & Evans, M. (2018). Financing the end of extreme poverty. Overseas Development Institute.	800m (2018?) 10.8% (2013)	Baseline	400	4.7
Crespo Cuaresma, J., Fengler, W., Kharas, H., Bekhtiar, K., Brottrager, M., & Hofer, M. (2018). Will the Sustainable Development Goals be fulfilled? Assessing present and future global poverty. Palgrave Communications, 4(1), 1–8. https://doi.org/10.1057/s41599-018-0083-y	9% or 647m (2017)	SSP1	397	4.8
		Benchmark/SSP2	445	5.3
		SSP3	506	5.9
		SSP4	499	5.95
		SSP5	377	4.6

Poverty rate, *No COVID* projections (cont.)

Source	Value (Year)	Scenario	2030 headcount (millions)	2030 rate (percent)
World Bank. (2015). A measured approach to ending poverty and boosting shared prosperity: Concepts, data, and the twin goals. World Bank.	1 billion or 14.5% (2011)	Growth based on annual growth over past 20 years	572.8	6.8
		Growth based on past 10 years	405.4	4.8
		Growth base on survey data from past 10 years	564.8	6.7
		Countries match their most rapid growth rates in past 20 years	332.9	4.0
Reddy, S. G. (2020). Global Absolute Poverty: The Beginning of the End? (SSRN Scholarly Paper ID 3537705). Social Science Research Network. https://doi.org/10.2139/ssrn.3537705	Unspecified[6]	Baseline – uses USDA growth rates to 2030	515	6
		USDA - 1 pp	614	7
		USDA - 2 pp	696	8
		USDA + 1 pp	440	5
		USDA + 2 pp	385	5
Rozenberg, J., & Hallegatte, S. (2015). The Impacts of Climate Change on Poverty in 2030 and the Potential from Rapid, Inclusive, and Climate-Informed Development (Policy Research Working Paper No. 7483; Shock Waves: Managing the Impacts of Climate Change on Poverty Background Paper). World Bank. https://doi.org/10.1596/1813-9450-7483	Shows country-level poverty rates in 2007 but not world	Prosperity, no climate change	142	-
		Prosperity, low-impact climate	145	-
		Prosperity, high-impact climate	158	-
		Poverty, no climate change	899	-
		Poverty, low-impact climate	934	-
		Poverty, high-impact climate	1,021	-

[6] The authors note they roughly replicate the World Bank's poverty estimates in 2015 and earlier years (p. 5).

Poverty rate, *COVID* projections

Source	Value (Year)	Scenario	2030 headcount	2030 rate
IFs v. 7.61	1 billion or 14.5% (2011)	COVID	720	8.4
		High Damage	886	10.4
		SDG Push	596	7.0
World Bank. (2020). Poverty and Shared Prosperity 2020: Reversals of Fortune. World Bank.	9.2% or 689m (2017)	COVID Baseline	573	6.7
		COVID Downside	597	7
Bill & Melinda Gates Foundation. (2020). COVID-19 A Global Perspective: 2020 Goalkeepers Report. Bill and Melinda Gates Foundation.	6.7% (2019)	Reference scenario	-	6.6
		Better scenario	-	5.7
		Worse scenario	-	7.5

Nutrition, *No COVID* projections

Source	Variable	Value (Year)	Scenario	2030 projection
IFs v. 7.61	Malnourished population (millions)	738 (2019)	No COVID	617
	Malnourished population (percent)	9.6 (2019)		7.2
	Malnourished children (millions)	97 (2019)		68
	Malnourished children (percent)	14.4 (2019)		10.1
FAO, IFAD, UNICEF, WFP, & WHO. (2020). The State of Food Security and Nutrition in the World 2020: Transforming food systems for affordable healthy diets. FAO, IFAD, UNICEF, WFP and WHO. https://doi.org/10.4060/ca9692en	Prevalence of Undernourishment	8.9 (2019)	Baseline	9.8
	Number of undernourished (millions)	687.8 (2019)	Baseline	841.4

Nutrition, *No COVID* projections (cont.)

Source	Variable	Value (Year)	Scenario	2030 projection
Baquedano, F., Christensen, C., Ajewole, K., & Beckman, J. (2020). International Food Security Assessment, 2020-2030 [GFA-31]. U.S. Department of Agriculture, Economic Research Service.	Population food insecure (millions) *76 countries in assessment	760.8 (2020)	Current projection – difference from pre-COVID-19 estimate	405.3
	Population food insecure (millions) *76 countries in assessment	760.8 (2020)	Current projection – difference from pre-COVID-19 estimate	405.3
Laborde, D., Parent, M., & Smaller, C. (2020). Ending Hunger, Increasing Incomes, and Protecting the Climate: Ceres2030, International Institute for Sustainable Development (IISD) and International Food Policy Research Institute (IFPRI).	Population affected by hunger (millions)	680 (2018)	Baseline	660

Maternal mortality rate, *No COVID* projections

Source	Value (Year)	Scenario	2030 projection
IFs v. 7.61	190 (2019)	No COVID	145
Bill & Melinda Gates Foundation. (2019). The Goalkeepers Report 2019: Examining Inequality. Bill and Melinda Gates Foundation.	139 (2018)	If we progress	115
		Current projection	126
		If we regress	143
Alkema, L., Chou, D., Hogan, D., Zhang, S., Moller, A.-B., Gemmill, A., Fat, D. M., Boerma, T., Temmerman, M., Mathers, C., & Say, L. (2016). Global, regional, and national levels and trends in maternal mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Maternal Mortality Estimation Inter-Agency Group. The Lancet, 387(10017), 462–474. https://doi.org/10.1016/S0140-6736(15)00838-7	216 (2015)	Maintaining country-level average annual rate of reduction from '00-'15	161

Maternal mortality rate, *No COVID* projections (cont.)

Source	Value (Year)	Scenario	2030 projection
McArthur, J. W., Rasmussen, K., & Yamey, G. (2018). How many lives are at stake? Assessing 2030 sustainable development goal trajectories for maternal and child health. BMJ : British Medical Journal (Online); London, 360. http://dx.doi.org.du.idm.oclc.org/10.1136/bmj.k373	218 (2015)	Business as Usual (maintaining country-level reduction rates of 2005-2015)	164
Maternal Health Atlas, IHME (https://maternalhealthatlas.org/)	140 (2017)	Undefined baseline	125

Maternal mortality rate, *COVID* projections

Source	Value (Year)	Scenario	2030 projection
IFs v. 7.61	190 (2019)	COVID	148
		High Damage	153
		SDG Push	142
Bill & Melinda Gates Foundation. (2020). COVID-19 A Global Perspective: 2020 Goalkeepers Report. Bill and Melinda Gates Foundation.	140 (2017)	Reference scenario	108
		Better scenario	93
		Worse scenario	137

Neonatal mortality rate, *No COVID* projections

Source	Value (Year)	Scenario	2030 projection
IFs v. 7.61	17.6 (2019)	No COVID	13.7
Bill & Melinda Gates Foundation. (2019). The Goalkeepers Report 2019: Examining Inequality. Bill and Melinda Gates Foundation.	17 (2018)	If we progress	12
		Current projection	14
		If we regress	16
Hug, L., Alexander, M., You, D., & Alkema, L. (2019). National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: A systematic analysis. The Lancet Global Health, 7(6), e710–e720. https://doi.org/10.1016/S2214-109X(19)30163-9	18 (2017)	Maintaining country-level average annual rate of reduction from '00-'17	13.2
		All countries reduce at the rate of the best-performing country in their region	10

Neonatal mortality rate, *COVID* projections

Source	Value (Year)	Scenario	2030 projection
IFs v. 7.61	190 (2019)	COVID	14.1
		High Damage	14.8
		SDG Push	12.2
Bill & Melinda Gates Foundation. (2020). COVID-19 A Global Perspective: 2020 Goalkeepers Report. Bill and Melinda Gates Foundation.	18 (2019)	Reference scenario	15
		Better scenario	14
		Worse scenario	18

Under-5 mortality rate, *No COVID* projections

Source	Value (Year)	Scenario	2030 projection
IFs v. 7.61	38.1 (2019)	No COVID	31.5
Bill & Melinda Gates Foundation. (2019). The Goalkeepers Report 2019: Examining Inequality. Bill and Melinda Gates Foundation.	37 (2018)	If we progress	25
		Current projection	28
		If we regress	33
You, D., Hug, L., Ejdemyr, S., Idele, P., Hogan, D., Mathers, C., Gerland, P., New, J. R., & Alkema, L. (2015). Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: A systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. The Lancet, 386(10010), 2275–2286. https://doi.org/10.1016/S0140-6736(15)00120-8	42.5 (2015)	Maintaining country-level average annual rate of reduction from '00-'15	26.2
		All countries reduce at the rate of the best-performing country in their region	13.2

Under-5 mortality rate, *COVID* projections

Source	Value (Year)	Scenario	2030 projection
IFs v. 7.61	38.1 (2019)	COVID	32.4
		High Damage	34.1
		SDG Push	28.1
Bill & Melinda Gates Foundation. (2020). COVID-19 A Global Perspective: 2020 Goalkeepers Report. Bill and Melinda Gates Foundation.	18 (2019)	Reference scenario	30
		Better scenario	24
		Worse scenario	40

Education completion at different levels, *No COVID* projections
Percent of of-age students/cohort measures

Source	Scenario	Level	Start value	2030 projection
IFs v. 7.61	No COVID	Primary	90.8 (2019)	93.6
		Lower secondary	72.1 (2019)	75.8
		Upper secondary	52.6 (2019)	60.4
UNESCO, & GEMR. (2019). Meeting commitments: Are countries on track to achieve SDG 4? UNESCO Institute for Statistics and Global Education Monitoring Report Team.	Baseline	Primary	84 (2018)	89
		LS	72 (2018)	81
		US	48 (2018)	58
Friedman, J., York, H., Graetz, N., Woyczynski, L., Whisnant, J., Hay, S. I., & Gakidou, E. (2020). Measuring and forecasting progress towards the education-related SDG targets. Nature, 580(7805), 636–639. https://doi.org/10.1038/s41586-020-2198-8	Baseline	Primary	83 (2018)	89
		Secondary	51 (2018)	61

Education completion at different levels, *COVID* projections (have not yet found non-IFs projections reflecting a COVID impact for 2030)
Percent of of-age students/cohort measures

Source	Scenario	Level	Start value	2030 projection
IFs v. 7.61	COVID	Primary	90.8 (2019)	93.5
		Lower secondary	72.1 (2019)	74.9
		Upper secondary	52.6 (2019)	59.3
	High Damage	Primary	90.8 (2019)	93.0
		LS	72.1 (2019)	73.5
		US	52.6 (2019)	57.5
	SDG Push	Primary	90.8 (2019)	94.5
		LS	72.1 (2019)	93.0
		US	52.6 (2019)	63.6

Access to water, *No COVID* projections

Source	Variable	Value (Year)	Scenario	2030 headcount	2030 percent
IFs v. 7.61	Water access, Unimproved	7.4% or 569m (2019)	No COVID	419m	4.9
	Water access, Other improved	27% or 2.1b (2019)	No COVID	1.6b	18.3
UNICEF. (2020a). UNICEF's Water Game Plan: Universal safe and sustainable water services for all by 2030. United Nations Children's Fund.	Population without access to basic water service	785m (2017)	Baseline	340m	4
	Population without access to safely managed water supply	2.3b (2017)	Baseline	1.8b	21

Access to water, *COVID* projections

Source	Variable	Value (Year)	Scenario	2030 headcount	2030 percent
IFs v. 7.61	Water access, Unimproved	7.4% or 569m (2019)	COVID	431m	5.0
			High Damage	485m	5.7
			SDG Push	311m	3.6
	Water access, Other improved	27% or 2.1b (2019)	COVID	1.6b	19.1
			High Damage	1.8b	21.2
			SDG Push	1.3b	15.0

Access to sanitation, *No COVID* projections

Source	Variable	Value (Year)	Scenario	2030 projection
IFs v. 7.61	Sanitation access, percent of pop, Other Unimproved	18.3 (2019)	No COVID	10.8
	Sanitation access, percent of pop, Shared	7.9 (2019)	No COVID	5.2
Bill & Melinda Gates Foundation. (2019). The Goalkeepers Report 2019: Examining Inequality. Bill and Melinda Gates Foundation.	Prevalence of populations using unsafe or unimproved sanitation (percent)	29 (2018)	If we progress	19
			Current projection	22
			If we regress	30

Access to sanitation, *COVID* projections

Source	Variable	Value (Year)	Scenario	2030 projection
IFs v. 7.61	Sanitation access, percent of pop, Other Unimproved	18.3 (2019)	COVID	11.1
			High Damage	11.1
			SDG Push	8.0
	Sanitation access, percent of pop, Shared	7.9 (2019)	COVID	11.1
			High Damage	11.1
			SDG Push	8.0
Bill & Melinda Gates Foundation. (2020). COVID-19 A Global Perspective: 2020 Goalkeepers Report. Bill and Melinda Gates Foundation.	Prevalence of populations using unsafe or unimproved sanitation (percent)	29 (2019)	If we progress	20
			Current projection	22
			If we regress	26