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1 Introduction

The world is increasingly experiencing a tragic "great divide". As of June 2021, while most advanced economies and a few emerging market economies have made considerable progress in national vaccination campaigns, vaccination campaigns in most low- and middle-income countries have stalled under supply constraints (Figure 1). Advanced economies pre-purchased more vaccines than necessary to fully vaccinate their population by the end of 2021; yet the rest of the world has been left struggling with insufficient vaccines, under limited supply. Moreover, world production is constrained in the next six critical months [1]. The distribution of vaccines continues to follow national lines as few countries are sharing vaccines with other countries before a significant part of their own population has been vaccinated. But is a distribution along national lines the best vaccine allocation to save lives?

Covid-19 hits different population groups in different ways. Some groups, including the elderly and people with specific preconditions, are much more at risk of falling severely ill or dying following infection with the virus.

This paper estimates how many lives could be saved if vaccines were distributed globally to high-risk individuals first –rather than along national lines. The thought experiment consists of transferring (part of) the vaccines from countries with a vaccine surplus to the neediest segments of the population in the rest of the worldand abstracts from economic, logistical, and political considerations.

Figure 2 displays the shares of country populations which would be covered by end-2021 using vaccines already procured as projected on June 22, 2021. Most advanced economies with an average GDP of 45,520 dollars per capita and with a population of 1.1 billion had procured enough vaccines to cover their entire population by the end of 2021.[1] The rest of

[1] These countries correspond to the OECD countries with the noticeable exception of Mexico, Korea,

the world, with an average income per capita of 11,840 dollars per capita and a population of 6.7 billion, had not purchased enough vaccines to cover their population.[2]

The results of this thought experiment depend on a set of crucial assumptions about the size of the high-risk population, the dynamic of the pandemics, vaccine efficacy, and vaccine availability. We discuss the key assumptions below.[3]

For simplicity, we group countries into five groups: (i) advanced economies; (ii) China; (iii) India; (iv) other emerging market economies (i.e., excluding China and India); and (v) low-income countries.

2 Size of high-risk populations

The size of the population at risk depends on the country-specific demographic structure of the population and the death-to-infection ratio. The population structure is available from UN population statistics. Age-stratified infection fatality ratios (IFRs) are modelled in three country groups, to account for health care system capacity under infection surges.[4] Since health care systems in emerging economies and low income countries have lower capacity than advanced economies, IFRs during infection surges are adjusted upwards in those country-groups, leading to a higher death-to-infection ratio for each class of age (see Figure 3).

We define high risk populations as those facing an infection-fatality ratio higher than

and Japan, and Turkey.

[2]As of June 22, 2021, China (GDP of 15,300 dollars per capita) has inoculated more than 60 jabs per hundred inhabitants and many emerging markets (GDP of 17,600 dollars per capita) have inoculated more than 30 jabs per hundred inhabitants, India (GDP of 6,400 dollars per capita) less than 30 jabs per hundred people and most low-income countries (GDP of 2,800 dollars per capita) less than 10 jabs per people.

[3]A more detailed discussion is in the appendix.

[4]IFRs were modelled in [2]: the authors adjusted age stratified IFRs for risks of health care system bottlenecks during large waves of infections, under different health care system capacity measures including access to oxygen support and to ICU units. Table 1 in the Appendix provides country level statistics on health care systems, which we used as a basis to assign country groups to modelled IFRs.

2.5 percent following infection, corresponding to the average IFR for individuals aged 65 to 70 in advanced economies. Given this threshold and IFRs adjusted for health care system capacity, populations aged 55 and above (respectively 45 and above) are considered at risk in emerging markets and China (respectively in India and in other LIDC). Given the demographic structure and the modelled infection fatality ratios, we estimate the total world population at risk amounts to 1.4 billion individuals globally, with the breakdown by country groups displayed in Figure 4.[5]

For each country-group, we calculate an average IFR for high risk populations using age-specific IFRs weighted by population in each age-groups. We assume that populations that are not considered at risk under these assumptions do not face any risk of death if infected with the virus. This implies IFRs ranging from 5 to 6 percent for high risk populations (respectively 0.8 to 1.8 percent for average populations) in each country group, during infection surges.[6]

3 Dynamics of the pandemic

The dynamic of the pandemic is difficult to predict as recent surges in India have reminded us. Given this caveat, we do not try to model the path of the pandemics in the future, rather we clearly set our assumptions as prolonging current trends taking into account well-established seasonal fluctuations. To factor in uncertainties about the future evolution of the pandemic, we perturbate the timing and severity of future waves in different runs of the model. In particular:

[5]These estimates compare with the 1.7 billion high risk individuals globally calculated in [3], in which the authors used a bottom-up approach based on country-level statistics on underlying health conditions. To account for uncertainty around the total number of high-risk individuals at the country-group level, we re-run the model by for a range of possible values for country-group high risk populations (see Figure 11 in the appendix, and the method section).

[6]Figure 9 in the Appendix provides implied average IFRs at the country group level for (i) high risk populations, and (ii) total population.

- *Advanced economies and China.* TThe number of infections per million inhabitants is projected to remain low in China, and to be about twice as low as the minimum number of new infections per people observed in June 2020 on average in advanced economies.

- *India.* The current wave of infections is assumed to abate through mid-Summer 2021 – no additional waves of infections are assumed in 2021.

- *Other emerging market economies and low-income countries.* COVID-19 waves are projected to mimic the 2020/21 winter wave observed in advanced economies, with similar shape but higher severities, including to adjust for potential under-measurement of past cases in advanced economies, and lower capacity in other emerging market economies and low-income countries to enforce lockdowns. Future waves are projected to peak between July 2021 and January 2022 in emerging market economies (excluding India and China), and between August 2021 and January 2022 in low-income countries. For India, other emerging market economies, and low-income countries, the number of new infections per million people is projected to peak at levels varying between the peak of the average winter 2021 wave in advanced economies and up to five time as high as that average. For comparison, the U.S. wave of infection in the winter 2021 was twice as severe as that in the average advanced economy.[7]

Figure 5 illustrates one potential future evolution of the pandemics, measured by the number of monthly new infections per million in the five regions of interest, as used in one run of the model.[8]

[7]Figure 10 in the Appendix depicts the evolution of the number of reported cases and deaths in key advanced economies since January 2020.

[8]See Figure 9 in the Appendix for details about the various scenarios envisaged for the evolution of the pandemic.

4 Vaccine types and efficacy

For simplicity, we assume that there is only one vaccine with 100 percent efficacy (i.e., the death risk from fully vaccinated individuals is zero). Monthly vaccine availability reflects the number of full vaccine courses that can be delivered and administered (both first and the second shots for two-dose vaccines). Vaccine surpluses are defined as the number of full vaccine courses available after 50 percent of the population has been fully inoculated within the country group. Vaccines are assumed to be given to high risk individuals first within each country group. Finally, we assume that 20 percent of donated vaccine courses are wasted during distribution.[9]

Projections for vaccine availability come from Airfinity at the country level – and are summarized in Figure 6 at the country-group level and monthly frequency.

5 Scenarios for global vaccine distribution

We consider two scenarios which differ *only* by their vaccine distributions:

- *Baseline scenario.* Countries access vaccines only through contracts that have already been signed with manufacturers and COVAX as of June 22.[10]

- *Vaccine sharing scenario.* Countries that are projected to accumulate surplus vaccine courses by end-2021 are assumed to start sharing vaccines as soon as 50 percent of their populations are fully vaccinated.

Crucially, we assume that, once fully vaccinated, a high-risk individual faces a trivial risk of death. Thus, the number of individuals that remain at risk of death if infected at

[9]This is consistent with average wasted rates for other large-scale vaccination campaigns, as described in [4].

[10]Data are obtained from Airfinity on June 22, 2021.

each point in time is equal to the remaining number of un-vaccinated high risk individuals. Figure 7 presents this statistics for the five country groups used in the exercise, under the baseline scenario (Figure 7a) and the vaccine sharing scenario (7b). At current projections for vaccine availability, vaccine sharing could lead to a reduction in the number of unvaccinated high risk individuals in India, low-income countries and other emerging markets starting in June, and a full vaccination of high risk populations globally by October 2021 - three months earlier than in the baseline scenario, if substantial vaccine sharing starts in June 2021.

6 Discussion

This paper presents a calculation of the number of lives that could be saved if vaccines were distributed to high-risk populations globally by priority rather than along country lines. The calculation is based on simple and transparent assumptions. While these assumptions may look simplistic, they allow for increased result transparency. For instance, the calculation does not attempt to model the dynamics of the pandemic using SIR models, it instead envisions a range of potential timing and severity variables for possible future waves.

Indeed, the results of the analysis crucially depend on key parameters that are difficult to measure or project and remain highly uncertain. These include: the size of high-risk populations, infection fatality ratios, the dynamics of the pandemic. To account for uncertainties around the value assigned to model parameters, each parameter is altered separately and the model re-run. For each country group, the number of high-risk individuals, the infection fatality ratio, and the timing and severity of potential future waves of infections are changed. This amounts to a total of close to one thousand model simulations.

Sharing vaccines with high risk populations in all countries after vaccinating high risk populations in surplus countries could save up to 800,000 people between June and December 2021, with the range depending on the value of parameters, including the timing and severity of potential future waves of infections. These gains crucially depend on the timing of vaccine sharing: should vaccines only be shared from September onwards, the model projects that no more than 200,000 lives could be saved in 2021, assuming the same future waves of infections (see Figure 13).

As vaccine supply remains the main bottleneck for vaccinations in most low- and middle-income countries over the short run, early vaccine sharing will thus be essential. Yet more will likely need to be done to make sure that vaccines reach arms early. Additional limitations around vaccine sharing exist in the model: this exercise abstracts from logistical issues in the vaccination campaign and ignores public health considerations that may hamper vaccine distribution at the national level. Second, the model considers five country groups which act as five countries: this assumes that within each country group, vaccines are shared to prioritize high risk populations. Third, the model assumes that high risk individuals get priority for vaccination everywhere, but many developing countries will face difficulties to target high risk individuals and indeed some countries have elected to open vaccinations to the entire populations before vaccinating high risk individuals. Finally, the sharing of vaccines in this exercise only depend on the remaining number of unprotected high-risk individuals, and abstracts from the state of the pandemic. In fact, prioritizing vaccine sharing to countries that face large surges, or that lack sufficient health care infrastructures to limit the death toll may yield higher numbers of saved lives [5]. Thus, the results presented herein may constitute a lower bound in the number of lives that could be saved through early vaccine sharing.

Despite all uncertainties, this paper provides a realistic calculation of the human life costs that could be averted if vaccine sharing can materialize quickly. This does not provide a plan for vaccine distribution globally, but rests on the best available data and projections of vaccine availability, making this paper as realistic as possible, and its making its results achievable, if political decisions are taken swiftly.

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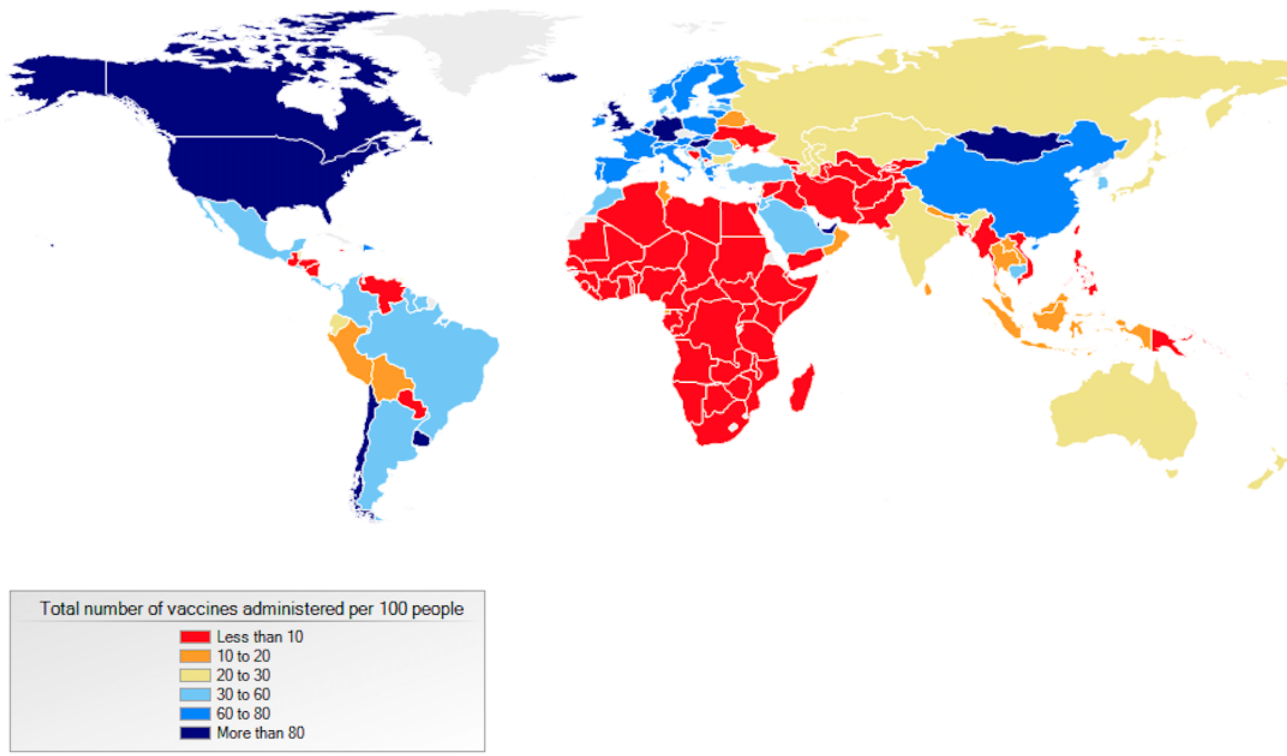
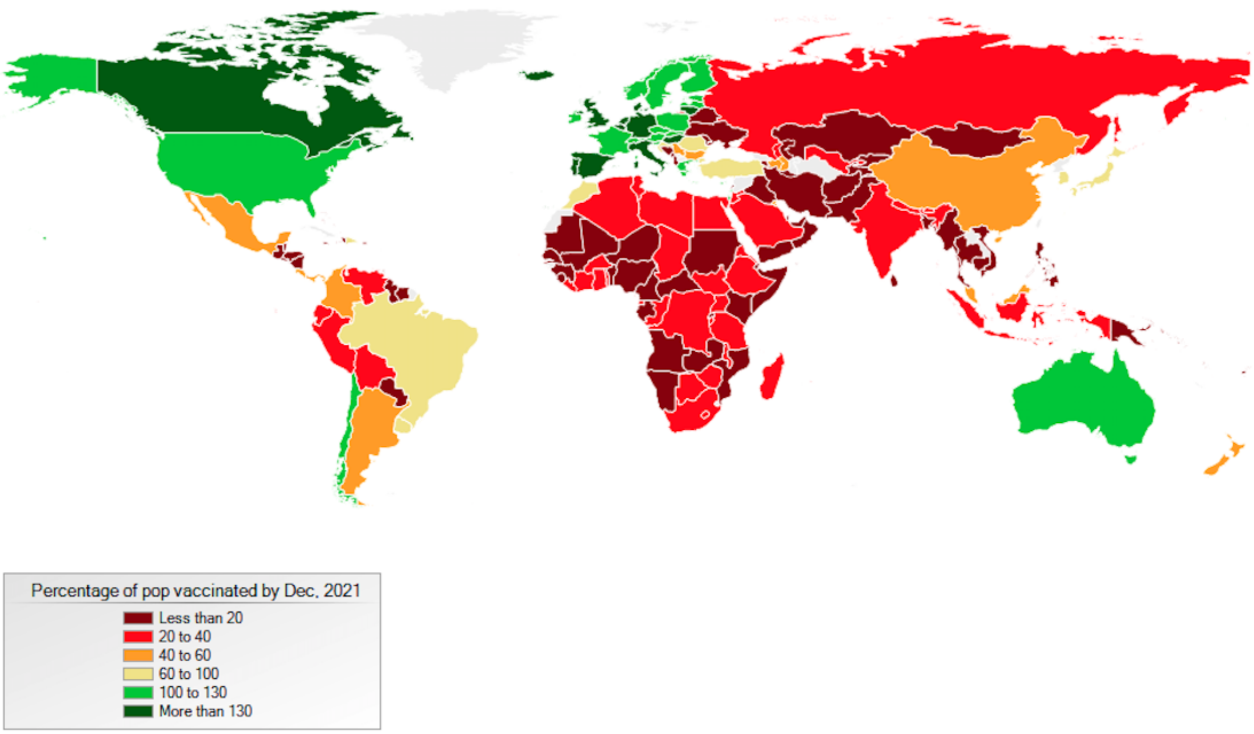
Figure 1: Vaccination rates as of June 22, 2021



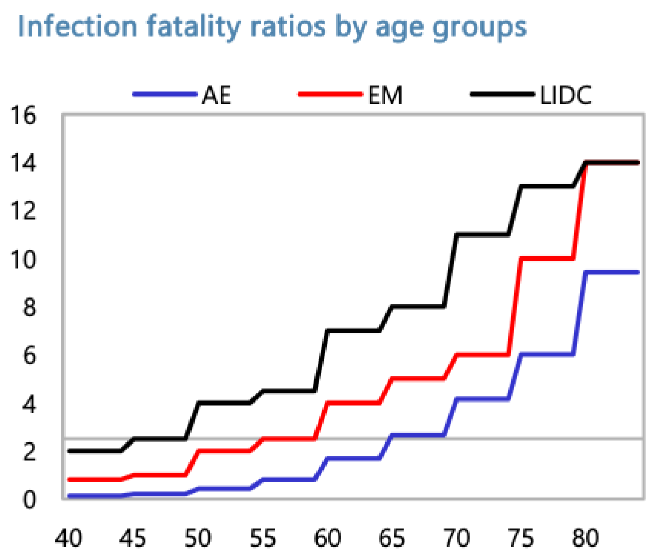
Notes: The map depicts the number of doses that have been administered per capita at the country level, as of June 22, 2021, or latest date available at the country level. Data was retrieved from Our World In Data on June 22, 2021.

Figure 2: Population projected to be covered by procured vaccines by end-December 2021



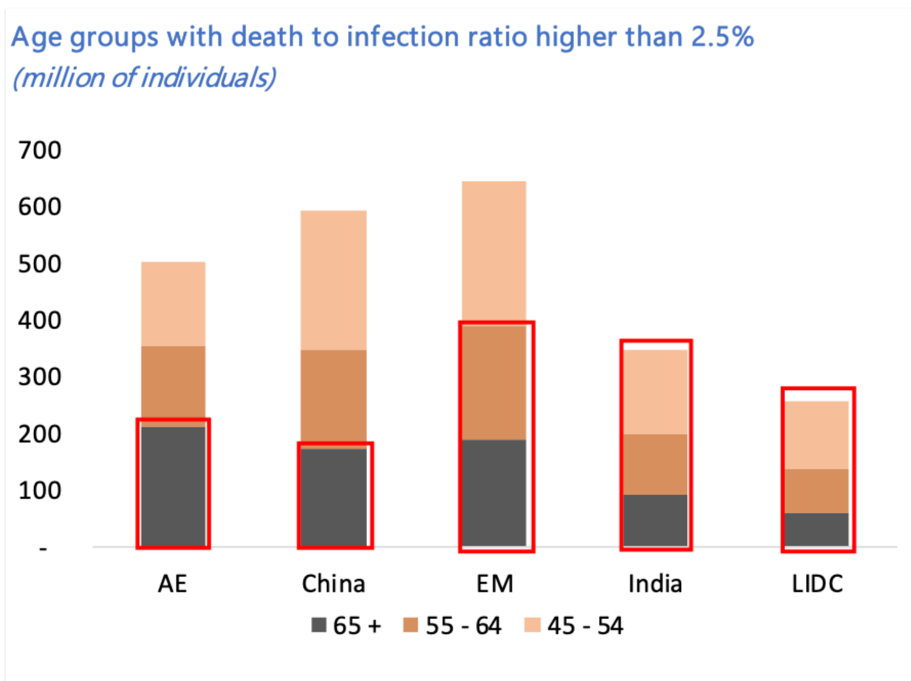
Notes: The map depicts the percentage of countries' populations projected to be fully covered for vaccinations with vaccines procured as of June 22, 2021. Projections come from Airfinity.

Figure 3: Modeled Infection Fatality Ratios per age groups



Notes: The graph depicts modelled Infection Fatality Ratios (IFRs) by age groups for three country groups: Advanced Economies (AE) in blue, Emerging Markets excluding China and India (EM) in red and Low Income and Developing Countries (LIDCs) in black. The x-axis represents age groups, and the y-axis the percentage of individuals at risk of death per age group, if infected by the virus causing COVID-19 during a surge of infections. IFRs were modelled in [2]: the authors adjusted age-stratified IFRs for risks of health care system bottlenecks during large waves of infections. The black line was derived from the authors' scenario in which only limited or poor-quality oxygen support is available in low and middle income countries. The red line was derived from the authors' scenario in which access to ICU units is constrained. Table XX in Appendix XX provides country level statistics on health care systems, which we used as a basis to assign country groups to modelled IFRs. Figure XX in Appendix XX provides implied average IFRs at the country group level for (i) high risk populations, and (ii) total population.

Figure 4: Total number of high risk individuals across country groups



Notes: This represents the estimated number of high risk individuals in each country groups, during COVID infection surges. This was derived from data on country-specific population age distributions from the UN, and age-stratified IFRs depiced in Figure 3. High risk populations are defined as those facing a probability of death if infected with the virus during a large wave of infection equal or superior to 2.5 percent. This corresponds to individuals aged 65 and above in AEs and China, 55 and above for EM, and 45 and above for LIDC and India.

Figure 5: Projected potential future waves of infections across country groups

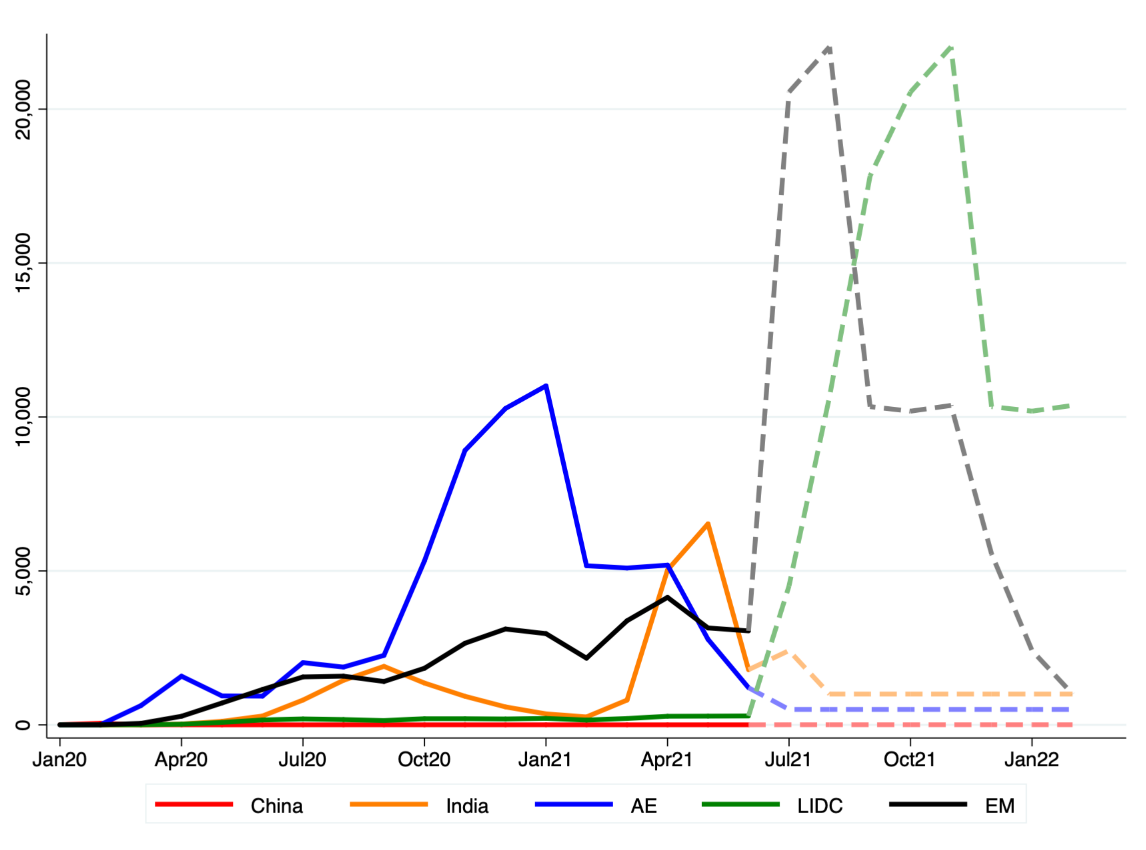


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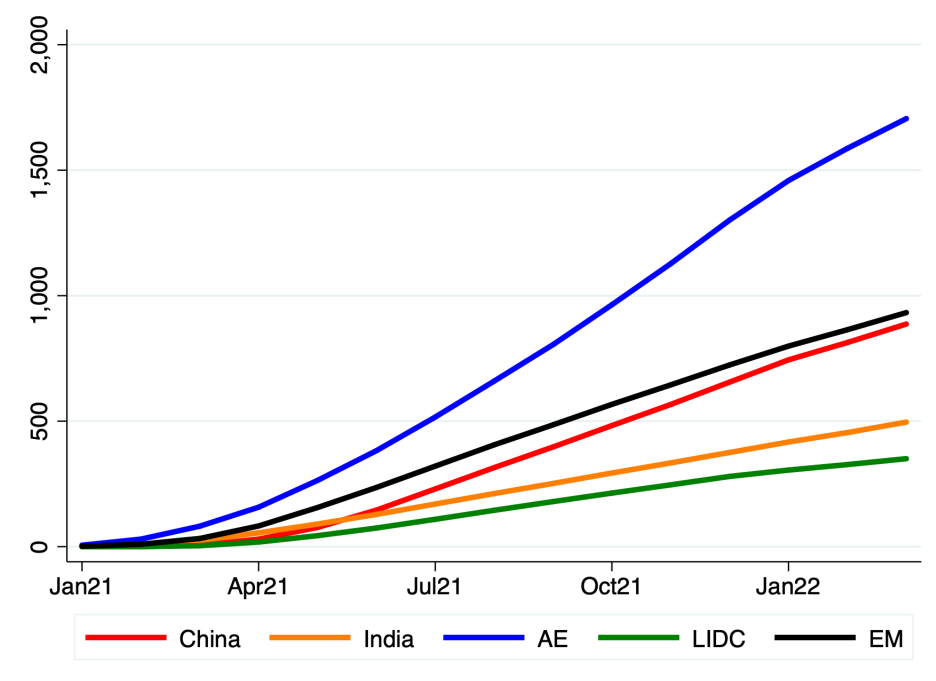
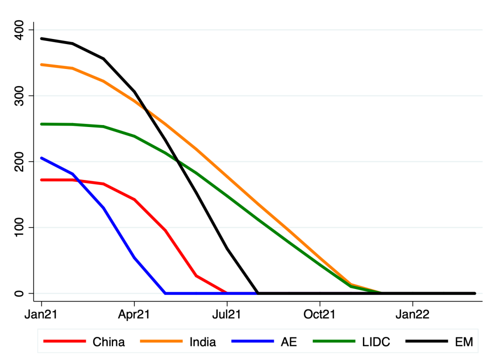
Figure 6: Projected vaccinations across country groups



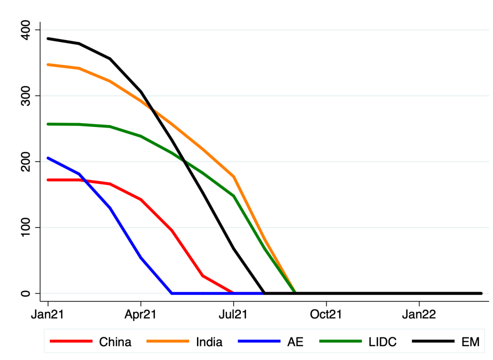
(a) Baseline scenario

Notes: The figure represents projections for the cumulative number of full courses that will be available at the country group level and monthly frequency in the baseline scenario. Projections are produced by Airfinity, a data provider, which aggregates all publicly available contracts between vaccine manufacturers and countries and projects vaccine availability through end of year. Data were obtained on June 22, 2021. T

Figure 7: Projected number of unvaccinated high risk individuals across country groups



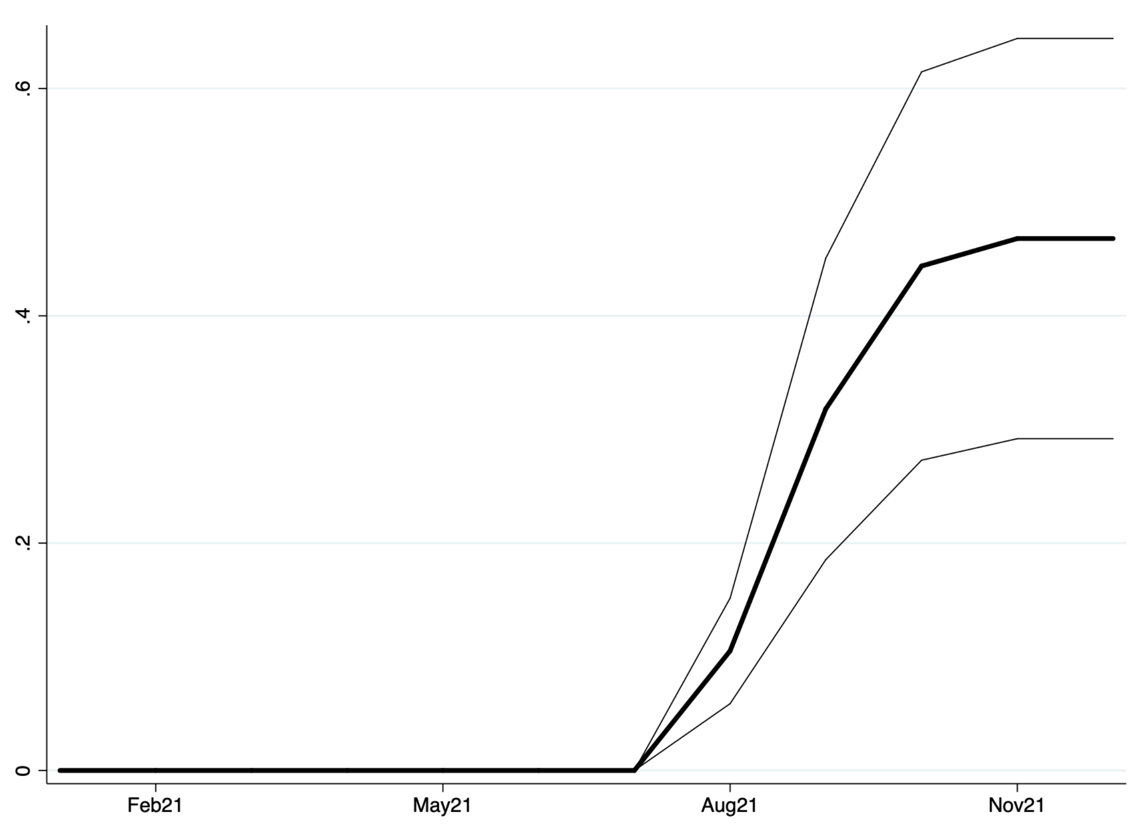
(a) Baseline scenario



(b) Vaccine sharing scenario

Notes: The figure represents the number of high risk individuals that remain unvaccinated in the baseline scenario (left) and the vaccine sharing scenario (right) in each country group. Individuals are considered vaccinated after they receive full courses (two doses for vaccines that require two shots). Vaccines are assumed to have 100 percent efficacy, and high risk individuals that receive full vaccine courses are considered fully protected against death from infection.

Figure 8: Projected number of lives saved from early sharing of vaccines



Notes: The thick black line represents the mean number of saved lives at the monthly frequency, in a scenario where surplus countries share vaccines as soon as they vaccinate fully their 50 percent of their populations. Thin black lines represent the 1-standard deviation bands around the mean result, when running the model over 1,000 times with perturbed parameters.

Appendix

1. Country grouping

Table 1: High risk populations and health care systems: Advanced economies

Country	Population	High Risk	Diabetes	Hospital beds	Poverty	HDI	Vacc. rate
Australia	25.5	4.1	5.1	3.8	0.5	0.9	107.5
Austria	9.0	1.7	.	.	.	.	.
Belgium	11.6	2.2	4.3	5.6	0.2	0.9	148.3
Canada	37.7	6.8	7.4	2.5	0.5	0.9	158.0
Cyprus	1.2	0.2	9.2	3.4	.	0.9	104.9
Czech Republic	10.7	2.2	6.8	6.6	.	0.9	129.7
Denmark	5.8	1.2	6.4	2.5	0.2	0.9	134.8
Estonia	1.3	0.3	4.0	4.7	0.5	0.9	116.4
Finland	5.5	1.2	5.8	3.3	.	0.9	116.1
France	65.3	13.5	4.8	6.0	.	0.9	127.3
Germany	83.8	18.2	8.3	8.0	.	0.9	144.6
Greece	10.4	2.3	4.5	4.2	1.5	0.9	127.6
Hong Kong	7.5	1.4	8.3	.	.	0.9	63.2
Iceland	0.3	0.1	5.3	2.9	0.2	0.9	178.4
Ireland	4.9	0.7	3.3	3.0	0.2	1.0	107.7
Israel	8.7	1.1	6.7	3.0	0.5	0.9	118.2
Italy	60.5	14.1	4.8	3.2	2.0	0.9	134.9
Japan	126.5	35.9	5.7	13.1	.	0.9	98.8
Latvia	1.9	0.4	4.9	5.6	0.7	0.9	101.2
Lithuania	2.7	0.6	3.7	6.6	0.7	0.9	134.4
Luxembourg	0.6	0.1	4.4	4.5	0.2	0.9	133.5
Macau	0.6	0.1	.	.	.	.	88.8
Malta	0.4	0.1	8.8	4.5	0.2	0.9	202.4
Netherlands	17.1	3.4	5.3	3.3	.	0.9	131.1
New Zealand	4.8	0.8	8.1	2.6	.	0.9	41.9
Norway	5.4	1.0	5.3	3.6	0.2	1.0	113.7
Portugal	10.2	2.3	9.8	3.4	0.5	0.9	133.8
Puerto Rico	2.9	0.6	.	.	.	.	14.8
Singapore	5.9	0.8	11.0	2.4	.	0.9	2.1
Slovakia	5.5	0.9	7.3	5.8	0.7	0.9	103.7
Slovenia	2.1	0.4	7.2	4.5	.	0.9	115.1
South Korea	51.3	8.1	6.8	12.3	0.2	0.9	76.3
Spain	46.8	9.3	7.2	3.0	1.0	0.9	139.3
Sweden	10.1	2.1	4.8	2.2	0.5	0.9	116.8
Switzerland	8.7	1.7	5.6	4.5	.	1.0	121.1
Taiwan	23.8	3.8	.	.	.	.	20.9
United Kingdom	67.9	12.7	4.3	2.5	0.2	0.9	155.7
United States	331.0	55.0	10.8	2.8	1.2	0.9	127.9

Source: OWID.

Table 2: High risk populations and health care systems: EM excl. China and India

Country	Population	High Risk	Diabetes	Hospital beds	Poverty	HDI	Vacc. rate
Albania	2.9	0.8	10.1	2.9	1.1	0.8	9.8
Algeria	43.9	6.1	6.7	1.9	0.5	0.7	31.6
Angola	32.9	1.9	3.9	.	.	0.6	18.4
Antigua and Barbuda	0.1	0.0	13.2	3.8	.	0.8	20.4
Argentina	45.2	9.1	5.5	5.0	0.6	0.8	45.9
Armenia	3.0	0.7	7.1	4.2	1.8	0.8	2.1
Azerbaijan	10.1	1.8	7.1	4.7	.	0.8	45.5
Bahamas	0.4	0.1	13.2	2.9	.	0.8	12.6
Bahrain	1.7	0.1	16.5	2.0	.	0.9	6.0
Barbados	0.3	0.1	13.6	5.8	.	0.8	33.1
Belarus	9.4	2.9	5.2	11.0	.	0.8	4.1
Belize	0.4	0.0	17.1	1.3	.	0.7	12.4
Bolivia	11.7	1.6	6.9	1.1	7.1	0.7	30.8
Bosnia and Herzegovina	3.3	1.1	10.1	3.5	0.2	0.8	3.2
Botswana	2.4	0.2	4.8	1.8	.	0.7	27.4
Brazil	212.6	41.5	8.1	2.2	3.4	0.8	62.5
Brunei Darussalam	0.4	0.1	.	.	.	.	.
Bulgaria	6.9	2.4	5.8	7.5	1.5	0.8	52.5
Cape Verde	0.6	0.1	2.4	2.1	.	0.7	28.3
Chile	19.1	4.5	8.5	2.1	1.3	0.9	122.7
Colombia	50.9	9.3	7.4	1.7	4.5	0.8	49.5
Costa Rica	5.1	1.1	8.8	1.1	1.3	0.8	55.6
Croatia	4.1	1.5	5.6	5.5	0.7	0.9	96.7
Dominican Republic	10.8	1.7	8.2	1.6	1.6	0.8	99.7
Ecuador	17.6	2.7	5.5	1.5	3.6	0.8	28.7
Egypt	102.3	12.0	17.3	1.6	1.3	0.7	29.8
El Salvador	6.5	1.0	8.9	1.3	2.2	0.7	19.8
Equatorial Guinea	1.4	0.1	7.8	2.1	.	0.6	33.9
Fiji	0.9	0.1	14.5	2.3	1.4	0.7	5.5
Gabon	2.2	0.2	7.2	6.3	3.4	0.7	11.8
Georgia	4.0	1.1	.	.	.	.	.
Grenada	0.1	0.0	10.7	3.7	.	0.8	19.9
Guatemala	17.9	1.8	10.2	0.6	8.7	0.7	8.9
Guyana	0.8	0.1	11.6	1.6	.	0.7	7.7
Hungary	9.7	3.1	7.5	7.0	0.5	0.9	177.6
Indonesia	273.5	40.7	6.3	1.0	5.7	0.7	21.1
Iran	84.0	12.3	9.6	1.5	0.2	0.8	16.0
Iraq	40.2	3.0	8.8	1.4	2.5	0.7	6.0
Jamaica	3.0	0.5	11.3	1.7	.	0.7	2.1
Jordan	10.2	0.9	11.8	1.4	0.1	0.7	23.1
Kazakhstan	18.8	3.4	7.1	6.7	0.1	0.8	13.0
Kuwait	4.3	0.5	15.8	2.0	.	0.8	51.7
Lebanon	6.8	1.1	12.7	2.9	.	0.7	16.1
Libya	6.9	0.7	10.4	3.7	.	0.7	27.8
Malaysia	32.4	5.0	16.7	1.9	0.1	0.8	40.3
Maldives	0.5	0.0	9.2	.	.	0.7	28.4
Mauritius	1.3	0.3	22.0	3.4	0.5	0.8	38.3
Mexico	128.9	20.3	13.1	1.4	2.5	0.8	48.4
Mongolia	3.3	0.4	4.8	7.0	0.5	0.7	10.1
Montenegro	0.6	0.2	10.1	3.9	1.0	0.8	13.1
Morocco	36.9	6.2	7.1	1.1	1.0	0.7	74.1
Namibia	2.5	0.2	3.9	.	13.4	0.6	16.0
Oman	5.1	0.4	12.6	1.6	.	0.8	7.0
Pakistan	220.9	21.8	8.3	0.6	4.0	0.6	4.8
Panama	4.3	0.7	8.3	2.3	2.2	0.8	43.8
Paraguay	7.1	1.0	8.3	1.3	1.7	0.7	16.0
Peru	33.0	5.6	6.0	1.6	3.5	0.8	35.2
Philippines	109.6	13.7	7.1	1.0	.	0.7	13.4
Poland	37.8	12.1	5.9	6.6	.	0.9	125.7
Qatar	2.9	0.2	16.5	1.2	.	0.8	2.1
Romania	19.2	6.0	9.7	6.9	5.7	0.8	77.3
Russia	145.9	43.1	.	.	.	.	.
Samoa	0.2	0.0	9.2	.	.	0.7	19.6
Saudi Arabia	34.8	3.4	17.7	2.7	.	0.9	27.1
Serbia	8.7	2.8	10.1	5.6	.	0.8	45.9
Seychelles	0.1	0.0	10.6	3.6	1.1	0.8	105.0
South Africa	59.3	7.3	5.5	2.3	18.9	0.7	20.3
Sri Lanka	21.4	4.8	10.7	3.6	0.7	0.8	4.4
Suriname	0.6	0.1	12.5	3.1	.	0.7	6.7
Syrian Arab Republic	17.5	1.9	.	1.5	.	0.6	3.2
Thailand	69.8	18.5	7.0	2.1	0.1	0.8	19.8
Tonga	0.1	0.0	15.4	2.6	.	0.7	20.0
Trinidad and Tobago	1.4	0.3	11.0	3.0	.	0.8	3.6
Tunisia	11.8	2.2	8.5	2.3	2.0	0.7	27.9
Turkey	84.3	15.2	12.1	2.8	0.2	0.8	74.8
Turkmenistan	6.0	0.7	.	.	.	.	.
Ukraine	43.7	13.4	7.1	8.8	0.1	0.8	11.9
United Arab Emirates	9.9	0.7	17.3	1.2	.	0.9	15.7
Uruguay	3.5	0.9	6.9	2.8	0.1	0.8	68.6
Vanuatu	0.3	0.0	12.0	.	13.2	0.6	16.1
Venezuela	28.4	4.9	6.5	0.8	.	0.7	21.4

Source: OWID.

Table 3: High risk populations and health care systems: China

Country	Population	High Risk	Diabetes	Hospital beds	Poverty	HDI	Vacc. rate
China	1,439.3	172.3	9.7	4.3	0.7	0.8	45.6

Source: OWID.

Table 4: High risk populations and health care systems: India

Country	Population	High Risk	Diabetes	Hospital beds	Poverty	HDI	Vacc. rate
India	1,380.0	347.2	10.4	0.5	21.2	0.6	27.2

Source: OWID.

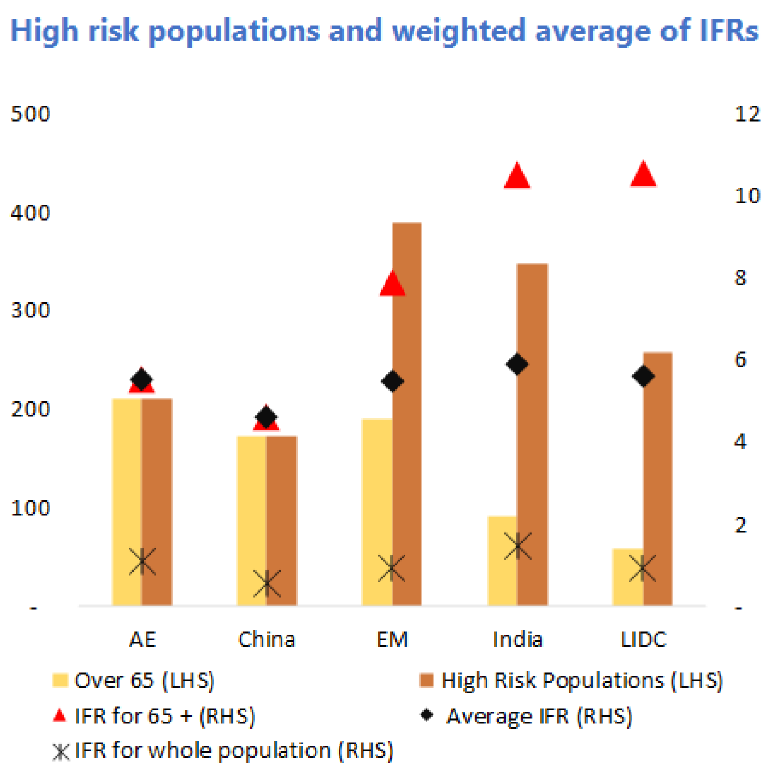
Table 5: High risk populations and health care systems: Low income countries

Country	Population	High Risk	Diabetes	Hospital beds	Poverty	HDI	Vacc. rate
Afghanistan	38.9	4.8	9.6	0.5	.	0.5	3.0
Bangladesh	164.7	37.5	8.4	0.8	14.8	0.6	8.8
Benin	12.1	1.7	1.0	0.5	49.6	0.5	16.1
Bhutan	0.8	0.2	9.8	1.7	1.5	0.7	32.2
Burkina Faso	20.9	2.5	2.4	0.4	43.7	0.5	27.9
Burundi	11.9	1.3	6.0	0.8	71.7	0.4	24.5
Cambodia	16.7	3.5	4.0	0.8	.	0.6	9.7
Cameroon	26.5	3.4	7.2	1.3	23.8	0.6	14.5
Central African Republic	4.8	0.6	6.1	1.0	.	0.4	19.1
Chad	16.4	1.8	6.1	.	38.4	0.4	28.0
Comoros	0.9	0.1	11.9	2.2	18.1	0.6	25.1
Democratic Republic of the Congo	89.6	11.5	6.1	.	77.1	0.5	28.5
Djibouti	1.0	0.2	6.0	1.4	22.5	0.5	16.2
Eritrea	3.5	0.5	6.0	0.7	.	0.5	23.6
Ethiopia	115.0	15.9	7.5	0.3	26.7	0.5	28.0
Gambia	2.4	0.3	1.9	1.1	10.1	0.5	24.5
Ghana	31.1	5.2	5.0	0.9	12.0	0.6	21.0
Guinea	13.1	1.6	2.4	0.3	35.3	0.5	19.4
Guinea-Bissau	2.0	0.3	2.4	.	67.1	0.5	27.8
Haiti	11.4	2.2	6.7	0.7	23.5	0.5	15.4
Honduras	9.9	1.9	7.2	0.7	16.0	0.6	15.2
Ivory Coast	26.4	3.5	2.4	.	28.2	0.5	28.2
Kenya	53.8	7.2	2.9	1.4	36.8	0.6	19.9
Kiribati	0.1	0.0	22.7	1.9	.	0.6	19.7
Kyrgyzstan	6.5	1.4	7.1	4.5	1.4	0.7	3.2
Lao P.D.R.	7.3	1.4	.	.	.	.	.
Lesotho	2.1	0.4	3.9	.	59.6	0.5	23.9
Liberia	5.1	0.7	2.4	0.8	38.6	0.5	21.0
Madagascar	27.7	4.0	3.9	0.2	77.6	0.5	24.7
Malawi	19.1	2.3	3.9	1.3	71.4	0.5	20.9
Mali	20.3	2.3	2.4	0.1	.	0.4	15.3
Mauritania	4.6	0.7	2.4	.	6.0	0.5	18.4
Moldova	4.0	1.5	5.7	5.8	0.2	0.8	2.6
Mozambique	31.3	3.8	3.3	0.7	62.9	0.5	14.2
Myanmar	54.4	14.5	4.6	0.9	6.4	0.6	12.8
Nepal	29.1	6.3	7.3	0.3	15.0	0.6	27.9
Nicaragua	6.6	1.4	11.5	0.9	3.2	0.7	15.4
Niger	24.2	2.7	2.4	0.3	44.5	0.4	14.6
Nigeria	206.1	27.6	2.4	.	.	0.5	17.9
Papua New Guinea	8.9	1.6	17.6	.	.	0.6	3.2
Republic of the Congo	5.5	0.8	7.2	.	37.0	0.6	29.3
Rwanda	13.0	1.9	4.3	.	56.0	0.5	18.2
Senegal	16.7	2.2	2.4	.	38.0	0.5	19.4
Sierra Leone	8.0	1.1	2.4	.	52.2	0.5	14.4
Solomon Islands	0.7	0.1	18.7	1.4	25.1	0.6	7.6
Somalia	15.9	2.0	6.0	0.9	.	.	18.1
South Sudan	11.2	1.6	10.4	.	.	0.4	22.9
Sudan	43.8	6.7	15.7	0.8	.	0.5	19.1
Tajikistan	9.5	1.7	7.1	4.8	4.8	0.7	3.2
Tanzania	59.7	7.6	5.8	0.7	49.1	0.5	24.6
Timor-Leste	1.3	0.2	.	.	.	.	.
Togo	8.3	1.2	6.2	0.7	49.2	0.5	21.3
Uganda	45.7	4.7	2.5	0.5	41.6	0.5	23.8
Uzbekistan	33.5	7.7	7.6	4.0	.	0.7	27.5
Vietnam	97.3	29.6	6.0	2.6	2.0	0.7	7.5
Yemen	29.8	3.8	5.3	0.7	18.8	0.5	3.2
Zambia	18.4	2.0	3.9	2.0	57.5	0.6	16.6
Zimbabwe	14.9	1.9	1.8	1.7	21.4	0.6	20.0

Source: OWID.

2. Infection Fatality Ratios

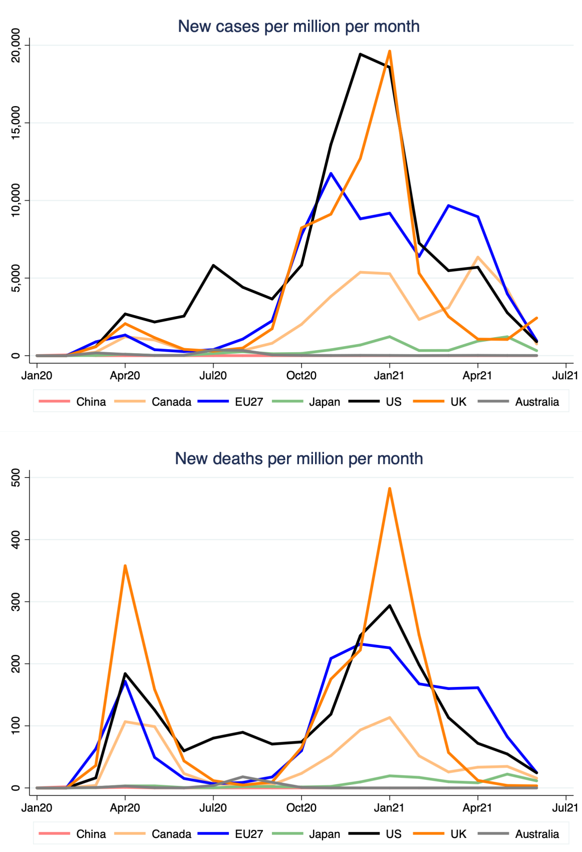
Figure 9: Infection Fatality Ratios - Modeled for high risk populations and general populations



Notes: For each country group, the figure depicts the number of high risk individuals (in million, on the left-hand side) and IFRs (on the right-hand side). Yellow bars represent the number of individuals aged 65 and above, which represent the high risk populations in countries with advanced health care systems. The brown bars represent the number of high risk individuals when accounting for health care system bottlenecks during surges. Red triangles are the average IFRs for populations aged 65 and above, the black diamonds represent the weighted averages for IFRs for high risk populations and the black crosses for entire populations.

3. Projected potential new waves of infections

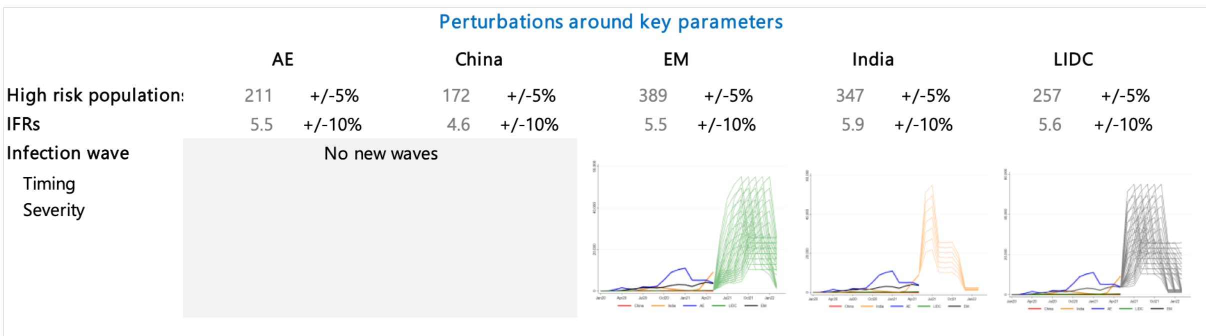
Figure 10: Reported number of cases and deaths in key advanced economies



Notes: The top panel depicts the reported number of new cases per million people at the monthly frequency in key advanced economies. The bottom panel depicts the reported number of COVID-deaths per million people in key advanced economies.

4. Sensitivity to choice of parameters

Figure 11: Perturbation of key parameters

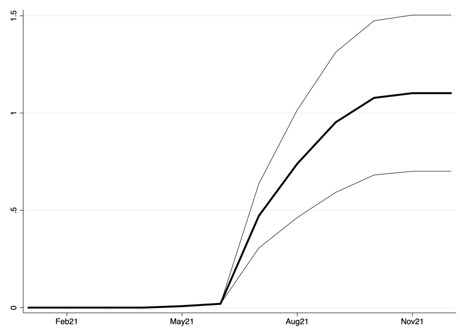


Notes: The figure presents the perturbations used for each key parameter seperately, when re-running the simulation about 1,000 times.

5. Additional scenarios

a. If sharing started as soon as surplus countries high risk populations were fully vaccinated

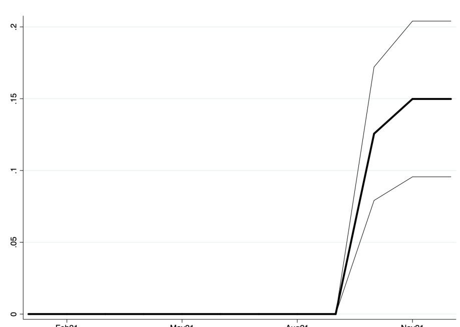
Figure 12: Projected number of lives saved from early sharing of vaccines



Notes: The thick black line represents the mean number of saved lives at the monthly frequency, in a scenario where surplus countries share vaccines as soon as they vaccinate fully their high risk populations. Thin black lines represent the 1-standard deviation bands around the mean result, when running the model over 1,000 times with perturbed parameters.

b. If sharing only starts after 75% of surplus countries population is fully vaccinated

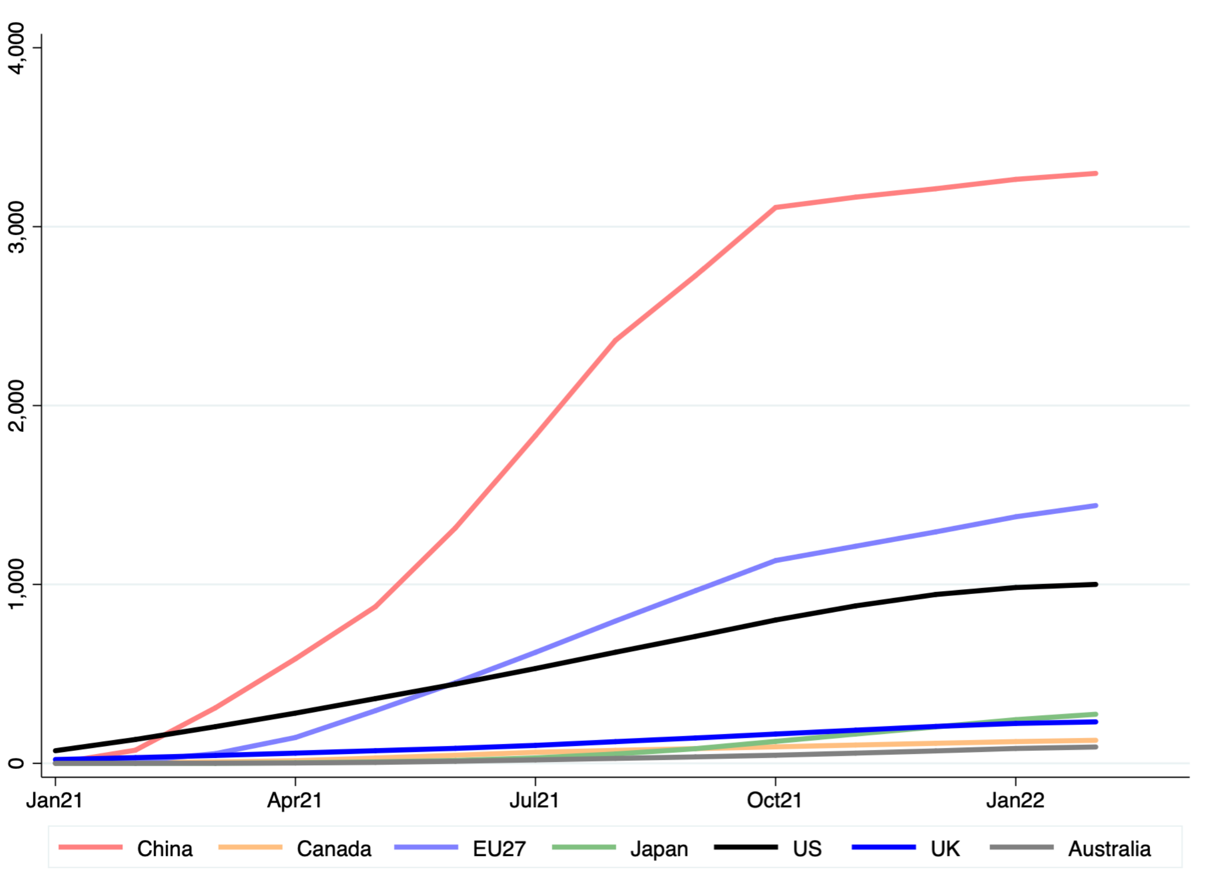
Figure 13: Projected number of lives saved from early sharing of vaccines



Notes: The thick black line represents the mean number of saved lives at the monthly frequency, in a scenario where surplus countries share vaccines as soon as they vaccinate fully their 75 percent of their populations. Thin black lines represent the 1-standard deviation bands around the mean result, when running the model over 1,000 times with perturbed parameters.

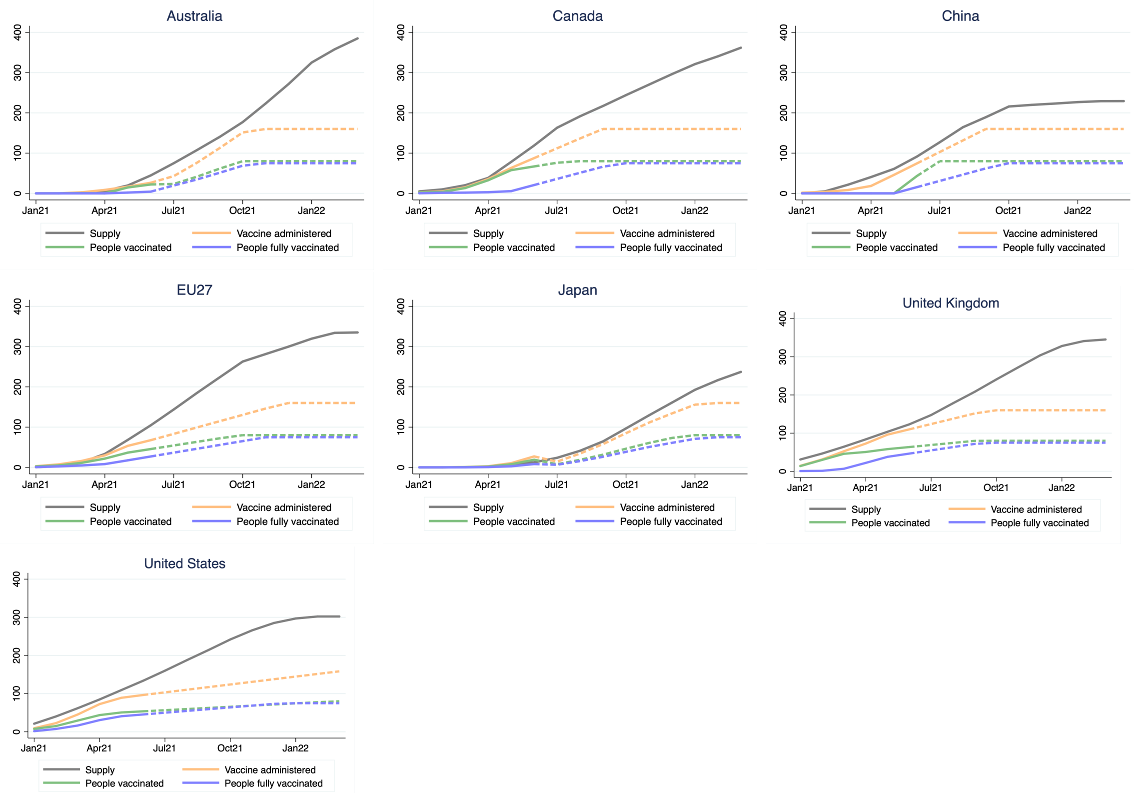
6. Projected vaccine supply and surpluses in key surplus countries

Figure 14: Projections for vaccine supply in main surplus countries



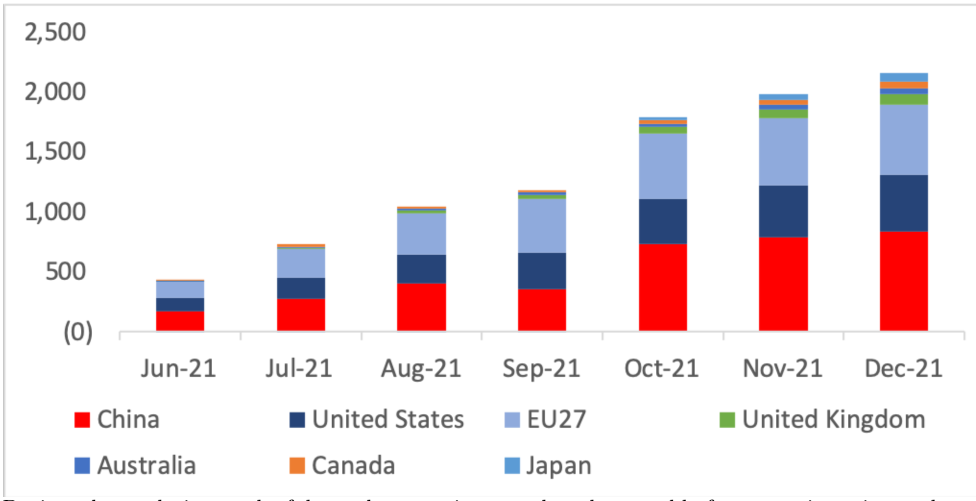
Notes: Projected vaccine supply is expressed in number of doses, cumulatively. Projections were provided by Airfinity in late-June 2021.

Figure 15: Projections for vaccine supply and vaccinations in main surplus countries



Notes: For each key main surplus country, the graphs display: the projected supply (in doses per capita), projected number of vaccines administered (in doses per capita), the percentage of the population who received at least one dose, and the percentage of the population who received full vaccination. Projections for vaccine supply was provided by Airfinity in mid-June, 2021. Data on vaccinations was retrieved from OWID on June 22, 2021. For July and following months, vaccination rates are projected to remain on the same trend as in June 2021, until 75 percent of the population is fully vaccinated (except for Australia and Japan, where vaccinations are projected to accelerate). This is illustrative, and is to give an order of magnitude of potential surpluses, defined at the monthly frequency as the difference between cumulative supply (in grey) and cumulative doses administered (in orange). In a few countries where vaccination started at a later stage, it is possible that vaccination rates can pick up, leading to smaller surpluses in per capita terms. However, for major producer countries (UK, EU27, US), vaccination rates will likely continue to slow as vaccination rates increase, opening the possibility for larger stocks of unused vaccines.

Figure 16: Projections for monthly stock of unused vaccines in main surplus countries



Notes: Projected cumulative stock of doses that remain unused at the monthly frequency in main surplus countries. Unused doses are estimated as the difference in the projected supply of doses and the projected administration of (or demand for) vaccines at the country level. Supply projections come from Airfinity, and projections for vaccine demand in surplus countries as described in figure 15. No booster shots are assumed to be needed in those calculations. This also assumes that no vaccines are shared across countries.