



Incentivizing wealthy nations to participate in the COVID-19 Vaccine Global Access Facility (COVAX): A game theory perspective

AUTHORS

**David McAdams, Kaci Kennedy McDade, Osondu Ogbuoji,
Matthew Johnson, Siddharth Dixit, Gavin Yamey**

Working Paper • August 2020

AUTHORS

David McAdams, Professor of Business Administration and Professor of Economics, Duke Fuqua School of Business and Economics Department

Kaci Kennedy McDade, Policy Associate, Center for Policy Impact in Global Health

Osondu Ogbuoji, Assistant Research Professor of Global Health & Deputy Director, Center for Policy Impact in Global Health

Matthew Johnson, Senior Director, Product Development, Duke Human Vaccine Institute

Siddharth Dixit, Policy Associate, Center for Policy Impact in Global Health

Gavin Yamey, Professor of Global Health and Public Policy & Director, Center for Policy Impact in Global Health*

*To whom correspondence should be addressed: gavin.yamey@duke.edu

SUGGESTED CITATION

McAdams D, McDade KK, Ogbuoji O, Johnson M, Dixit S, Yamey G. Incentivizing wealthy nations to participate in COVID-19 vaccine Global Access Facility (COVAX). The Center for Policy Impact in Global Health. Working paper, August 2020. Available at: <http://centerforpolicyimpact.org/our-work/coronavirus-covid-19-and-pandemic-preparedness/incentivizing-wealthy-nations-to-participate-in-covax/>.

ACKNOWLEDGEMENTS

The authors would like to thank Heather Hille, Project Coordinator at the Center for Policy Impact in Global Health, for her project assistance.

TABLE OF CONTENTS

Summary.....	4
1 Introduction.....	5
Table 1: Examples of bilateral COVID-19 vaccine purchasing agreements	5
2 The COVID-19 Vaccine Global Access Facility (COVAX).....	6
3 Incentivizing COVAX participation by wealthier nations.....	8
Figure 1: Investments by HICs to secure their own vaccine supplies: examples of potential spillovers and possible associated safe-harbor criteria	13
4 Conclusion	14
References.....	15

● SUMMARY

Developing a safe, effective COVID-19 vaccine alone will not be enough to end the pandemic—the vaccine must also be delivered globally at a price affordable to all governments and allocated in a way that maximizes public health impact and achieves equity. These goals are being threatened as rich nations enter into bilateral purchase agreements with COVID-19 vaccine manufacturers, potentially hoarding the global supply. It is impossible to stop these bilateral deals—the best we can achieve is to find ways to configure these deals to also benefit the new COVID-19 Vaccine Global Access Facility (COVAX), which aims to guarantee equitable access to COVID-19 vaccines worldwide.

Countries that participate in COVAX are guaranteed sufficient doses to vaccinate 20% of their population (enough to cover high priority populations). Rich countries can participate as “self-financing” countries. By joining COVAX, they commit to procure enough doses from the Facility to vaccinate 20% of their population and also make an up-front payment to contribute towards advanced purchase agreements and select at-risk costs including technology transfer to support manufacturing scale up. The more rich countries that participate, the more that the financial risks of investing in manufacturing scale up of multiple vaccine candidates will be shared and the more doses that can eventually be purchased. Less wealthy countries can participate as “funded” countries, with their financial commitments covered by official development assistance.

We conducted a game theory analysis to explore ways in which wealthier nations could be incentivized to participate in COVAX. Our analysis had two key findings.

The first is the important role of fungibility and harmonization. Everyone benefits when (i) COVAX investments to accelerate production of a specific vaccine candidate can be quickly repurposed to accelerate production of another vaccine (“*fungibility*”), and (ii) critical inputs, processes, and data are standardized across as many vaccine candidates and production facilities as possible (“*harmonization*”). Fungibility and harmonization could change the “value proposition” that COVAX offers to wealthier countries that fund the Facility. For example, fungibility magnifies wealthier nations’ bang-for-the-buck from funding COVAX, while the fungibility of non-COVAX investments expands the potential reach of vaccines in the COVAX portfolio.

The second is that “safe harbor criteria” could be defined for the bilateral deals made by wealthy nations—these criteria would define ways in which a bilateral deal could *also* expand global vaccine supply. Articulating such criteria could influence how such deals are structured, steering them more toward the global good. Examples include if the manufacturer involved in the bilateral deal shares know-how or if the deal expands the global supply of critical inputs that might otherwise constrain production of COVAX vaccines.

1 INTRODUCTION

Progress in developing COVID-19 vaccines has been rapid: the first clinical trial of a vaccine candidate began in Seattle, USA on March 16, 2020—just 63 days after China shared the genetic sequence of SARS-CoV-2, the virus that causes COVID-19. As of August 13, 2020, there were 29 candidate vaccines in clinical trials.¹ Given standard attrition rates, we can expect at least a handful of COVID-19 vaccines to eventually be launched.

However, developing a safe, effective vaccine alone will not be enough to end the pandemic. The vaccine must also be delivered globally at a price affordable to all governments and allocated in a way that maximizes immediate and long-term public health impact and simultaneously achieves equity. In previous pandemics, these goals were not achieved. For example, in the 2009 influenza A (H1N1) pandemic, rich countries monopolized the vaccine supply; low-income countries (LICs) and middle-income countries (MICs) received fewer doses much later in the pandemic.²

The international community could have learned lessons from this debacle and put in place a different kind of global vaccine allocation system for COVID-19. In an ideal system, manufacturers would openly share patents and manufacturing technology and adopt transparent, non-profit pricing; manufacturing would be globalized; and countries worldwide would pool funding to buy and allocate vaccines for everyone who needs them, free at the point of care. Unfortunately, we failed to learn from the H1N1 pandemic—rich nations are again flexing their market power by entering into bilateral purchase agreements with COVID-19 vaccine manufacturers (Table 1), potentially hoarding the global supply.³ Such “vaccine nationalism” is a major threat to reaching global herd immunity and a return of normal social and economic activity.^{4,5}

Purchaser (country)	Vaccine manufacturer	Number of doses committed
United Kingdom	AstraZeneca	100 million
United Kingdom	GSK and Sanofi	60 million
United Kingdom	Valneva	60 million
United Kingdom	BioNtech and Pfizer	30 million
Inclusive Vaccines Alliance (Germany, France, Italy, Netherlands)	AstraZeneca	300 million
United States	AstraZeneca	300 million
United States	Moderna	300 million/year
United States	BioNtech and Pfizer	100 million (to start), with option for 500 million additional doses
United States	Novavax	100 million
Israel	Arcturus Therapeutics	4 million

Table 1. Examples of bilateral COVID-19 vaccine purchasing agreements

2 THE COVID-19 VACCINE GLOBAL ACCESS FACILITY (COVAX)

The new COVID-19 Vaccine Global Access Facility (COVAX)—co-led by Gavi, the Vaccine Alliance (Gavi), the Coalition for Epidemic Preparedness Innovations (CEPI), and the World Health Organization—attempts to overcome vaccine nationalism. Acknowledging that bilateral deals cannot be prevented, since rich nations will inevitably act in their self-interest, it encourages these nations to *also* participate in an innovative facility to “guarantee rapid, fair and equitable access to COVID-19 vaccines worldwide.”⁶

COVAX aims to deliver 2 billion doses of vaccine by the end of 2021 to participating countries. These doses will include doses from CEPI, a public-private partnership that is financing the development and initial manufacturing of a portfolio of COVID-19 vaccines. CEPI’s global access agreements require doses to be made available to COVAX (though the terms of how many doses, at what price, and in what order of priority still need to be negotiated). Gavi will simultaneously solicit expressions of interest from other companies. Allocation of vaccine via COVAX to all participating countries of any income status will “proceed at the same rate until all countries have received sufficient doses through the Facility to ensure coverage of 20% of their populations.”⁷ This amount should be enough to vaccinate highest priority populations (e.g., health workers and the elderly). About 10% of the facility’s vaccine supply will be held in a reserve stockpile for deployment in acute outbreaks and humanitarian settings.^{6,7}

There are two ways to participate in COVAX, depending on a country’s income status:

- *Wealthier countries* (high-income countries [HICs] and upper MICs) can participate as “self-financing” countries. By joining COVAX, they commit to procure enough doses from the facility to vaccinate 20% of their population and also make an up-front payment to contribute towards advanced purchase agreements and select at-risk costs including technology transfer to support manufacturing scale up. These up-front contributions will allow the facility to “enter into agreements with manufacturers to secure future vaccine doses for participating countries.”⁷ The more wealthier countries that participate, the more that the financial risks of investing in manufacturing scale up of multiple vaccine candidates will be shared (known as “derisking”) and the more doses that can eventually be purchased.
- *Less wealthy countries* (lower MICs and LICs) can participate as “funded” countries, with their financial commitments covered by official development assistance (ODA). Within COVAX, a financing mechanism called the COVAX Advanced Market Commitment (AMC) will be used to raise funds, mostly ODA, to pay for vaccine supply to these funded countries.

If a wealthy country is already doing deals on its own to secure vaccine, often with a manufacturer based in that country (e.g., the United States [US] government with the US company Novavax—Table 1), participating in COVAX could still be valuable as an insurance policy. If their bilateral deals fail to produce a safe and effective

vaccine, but the country has participated in the Facility, it can still get enough doses from COVAX to vaccinate 20% of its population.

Whether COVAX succeeds or fails depends in large part on how many and which wealthier nations agree to participate in the mechanism. To date, 75 countries have submitted non-binding expressions of interest, including several G20 nations (Argentina, Brazil, Canada, Japan, Republic of Korea, Mexico, Saudi Arabia, United Kingdom), and the first financially binding commitments will be made by August 31, 2020.⁸ But many powerful nations, notably China and the US, have so far expressed no interest in COVAX and are inking major bilateral deals, while the European Union (EU) says it will procure vaccines outside the COVAX mechanism.⁹

3 INCENTIVIZING COVAX PARTICIPATION BY WEALTHIER NATIONS

Other than offering an insurance policy, are there other incentives that COVAX could provide to increase the number of wealthier countries that participate? We used game theory to address this question.

Game theory attempts to predict the behavior of key actors in a particular setting, where the “payoff to strategies chosen by individuals depends on the strategies adopted by others in the population.”¹⁰ Game theory analysis has been used to address various global health challenges, such as in predicting (i) the prescribing behavior of physicians in the face of rising antimicrobial resistance;^{11,12} (ii) population behavior under voluntary vaccination policies for childhood diseases;¹⁰ and (iii) when social distancing practices are most valuable during pandemics.^{13,14}

In a game theory analysis, researchers first identify the strategic ecosystem of interest (in this case, the landscape of COVID-19 vaccine development, manufacturing, and deployment); the relevant decision-makers (called “players”) and their objectives; players’ strategic options; third parties capable of changing the game; and other factors such as the timing and observability of moves. In our “game,” the key players were:

- countries, deciding whether or not to participate in COVAX and/or to make bilateral deals with vaccine manufacturers;
- vaccine manufacturers, deciding whether (and when) to agree to commit capacity through COVAX and/or to make bilateral deals with countries; and
- Gavi and other global health institutions capable of influencing the “rules of the game” directly (e.g., through the specific rules of COVAX) and indirectly (e.g., by articulating principles and coordinating countries’ behavior).

Our analysis generated two key findings, on (i) the benefits of fungibility and harmonization of investments, and (ii) the potential value of “safe harbor” criteria for bilateral deals. We discuss each of these further below.

Fungibility of investments and supply-chain harmonization

Everyone benefits when (i) COVAX investments to accelerate production of a specific vaccine candidate can be quickly repurposed to accelerate production of another vaccine (“*fungibility*”), and (ii) critical inputs, processes, and data are standardized across as many vaccine candidates and production facilities as possible (“*harmonization*”). Gavi and CEPI have a number of options to increase fungibility and promote harmonization, not just for their own investments but also for those being made by individual countries or coalitions of countries (e.g., the EU) outside COVAX. Many of these steps are already being taken, such as putting explicit repurposing clauses in COVAX contracts and standardizing vials and other downstream inputs.

Fungibility and harmonization also have strategic importance for COVAX, by changing the “value proposition” that COVAX offers to wealthier countries that fund the Facility, for three main reasons.

First, increasing the fungibility of COVAX investments increases the value of each “share” of COVAX output. If investing in Vaccine A allows one to accelerate production of Vaccine A *or* Vaccine B, then if Vaccine A fails, having a “share” in that investment gives a country accelerated access to Vaccine B instead. In this way, fungibility magnifies wealthier nations’ bang-for-the-buck from funding COVAX.

Second, increasing the fungibility of non-COVAX investments expands the potential reach of CEPI vaccines (i.e., the vaccines that will be included in the COVAX portfolio). Imagine that Vaccine X is outside of the CEPI portfolio and Country X makes investments to accelerate production of Vaccine X. If Vaccine X fails and the investments are non-fungible, then Country X loses all of its investment and the rest of the world gets no value from that investment. By contrast, if Vaccine X fails but the investments can be repurposed to accelerate production of a CEPI vaccine, then CEPI and Country X will be able to strike a deal that enables the CEPI vaccine to be produced by Country X—with the output split between Country X and other nations through COVAX. The prospect of cultivating alternative uses for their own investments gives wealthier nations more incentive to collaborate with COVAX.

Third, increasing harmonization across the supply chain allows CEPI to deploy its own resources strategically, to fill gaps in others’ supply chains. Countries that use CEPI resources to produce doses more quickly could be required to allocate some of those doses to poorer countries through COVAX. The prospect of a robust supply of inputs gives wealthier nations more incentive to collaborate with COVAX, and to adopt any standardization (e.g., vials, clinical data, regulatory procedures) that COVAX proposes.

“Safe-harbor criteria” for bilateral deals

How a bilateral deal impacts the rest of the world depends on how it is structured. This differential impact can be seen in the stark contrast between two of the bilateral deals made recently by the US government: the agreement between AstraZeneca and the Biomedical Advanced Research and Development Authority (BARDA) (the “BARDA deal”), and the agreement between the US Department of Health and Human Services (HHS) and Pfizer/BioNtech (the “HHS deal”).

The HHS deal secures 100 million doses of the Pfizer vaccine for the US (with an option to buy 500 million more doses), but makes no at-risk investment and hence does little to support vaccine development or to expand the availability of doses. This is a deal designed to benefit the US and Pfizer, but no one else. By contrast, the BARDA deal funds advanced clinical studies, vaccine manufacturing technology transfer, process development, and scaled-up manufacturing. This deal potentially benefits LICs and lower MICs in several ways, by funding higher-risk activities and by generating vaccine products, processes, and manufacturing capability that can then be broadly shared. Knowledge gained and shared in this way could help expand and accelerate production of the AstraZeneca vaccine for other markets, and perhaps also speed up production of other similar vaccines. This is a deal designed to benefit the US, AstraZeneca, *and* the rest of the world.

The HICs supporting the COVAX Facility have an incentive to secure bilateral deals of their own. There is no way to stop HICs from pursuing these deals, but COVAX can influence how these deals are made, so that more of these deals are beneficial to the rest of the world (like the BARDA deal) and not simply “vaccine grabs” that take doses away from everyone else (like the HHS deal). To do so, we suggest that COVAX take a page from antitrust regulators and articulate “safe-harbor criteria” for bilateral deals made by HICs funding the COVAX Facility.

In 2000, US antitrust agencies issued joint venture (JV) guidelines laying out criteria that, if met, would ensure that the JV benefits consumers. The agencies then committed to treat any JV meeting these criteria as automatically lawful.¹⁵ Creating a “safe harbor” for JVs benefits consumers since (i) firms with a JV opportunity that benefits consumers are not discouraged from pursuing it, and (ii) firms that might have collaborated outside of the safe harbor, but do not need to do so, have an incentive to redesign their JV to more clearly benefit consumers. Unlike US antitrust agencies, the COVAX Facility has no authority over countries and would be unlikely ever to punish a country for pursuing its own national interest. Nonetheless, articulating desirable criteria for the bilateral deals that rich countries are making outside of COVAX could influence how those deals are structured, steering them toward the global good, especially along dimensions with the potential for mutual gain.

The economic concepts of “first best” and “second best” are useful here, in setting bounds on what we can hope to achieve. In an ideal world, each country would devote most of its COVID-19 investment dollars to the coordinated global effort—the “first best.” In the real world, each country is captive to its own incentives. The “second best” is the best we can achieve subject to incentive constraints. In this case, rich nations that fund COVAX have an incentive to also try to secure enough supplies for their entire population. The fact that such investments could have helped the world *even more* if they had been made within COVAX is irrelevant. The best we can hope for—the *second-best*—is to steer countries toward making bilateral deals with positive spillovers for the rest of the world.

When articulating safe-harbor criteria for how HICs ought to structure their bilateral investments, we therefore need to bear in mind (i) how those investments impact less wealthy nations (“spillovers”) and (ii) what might HICs be willing to do? Room for improvement arises wherever there is potential for mutual gain, a way for HICs to make themselves better off while also benefiting the rest of the world.

Guiding principle 1: what are the spillovers?

When a country makes a bilateral deal to accelerate production of doses to cover its own population, how does that deal directly or indirectly impact other countries?

If vaccine availability were fixed, then vaccine distribution would be a “zero-sum game,” with any deal that benefits richer countries necessarily harming LICs and lower MICs. In that context, the race by the rich world to strike bilateral deals clearly harms poorer nations, as (i) rich nations are able to secure the first supplies and (ii) the race reduces the effectiveness of the global pandemic response. But vaccine availability is *not* fixed. The game that countries are playing is therefore not zero-sum, and the investments that richer countries are making to help themselves may also help poorer ones.

Four sorts of spillovers—three positive, one negative—are significant in the context of COVAX.

- **Increased production flow (positive spillover).** The bilateral deals that wealthier nations are making for COVID-19 vaccines typically entail massive at-risk investments to increase the quantity and accelerate the timing of vaccine availability. Such investments benefit these wealthier nations, but could also benefit other countries by expanding the global flow of vaccine production. For instance, suppose the US were to make massive investments that sped up by 6 months the availability of a US-based vaccine with capacity to vaccinate 100 million people per month. The first batches would go to Americans but, because there are fewer than 600 (6 x100) million US citizens, doses would start being exported before the vaccine would otherwise have been available.
- **Increased optionality (positive spillover).** Bilateral deals could be a means of identifying “backup/pivot options” for CEPI and non-CEPI vaccine production. For example, suppose that a HIC that has chosen to fund and partner with COVAX *also* makes a bilateral deal with a vaccine maker to stand up some vaccine production facility, to be ready to accelerate production of that vaccine. Much of the work that goes into that preparatory process (e.g., generating knowledge products, sourcing raw materials, and establishing supply chain systems) could then be shared with COVAX to ease efforts to build COVAX’s own option to pivot to produce that vaccine. This sharing can occur: (a) if or when a CEPI vaccine fails yet a similar vaccine produced through the bilateral deal succeeds, and/or (b) to expand overall production through multiple supplying sites and partners. Neither the HIC nor the vaccine maker in this scenario has any reason to object to complementary production in a COVAX-funded manufacturing facility. Indeed, both would benefit: the HIC, by speeding the global recovery (and hence helping its own economy), and the vaccine maker, by reaching additional markets and taking advantage of the COVAX AMC subsidy.
- **Increased knowledge (positive spillover).** Bilateral deals that accelerate learning about a vaccine candidate could benefit others—as long as the learning is shared—by improving others’ decisions and speeding their ability to pursue producing and/or using that vaccine themselves. For example, as

experts in a COVAX-funded production facility learn how to accelerate production of a new vaccine candidate, what they learn could benefit COVAX partners seeking to produce another similar vaccine. This could be especially important for newer vaccine-technology platforms, both because more remains to be learned about how to optimize production and because process and data-sharing standards are less likely to be well-established. At the same time, those working with newer technologies have more incentive not to share details that could make it easier for others to backward-engineer their intellectual property. A trusted third party such as COVAX could play an important intermediating role, to encourage information sharing.

- **Tying up scarce inputs (negative spillover).** If domestic production ties up a critical input, then accelerating production for a rich country will slow down production for the rest of the world, setting up a zero-sum game. Negative spillovers could also arise if a country's efforts to secure its own supply disrupt the global supply chain. For instance, an unscrupulous country might try to buy up all of some input as a means of pressuring others to supply them with early doses and/or induce some supplier in the COVAX supply chain to dishonor its agreements and instead serve their own individual interests.

Guiding principle #2: What discretion do countries have?

Richer nations will make bilateral deals no matter what. But articulating a safe harbor can influence how these nations craft such deals, to improve outcomes for lower MICs and LICs, so long as richer countries can accommodate the requirements of the safe harbor without too much trouble or cost. For instance, to maximize positive spillovers due to increased knowledge, a safe-harbor criterion might be that the manufacturer share COVAX-standardized technical and clinical data. Similarly, to minimize any negative spillovers due to tying up scarce resources, a safe-harbor criterion could be that any bilateral deal includes arrangements to expand global supply of critical inputs that might otherwise constrain COVAX production. So long as meeting these conditions is feasible and not too costly, countries can be expected to comply.

Figure 1 summarizes the spillovers and the potential associated safe-harbor criteria described above.

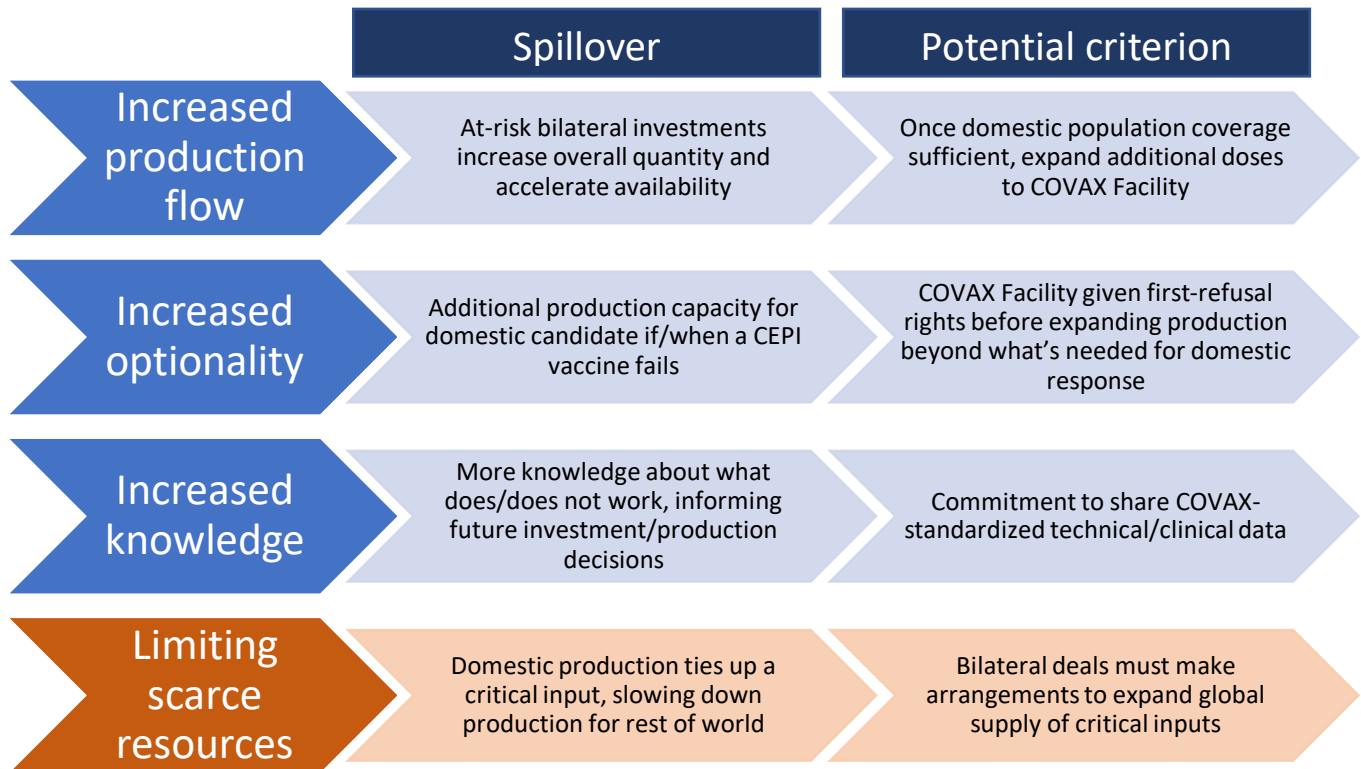


Figure 1. Investments by HICs to secure their own vaccine supplies: examples of potential spillovers and possible associated safe-harbor criteria

4 CONCLUSION

The proliferation of bilateral deals between richer nations and COVID-19 vaccine manufacturers is a major threat to ensuring global distribution of vaccines and to achieving herd immunity at a global scale. Such deals cannot be stopped, but insights from a game theory analysis suggest ways in which these deals could be configured to potentially improve the global supply of vaccines, by increasing fungibility of investments, enhancing supply-chain harmonization, and articulating “safe-harbor criteria” for such deals.

● REFERENCES

1. <https://www.who.int/who-documents-detail/draft-landscape-of-covid-19-candidate-vaccines>
2. Fidler DP. Negotiating equitable access to influenza vaccines: global health diplomacy and the controversies surrounding avian influenza H5N1 and pandemic influenza H1N1. *PLoS Med* 2020; 7(5): e1000247.
3. Yamey G, Schäferhoff M, Pate M, et al. Ensuring global access to COVID-19 vaccines. *Lancet* 2020;395: 1405-1406
4. Goodman PS, Thomas K, Wee S-L, Gettleman J. A new front for nationalism: the global battle against a virus. *New York Times* April 10 2020. <https://www.nytimes.com/2020/04/10/business/coronavirus-vaccine-nationalism.html>
5. Bollyky TJ, Bown CP. The tragedy of vaccine nationalism. July 7, 2020. *Foreign Affairs*. <https://www.foreignaffairs.com/articles/united-states/2020-07-27/vaccine-nationalism-pandemic>
6. Gavi, the Vaccine Alliance. COVID-19 Vaccine Global Access (COVAX) Facility. Preliminary technical design. Discussion document, 11 June 2020. At <https://www.keionline.org/wp-content/uploads/COVAX-Facility-Preliminary-technical-design-061120-vF.pdf>
7. Gavi, the Vaccine Alliance. The COVAX facility. Global procurement for COVID-19 vaccines. At <https://www.gavi.org/sites/default/files/covid/COVAX-Facility-background.pdf>
8. <https://www.who.int/news-room/detail/15-07-2020-more-than-150-countries-engaged-in-covid-19-vaccine-global-access-facility>
9. <https://www.reuters.com/article/us-health-coronavirus-eu-vaccines-exclus/exclusive-eu-eyes-covid-19-vaccines-at-less-than-40-shuns-who-led-alliance-sources-idUSKCN24P1OY>
10. Bauch CT, Earn DJD. Vaccination and the theory of games. *Proc Natl Acad Sci*. 2004; 101: 13391–13394.
11. Colman AM, Krockow EM, Chattoe-Brown E, Tarrant C. Medical prescribing and antibiotic resistance: A game-theoretic analysis of a potentially catastrophic social dilemma. *PLoS ONE* 2019;14(4): e0215480
12. McAdams, D. Resistance diagnosis and the changing epidemiology of antibiotic resistance. *Antimicrobial Therapeutics Reviews*, 1388(1), 5-17, January 2017
13. McAdams, D. Nash SIR. An economic-epidemiological model of strategic behavior during a viral epidemic. *Covid Economics*, 16, 115-134, 11 May 2020.
14. Reluga, TC. (2010). Game theory of social distancing in response to an epidemic. *PLoS Comput Biol* 2010; 6(5), e1000793.
15. Federal Trade Commission and US Department of Justice. Antitrust Guidelines for Collaborations Among Competitors. April 2000. At https://www.ftc.gov/system/files/documents/public_statements/300481/000407ftcdojguidelines.pdf