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Purchasing COVID-19 Vaccines at Risk

Costs and Benefits for Latin America and the Caribbean

The Accelerating Health Technologies Group

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The Accelerating Health Technologies Group: Amrita Ahuja, Susan Athey, Arthur
Baker, Owen Barder, Juan Camilo Castillo, Rachel Glennerster, Michael Kremer, Scott
Kominers, Greg Larson, Jean Lee, Jonathan Levin, Jessica Pickett, Christopher
Snyder, Alex Tabarrok, Brandon Tan, Duc Tran and Witold Więcek.

Purchasing COVID-19 Vaccines at Risk

Preliminary Analysis of Costs and Benefits for Latin America and the Caribbean

EXECUTIVE SUMMARY

There are major gains to accelerating access to a COVID-19 vaccine. The World Bank predicts a cumulative $1.02 trillion loss to the economies of Latin America and the Caribbean over 2020 and 2021 due to COVID-19. Based on this estimate, ending the pandemic just three months earlier would yield nearly $125 billion for the region in economic benefits alone. This note describes a framework for assessing the costs and benefits of at-risk investments in COVID-19 vaccines and assesses the net benefits for Latin American and Caribbean (LAC) countries.

The normal vaccine timeline would mean long delays for developing countries. Firms usually install manufacturing capacity at commercial scale only after a vaccine has been proven safe and effective. Moreover, firms typically build limited capacity to serve high income markets initially, which creates even longer delays before all countries are served. By making at-risk investments that effectively pay for firms to install or repurpose manufacturing capacity while vaccine trials are still in process (before they are proven safe and effective), governments can accelerate access to a vaccine.

Even under very conservative assumptions, it is in the interest of LAC countries to make substantial at-risk investments in vaccines. We present a simplified cost-benefit analysis of these investments for LAC countries using very conservative assumptions. If budgets are limited, investments smaller than the ones discussed here would still be valuable to a country because the economic benefits are so large.

The high benefits associated with these investments justify the public spending or even borrowing. Countries currently face high levels of fiscal stress and may be unable to make these investments without financial support. Since the economic benefits of accelerating a vaccine would outweigh the cost, borrowing to invest in vaccines would be a sensible investment.

Contract design has a major influence on the benefits of vaccine investments because it influences how quickly LAC countries obtain the benefits of vaccine access. The earlier vaccines are delivered, the more valuable they are. To secure earlier access to vaccines, contracts could cover the manufacturers' cost of installing or repurposing capacity, in exchange for an option to purchase output from that capacity. Alternatively, contracts could purchase doses with appropriate safeguards in place to ensure that vaccines are delivered early.

Purchasing COVID-19 Vaccines at Risk

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The Accelerating Health Technologies Group[1]

1. INTRODUCTION

This note assesses the social costs and benefits of at-risk investments in COVID-19 vaccines for Latin American and Caribbean (LAC) countries, where the impact of the pandemic has been particularly severe. LAC countries account for about 10% of the world's population but about 25% of global COVID-19 cases. The World Bank estimates that the region's economy will have contracted 7.2% by 2021, generating cumulative losses of $1.02 trillion in the region from the pandemic over 2020-2021. Based on this estimate, ending the pandemic just three months earlier would yield nearly $125 billion for the region in economic benefits alone. This note examines the effects of early, at risk investments by governments in vaccines. We show how such at-risk investments by governments could accelerate vaccine access.

Several countries are currently pursuing at-risk deals with vaccine manufacturers. For example, the United States paid $1.2 billion to assure delivery of 300 million doses of the AstraZeneca vaccine in the event that it proves safe and effective. A simple back-of-the-envelope calculation suggests that this deal would more than pay for itself if there was only a small chance it would accelerate economic recovery by a few months, because the United States is losing on the order of $90 billion a month from the pandemic. For example, if the deal had a 10% chance of accelerating economic recovery by 6 months, it would generate benefits that would be 45 times greater than the costs. There would be net benefits if the investment had even a 0.25% chance of accelerating recovery by 6 months.

In this paper, we present a framework for assessing the net benefits of investments that accelerate recovery, and conduct a simplified calculation to demonstrate their value to LAC countries. Our calculations show that even under conservative assumptions, at-risk investments to accelerate vaccine access would have large, expected net benefits for LAC countries. This exercise is intended to provide a sense of the order of magnitude of the benefits of such investments, rather than to produce precise estimates. In separate work, we are designing a more complex model with more realistic, and therefore less conservative, parameters to guide country-specific investment decisions. Although there is high uncertainty about the correct value for these parameters, the more fully specified model invariably recommends even larger investments than this simplified version. Our analysis does not address the question of which specific vaccine candidates to invest in. Rather, it estimates the net benefits of investing in a given number of vaccine candidates and quantity of each candidate, based on the latest vaccine prices disclosed publicly in bilateral deals.

The Accelerating Health Technologies Group is willing to repeat this exercise as more cost information becomes available or as other parameters in the model become more certain. We strongly advise that

countries liaise with experts at Pan American Health Organization (PAHO) and/or convene other scientific panels (e.g. for the purposes of health technology assessment) to determine which specific vaccines to invest. Our model can then be updated to reflect the actual results of price negotiations for specific vaccines.

The rest of this note is organized in four sections. **Section 2** provides background. **Section 3** shows the costs and benefits of vaccine investment options for LAC countries. **Section 4** discusses further analysis that may be necessary. **Section 5** concludes by considering the financial rational for investing in vaccine development and distribution.

2. BACKGROUND

This section outlines the key market failures associated with producing COVID-19 vaccines and provides a brief description of the current vaccine landscape, the bilateral deals completed to date, and efforts to establish a global vaccine pool.

Market failures

Vaccines typically take 5-15 years to develop. (The fastest on record is Merck's mumps vaccine, which took four years from initial research to commercial use, but the process is typically much longer.) While there are massive benefits to accelerating this process in the case of COVID-19, there are three key market failures:

- Vaccination has significant health and economic externalities, so market prices and firm profits are unlikely to reflect vaccines' full social value.

- It is not in firms' interest to install capacity at commercial scale before they know their vaccines are safe and effective, because most vaccine candidates fail. If firms were to install capacity early, they would bear the risk of vaccine failure but capture only a fraction of the benefits of accelerating a vaccine. On the standard vaccine development timeline, firms only scale up manufacturing capacity after completing clinical trials. Since installing or repurposing capacity generally takes at least 6 months doing so in parallel with clinical trials could accelerate access by up to six months, depending on how early it begins. In the case of COVID-19, the accelerating access would be of great benefit to society, given the substantial costs associated with the pandemic.

- Firm's incentives are not aligned with installing as much capacity as would be socially optimal. A monopoly provider can reduce costs by building limited capacity and selling to the same market over a longer period. With limited supply, the early doses are likely to go to those who can pay high prices—i.e. high-income countries. Middle- and low-income countries are more likely to be served only after long delays.

The COVID-19 pandemic requires unprecedented capacity on an unprecedented timeline. Hence, these market failures, if unaddressed, will contribute to substantial social loss. These issues motivate public investments to accelerate vaccine availability.

Brief description of vaccine landscape

Many vaccine candidates are currently being tested. There are so many candidates moving so quickly that even dedicated vaccine tracking sources cannot agree on the exact number. According to recent estimates from FasterCures, a center of the Milken Institute, there are 204 vaccines candidates being developed across multiple technology platforms, of which 26 are in different phases of clinical trial:
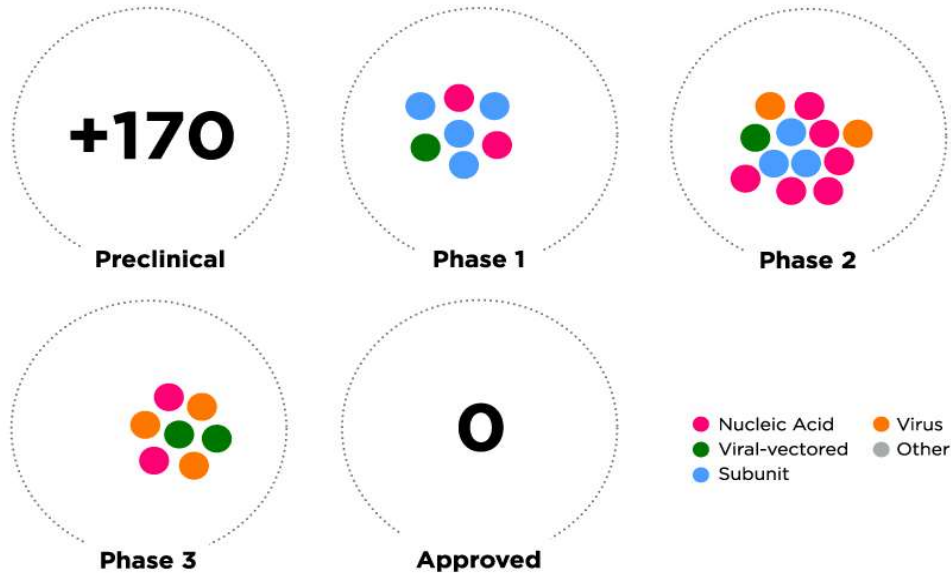
Source: Own elaboration based on Washington Post, available at
https://www.washingtonpost.com/graphics/2020/health/covid-vaccine-update-coronavirus/.

By comparison, the World Health Organization on August 25 recognized 31 candidates in human trials, but only identified 142 preclinical candidates.

Bilateral deals

Several countries have already made bilateral deals with vaccine manufacturers. For example, the United States has signed a series of vaccine deals with pharmaceutical companies, including AstraZeneca, Moderna, Novavax, and Johnson & Johnson, as have the United Kingdom and other European countries.

As noted, the AstraZeneca deal with the United States is a $1.2 billion contract for 300 million doses of the AstraZeneca vaccine. More recently, AstraZeneca has signed similar agreements with Brazil, Argentina, and Mexico for licensing agreements to manufacture the vaccine domestically (Blankenship 2020). The Argentina and Mexico deal with AstraZeneca and the biotechnology company mAbxience of the INSUD Group, with funding from the Carlos Slim Foundation, is expected to produce approximately 150-250 million doses to distribute across Latin America and the Caribbean in the first half of 2020. Under the deal, vaccines will be produced in Argentina with some of the final "fill and finish" manufacturing done in Mexico. The United States, Argentina, and Mexico deals with AstraZeneca set a vaccine price of around

$3-$4 per dose for distribution throughout Latin America and the Caribbean (with the exception of Brazil).

Vaccine capacity and Pre-orders

Manufacturers intend to ramp up their capacity to produce COVID-19 vaccines by the end of 2021. The wealthiest natios have already struck beals to buy more than billion doses.

Vaccine manufacturer: Oxford/AstraZeneca
Publicly announced estimated capacity to 2021 (number of doses)

2.94 billion

← 2020 possible capacity

Publicly announced commitments

- Europe
- United States
- Japan
- United Kingdom
- Brazil
- LMICS*
- Other purchases

2.4 billion

*92 low and middle-income countries and economies eligible to receive doses through the COVAX International fund.

Sanofi/GSK

1.6 billion

460 million

Pfizer/BioNTech

1.3 billion

230 million

Moderna

0.95 billion

104.5 million

Johnson & Johnson/Janssen

1.1 billion

330 million

Novavax

1.35 billion

160 million

Valneva

100 million

60 million

Sinovac

350 million

370 million

CureVac

1.1 billion

225 million*

*Agreement expected; EU announced "envisaged" contract

Gamaleya

100 million

50 million

Where vaccines will be produced

Most of the vaccines will be manufactured in the United States and Europe

- Oxford/AstraZeneca
- Sanofi/GSK
- Novavax
- Pfizer
- Johnson&Johnson/Janssen
- Curevac
- Vaxart
- Other

Doses (billions)

United States, United Kingdom, India, Norway, France, Switzerland, China, Czech Republic, Netherlands, Belgium, Japan, Indonesia, South Korea, Russia, Argentina, Canada
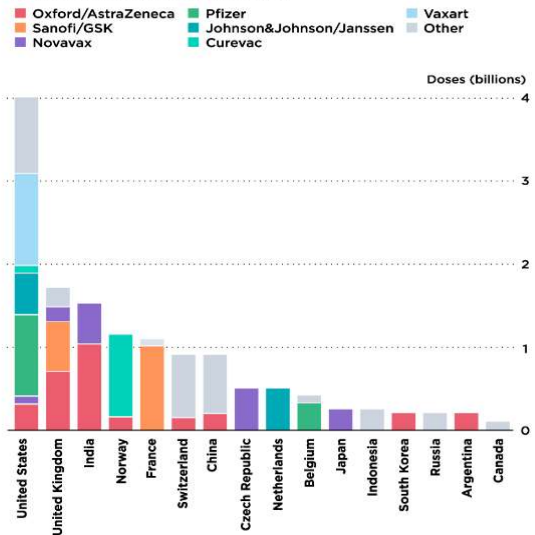
Best and worst supplied

The United Kingdom has pre-ordered enough vaccines for fice doses per person.
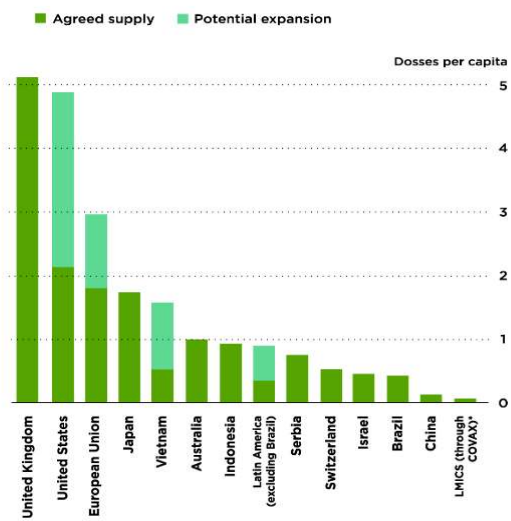
- Agreed supply
- Potential expansion

Dosses per capita

United Kingdom, United States, European Union, Japan, Vietnam, Australia, Indonesia, Latin America (excluding Brazil), Serbia, Switzerland, Israel, Brazil, China, LMICS (through COVAX)*

*92 low and middle-income countries and economies eligible to receive doses through the COVAX International facility; some, such as India and Indonesia, have also ordered doses separately.

Below is a summary of existing bilateral deals. *Summary of existing bilateral deals*
Source: Own elaboration based on: Callaway, "The unequal scramble for coronavirus vaccines — by the numbers," *Nature* 2020.

3. ANALYZING THE COSTS AND BENEFITS OF VACCINE INVESTMENTS

In this section, we first present a simplified cost-benefit analysis of vaccine investments for LAC countries. It demonstrates that, even under conservative assumptions, at-risk investments to secure early access to a vaccine would have large net benefits for these countries.

Table 1 describes the vaccine portfolios analyzed in this note. Table 2 summarizes our simplified cost benefit calculations associated with at-risk investments in these portfolios across LAC countries. Estimates are provided under different scenarios in terms of percentage of the population vaccinated (20%, 40%, or 60%) and the number of vaccine candidates in the portfolio (1, 3 or 6). We also compute benefit-cost ratios for every option. We note, however, that the goal of a government's exercise should be to maximize social surplus, not to maximize benefit/cost ratios.

We caution that both the benefit-cost ratios and social surplus estimates depend critically on specific assumptions, which we describe below. For the purpose of this exercise, we have attempted to use very conservative assumptions. For example, we estimate the benefits of accelerating vaccine access by 3 months, and subtract the full cost of purchasing vaccines. In reality, countries would incur costs purchasing vaccines if they did so later. Further, our calculations assume that at-risk investments will speed vaccine purchases by only three months; the benefits would be even greater if these investments were to accelerate vaccine purchases by more months. Further, we caution against interpreting these estimates as a guide to *specific* vaccine purchases. Our numbers should be interpreted as guidelines about the benefits that would be obtained from at-risk investments in a certain number of vaccine candidates, and quantity of each candidate.

Method

Probabilities of success

To compute the probability of success for a vaccine portfolio, we first assign probabilities of success to each vaccine candidate, considering correlations in failure across candidates. We estimate each candidate's probability of success based on expert opinion and historical data of regulatory approvals for various technology platforms at different stages of development. If a platform has previously been licensed for human use, for example, all candidates on that platform have a higher probability of success. Similarly, if a candidate is already at an advanced stage of trials, it has a higher probability of success. Our approach allows for correlations between the probability of success of candidates based on their similarity in terms of platform or subcategory.

Suppose vaccine candidate j belongs to a platform l and subcategory s. Let y_j be an indicator variable for whether candidate j is successful, requiring all the following events to happen:

- No overall problem prevents feasibility of a vaccine (denoted by $x_o = 1$, with probability q_o),
- No problem shows up at the platform level ($x_l = 1$, with probability q_l),
- No problem shows up at the subcategory level ($x_s = 1$, with probability q_s), and
- No problem shows up at the individual candidate level ($x_j = 1$, with probability q_j)

The indicator for candidate j is then given by $y_j = x_o x_l x_s x_j$, and the probability of success for candidate j is $Pr(y_j = 1) = q_o q_l q_s q_j$.

For illustration, we assume that:

- A vaccine is feasible with probability $q_o = 0.9$.

- The probability that there is no problem at the platform level (q_l) is 0.8 for extensively used platforms like viral vectors, live attenuated virus, and inactivated virus. The probability is 0.6 for somewhat more experimental platforms like RNA vaccines that have been licensed for animal vaccination but not for humans, and 0.4 for technologies like DNA vaccines that have not yet been used to produce a vaccine for humans.

- There is no problem in each individual subcategory with probability $q_s = 0.8$.

- No problem prevents specific candidates from working with probability (q_j) 0.5 if the candidate is in phase 3 clinical trials, 0.32 if it is in phase 2 clinical trials, 0.23 if it is in phase 1 clinical trials, and 0.14 if it is in preclinical trials.

With these assumptions, a one-candidate portfolio for a viral vector vaccine which is in phase 3 clinical trials has a probability of success of 29%. Similarly, for portfolios with 3 and 6 candidates (as described in Table 2), the probability that at least one of the candidates is successful is 58% and 74%, respectively. These are the optimal portfolios which maximize the probability of at least one successful vaccine, given our estimates of probabilities of success, and correlations between candidates.

Benefits of vaccination

We assume that the benefits of vaccination derive from health and economic benefits. We assume that health benefits have diminishing returns as a result of high-risk individuals being vaccinated first. Economic benefits depend both on the health benefits and on how reduced risk of infection and death translates into greater general economic activity. The latter relationship is relatively unknown. If the elderly are vaccinated first, for example, will the young go back to work or will they still be worried about infection? Epidemiological models of COVID-19 vaccination suggest, not a diminishing, but a linear impact of vaccination on infections until society approaches the level required for herd immunity. Our framework allows diminishing-returns factor and the linear epidemiological factor to receive some weight. Putting a larger weight on the diminishing returns factor would mean that health and economic activity improve quickly as we vaccinate, whereas larger weight on the linear function would mean that more people need to be vaccinated, approaching close to herd immunity, before most of the economic benefits are realized.

More specifically, let H_i be the country-specific, monthly health and economic harm due to the pandemic. Economic harm is a function of country-specific GDP and population, as reported by the World Bank, and an overall estimate of the fraction of the population that is high risk[2]. Health harm is the product of: (a) mortality, which we assume is 200,000 per month distributed across the world in proportion to population; (b) the value of a statistical life, which is proportional to GDP per capita (and is $7 million for the United States); and (c) the fraction of one life that is lost on average due to Covid-19 deaths, $\frac{10}{71}$, which

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[2] In our more fully specified model, we allow the fraction of the population that is high-risk population to vary by country.

assumes that each death implies a loss of 10 years and that there is a life expectancy of 71 years. There are a variety of factors why vaccination may not be necessary to avert all the harm. There might be successful treatments for Covid-19: social distance and contact tracing might become more effective over time; or, in the worst case, vaccine development might be delayed until the population has suffered so many infections that herd immunity is achieved. For these reasons, we assume that, in expectation, vaccination can only avoid a fraction $\delta = 0.5$ of the health and economic harms (H_i).

If everyone were vaccinated, the benefits from vaccination would equal avoidable harm (δH_i). More generally, we recognize that only a share of the population is likely to be vaccinated. As such, we allow the benefits from vaccination to vary as a function of the number of people who are vaccinated. Let λ_i be the fraction of the population of country i for which vaccines are bought. The fraction of potential benefits (δH_i) that are obtained as a function of λ_i are given by $f_i(\lambda_i)$. We assume that the form of $f_i(\lambda_i)$ is a convex combination of two functions:

- $f_i^C(\lambda_i)$ is the piece of the benefit function that is itself convex in the share of the population that is vaccinated. This segment of the benefit function is piecewise convex. In the first segment, there are large benefits from each person that is vaccinated, because vaccines are given to high-risk people. In the second segment, benefits are lower than in the first segment because vaccines are given to the general population. In this segment, we assume vaccinating every person brings a fraction $\frac{1}{\theta}$ of the benefits from vaccinating every high-risk person, where θ is a number between 5 and 10 that varies linearly with the country's GDP per capita: 5 for the lowest income countries, and 10 for the highest income countries. The third segment of the health benefits function is related to nearing the level of herd immunity. Once the fraction of the population vaccinated reaches 40% of the population (a low estimate for herd immunity to begin to materialize according to studies), the slope declines from $\frac{1}{\theta}$ to $\frac{1}{2\theta}$ of the slope in the first segment. The fourth and final segment of the health benefits function begins once the share of the population vaccinated reaches 70% (a high estimate for the level of herd immunity), after which the slope is zero—i.e., all the health benefits have already been obtained.

- $f_i^L(\lambda_i)$ is the piece of the benefit function that is linear in the share of the population that is vaccinated. This piece of the benefit function is a simple linear function. It ranges from zero when no one is vaccinated to the maximum avoidable economic harms projected by the World Bank models when the share vaccinated reaches the higher estimate for the level of herd immunity (70%). Beyond that share, the avoided economic harms level off and remain unchanged for further increases in the vaccinated share.

The final functional form of benefits is $f_i(\lambda_i) = \rho f_i^L(\lambda_i) + (1 - \rho)f_i^C(\lambda_i)$ where $\rho \in [0,1]$ determines where the form of benefits lies between the two extremes of $f_i^L(\lambda_i)$ and $f_i^C(\lambda_i)$. We take $\rho = 0.5$ as our baseline value.

In the end, total monthly benefits are given by $\delta H_i f_i(\lambda_i)$, the product of the fraction of harms that can be averted through vaccination, the monthly harm due to the pandemic, and the fraction of benefits that are obtained given the fraction that is vaccinated. For the illustrative calculations below, we assume that if the vaccine is successful, benefits accrue for $T = 3$ months, which is how long access to a vaccine is accelerated.

Given these assumptions, our model has the result that vaccinating 20% of the population averts 46% of the health and economic harms. Vaccinating 40% of the population averts 69% of the harms and vaccinating 60% of the population gives 90% of the harms relative to full vaccination.

In this simplified example, we only consider benefits from having *at least* one successful vaccine. Our calculations are therefore conservative for portfolios with more candidates, because such portfolios could produce more than one successful vaccine and therefore could provide a country with a larger number of doses to vaccinate a larger share of the population.

Cost
We assume that two doses will be required to obtain protective immunity against severe illness, and therefore the costs are based on vaccinating a given portion of the population twice.

For the sake of illustration, we construct potential portfolios of 1, 3 and 6 vaccine candidates. We assume that countries that select portfolios with multiple candidates choose different kinds of vaccine candidates in order to diversify risk. We calculate an optimal mix of platforms for each of these portfolios, shown in Table 1. To estimate the costs of investing in a portfolio we use information from publicly available bilateral deals or price announcements where possible. We assume that vaccine costs are similar within a given technology platform (so if a price for Vaccine A from a platform has been publicly announced, we assume Vaccine B from the same platform has the same price). Where the price of a vaccine or portfolio cannot be estimated from publicly available information, we adopt the estimated average price of the COVAX Facility portfolio as a proxy.

For simplicity, we assume that countries invest in an equal number of doses for each candidate in a given portfolio although, in reality, countries could vary the amount of investment by candidate characteristics (e.g. invest more in cheaper vaccines).

Table 1: Assumptions regarding optimal portfolios and prices

Number of Candidates	Type of Vaccine(s) Included	Average blended price
1 candidate	Inactivated	$10.55 / dose
3 candidates	Inactivated (2x), viral vector	$8.37 / dose
6 candidates	Inactivated (2x), viral vector, RNA, protein subunit (2x)	$12.77 / dose

We include the full cost of purchasing vaccines, without subtracting the cost of purchasing vaccines later, if countries do not make early investments. This is a highly conservative assumption, because we have included only the benefit of accelerating a vaccine by three months, not the full benefit of having access to vaccines. In effect, this means we are comparing the benefits of early investments to a counterfactual in which countries receive vaccines for free just three months later. In reality, most countries which do

not make early investments to access vaccines will still need to pay to receive vaccines. A further analysis could estimate the future cost of vaccines, which would increase the expected net-benefits of early investments.

Contract

To illustrate the benefits of at-risk investments that accelerate vaccine development, we have assumed a simple contractual structure for illustrative purposes. In this simple case, we assume that countries sign a contract to purchase a guaranteed volume of doses based on the share of the population to be vaccinated and agree to pay the full price per vaccine dose in advance and at risk. If the vaccine development is successful, they get the vaccines. If the vaccine is not successful, they have lost the money and do not have vaccines. While contracts with this structure would be beneficial, we are not recommending this structure over other ways of organizing contracts, which may be more efficient, including structures that vary the share of upfront payments and pricing formulas, as discussed at the end of this note. Rather we are presenting this simple contractual structure because, again, it generates a conservative estimate of benefits and costs to orient countries and multilaterals regarding the value of considering advance purchase agreements and at-risk investments. This analysis assumes that contracts successfully incentivize firms to accelerate vaccine delivery. The design of contracts is key, as poorly designed contracts may not accelerate vaccine access.

Results

Table 2 shows that for LAC countries, there are large net benefits to significant at-risk investments in vaccines. Even under conservative assumptions, countries could invest up to $19 billion in the aggregate and generate positive net benefits. While smaller investments have smaller net benefits, they tend to have higher cost-benefit ratios, because we assume that there are diminishing marginal returns both to adding more candidates and to adding more doses.

This table illustrates that large at-risk investments in vaccine candidates are justified, even under conservative assumptions. It should not be misinterpreted as providing information regarding the trade-off between number of doses and number of vaccine candidates, which would require more information about the doses required for different vaccine candidates in any given country.

Table 2: Costs and benefits for LAC countries under different scenarios

Parameters					Results			
Fraction Vaccinated	Fraction of Benefits**	# of Candidates	Probability of Success	Price*	Benefits (Bn.)	Costs (Bn.)	Benefit / Costs	Net benefits
0.20	0.46	1	0.29	10.55	8.71	2.64	3.30	6.07
0.20	0.46	3	0.58	8.37	17.66	6.28	2.81	11.38
0.20	0.46	6	0.74	12.77	22.52	19.17	1.17	3.35
0.40	0.69	1	0.29	10.55	13.07	5.28	2.47	7.79
0.40	0.69	3	0.58	8.37	26.49	12.56	2.11	13.92
0.40	0.69	6	0.74	12.77	33.78	38.34	0.88	-4.56
0.60	0.90	1	0.29	10.55	17.15	7.92	2.17	9.23
0.60	0.90	3	0.58	8.37	34.76	18.84	1.84	15.92
0.60	0.90	6	0.74	12.77	44.34	57.51	0.77	-13.17

*Note: Country-level results are available in the annex. A number of conservative assumptions are made in this analysis. For example, only the benefits of the first successful candidate per portfolio are considered. Larger portfolios would not only have a higher probability of at least one success, but also to a larger expected number of doses. See paper for more details. *Price based on expected average price of portfolio based on platform and current prices; Costs scale with prices. **Fraction of the benefits of full vaccination which can be obtained by vaccinating a given percentage of the population*

4. ENRICHING THE ANALYSIS

Designing a vaccine investment portfolio

Determining the composition of the best portfolio for any given country or for the region is outside the scope of this paper. The Accelerating Health Technologies Group has been constructing a model which estimates the optimal program for each country or for groups of countries using a larger set of more tailored parameters. The initial results from our expanded modeling effort suggest that the optimal program would involve investments that are larger than that given in Table 2. Since even our conservative calculations would recommend investments that appear to exceed available financing, a next step would be to use this model to help inform the design of a vaccine investment portfolio within the constraints of a budget constraint.

Refining the structure of contracts: an illustrative example

The contractual forms assumed in the results section assumed, for the sake of simplicity, that countries pay upfront for the entire cost of the vaccine doses. However, alternate contract structures are actually more efficient.

One alternative would be to use a contract with two parts: (a) a payment to build production capacity; and (b) a commitment to purchase doses. Under such a contract, countries pay upfront to finance the installation of capacity to produce a certain monthly number of doses, and simultaneously commit to buy and/or have the option to buy a certain number of doses each month. Such options contracts—where in return for payment, countries receive designated capacity and the output that flows from it—are fairly standard. Indeed, variations of such contracts have already been incorporated into the proposals currently offered by the COVAX Facility.

Paying for capacity up front in return for an option to buy vaccines produced with that capacity has a number of benefits for countries. First, it encourages firms to install or repurpose capacity and to fulfill requirements regarding facility testing in parallel with clinical trials, so doses can be produced and available as soon as the vaccine is approved, which is much sooner than it would be if firms were choosing how much to invest and when on their own. Second, it ensures that countries that enter such agreements are not "sent to the back of the queue," that is, find themselves seeking to buy vaccines at a time when the existing capacity has been fully committed to other, probably higher-income, countries. Finally, it means that only the investment costs are unrecoverable, and the portion of funding committed to purchasing vaccine doses is only paid if the vaccine candidate is successful.

Despite the potential benefits of such a contract structure, public information regarding most of the deals for advance purchases of Covid-19 vaccines to date have been written in terms of doses, not production capacity. Our preceding calculations show that similar outcomes can be achieved by committing to purchase a guaranteed number of doses per month. In these cases, though, it is especially important that contracts specify when doses will be delivered. Paying a premium for early doses and for higher quality vaccines in terms of efficacy and safety may also be worthwhile.

Purchases could be made bilaterally or through multilateral bodies such as COVAX. Analysis of decisions about whether to purchase vaccines bilaterally or multilaterally is beyond the scope of this note.

5. CONCLUSION

Currently, many Latin American and Caribbean countries face a disproportionately high disease burden from COVID-19. Many are also responding to the crisis with extremely constrained fiscal space. Given the region's relatively low levels of growth and productivity before the pandemic, these countries face high opportunity costs as they make difficult budgetary decisions in the face of COVID-19. In such a highly constrained fiscal environment, the benefits of at-risk investments are still very worthwhile. Whether countries can pay for such investments out of current budgets or need to borrow, the payoffs are large. The main conclusion of our analysis is that such financing would be well-justified by the health and economic returns.

This note focuses on purchases of finished vaccines, but investments could also be made to improve supply chains and manufacturing capacity more broadly. Investments in regional firms interested in

expanding manufacturing capacity or supporting efforts to improve vaccine supply chains, in particular by coordinating investment in manufacturing inputs, would also be beneficial.

Given the enormous benefits from vaccination against COVID-19, finding ways to finance investments that enable accelerated access to vaccines, whether through advance purchase commitments or through expanding manufacturing capacity at scale for a large number of diverse vaccine candidates, is in the interest of Latin American and Caribbean countries.

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