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Pandemic prospects and the global economic recovery

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Pandemic prospects and the global economic recovery

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AEI Economics Working Paper 2021-09

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Pandemic Prospects and the Global Economic Recovery

Abstract

This paper develops an empirical model of the economic impact of COVID-19 and uses it to gauge how the evolution of the pandemic will affect the global economic recovery. We start with country-specific projections for pandemic deaths constructed by the Institute for Health Metrics and Evaluation (IHME). These projections, along with corresponding projections for the stringency of pandemic lockdown restrictions, are plugged into an empirical multi-country regression model, relating GDP to COVID-19 deaths and lockdown regulations. Based on the projections of this model, we find that under the IHME's baseline scenario, progress toward reducing pandemic deaths and lockdown restrictions should add 1.4 percentage points to global growth (four-quarter basis) in 2021. However, the economic effects of suppressing the pandemic will not be equally distributed: the boost to growth in the advanced economies (AEs) should amount to 2.2 percentage points compared with only 0.8 percentage point for the emerging market and developing economies (EMDEs). This disparity reflects both that the pandemic hit the AEs harder last year, leading to a sharper economic bounceback this year, but also that the AEs are now enjoying a much faster easing of the pandemic as a result of their faster progress in vaccinations. The effects of unequal vaccinations rates around the world are also apparent in alternative scenarios for the pandemic: Owing to their low rate of vaccinations, growth in the EMDEs would be hardest hit in a "worse" scenario, which assumes less social distancing and more COVID-19 deaths, and would have the most to gain from a "better" scenario, which assumes more rapid vaccinations and fewer deaths. All told, compared to the better scenario, the worse scenario entails roughly 2 million additional deaths and \$950 billion in lower global GDP in 2021, with these burdens falling disproportionately on the world's poor. Accordingly, accelerating the production and distribution of vaccinations around the world, such as specified in the \$50 billion plan recently aired by the IMF, would appear to be a highly cost-effective means of saving lives while promoting economic recovery.

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I. Introduction

It is generally agreed that a critical factor in the world's economic recovery prospects will be success in eradicating the COVID-19 pandemic. It is also a matter of consensus that inequality in the pace of vaccinations around the world will lead to corresponding inequality in the pace of economic recovery. However, little attempt has been made to quantify to what extent progress toward vanquishing the pandemic will engender progress toward economic normalization, and how this progress will vary across countries. In large part, this reflects the considerable degree of uncertainty attending every link in the causal chain: the pace of vaccinations around the world; the impact of vaccinations on the course of pandemic cases and deaths; and the impact of pandemic spread on economic activity.

In this note, we attempt to quantify some of the links in this chain. We start with country-specific projections for pandemic deaths constructed by the Institute for Health Metrics and Evaluation (IHME). These projections, along with corresponding projections for the stringency of pandemic lockdown restrictions, are then plugged into an empirical model of the responses of GDP to COVID-19 deaths and lockdown regulations. This model is based on a panel-data regression for 70 economies, comprising the lion's share of global population and GDP, estimated during the first year of the pandemic. The output of this model is the impact of the projected evolution of pandemic deaths and lockdown restrictions on the 2021 growth rates of GDP for those 70 economies.

Our main findings are as follows:

- Under the IHME's baseline scenario, progress toward reducing pandemic deaths and lockdown restrictions should add 1.4 percentage points to global growth (four-quarter basis) in 2021, relative to a scenario in which pandemic deaths and lockdown restrictions remained at their 2020 Q4 levels. (See Table 2 at the back of this note.)
- However, the economic effects of suppressing the pandemic will not be equally distributed. As shown in Figure 1 below, under the baseline scenario, the boost to growth in the advanced economies should amount to 2.2 percentage points compared with only 0.8 percentage point for the emerging market and developing economies.¹ This disparity in part reflects the fact that the pandemic caused more deaths per capita in the advanced economies; consequently, the alleviation of the pandemic will lead to a greater economic bounceback in those countries. However, the disparity also reflects the much faster progress of vaccinations, and resultant faster decline in COVID-19 deaths and lockdown restrictions, in the advanced economies.

¹ In Figure 1 and throughout this paper, GDP growth rates for the countries in our sample are aggregated to regional growth rates based on their 2020 PPP GDPs, and these regional growth rates are then aggregated to global growth rates based on regional shares in global GDP. (IMF April 2021 WEO). COVID-19 death rates and lockdown restrictions are similarly aggregated to regional and global values based on 2019 population as estimated in the United Nations 2019 World Population Prospects report, accessible at population.un.org/wpp/.

- The effects of unequal vaccinations rates around the world are also apparent in the alternative scenarios for the pandemic that we examined: a “worse” scenario which assumes lower social distancing and more pandemic deaths, and a “better” scenario which assumes that more rapid vaccinations lead to a quick and sustained decline in deaths. In the advanced economies, the boost to GDP growth from suppressing the pandemic is only a touch higher in the better scenario than in the baseline, since the baseline still entails rapid declines in pandemic deaths; even in the worse scenario, the boost to advanced-economy growth is a sizeable 1.4 percent, since widespread vaccinations limit surges in the disease. Conversely, in the emerging market and developing economies, growth in the baseline falls materially short of its pace in the better scenario, and it plunges nearly to zero in the worse scenario.²
- A formal economic cost-benefit analysis of a speed-up in the global production and distribution of vaccines is beyond the scope of this paper. Suffice it to say that compared to the better scenario, the worse scenario entails roughly 2 million extra deaths and \$950 billion in lower global GDP in 2021. As described above, these adverse effects will fall disproportionately on the world’s poor. Thus, accelerating vaccinations, and in particular channeling vaccination support to the emerging market and developing economies, would seem highly desirable from both from a humanitarian and economic perspective.
- Notably, the IMF’s recent proposal to accelerate vaccine production and dissemination around the world is estimated to cost \$50 billion, less than 10 percent of the difference in global GDP between the better and worse scenarios cited above (Georgieva, Gopinath, and Agarwal, 2021; Agarwal and Gopinath, 2021). It is unclear to what extent the proposal would achieve the better scenario and suppress the worse scenario, but on the face of it, it looks to be a highly cost-effective means of saving lives while promoting economic recovery.

Our study makes several contributions to our understanding of the economic effects of the pandemic. To begin with, our analysis, which builds on our earlier research described in Kamin and Kearns (2021) and Gagnon, Kamin, and Kearns (2021), is one of very few attempts to empirically estimate the effect of pandemic outcomes on GDP.³ Additionally, our study is the only one of which we are aware that explicitly translates projections for the evolution of the pandemic in different countries into empirically-based projections for GDP.⁴ Finally, our study

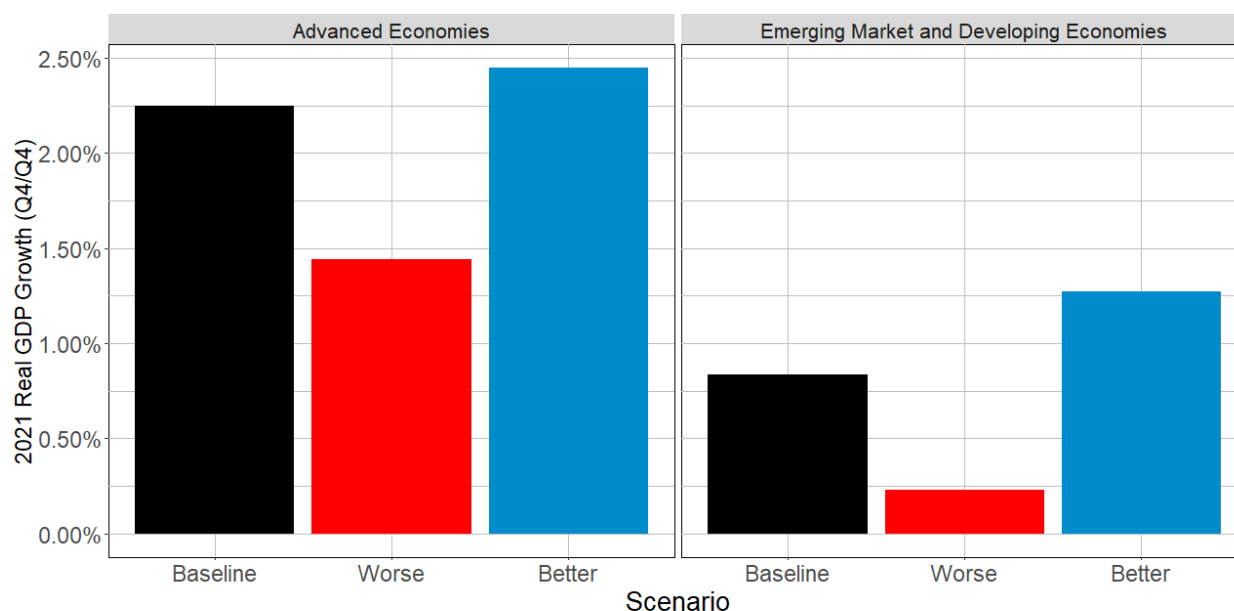
² As will be discussed below, the differences in growth across the scenarios for the emerging market and developing economies would be even greater but for the large economic weight of China, where pandemic deaths have been very low, and India, where the IHME assumes death rates will fall briskly from their current surge.

³ See, also, IMF (2020), Maloney and Taskin (2020), Deaton (2021), and Furceri et al. (2021). However, none of these analyses focus on recent quarterly data suitable for projecting outcomes in 2021.

⁴ Castillo et al. (2021) calculate the effect of vaccinations on global GDP; however, the study relies on very dated (mid-2020) estimates of the effect of the pandemic on global GDP, and does not account for adjustments that households and businesses have made that have moderated the economic effect of the disease. Cakmakli et al. (2021) analyze how international disparities in vaccinations may effect GDP around the world. Their analysis for the most part relies on a calibrated general equilibrium model, and it

contributes to the ongoing discussion of vaccine inequality and its implications for economic welfare around the world.

Figure 1: Impact of COVID-19 suppression on economic growth (Q4/Q4) in 2021



Source: Author Calculations

In the remainder of this note, we first review the pandemic projections constructed by IHME. We then describe the specification and estimation of our pandemic GDP model. Finally, we describe the resultant economic projections.

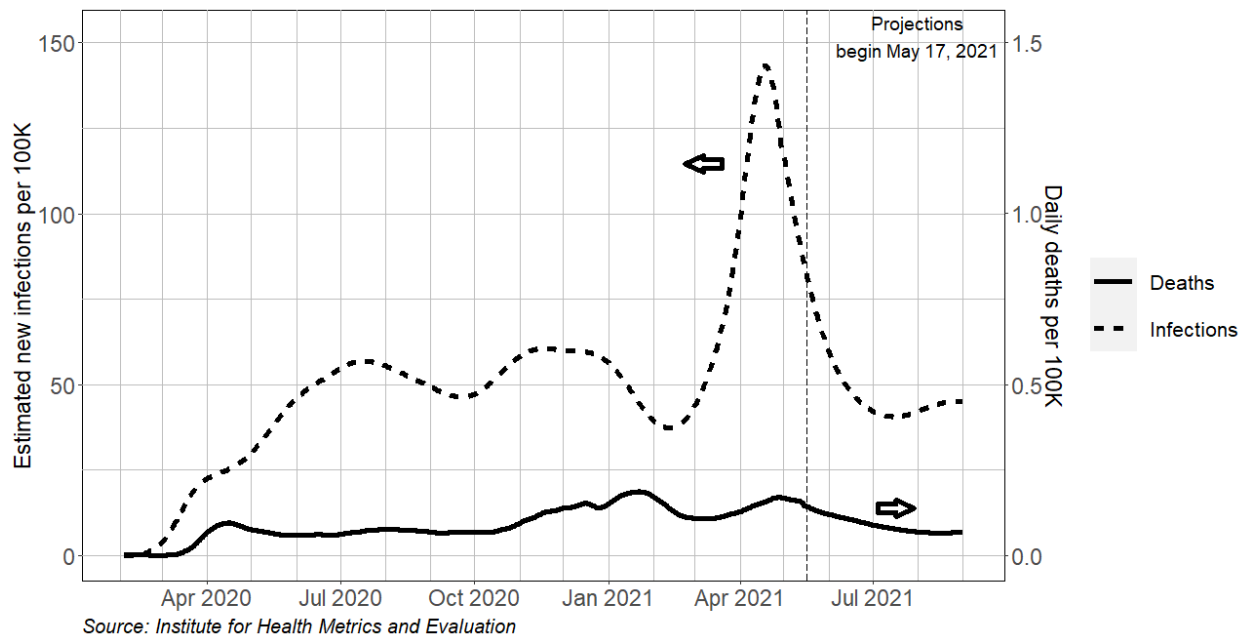
II. IHME Projections of Pandemic Outcomes

Figure 2 displays the baseline path of pandemic cases and deaths for the world as projected by the Institute for Health Metrics and Evaluation (IHME) as of May 21, 2021.⁵ Despite the fact that large swaths of the world population, especially in developing countries, will not be vaccinated until 2022, the projections indicate a rapid and sustained reversal of the most recent surge in cases and deaths, though flattening out toward the end of the projection period on September 1. This moderate optimism reflects the historical pattern in which, even in the absence of vaccinations, surges in the pandemic tend to ease as infected survivors become immune, social distancing increases, and lockdown restrictions become more stringent. Moreover, while future surges in the pandemic are likely to occur, especially in countries where vaccinations have made few inroads, it is difficult to forecast when and where those surges will take place.

is unclear how well it mirrors real-world behavior. IMF (2021) also uses a calibrated model to assess the impact of different scenarios for vaccine distribution on economic growth around the world. Agarwal and Gopinath (2021) put the benefit of faster progress in fighting the virus at \$9 trillion by 2025, but it is not clear how this figure was calculated.

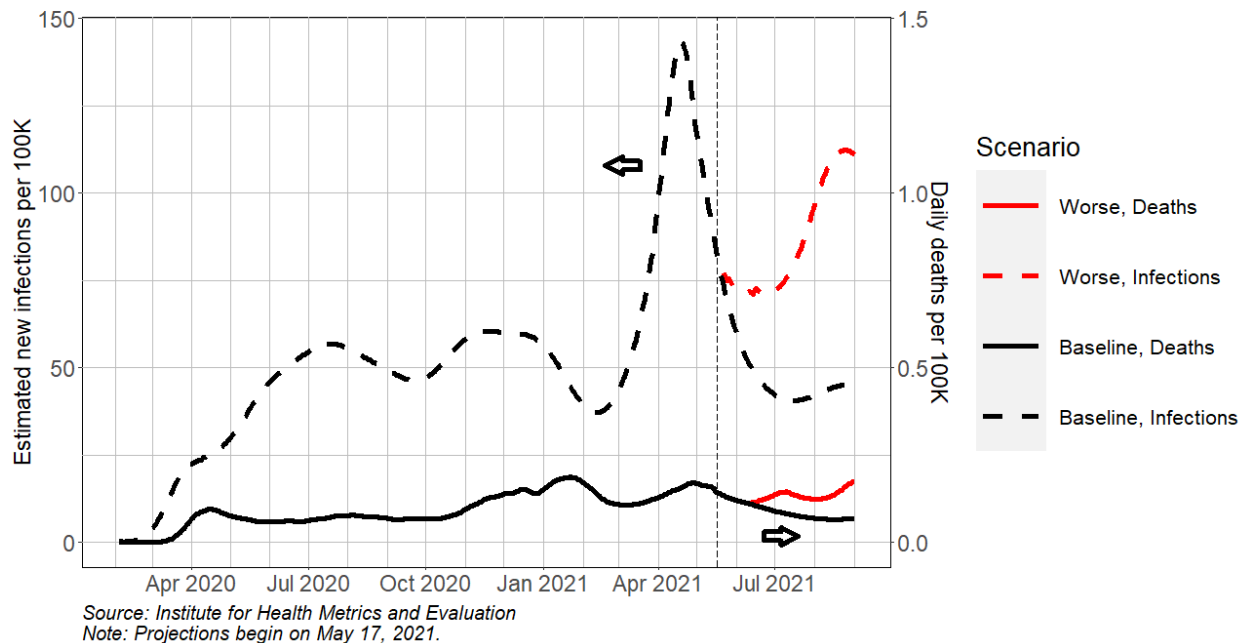
⁵ IHME projections are available at <http://www.healthdata.org/covid/updates>.

Figure 2: IHME baseline COVID projections through August 2021



Accordingly, it makes sense to consider IHME’s “worse” scenario in addition to its baseline projection. Figure 3 compares the global baseline scenarios for infections and deaths with the IHME’s worse scenario.

Figure 3: IHME baseline and “worse” COVID projections through August 2021



Unfortunately, the IHME projections extend only through September 1. To extend the projections through the end of this year, we adopted two procedures for deaths in both the baseline and worse scenarios. These are described below and shown in Figure 4.

- We estimated a separate regression for each country of daily deaths on lagged daily infections, using a 14-day lag. This was then used to project deaths out to September 15.
- We then assumed deaths in either scenario began to decline at the same percent rate as experienced during the period of April 22, 2021 (its recent peak) to May 16, 2021. For the worse scenario, in particular, this seems reasonable as it follows a projected spike in deaths similar to that which occurred in April. For the baseline scenario, some further declines also are plausible, as vaccinations will be ramping up throughout the period. Since these declines do not follow a surge, they are likely to be slower than in the worse scenario – this occurs automatically in our projection as the same percent declines are applied to a lower initial level of deaths.

Figure 4 also includes a ‘better’ scenario in which all countries experience a rapid decline in deaths from their May 16 levels, calibrated to match the same rate of decline in pandemic deaths as experienced by the UK this year. We assume that once deaths fall to very low levels, they stay there and do not experience subsequent surges. The initial decline in cases and deaths could reflect a combination of good luck, on-going vaccinations, and endogenous responses to recent pandemic surges. The subsequent sustained low level of deaths would require a high share of the population being vaccinated. Given the poor prospects for vaccination in many parts of the world, this scenario is unrealistic, but it provides a sense of the upper-bound benefit of aggressively vaccinating the world’s population against COVID-19.

Figure 4: IHME baseline, ‘worse’, and ‘better’ projections extended to year-end 2021

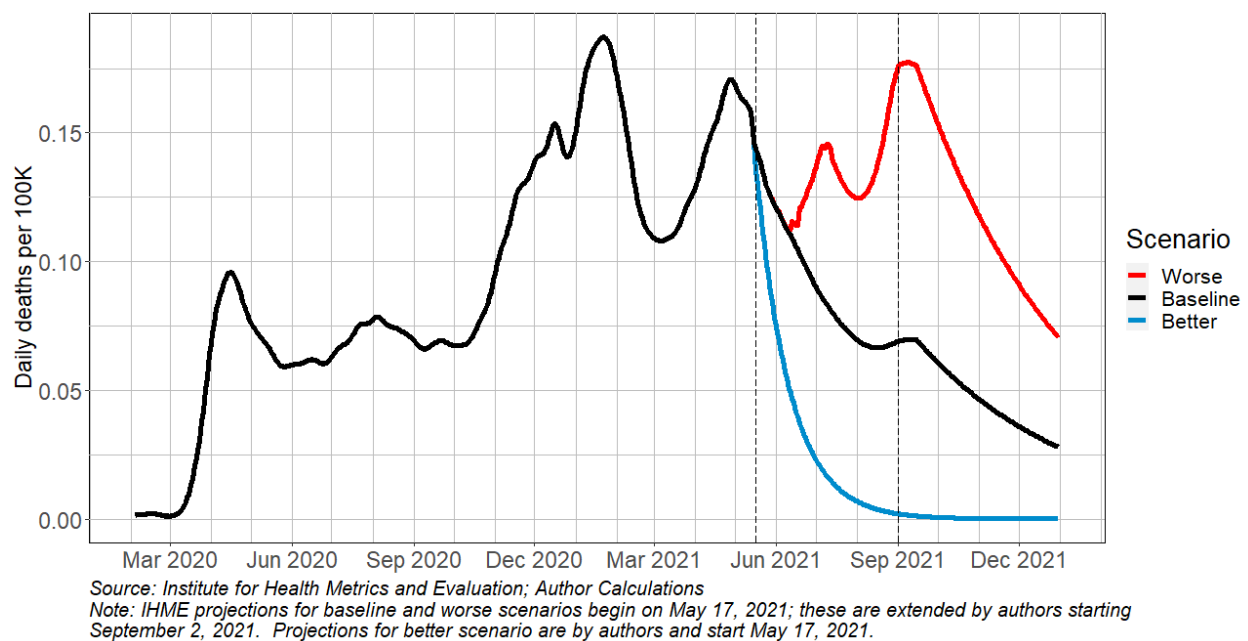
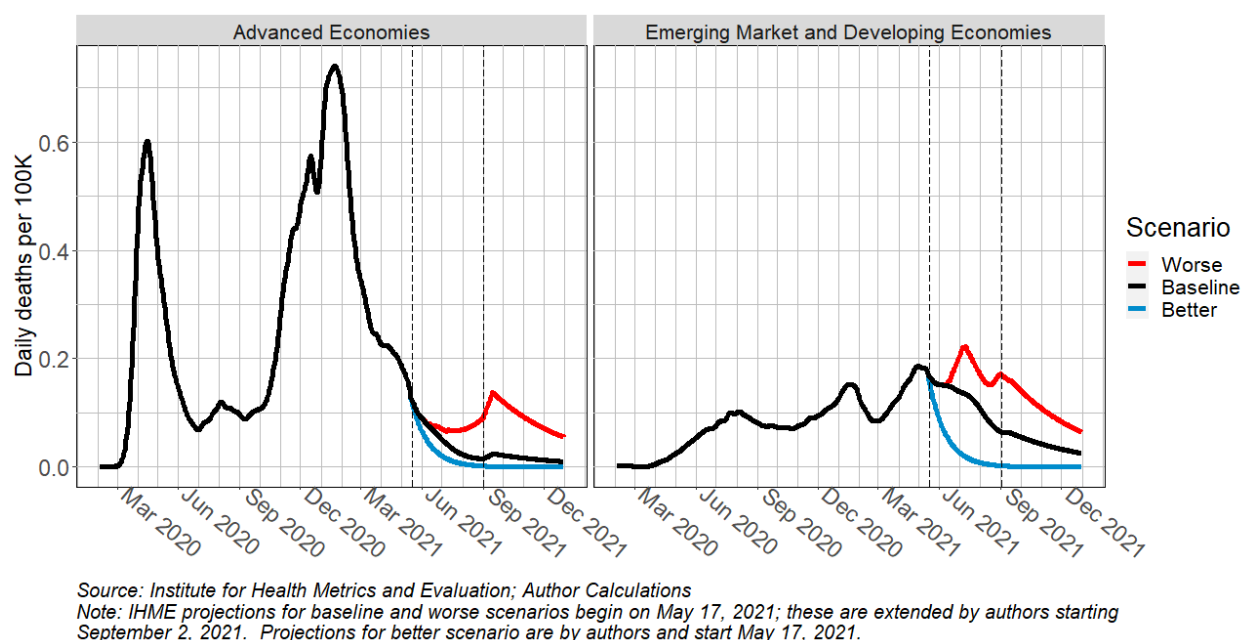


Figure 5 below repeats the presentation in Figure 4, but compares the advanced economies (AEs) with the emerging market and developing economies (EMDEs). The figure highlights a number of important differences between the two groups. To begin with, until recently, the AEs experienced much higher pandemic death rates than the EMDEs.⁶ But over the past few months and going forward, AEs benefit from their faster pace of vaccinations, as can be seen in a number of ways. First, baseline deaths in the AEs continue to decline to low levels and stay there, whereas baseline deaths in the EMDEs decline more slowly from their recent pandemic surge. Second, baseline deaths in the AEs fall to nearly the same level as in the better scenario, whereas the gap between deaths in the baseline and better scenarios remains larger in the EMDEs. And, finally, deaths in the worse scenario rise higher in the EMDEs than in the AEs, with a much wider gap relative to the better scenario.

Figure 5: Alternative projections for Advanced Economies and Emerging Market and Developing Economies



III. A Model of Pandemic Effects on GDP

III.1 Econometric methodology

To assess the impact of pandemic variables on GDP, we use a panel regression model applied to 70 economies that have published quarterly GDP data for most or all of 2020, including the United States. (See appendix.) The quarter-to-quarter percent change in real GDP

⁶ See Deaton (2021). As discussed further below, it is generally agreed that the official data shown here underestimate the true number of pandemic deaths, and the extent of under-estimation is likely higher for EMDEs than for AEs. Therefore, these data likely overstate the discrepancy in pandemic deaths between AEs and EMDEs. Even so, as discussed in The Economist (2021), even when the official deaths data are adjusted for estimation problems, they still show higher death rates in the AEs.

is regressed on the number of deaths in that quarter (which is believed to influence the extent of voluntary social distancing), a measure of lockdown restrictions (the Oxford Stringency Index, or OSI), and lagged GDP growth.⁷

One issue we had to address is the likely endogeneity of deaths and lockdown restrictions. For example, a rise in social distancing not associated with increases in deaths or more stringent lockdowns—such as might occur in response to a successful public information campaign—could simultaneously lead to declines in COVID-19 infections, deaths, OSI, and economic activity; this could bias the coefficients on deaths and OSI to be more positive. To address this concern, we use a two-stage least squares (2SLS) procedure: In the first stage regression, COVID-19 deaths and OSI are regressed on contemporaneous COVID-19 infections; in the second stage, the residuals from these regressions—that is, the variation in deaths and OSI not directly related to contemporaneous cases—are substituted for actual deaths and OSI.

Another issue is that officially reported COVID-19 deaths are believed to be widely under-estimated, especially in poorer countries.⁸ To address this concern, we applied our regression analysis to two different estimates of deaths, besides the officially reported figures: the Economist estimate of excess deaths and the IHME estimate of total deaths.⁹ Despite the higher levels of these estimates, the use of their quarterly changes in our estimations did not result in model estimates that were substantially different, or had greater explanatory power, than those based on officially reported data. Accordingly, we used the official data for our analysis.

Table 1 at the end of this note presents the estimation results. The coefficients in the regression estimated over the entirety of 2020 (column 1) imply implausibly large effects on GDP if applied to 2021. For example, using the full sample regression results, the model predicts that if US COVID-19 deaths fell from their 2020 Q4 average of 1560 per day to zero by the end of 2021, and OSI fell to zero from its 2020 Q4 average of 69, that this would ultimately boost US GDP by 10.9 percent. This outsized effect probably reflects that in the initial outbreak of the pandemic, social distancing reacted very strongly to even small COVID-19 death counts and lockdown restrictions were crudely and indiscriminately applied.¹⁰ As households, workers, and businesses learned to adjust to the new environment, the effect of deaths and lockdowns on economic activity diminished.¹¹ Accordingly, we use the estimates based on 2020 H2, the third column in Table 1, to gauge the effect of the easing pandemic on economic activity. These coefficients suggest that the eradication of deaths and lockdowns from their 2020 Q4 level would boost US GDP by 3.2 percent, a more plausible increase.

⁷ This follows the approach applied by Kamin and Kearns (2021) to industrial production data and Gagnon, Kamin, and Kearns (2021) to the GDP of high-income countries.

⁸ See Economist (2021), Felter (2021), Geddes (2021), and Yeung (2021).

⁹ Details on the Economist's excess mortality model can be found at www.economist.com/graphic-detail/coronavirus-excess-deaths-tracker.

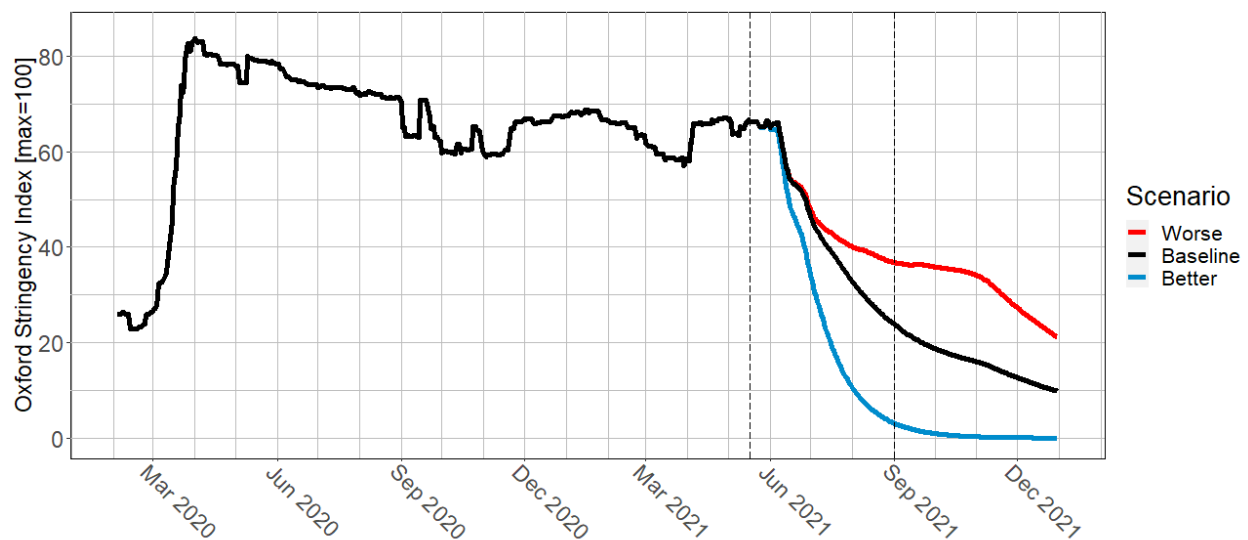
¹⁰ Leaving aside the magnitude of the effect, the negative impact of COVID-19 deaths on GDP growth in 2020 is consistent with several other empirical studies of the international economic effects of the pandemic, including IMF (2020), Maloney and Taskin (2020), Deaton (2021), and Furceri et al. (2021).

¹¹ IMF (2021) documents that lockdown restrictions had smaller impacts on economic activity in late 2020 compared with the period of the initial surge of the pandemic.

III.2 Projections of lockdown restrictions

To use the model to project future GDP, we need to enter as inputs not only the projections for COVID-19 deaths discussed above, but associated paths of lockdown restrictions (OSI). The relationship between deaths and OSI has been quite loose and appears to vary over time. But it is likely the case that if the virus was largely eliminated (100 percent fall in deaths), then lockdown restrictions would be largely eliminated (100 percent decline in OSI). Accordingly, we assume that projected percent declines in deaths will in the long run translate on a one-for-one basis to percent declines in OSI. However, we note that countries have not fully eliminated restrictions during temporary lulls in pandemic spread, as they were (correctly) fearful of the pandemic's return. Accordingly, we assume that OSI reacts proportionately not to contemporaneous declines in deaths, but to a two-month moving average of deaths. Figure 6 below portrays the average path of OSI in our sample under the baseline, worse, and better scenarios.

Figure 6: Global Average Path of OSI through December 2021



Source: Oxford University; Institute for Health Metrics and Evaluation; Author Calculations

Note: Projections for OSI by authors begin on May 17, 2021, and are based on projections for deaths. IHME deaths projections for baseline and worse scenarios begin on May 17, 2021; these are extended by authors starting September 2, 2021. Deaths projections for better scenario are by authors and start May 17, 2021.

IV. Impact of Pandemic Outcomes on 2021 GDP Growth

We apply the coefficients of the model, based on the estimation for 2020 H2 data shown in column 3 of Table 1, to our projections for pandemic deaths and lockdown restrictions, using each country's GDP in 2020 Q4 as the jumping-off point for the projections. Values of the lagged dependent variable (GDP) in quarters 2 through 4 are calculated endogenously in this dynamic simulation.

Our results are shown in Tables 2 and 3. For each of the three scenarios—baseline, worse, and better—we show the impact of the pandemic projections on two measures of GDP growth for 2021: four-quarter growth rates, which measure the growth of real GDP from the fourth quarter of 2020 to the fourth quarter of 2021, and year-average growth rates, which measure the average of the four quarters of 2021 relative to the average for 2020. This distinction may sound arcane, but as evident in the tables, large within-year swings in growth can cause very different outcomes for four-quarter and year-average growth rates. We focus mainly on the Q4/Q4 projections, since the year-average projections are so much influenced by the swings in performance over the course of 2020. Finally, the right-most columns of Tables 2 and 3 present actual and projected growth GDP rates (as opposed to the impact of the pandemic on GDP growth rates), drawn from the IMF World Economic Outlook (WEO) April 2021 report and database.

IV.1 Baseline scenario

Starting at the top left corner of Table 2, our calculations indicate that the substantial reduction in pandemic deaths and restrictions under the baseline scenario would boost global Q4/Q4 growth by 1.4 percentage points. Considering the extent of the economic cataclysm that hit the global economy in 2020, this may not seem like a large boost, but several factors should be kept in mind. First, in the baseline scenario, the pandemic is largely but not completely eliminated: deaths per 100,000 fall from 0.13 in 2020 Q4 to 0.04 in 2021 Q4, and OSI falls from 63.2 to 14.3. Second, even though the pandemic hit the global economy hard in early 2020, the world economy experienced substantial recovery in the latter half of 2020, largely as households and businesses learned to adjust to the new pandemic realities; global GDP in the fourth quarter of 2020 ended only 0.8 percent below its level during the previous year. (See the column for actual GDP growth in 2020.)¹²

We should emphasize that these projections are not complete forecasts of GDP growth—they are only projections of the impact of falling deaths and OSI on GDP. Indeed, these projections are below the IMF forecasts for GDP shown in the final columns of the tables. Those projections take into account the full range of influences on GDP, including fiscal and monetary policies, commodity and trade developments, and business and household confidence. All that said, and unsurprisingly, the economic effects of the suppression of the pandemic account for much of the recovery projected by the IMF.

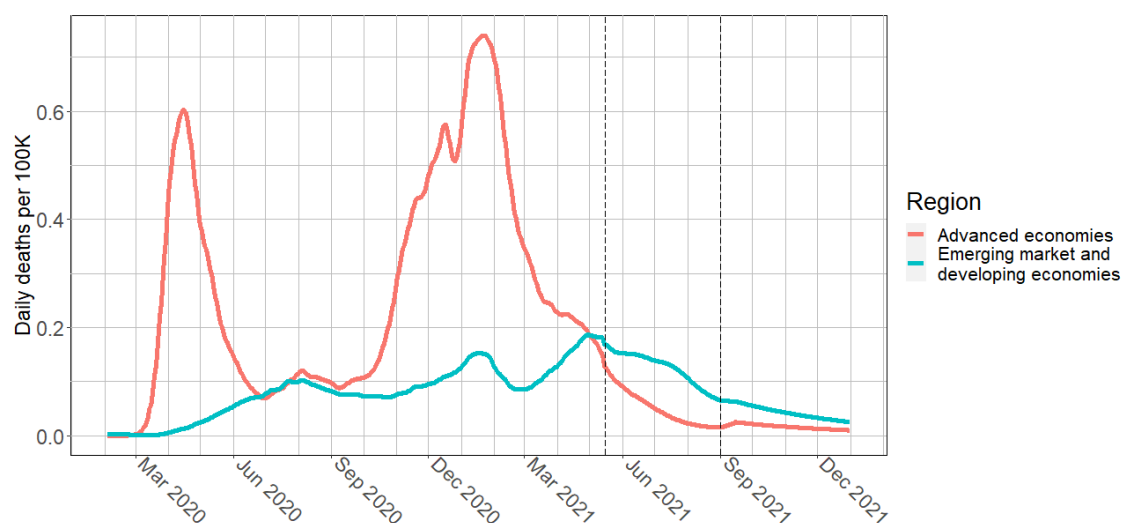
One of the most important features of our projections is the wide disparity in the impact of pandemic outcomes on growth across geographic regions. As shown in Figure 1 above, as well as in Table 2, advanced economies (AEs) lead the way in predicted Q4/Q4 growth with 2.2 percent, above the 0.8 percent growth projected for the emerging market and developing economies (EMDEs). This reflects two main factors. First, as discussed above, the AEs were in aggregate hit harder by the pandemic than the EMDEs during 2020 and had higher death rates in

¹² Notably, as shown in Table 3, the projection of the pandemic boost to *year-average* GDP growth in 2021 is a much larger 4.2 percent, reflecting the drag on the *average level* of GDP in 2020 exerted by the first wave of the virus.

the fourth quarter, as shown in Figure 7.¹³ (Levels of lockdown restrictions, shown in Figure 8, were more similar.) In consequence, even if both AEs and EMDEs were projected to eliminate all deaths and restrictions by the end of this year, the advanced economies would enjoy larger reductions in deaths and thus a greater economic bounceback from the pandemic.

The second factor, however, is that the advanced economies are making much faster progress in vaccinating against COVID-19 and are expected to tamp down death rates much more thoroughly this year than the EMDEs. As shown in Figures 7 and 8 (and also Figure 5 above), even as the AEs are normalizing, death rates and lockdown restrictions in the EMDEs have been surging. Accordingly, slower and unsteady progress in eradicating the virus, and thus reducing deaths and lockdown restrictions, means the economic recovery from the pandemic will be slower in the EMDEs.

Figure 7: Baseline path of deaths for advanced and emerging economies

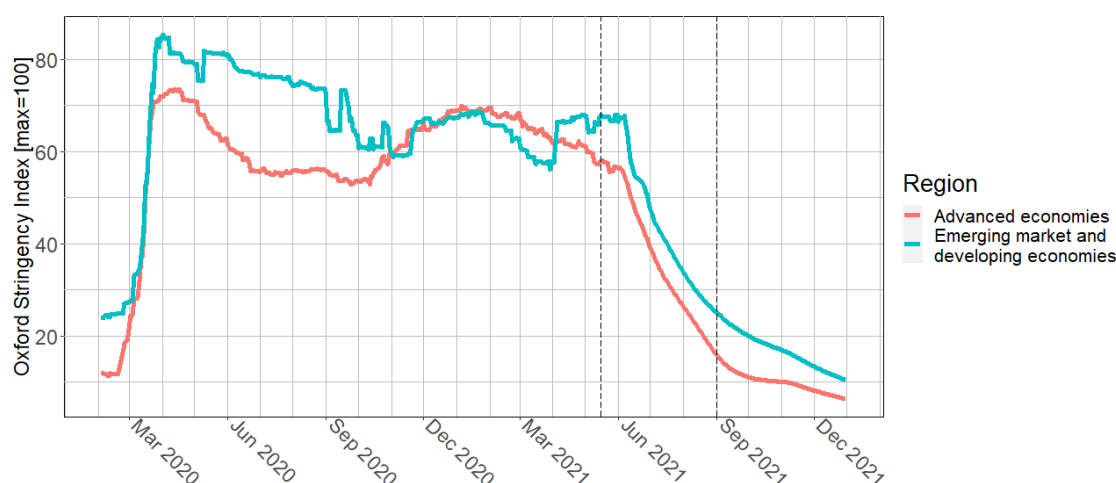


Source: Institute for Health Metrics and Evaluation; Author calculations

Note: IHME projections for baseline scenario begin on May 17, 2021; these are extended by authors starting September 2, 2021.

¹³ See, also, Deaton (2021). This helps explain why in 2020, Q4/Q4 growth in advanced economies fell 4.6 percentage points (from 1.5 percent in 2019 to -3.5 percent in 2020) while growth in EMDEs fell only 2.3 percentage points (from 3.5 percent to 1.2 percent).

Figure 8: Baseline path of OSI for advanced and emerging economies



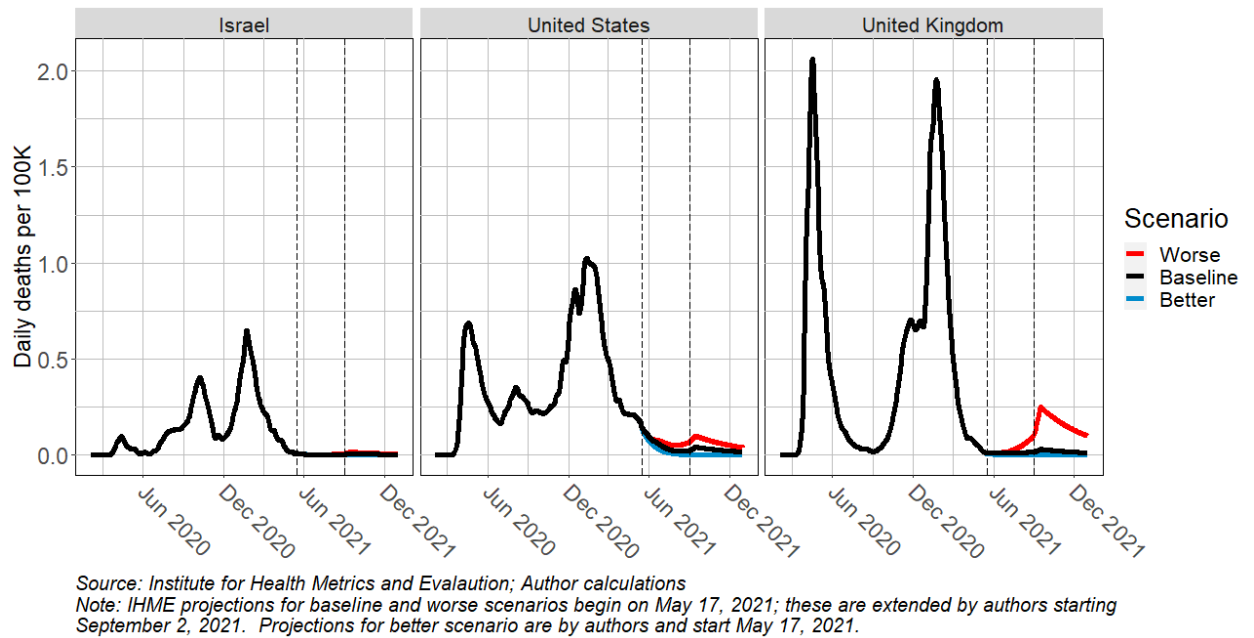
Source: Institute for Health Metrics and Evaluation; Oxford University; Author calculations
 Note: Projections for OSI by authors begin on May 17, 2021, and are based on projections for deaths. IHME deaths projections for baseline scenario begins on May 17, 2021; these are extended by authors starting September 2, 2021. Deaths projections for better scenario are by authors and start May 17, 2021.

IV.2 Alternative pandemic scenarios

We now turn to the alternative scenarios for progress in eliminating the pandemic. To begin with, the effect of the trajectory of pandemic deaths and lockdowns on global growth under the better scenario is only a little higher (1.8 percent) than under the baseline (1.4 percent). As noted above, this reflects the relatively sanguine nature of the baseline projection, especially for the AEs, which does not anticipate future surges in the pandemic.

The costs of slow vaccinations around the world are more evident in the worse scenario. Here, global growth, at 0.7 percent, is nearly a percentage point below the baseline and even further below the better scenario, a very substantial reduction. Even in the AEs, where vaccinations are expected to make the most progress, growth falls almost a percentage point to 1.4 percent. (See Figure 1 above.) In part, this reflects the IHME's anticipation that vaccine hesitancy in the United States and other countries will prevent achievement of herd immunity. Figure 9 below presents a few examples: the IHME is not predicting any pickup in deaths under the worse scenario in Israel, another world leader in vaccinations, but is predicting a slight pickup in the United States and a somewhat larger one in the United Kingdom.

Figure 9: Alternative deaths projections for selected Advanced Economies

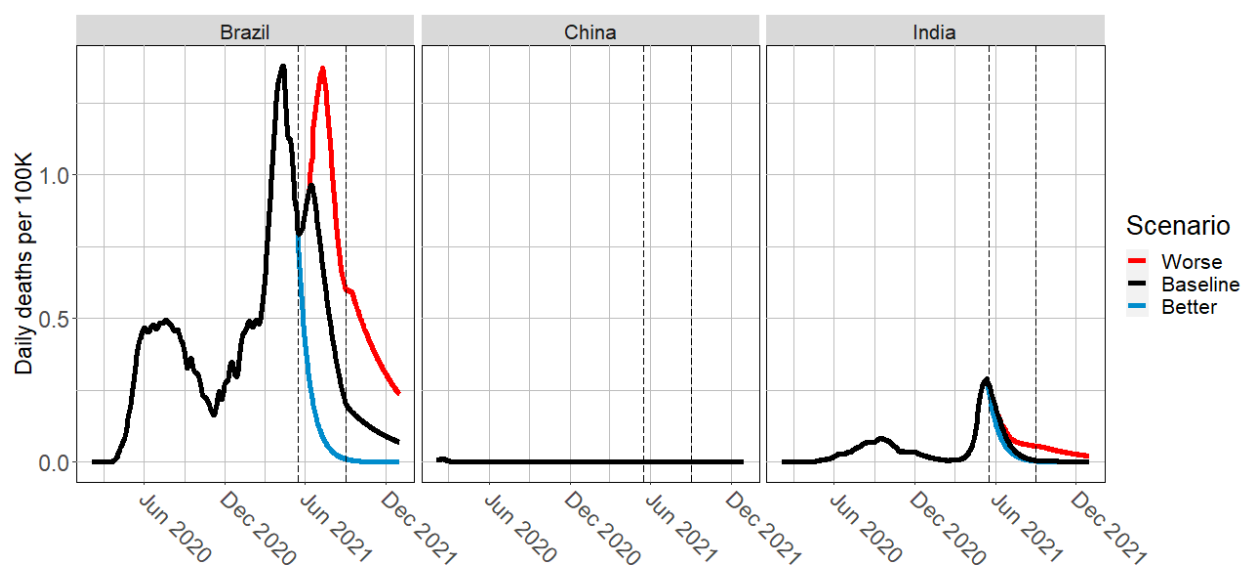


In the EMDEs, where the share of the population protected from the virus is expected to rise more slowly, deaths in the worse scenario rise above those in the AEs (again, Figure 5) and GDP growth falls much lower than in the baseline and better scenarios, to only 0.2 percent. The gap in EMDE 2021 GDP growth between the better and worse scenarios is 1.1 percentage points, about the same as in the AEs. But on a proportional basis, EMDE growth under the worse scenario is less than a quarter of its pace in the better scenario, whereas AE growth in the worse scenario is nearly two-thirds of its better-scenario pace.

Moreover, these aggregates understate the damage suffered under the worse scenario by many EMDEs. In the Middle East, growth in the worse scenario falls 1.6 percentage points below its pace in the better scenario, and that gap widens to 1.9 percentage points in Latin America. (Figure 10 shows how Brazilian deaths ratchet up in the worse scenario.) Projected economic performance in the EMDEs is buoyed by emerging Asia, which has a high weight in the EMDE aggregate: the gap in growth between the better and worse scenarios is only 0.9 percentage point. This reflects that pandemic deaths in China are already very low while the IHME anticipates good progress in India in reducing deaths, even in its worse scenario.¹⁴

Figure 10: Alternative deaths projections for selected Emerging Market and Developing Economies

¹⁴ Additionally, and for reasons we do not understand, the IHME assumes little pickup in infections and deaths under the worse scenario in Sub-Saharan Africa, though its weight in the overall EMDE aggregate is small.



Source: Institute for Health Metrics and Evaluation; Author calculations
 Note: IHME projections for baseline and worse scenarios begin on May 17, 2021; these are extended by authors starting September 2, 2021. Projections for better scenario are by authors and start May 17, 2021.

IV.3 Benefits of faster global vaccinations

Given the wide uncertainties about the linkages between vaccination rates and deaths and between deaths and GDP performance, as well as reservations about the cost and feasibility of speeding up vaccine production and distribution throughout the world, we will not attempt a formal economic cost-benefit analysis of accelerating global vaccinations. Suffice it to say that compared to the better scenario, the worse scenario entails 2 million extra deaths and \$947 billion in lower global GDP in 2021.¹⁵ Thus, reducing the likelihood of the worse scenario would seem highly desirable from both from a humanitarian and economic perspective.

In this connection, it bears noting that the IMF has recently launched a proposal to accelerate vaccinations in the developing world (Georgieva, Gopinath, and Agarwal, 2021; Agarwal and Gopinath, 2021). This initiative would aim to vaccinate at least 40 percent of the population in all countries by the end of 2021, and at least 60 percent by the first half of 2022, while supporting a range of other measures to control the pandemic in the absence of full vaccination. It is unclear whether this plan would be adequate to secure the better scenario for pandemic deaths, but it would certainly help to reduce the likelihood of the worse scenario. The IMF puts the price tag of this initiative at \$50 billion, less than a tenth of the difference in global GDP between the better and worse scenarios. It would thus seem highly cost-effective on an economic basis, in addition to saving a great many lives.

¹⁵ To calculate the GDP effect, we take the differential in year-average growth rates between the better and worse scenarios and multiply it by global 2020 GDP in PPP dollars, from the IMF WEO Database, of \$132 trillion.

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Tables

Table 1: Panel Regressions for real GDP Growth

	Full Year 2020	H1 2020	H2 2020
	(1)	(2)	(3)
Intercept	-0.0059 (0.0040)	-0.0560*** (0.0052)	0.0404*** (0.0041)
Δ Quarterly Deaths	-0.1530*** (0.0249)	-0.1480*** (0.0460)	-0.0328** (0.0154)
Δ Quarterly OSI	-0.0009*** (0.0002)	0.0007*** (0.0002)	-0.0004 (0.0003)
Lagged Dependent Variable	-0.2380*** (0.0619)	0.3740 (0.4140)	-0.3510*** (0.0471)
R ²	0.2777	0.2239	0.5466
Adjusted R ²	0.2696	0.2068	0.5360
Num. obs.	273	140	133
RMSE	0.0665	0.0518	0.0386

* p < 0.10; ** p < 0.05; *** p < 0.01

Note: See appendix for the list of countries.

Table 2: Projected Effects of Alternative Pandemic Outcomes on 2021 GDP (Q4 over Q4 % Growth)

Country/Region ¹	Baseline	Worse	Better	Actual and IMF-Projected Growth		
				2019	2020	2021 ²
Global ³	1.4	0.7	1.8	2.5	-0.8	4.5
Advanced Economies	2.2	1.4	2.4	1.5	-3.1	4.9
United States	2.6	2.1	2.9	2.3	-2.5	6.3
Euro Area	3.0	1.7	3.1	1.0	-4.9	4.4
Japan	0.7	0.3	0.5	-1.0	-1.3	2.0
UK	1.6	-0.4	2.8	1.2	-7.8	6.5
Canada	1.8	0.4	1.7	1.7	-3.2	4.1
Emerging market and developing economies	0.8	0.2	1.3	3.5	1.2	4.0
Sub-Saharan Africa	1.5	1.4	1.5	-	-	-
South Africa	1.5	1.4	1.4	-0.6	-4.2	1.1
Emerging Asia	0.5	-0.1	0.8	4.5	3.1	4.6
China	1.1	0.4	1.2	5.1	6.3	4.4
India	-0.6	-1.1	-0.6	2.9	-0.7	4.2
Emerging Europe	2.0	1.5	2.2	-	-	-
Russia	2.1	2.0	2.0	2.9	-3.0	4.6
Emerging Lat. Amer.	0.6	-0.2	1.7	-0.3	-3.5	1.8
Brazil	1.2	0.6	1.2	1.6	-1.2	0.9
Mexico	-1.3	-2.8	2.3	-0.8	-4.5	2.6
Mid-East and Central Asia	0.9	0.3	1.9	-	-	-
Saudi Arabia	-0.2	-0.9	1.7	-0.3	-4.1	4.8

¹ Appendix 2 lists the countries in each regional aggregate.

² Projected as of the IMF April 2021 WEO.

³ GDP growth rates for the countries in our sample are aggregated to regional growth rates based on their 2020 PPP GDPs, and these regional growth rates are then aggregated to global growth rates based on regional shares (including the GDP of countries not in our sample) in global GDP. (IMF April 2021 WEO)

Source: International Monetary Fund; Authors' calculations

Table 3: Projected Effects of Alternative Pandemic Outcomes on 2021 GDP (year-average % growth)

Country/Region ¹	Baseline	Worse	Better	Actual and IMF-Projected		
				2019	2020	2021 ²
Global ³	4.2	3.9	4.6	2.8	-3.3	6.0
Advanced Economies	3.4	3.0	3.6	1.6	-4.6	5.1
United States	3.5	3.3	3.7	2.2	-3.5	6.4
Euro Area	4.1	3.5	4.2	1.3	-6.6	4.4
Japan	1.7	1.5	2.1	0.3	-4.8	3.3
UK	3.9	3.0	4.5	1.4	-9.9	5.3
Canada	3.4	2.6	3.5	1.9	-5.4	5.0
Emerging market and developing economies	4.9	4.5	5.3	3.6	-2.2	6.7
Sub-Saharan Africa	1.5	1.4	2.3	3.2	-1.9	3.4
South Africa	2.0	2.0	3.3	0.2	-7.0	3.1
Emerging Asia	7.0	6.7	7.2	5.3	-1.0	8.6
China	6.6	6.4	6.7	5.8	2.3	8.4
India	7.4	7.1	7.5	4.0	-8.0	12.5
Emerging Europe	3.3	3.0	3.4	2.4	-2.0	4.4
Russia	0.6	0.5	0.7	2.0	-3.1	3.8
Emerging Lat. Amer.	3.0	2.1	4.2	0.2	-7.0	4.6
Brazil	2.6	1.8	3.3	1.4	-4.1	3.7
Mexico	2.8	1.6	4.8	-0.1	-8.2	5.0
Mid-East and Central Asia	0.1	-0.2	0.9	1.4	-2.9	3.7
Saudi Arabia	-0.6	-1.2	0.4	0.3	-4.1	2.9

¹ Appendix 2 lists the countries in each regional aggregate.

² Projected as of the IMF April 2021 WEO.

³ GDP growth rates for the countries in our sample are aggregated to regional growth rates based on their 2020 PPP GDPs, and these regional growth rates are then aggregated to global growth rates based on regional shares (including the GDP of countries not in our sample) in global GDP. (IMF April 2021 WEO)

Source: International Monetary Fund; Authors' calculations

Appendix 1: Countries used in panel regression

Luxembourg	Malta	Kazakhstan
Switzerland	Spain	Turkey
Ireland	Cyprus	Brazil
Norway	Slovenia	Thailand
Iceland	Taiwan	Serbia
United States	Estonia	Belarus
Singapore	Czech Republic	Colombia
Denmark	Portugal	Bosnia and Herzegovina
Australia	Saudi Arabia	South Africa
Netherlands	Lithuania	Albania
Sweden	Greece	Azerbaijan
Austria	Slovak Republic	Sri Lanka
Finland	Latvia	Ukraine
Hong Kong	Hungary	Philippines
Germany	Poland	Tunisia
Belgium	Croatia	Morocco
Canada	Chile	Egypt
Israel	Romania	Vietnam
United Kingdom	Russia	Ghana
New Zealand	Malaysia	India
France	China	Kenya
Japan	Mexico	Mozambique
Italy	Argentina	
South Korea	Bulgaria	

Note: Countries ranked by GDP per capita (2019) descending (World Bank World Development Indicators 2019).

Appendix 2: Countries by regional aggregate

Advanced Economies		Emerging Market and Developing Economies				
Advanced Economies (Non-Euro Area)	Euro Area	Emerging Sub-Saharan Africa	Emerging Asia	Emerging Europe	Emerging Latin America	Emerging Middle East and Central Asia
Australia	Belgium	Ghana	China	Albania	Argentina	Azerbaijan
Austria	Cyprus	Kenya	India	Belarus	Brazil	Egypt
Canada	Estonia	Mozambique	Malaysia	Bosnia and H.	Chile	Kazakhstan
Czech Republic	Finland	South Africa	Philippines	Bulgaria	Colombia	Morocco
Denmark	France		Sri Lanka	Croatia	Mexico	Saudi Arabia
Hong Kong SAR (China)	Germany		Thailand	Hungary		Tunisia
Iceland	Greece		Vietnam	Poland		
Israel	Ireland			Romania		
Japan	Italy			Russia		
New Zealand	Latvia			Serbia		
Norway	Lithuania			Turkey		
Singapore	Luxembourg			Ukraine		
South Korea	Malta					
Sweden	Netherlands					
Switzerland	Portugal					
Taiwan	Slovak Republic					
United Kingdom	Slovenia					
United States	Spain					

Source: International Monetary Fund World Economic Outlook (April 2021)