



Globalizing Vaccines: A Post-COVID Perspective on Industrial Policy, International Health Cooperation, and the Characteristics of Vaccine Production

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PREFACE

The COVID-19 pandemic exposed both the extraordinary potential and persistent limitations of global health cooperation. While the world witnessed the rapid development of safe and effective vaccines, the promise of global solidarity quickly gave way to a harsh realpolitik: wealthy nations prioritized vaccines for their own populations, leading to delayed, insufficient, and inequitable distribution in many low- and middle-income countries, most notably in Africa.

This CGD Note explores this challenge and its implications for future policies related to vaccine production and pandemic preparedness more broadly. Drawing on firsthand insights and research on industrial and political trends, the note examines how countries can diversify vaccine production in a world shaped by globalized supply chains and strategic dependencies.

Specifically, it examines long-term economic and political shifts that have shaped current trends in vaccine production. These include: 1) the global retreat from industrial policy; 2) the erosion of international health cooperation; and 3) the complex technological and regulatory realities of vaccine development and manufacturing.

The conclusion explores alternative scenarios for geographically diversifying vaccine production, offering helpful insights to guide current and future efforts in building more resilient regional vaccine manufacturing ecosystems.

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Introduction

Humanity's response to COVID-19 was like no other disease before. Within a month of its official recognition by the medical community, researchers had mapped its genome and investigated strategies for developing vaccines. In record time, safe and effective vaccines were developed and were being administered to health workers and high-risk individuals (Mao et al. 2023). In parallel, global public institutions mobilized unparalleled amounts of funding in a short period of time to assist countries in dealing with the pandemic and established a mechanism (COVAX) for low- and middle-income countries to gain access to COVID-19 vaccines in a timely fashion and with attention to global equity.¹

Had this approach played out as intended, the world would have demonstrated how international solidarity in solving health problems could supersede national chauvinism while preserving the existing structure of patents, markets, and production.² However, things turned out otherwise. Instead, most wealthy and vaccine-producing countries reserved vaccines for their own populations, leaving other countries without vaccines for months or even years (Glassman, Kenny, and Yang 2022; Brown and Rosier 2023).

A major consequence of this experience were calls to diversify vaccine manufacturing.³ Countries like Mexico and Vietnam have the capacity to produce some vaccines, but are still largely dependent on imports for their domestic needs. In addition, some countries that produce vaccines are dependent on a few countries for the active ingredients. For example, Brazil produces enough vaccine to cover more than half of its needs; however, more than 90 percent of the Active Pharmaceutical Ingredients (APIs) for producing these vaccines are imported, two-thirds of which come from India or China. Even the APIs that Brazil produces are dependent on raw materials imported from other countries (Tonini, Lopes, and Barbosa 2023).

Consequently, many governments began to investigate ways to produce vaccines domestically. Other initiatives began in Latin America, Africa and Asia to build local capacity to produce vaccines for regional markets. This proliferation of initiatives has been fragmented and uncoordinated. For example, at least 20 efforts to expand vaccine manufacturing in Africa were underway in 2022.⁴ Despite this, little has changed. Some of the early initiatives have been abandoned, while success is uncertain for those that remain.

1 Between April 2020 and April 2022, COVAX received donations of US\$12.4 billion, or US\$6.2 billion per year. By contrast, between 2002 and 2019, the Global Fund to Fight AIDS, Tuberculosis, and Malaria received donations of US\$45.8 billion, or US\$2.7 billion per year.

2 For this note, the term "production" will refer to the entire sequence of activities from manufacture of Active Pharmaceutical Ingredients (API) to the completion of finished vials of vaccines. "Manufacturing" will refer to most of this process up through batch processing, but exclude repackaging and fill and finish activities.

3 For example, the WTO's director-general called for geographical diversification of vaccine production in a speech to European Union legislators on May 20, 2021. See <https://www.latimes.com/world-nation/story/2021-05-20/wto-chief-calls-for-diversification-of-vaccine-production>, accessed Feb. 5, 2025.

4 Two reports, from Gavi and CHAI, report the results of inquiries regarding vaccine production in Africa and planned investments. They can be found at: <https://www.gavi.org/sites/default/files/white-paper/new-era-vaccine-manufacturing-in-africa-wp.pdf> and <https://www.clintonhealthaccess.org/research/african-vaccine-manufacturing-supply-landscape-and-expansion-white-paper/> (Accessed March 13, 2025).

This CGD Note considers the strategies countries need to adopt if they are going to successfully diversify vaccine production. It is not meant to be a research paper. Rather, it shares reflections based on a combination of my past research and what I learned during the COVID-19 crisis. From my past research, it considers the long-term trends that have led to our current reliance on concentrated production; namely, the rejection of past industrial policies in favor of a globalized economy and the rise and fall of international political cooperation in health. From my experience during the COVID-19 crisis, the note addresses the specific technological and economic features of vaccine research, development, and production which I learned from vaccine suppliers, pharmaceutical consultants, and public health experts with whom I worked.

The note's contribution is to combine these perspectives and look at the implications for the geographical diversification of vaccine production. One alternative that is likely for many vaccines is a continued reliance on geographically concentrated manufacturing, though linked to a range of middle-size countries for clinical testing and ancillary production (e.g., fill and finish). Another alternative is possible for simple vaccines or those which are of little interest to major manufacturers, such as malaria vaccines.⁵ In this case, regional development of vaccine manufacturing is more likely, especially in larger middle-income countries.

Any effort to diversify vaccine production beyond these alternatives is likely to require significant political effort, either to design novel contracts, to exploit unique niches in global markets, or choose partner countries with strong incentives for collaboration.⁶ Using pooled purchasing to promote regional centers of vaccine manufacturing is the most conventional and promising approach. However, such agreements need significant political commitments, including a willingness to pay premiums over market prices. This is possible to the extent that vaccine security is a political priority but is otherwise unlikely with a globalized economy and limited solidarity for global health cooperation.

Rejection of past industrial policies and embrace of a global economy

Vaccine production is not the only manufacturing process that is highly concentrated. Global manufacturing has been geographically concentrated for decades if not centuries. While the world's first massive expansion of global trade in the 19th century was largely driven by comparative advantage and trade in final goods, global trade in the 20th century has been characterized by much larger shares of intermediate goods and services. Therefore, the fundamental explanations for concentrated manufacturing today are related to economies of scale, scope, and agglomeration (see Box 1).

5 One of the most promising malaria vaccines (R21) was developed by international pharmaceutical firms, with production to be based in the Serum Institute of India. Since the burden of disease represented by malaria is concentrated in Africa, researchers have called for efforts to have this vaccine eventually produced, "end-to-end," in Africa (Adeyi et al. 2024).

6 Consider, for example, the proposal to support vaccine manufacturing in countries with small populations and which, therefore, have little incentive to hoard vaccines (Mukherjee, Kalra, and Phelan 2023).

BOX 1. ECONOMIES OF SCALE, SCOPE, AND AGGLOMERATION

Economies of scale occur when an increase in the volume of an output leads to lower average costs of production. Technically this requires that the marginal cost of an additional unit of production is lower than the average costs of production over some range. This is a generally well understood concept wherever people recognize that larger manufacturers have a cost advantage over smaller scale manufacturers. Vaccine production is characterized by economies of scale due to the high fixed costs of research & development as well as large fixed costs in manufacturing facilities, staffing, and quality control.

Economies of scope are present when a firm can lower its average costs by manufacturing or selling a variety of products. This is well-known in retail businesses, which can increase sales by increasing the variety of products they offer. In manufacturing, this can occur when different products can be produced with similar equipment or based on the same proprietary technologies, allowing them to spread the fixed costs of capital over a wider range of products. Vaccine production is characterized by economies of scope because the technologies and equipment required to produce one set of vaccines is often directly relevant or useful in producing other kinds of vaccines.

Economies of agglomeration occur when the geographic concentration of many firms lowers the production costs for all the firms in the aggregate. This can occur for many reasons, but some examples include: (1) firms may get lower prices from locally competing suppliers, (2) greater specialization may be possible with a larger range of potential suppliers and producers, and (3) the clustering of firms may make it possible to attract more suppliers and customers than would be possible for a single firm. Vaccine production is characterized by economies of agglomeration because of the need for a range of research, inputs, and manufacturing capacities which can be produced by a single firm, but which generally have lower costs when the benefits of specialization are leveraged.

Still, the factors leading to concentration do not predict *where* manufacturing will be concentrated. The location of manufacturing centers has shifted dramatically over time, roughly speaking from the UK and Western Europe in the 19th century to the US during the 20th century and eventually to Asia. The key factors that contributed to shifting manufacturing centers in the last fifty years are technological, economic, and political.

A key technological change that has contributed to shifting the geographic distribution of manufacturing has been massive reductions in transportation costs. Business strategies have also shifted, aiming to reduce production costs by outsourcing, that is, distributing different phases of manufacturing to different locations.

Political changes have played a significant role in the shift of manufacturing toward Asia. The rise of conservative governments in high-income countries in the 1980s, especially with the elections of Reagan in the US and Thatcher in the UK, initiated a forceful push toward opening economies

around the world to trade, liberalizing domestic and international financial markets, deregulating the transportation sector, and privatizing ports and other forms of infrastructure. This created even more opportunities for export-led industrialization in several East Asian countries and eventually, in this century, in China.

The distinction between successful “export-oriented” industrialization in East Asia and the more uneven results of “import-substitution” industrialization in Latin America is a rough generalization, but it illustrates an essential trade-off apparent in older industrial policy strategies. In general terms, East Asian countries which experienced rapid economic and productivity growth were able to build their manufacturing foundations and achieve economies of scale, scope and agglomeration through exportation. By focusing on export markets, these East Asian firms faced competitive pressures to achieve international standards of efficiency and quality set by domestic manufacturers in richer countries. By contrast, many Latin American countries tried to build their “infant industries” by raising tariffs and producing for protected domestic markets. While occasionally successful, most commonly this strategy led to firms that were unable to reach the scale, efficiencies, or quality necessary to be internationally competitive. Consequently, when Latin American countries began to liberalize their trade policies in the 1980s and 1990s, many of them experienced a decline in manufacturing and a return to participating in the global economy primarily as suppliers of natural resources and agricultural products.

Another factor that has reinforced the concentration of manufacturing is the increasing role of scientific knowledge. Science has always been a part of technological advances in manufacturing, but the scientific process today is quite different than in former times. First, scientific research has become more expensive. It requires more scientists organized into larger teams, as well as specialized laboratories which are more costly to build and maintain. These high costs have become barriers to entry for countries and businesses seeking to compete with established industrial-research centers. Second, in most countries, the production of scientific knowledge has become more tightly linked to industrial financing. Until the 1980s, basic research in universities and research institutions was largely dependent on public sources of funding. A combination of reduced support from governments, greater interest from industry to access university researchers and their laboratories, and, in some places changes, in patent laws, all combined to create more blended industrial-research ecosystems.

Despite these trends toward concentration of manufacturing, some countervailing forces have also emerged. The decline in communication costs facilitates the ability of researchers to share information more quickly and more widely. Access to scientific literature is much easier today as well. The rapidly increasing power of computers and declining costs of computing power are another factor which mitigates against the concentration of scientific knowledge and associated manufacturing. The most innovative fields in manufacturing have also shifted away from products and services that are largely mechanical, heavy, and reliant on physical engineering toward things

which are chemical and biological, involve plastics, use new alloys, or rely on organic processes. Software also plays a more significant role in manufacturing, for design, robotics, and consumption. The revolution in DNA coding and editing is just one aspect of these changes which encourages concentration of activity in existing industrial-research centers, but which provides the knowledge base for deconcentrating these same activities. The recent burst in activity around Artificial Intelligence (AI) could encourage or discourage manufacturing concentration depending how it develops, how it is regulated, and the strategies employed by those who control it.

While the past half century of globalization has shifted the centers of manufacturing, causing social and economic dislocation in many communities, it has not been without its benefits. In many cases, countries have been able to grow faster by having access to lower cost and better-quality inputs or by exploiting their true comparative advantage in trade. Many countries have also benefited from the ability to identify niches in the global economic system.

Economic globalization has numerous implications for efforts to diversify vaccine production. First, efforts to diversify vaccine production are likely to require paying a premium over vaccines available from existing suppliers. Unless new vaccine manufacturers can match the scale, scope, and agglomeration economies enjoyed by today's vaccine producers, they will almost certainly have higher costs. This reopens the debates over industrial policies of the last century and the fundamental question of how to create incentives for the establishment, expansion, and sustainability of industries without creating conditions that countenance inefficiency.

A second implication is that diversifying vaccine production will require diversifying all phases of production—from basic research through clinical trials, addressing intellectual property issues, obtaining basic inputs, and including “fill and finish.” While this does not need to be accomplished all at once, any stage which relies on existing foreign suppliers can create a bottleneck during major health emergencies, leaving countries vulnerable to interruptions or obstacles to vaccine production.

The changing character of international cooperation for health

International cooperation on health has changed significantly since it emerged in the 19th century, focused on halting the spread of diseases like cholera, tuberculosis, and yellow fever. These early responses were structured around non-governmental conferences of public health organizations and philanthropists but, eventually, engaged national governments. Nevertheless, in the early 20th century, philanthropists continued to play a major role. The Rockefeller Foundation was a pioneer in promoting and financing many important initiatives in this period. It supported the Pan-American Sanitary Bureau, the creation of institutes of health in many Latin American countries, and provided about half the funding for the League of Nations Health Office in the 1920s and 1930s (Savedoff 2012).

In the aftermath of World War II, countries and international public institutions assumed the lead role in health cooperation. A range of specialized institutions were created under the auspices of the United Nations, including the IMF, the World Bank, and the World Health Organization (WHO). In subsequent decades, many other non-specialized regional organizations—such as the Organization of Central American States, the African Union, and the Arab League—were given responsibilities related to regional health cooperation (Aginam 2024).

This model of using public international institutions to promote better health had numerous successes. One of the most significant successes of global cooperation in the 20th century was the eradication of smallpox, which began with an initiative by the Pan-American Health Organization (PAHO) in 1950 and was adopted as a global goal by WHO in 1958. At a cost of about US\$300 million, only one-third of which was foreign aid, the eradication of smallpox is estimated to be generating benefits of more than US\$2.6 billion annually⁷ (Henderson and Moss 1999). Other successes in the post-WWI era included (McCarthy 2002):

- Mass campaigns in the 1960s against yaws, endemic syphilis, leprosy, and trachoma, as well as contributing to control a major cholera pandemic in Asia and the Western Pacific and a yellow fever epidemic in Africa.
- The Expanded Programme of Research, Development, and Research Training in Human Reproduction that was launched in the 1970s to support fertility choices and provide birth-control options.
- The Expanded Programme on Immunization (EPI), launched in 1974, to vaccinate children against diphtheria, pertussis, tetanus, measles, poliomyelitis, and tuberculosis. While this program did not attain its goal of universality, it still expanded vaccination coverage in lower income countries in collaboration with UNICEF and averted an estimated 146 million deaths among children under 5 years of age (Shattock et al. 2024).

Regional and global cooperation involved many innovative and successful efforts to improve the quality and efficiency of public policy toward health as well. For example, in 1977, 35 countries in Latin America and the Caribbean established an EPI Revolving Fund to purchase vaccines on their behalf. Another example is The Gulf Cooperation Council (GCC) Group Purchasing Program that issues tenders for vaccines on behalf of seven Persian Gulf States. The countries then purchase the vaccines that they need under the terms of the contract. Both the PAHO and GCC agreements have provided benefits regarding price and administrative costs (DeRoeck et al. 2006).

The largest example of international cooperation for vaccine purchasing (though not for manufacturing) is UNICEF, which is the world's largest buyer of vaccines. UNICEF assumed this

7 Figure in 2024 US dollars, using the US Bureau of Labor Statistics CPI to update figures for 1988 US dollars reported in the referenced study.

role in 1974 when the EPI program was first launched. Since 2000, Gavi has become a major vaccine purchaser through UNICEF, as well as promoting policies and initiatives to “make markets,” i.e., create incentives for new or easier to administer or less costly vaccines. In 2023, UNICEF procured and delivered 2.79 billion doses to 105 countries (UNICEF 2024). In contrast to the cooperative agreements among PAHO and GCC members, UNICEF procurement relies primarily on contributions from high-income countries, either directly or through multilateral institutions. Gavi is one of the most prominent of these multilateral channels, purchasing more than US\$1 billion through UNICEF each year (UNICEF 2024; GAVI 2022; 2025).

The success of regional and global initiatives like these is not guaranteed. Despite the benefits they provide, the essential elements of cooperation still require a degree of solidarity and a willingness by countries to cede some control over their ambitions for self-sufficiency or autonomy in purchasing. This dynamic of inward-looking politics began to manifest in the 1990s as support for international public institutions working in the health sphere began to fade in concert with skepticism toward other forms of public international cooperation. This political mood included calls for reforming international institutions and the slowing of public contributions and commitments to existing international organizations.

In the case of global health, the period since 2000 has involved an exponential increase in international cooperation and funding but not through the existing multilateral organizations. Instead, new institutions were created such as the Global Alliance for Vaccines and Immunization (known today as “Gavi, The Vaccine Alliance”). Gavi was established in 2000, largely in response to dissatisfaction over the pace of progress in childhood vaccinations and to newly available funding from the Bill and Melinda Gates Foundation. Similarly, when WHO proved ill-equipped to address the AIDS epidemic, the UN system responded by creating UNAIDS and the World Bank began to support country programs to deal with AIDS. When even these initiatives were deemed inadequate, a “mixed coalition”⁸ of public and private institutions established the Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund). The Global Fund’s founding institutions intended to create an organization that would be more agile, less bureaucratic, and more reliant on country-owned strategies, than was forthcoming from existing institutions.

By 2020, the community of organizations working on international health was substantially different than it was in 2000, and today we are experiencing yet another major shift. Before 2000, bilateral agencies, UN agencies, and multilateral development banks were the most prominent funders and voices in international health cooperation. Beginning in the 1990s and accelerating after 2000, international organizations proliferated with the creation of public-private partnerships and mixed coalitions. From 2000 to 2020, private philanthropy greatly increased as a share of total foreign assistance in health, with the Gates Foundation foremost among them. Furthermore, the United

8 See (Savedoff 2012) for a discussion of different forms of international cooperation as they evolved in the late 20th and early 21st centuries.

States (US) which had always been a major contributor to international health increased its share of total development assistance to health from about 25 percent to 33 percent.⁹ This occurred even as overall foreign funding for health grew more than threefold, from annual flows of US\$14 billion to near US\$50 billion.¹⁰

Today, however, this is changing dramatically. Official assistance from the United States is being slashed by the Trump administration and the United Kingdom, another major international health funder, has stepped back from its commitment to foreign aid. European countries that strongly supported international health in the past are also reducing their commitments given increased pressures to address domestic issues related to refugee settlement and other important concerns like military defense in light of Russia's war on Ukraine.

Before this latest retraction of funding, however, the limits of official organizations and public-private partnerships were already apparent. When COVID-19 emerged as a global pandemic, governments were accustomed to being part of mixed coalitions in the health sphere. WHO remained a touchstone for technical expertise and policy guidance, and it served as a coordinating center for much of the COVID-19 response. However, it was unable to get data from China and hesitated to declare the pandemic because of the potential economic impact, the risk to WHO's relationship with member countries, and its reliance on China's voluntary cooperation in providing critical information (Good 2021). While WHO staff convened numerous committees and networks for responding to the crisis, its efforts to support the procurement of medicines and hospital equipment were eclipsed by other multilateral and bilateral agencies that commanded larger amounts of funding. And while WHO helped coordinate vaccine production, licensing, and deployment for low- and middle-income countries, it lacked the resources and mechanisms available to a mixed coalition: COVID-19 Vaccines Global Access (known as COVAX).

COVAX demonstrated both the enormous potential for international health cooperation and the extreme difficulties of building and sustaining cooperation among sovereign nations. COVAX was created in April 2020 to help low- and middle-income countries obtain COVID-19 tests, therapies, and vaccines. Directed by CEPI, Gavi, and WHO, it also negotiated an Advance Market Commitment (AMC) to accelerate the creation of the new vaccines and to assure an equitable distribution of vaccines once they were available.

Nevertheless, adherence to the COVAX AMC was slower than anticipated. Even smaller countries, who should have seen the advantages of such an arrangement, were reticent. Sometimes countries were cautious about joining because of the novelty of the arrangement, sometimes they were legally constrained from signing advance commitments to purchase a product that didn't exist and whose

9 This includes all US sources, primarily US government bilateral programs through USAID and PEPFAR but also private foundations and especially the Bill and Melinda Gates Foundation.

10 Data on DAH expenditures from Institute for Health Metrics and Evaluation (IHME). Development Assistance for Health Database 1990–2020. Seattle, United States of America: Institute for Health Metrics and Evaluation (IHME), 2023. Accessed Feb. 8. 2025.

price might not be justifiable to internal audit controls. In other cases, they found opportunities to negotiate special deals with manufacturers or suppliers and considered participation in COVAX, with its goal of providing coverage for only 20 percent of the population, to be a side effort. For example, several countries in Latin America leveraged their domestic research capacity to provide vaccine manufacturers with clinical test data in return for promises of early access to vaccines. Agreements with Russia, China, and Cuba were sometimes obtained as part of geopolitical interests and alliances.

Furthermore, COVAX was delayed in delivering promised doses of COVID-19 vaccine. By mid-August 2021, it had only supplied a third of the planned deliveries because the world's rich countries were slow to fulfill their funding commitments and because countries manufacturing the vaccines—including the US, Europe, and India—chose to supply their citizens first—before supplying vaccines to higher risk people in other countries. The latest retraction of funding for international health programs—dramatically by the United States and less dramatically by other official channels—demonstrates quite clearly the breakdown of international solidarity and even self-interest as motivations for providing aid to other countries for population health.

COVAX could have been a demonstration of international health solidarity. It accelerated the development and deployment of vaccines but fell short of its mandate to assure an equitable global response. COVAX and its allies were unable to reach their goals due to a combination of inadequate funding and to the victory of nationalist sentiment over international solidarity. Consequently, countries in Latin America did not reach 80 percent coverage until the end of 2021 and some countries in Africa and Asia never met those coverage levels at all.

The COVID-19 crisis exposed the ways in which countries are vulnerable during major health emergencies and not just for vaccines. Early in the crisis, supplies of basic medical supplies, equipment, and drugs became scarce. Countries in which production was concentrated supplied their own healthcare systems first, whether the supplies were simple things like surgical masks or complex things like ventilators. As vaccines began to emerge, countries quickly realized that, unless they had their own manufacturing capacity, they would be waiting in line along with most other countries to negotiate agreements with the few companies or countries that had such capacities. The failure of rich countries to fulfill their funding pledges, and of producing countries to fulfill vaccine delivery commitments generated a level of mistrust which is unlikely to abate. Countries recognize that in a health emergency, the countries that might have provided funding and supplies are not going to address the needs of high-risk populations around the world before addressing the needs of their own citizens first.

As a result, and with an eye on the future, numerous efforts started with the aim of building vaccine manufacturing capacity outside of major centers in the US, Europe, India, and China. So far, these efforts have met little success. For example, Colombia led an effort under the auspices of PROSUR to generate new vaccine manufacturing capacity on a regional basis within South America. However,

this initiative foundered when countries could not agree on the terms of an agreement—particularly where manufacturing investments would occur.

Other agreements are still active though progressing slowly. Southeast Asian countries have adopted a vaccine security plan in the form of a Coalition for Local and Regional Production, Innovation and Equitable Access.¹¹ African countries are considering an initiative to establish a US\$50 billion market for vaccines and medicines as well as invest in regional capacity to develop and manufacture vaccines which would be housed in the Africa Centres for Disease Control and Prevention (Africa CDC). Other initiatives include the Regionalized Vaccines Manufacturing Collaborative (RVMC), incubated by the World Economic Forum and now hosted by CEPI¹² and Gavi's African Vaccine Manufacturing Accelerator (AVMA). Unlike other initiatives, Gavi's AVMA is already functioning, launched in June 2024 with US\$1.2 billion in funding available over a 10-year period.¹³

Such agreements can be divided into three broad categories. Many are supply-side initiatives that provide funding, incentives, or technology transfer so that countries can improve their ability to research, develop, and manufacture vaccines. Other initiatives include such capacity-building efforts but additionally commit countries to purchase from specific regional producers.¹⁴ A third category includes capacity-building support and purchase commitments but goes further, requiring country commitments to share vaccines during a crisis. As discussed below, the commitment to purchase regional production and to share vaccines in a crisis are critical to successful diversification of vaccine manufacturing in most cases. Thus, regional agreements will face two critical tests related to (1) whether countries will sign binding agreements to pool purchasing and share vaccines equitably and (2) whether countries abide by these agreements when health emergencies arise.

This brief history of international cooperation on health has many implications for diversifying vaccine manufacturing today. First, the successes after WWII demonstrate that international health cooperation is possible and that it can be highly cost-effective. Eradicating smallpox, creating revolving credit funds, and deploying childhood vaccines demonstrated that cross-national efforts can succeed when countries cooperate with and fulfill commitments to international agreements and institutions.

Second, the ecosystem of international health organizations has changed since the last century, making international cooperation to diversify vaccine production less likely. While international

11 See https://asean.org/wp-content/uploads/2021/10/AHMM-ADOPTED_AVSSR-Strategic-and-Action-Plans-2021-2025-cleaned-version_FINAL.pdf. Accessed Feb. 8, 2025.

12 See <https://www.weforum.org/stories/2024/01/initiative-supports-equitable-regional-vaccine-manufacturing/>. Accessed Feb. 3, 2025.

13 See <https://www.gavi.org/programmes-impact/types-support/regional-manufacturing-strategy/avma#resources> (accessed March 14, 2025).

14 Similar points are raised by (Bonnifield and Madan Keller 2023) with respect to assuring effective demand and realistic assessments about manufacturing capacity.

health funding grew massively through 2021, it is now declining sharply. The new mixed coalitions like GAVI and CEPI that were created to substitute for official international organizations that were considered too slow or bureaucratic may be sharply constrained by reduced funding in coming years.

Third, the COVID-19 crisis demonstrated that conventional approaches to coordination (i.e. WHO, US CDC) are less effective than expected; that international solidarity was not forthcoming; and that countries have a decided preference for bilateral negotiation and relying on technological fixes rather than banding together to establish large buyers' groups or committed egalitarian deployment of vaccines.

Characteristics of vaccines and vaccine production

Vaccines are a class of materials used to stimulate the human body's immune system to be more effective at destroying or neutralizing infectious agents, primarily bacterial or viral ones.¹⁵ Infectious diseases have characteristics that make them more or less amenable to vaccine-protection than others. They vary by such things as routes of transmission, survivability in different hosts, sensitivity to climate and temperature, life cycle, and ability to mutate. Vaccines also vary in their effectiveness at stimulating the immune system, both because of the vaccine's own composition and in the way it interacts with genetic and biophysical variations across people and infectious agents.

Major classes of vaccines can be distinguished by whether they contain a weakened version of the infectious agent or only a part or specific protein from it. Rather than manufacture such antigens, recent developments involve a class of vaccines that inject genetic material, causing the human body to produce a protein that stimulates the human body's immune response. Vaccines can be delivered orally, through the skin, or injected. Some have exacting requirements for storage and temperature while others can be transported and reconstituted easily.

Vaccines are similar to other goods in terms of requiring a mix of skilled and unskilled workers, capital investments in infrastructure, and quality control processes. However, vaccines also have characteristics which differentiate them from other goods in important ways. The foremost difference is the very low tolerance for unsafe vaccines. While some goods can be produced, sold, and subsequently re-engineered to deal with failures and poor quality, vaccines need to be developed and tested exhaustively before being broadly deployed due to the potential risks to health. Furthermore, during deployment, vaccines must be rigorously and continually monitored to assure that manufacturing protocols are being followed and that assessments confirm each lot has the necessary level of purity, potency, identity, and sterility (see Box 2).

¹⁵ For an summary of the history of vaccination, the science of immune response, and an overview of vaccination strategies, see (Montero et al. 2024)

BOX 2. STAGES OF VACCINE DEVELOPMENT

- Research and discovery stage
- Pre-clinical phase
- Clinical development (Phases 1, 2, and 3)
- Assessment of manufacturing
- Approval process
- Prescribing information and labelling
- Monitoring safety & effectiveness

Vaccines are frequently produced by very few firms because of barriers to entry or because of unstable and limited demand. New vaccines may be produced by few firms because they are protected by patents. Even when vaccines are off-patent, new entrants may be deterred by the need for large amounts of capital, highly specialized personnel, and lack of access to a supportive research-manufacturing-regulatory ecosystem. In still other cases, production may not be so demanding, but the market for an off-patent vaccine may be fully supplied by a few producers at prices too low for new entrants to be profitable.

Consequently, when researchers or firms get involved in vaccine production, they are more likely to participate in a part of the process than engage in full transfer of technological capabilities (Druehl, Minssen, and Price 2021). For example, during the COVID-19 crisis, Chilean laboratories conducted clinical trials in return for access to vaccines from four different manufacturers and Mexico contracted to provide finish and fill services. An exception to these limited roles involved AstraZeneca which concluded agreements to produce the active ingredient in Argentina and Brazil.¹⁶

To diversify vaccine production, production costs need to be addressed. The special features of vaccines lead to production cost structures with economies of scale, economies of scope, and economies of agglomeration.

- Economies of scale occur whenever unit production costs decline when volumes increase. This is a feature of vaccine production due, in part, to the large, fixed costs of manufacturing facilities which can cost between US\$50 million and US\$700 million (Plotkin et al. 2017).
- Economies of scope refer to forms of production for which a firm producing several goods has lower costs than a firm producing just one (Panzar and Willig 1981). Firms that produce one vaccine often have a cost advantage in producing other similar vaccines when they can more fully utilize their management technologies, knowledge of the manufacturing and licensure processes, and apply their procedures for clinical testing and quality control.

16 Press accounts describe other examples, but these are the only ones I was able to confirm.

- Economies of agglomeration refer to cases where firms have lower costs when they physically locate near other firms (Ellison and Glaeser 1999). Vaccines also exhibit this feature because of substantial benefits from locating production close to research centers where firms can not only gain access to basic research and sophisticated laboratories, but also because it facilitates access to the kind of skilled workforce, financing, and transportation networks made possible by a concentration of similar firms.

Of these three cost-factors, economies of agglomeration may be the most significant for vaccines. The scale of a vaccine manufacturing facility has physical limits and assuring quality at large-scale can be difficult for some vaccines (Mitchell, Philipose, and Sanford 1993). If economies of scale were the only factor hindering diversification, any country with a significant population would find it economical to produce their own. This appears to be the case with some vaccines, such as DPT, which has regular and predictable demand related to demographics (i.e., the number of births), uses widely available technologies, and consequently has more dispersed manufacturing than most other vaccines.

Economies of scope are an important factor but do not seem adequate to explain the extent of concentration in vaccine production today. WHO lists 162 firms that produce vaccines.¹⁷ The average manufacturer produces 5.7 vaccines, consistent with the presence of economies of scope. Nevertheless, 58 of these firms—almost 36 percent of them—produce only one vaccine. So, production of multiple vaccines may be helpful, but it is not a necessary condition for entering this market.

By contrast, economies of agglomeration are clearly significant in vaccine production and are a big hurdle for firms and countries interested in building vaccine production capabilities. Consistent with the literature on clustering (Porter 2000), “Innovation Hubs” and other research on how scientific advances become embodied in commercialized products, the creation of an ecosystem with a large enough scientific community and skilled workforce that interacts with a variety of entrepreneurial agents is essential to today’s world of vaccine manufacturing. Furthermore, vaccines require access to a community of researchers capable of undertaking clinical testing at large scale and access to a large and diverse population.

It is also difficult to establish and maintain such innovation hubs without predictable and steady demand for vaccines (Bonnifield et al. 2019). Longer term visibility of the prospects for selling a vaccine is essential for a product which can take as long as 7 years to move from basic research to a safe and effective product that is licensed and ready for deployment.¹⁸ Long-term, consistent public

17 See <https://www.who.int/publications/m/item/full-vaccine-product-list>, accessed Feb. 5, 2025.

18 COVID-19 vaccines demonstrated that the pace of innovation and ability to develop new vaccines has sped up considerably in recent years due to technological advances. Nevertheless, certain diseases have features which will continue to make the development of safe and effective vaccines a long process as demonstrated by the modest effectiveness of influenza vaccines despite decades of research and work.

policies play a particularly important role in this predictability, both because governments are often the main purchaser of vaccines and because public agencies have the responsibility for establishing the criteria for safety and effectiveness that will permit commercialization.

These features of the cost structure for vaccine development and manufacturing have significant implications for diversifying production. To produce vaccines in new places requires substantial long-term investments not just in training people but in the creation of a vibrant, critical mass of researchers surrounded by a variety of skilled workers. It also requires cultivating many complementary and competing firms to provide a mix of flexible and responsive inputs, supplies, financing, and services. All this is only possible with a long-term perspective on establishing predictable demand that can justify and maintain the fixed investments that will pay off over long periods of time. Finally, it requires a supportive policy environment, including strong regulatory institutions that provide trustworthy judgments about the safety and efficacy of vaccines, something that can be provided by a strong and internationally respected regulatory authority.

A correlate of these points is that existing firms and institutions in the vaccine manufacturing business have few reasons to diversify out of existing innovation centers. Yet some factors do favor geographical diversification. For example, diversification is more likely if new areas can be found that provide access to lower cost inputs in the quantities and qualities needed. For example, real estate and labor costs often rise substantially in successful innovation centers and may be available in other lower cost areas, especially if public policies offer inducements, regulatory environments, and stability favorable to the creation of new agglomerations. Another factor supporting dispersion beyond the borders of today's leading countries is the availability of clinical researchers in countries where clinical testing can be conducted. This can be an entry point for the transfer of technical and managerial knowledge necessary to start building centers for vaccine research, development, manufacturing, and commercialization.

Countries as different as India and Cuba have demonstrated that establishing innovation hubs for vaccine production is possible with concerted, long term public investment and promotion. Supply policies in these two countries were similar in many ways, but the demand story was quite different. India's success relied on domestic demand from its large and growing population while Cuba used export markets to assure the financial viability of its investments (Yadav 2024; Villanueva and Espiñeira 2023).

BOX 3. COULD CUBA'S EXCEPTIONAL EXPERIENCE BE REPLICATED?

Cuba is an island of 10.9 million people and a per capita income of about US\$11,000. Its capacity to produce COVID-19 vaccines in 2021 with efficacy comparable to vaccines produced by much larger and richer countries was an exceptional case that provides insights into (1) key investments required to promote domestic production of vaccines and (2) potential strategies for complementing domestic vaccine development with international partnerships.

Cuban development of COVID-19 vaccines was not an isolated event. The Cuban Biotechnological and Pharmaceutical Industries Group (BioCubaFarma) is comprised of 32 companies, producing more than 1,000 vaccines and medicines, with over 20,000 employees. Cuba ranks among the top 20 vaccine manufacturers in the world and produces 72.7 percent of its vaccine requirements (compared to 54.2 percent for Brazil and 25 percent for Mexico) (Ortiz-Prado et al. 2021).

Cuba's success at creating a rich environment in which biotechnological research and development flourished can be attributed to a few important investments. First, Cuba invested heavily in education more generally and medical education specifically. Second, the Cuban government directly addressed market failures common to the development of vaccines related to lack of coordination between research, development, production, and marketing by creating multiple businesses that were vertically integrated. Third, the government addressed the lack of incentives for innovation by retaining intellectual property rights but giving researchers rights to a portion of the resulting income. Along with better working conditions and professional development opportunities, giving researchers a financial stake in patents encouraged innovation, efficiency, and productivity. In this way, Cuba shows how public investment can establish conditions for innovation hubs in biotechnology, a field in which a significant portion of value added is based on skilled human resources, i.e., intellectual capital.

International engagement is a second way that Cuba demonstrates an alternative strategy to relying exclusively on imported vaccines and the vagaries of external suppliers. While Cuba has the wherewithal to manufacture a substantial amount of its own demand for vaccines, it often lacks the financial resources needed to conduct large scale clinical trials, expand the scale of production, and reach export markets. Cuba's strategy has been to use its comparative advantages in research and development—and its resulting licenses—to attract partners among foreign businesses who provide complementary resources, technologies, and services. Some of these partnerships are structured as joint ventures (e.g., with South Africa), while others involve technology transfer agreements (e.g., with Brazil) or joint development initiatives (e.g., with Vietnam). The outward orientation of Cuban researchers and biotechnology firms is also characterized by engagement with intergovernmental commission on biotechnology and scientific exchanges with leading research centers around the world. Through its partnerships, Cuba can both assure access to vaccines for its own population and benefit from the volume of demand represented by export markets.

This experience shows how a small country can leverage its human resources and public investment to achieve a substantial level of self-sufficiency and manufacturing capacity for vaccines. For other countries to follow this path, the initial investments in human resources may be the most significant limiting factor. While Cuba's unique political history and economic structure has given it certain advantages—like low-paid high-skilled workers—it also has not enjoyed advantages available to other countries because the hostility of U.S. governments has constrained Cuba's access to international technology, communications, financing, and supplies.

Sources: (Guillen et al. 2023; Villanueva and Espiñeira 2023)

What are the alternatives for diversifying vaccine production?

Any effort to geographically diversify vaccine manufacturing must confront the challenges laid out above, namely:

- pressures of globalization have reduced transportation costs, concentrated manufacturing in a few large countries, and exposed the risks of old industrial policies which may protect infant industry but fail to provide incentives for efficient production;
- international cooperation on health is not necessarily forthcoming, even when it is in the interest of all participants, making it difficult to assure equitable access to vaccines through solidarity or to assure countries will fulfill international agreements to deliver critical supplies during health emergencies; and
- establishing new vaccine manufacturing centers is unlikely to be successful without policies that either encourage the creation of innovation hubs that provide a full ecosystem of research centers, manufacturers, suppliers, and services or identify strategies for providing equivalent cost advantages through other means.

The characteristics of a solution to these challenges hinge critically upon the ability of public policy to assure *predictable and long-term demand* for vaccines with adequate volume to justify large investments; and a regulatory environment that is both supportive of vaccine production and rigorous in terms of assuring high standards for safety and efficacy.

Given the differences among vaccines, several options are possible. Any vaccine which can be produced by current centers has a cost advantage. Therefore, efforts to diversify production will need buyers who will commit to paying higher than market costs to assure incentives for building capacity and maintaining production—at least temporarily and possibly over the long term. Niche vaccines which cannot be manufactured in today's centers or for which the current centers do not have a cost advantage can be developed in new centers. Finally, orphan diseases, i.e., diseases that are not addressed by current players because there is no effective demand or no current capacity, are good candidates for regional manufacture, but only if the countries involved, or their funders, are willing to assure demand (Bonnifield and Madan Keller 2023; Guzman et al. 2022).

Thus, alternative paths can be envisioned for different vaccines in relation to the geographical diversification or concentration of production. Given the trends in globalization, industrial policy, international health cooperation, and the features of vaccine manufacturing discussed here, the most likely alternative for many vaccines is continued concentration of production in a few large countries, though linked to a range of middle-size countries for clinical testing and ancillary production or services.

Vaccines that are based on simpler technologies might follow a different path toward geographical diversification because they can attain safety and efficacy standards more easily and can rely more on automated production processes (so that capital can be used as a substitute for local pools of skilled labor). This same category would include vaccines for which demand is steady, predictable, and publicly financed, like childhood vaccines. Vaccines which are of less interest to and lower profitability for multinational companies are also good candidates for geographical diversification. It is not difficult to envision large, middle-income countries like Brazil, South Africa, and Indonesia becoming centers of vaccine production for tropical illnesses like dengue and chikungunya, expanding the range of vaccines that they produce as technologies become better known and testing equipment becomes easier to use.

Other alternatives are possible, but they tend to require strong, credible commitments between sovereign governments and strong, credible commitments of public funding over relatively long time frames. Regional and global agreements can be negotiated to create pooled demand for vaccines like PAHO's Revolving Fund and GCC's Group Purchasing Program. But PAHO and GCC are successful because they can obtain lower cost vaccines for their members. Using pooled demand to promote region-specific vaccine production will require prices that involve a premium over global prices to build and maintain this capacity any time that an existing innovation hub sells similar vaccines on the market.¹⁹ Thus, these agreements will need self-enforcing designs or countries will need a sustained interest in the long-term benefits if they are going to provide the predictable, effective demand in volumes adequate to justify the investments in vaccine manufacturing capacity.

Such agreements also risk creating opportunities for rent-seeking by the new vaccine manufacturers and can protect inefficient producers. To mitigate this risk, countries participating in such agreements need to adopt new approaches to industrial policy which can gradually expose producers to price competition or other ways of disciplining inefficient production.

Typically, larger countries provide the base for vaccine manufacturing because they have adequate internal demand, and their unit costs can be reduced by exporting to non-producing countries. However, one possible way of resolving the commitment not to hoard vaccines during emergencies is for regional agreements to locate new vaccine manufacturing capacity in one or more small countries (Mukherjee, Kalra, and Phelan 2023). If it is sustainable in the face of low economies of agglomeration, the small country will have an interest in providing vaccines to other countries because it will be the only way for it to recover its fixed investments. Though this would solve one part of the commitment problem, it still requires other (often politically more powerful) countries to forego investments in their own production facilities and justify providing capital to another country.

19 For example, the AVMA will pay US\$0.50 per dose for any GAVI-purchased vaccines for which the drug substance is manufactured in Africa over a ten-year period. See, <https://www.gavi.org/programmes-impact/types-support/regional-manufacturing-strategy/avma/> Accessed May 19, 2025.

Looking forward, each country is going to have to make choices about how best to assure the vaccines it needs considering the prices it is willing to pay and the risks it is willing to assume. The existence of regional or global agreements expands the available options but if they are not forthcoming, then the range of policies available to countries might look like this:

- Accept dependence in return for low-cost vaccines and seek other ways to mitigate potential fallout from crises that interrupt supply, such as stockpiling, purchasing insurance, or negotiating contracts with major manufacturers based on a retainer fee model.
- Engage with major vaccine producing centers and develop elements of the vaccine production process that are separable, such as fill and finish or clinical testing, to leverage preferential access to vaccines when needed.
- Reject dependence on external firms and countries and invest in domestic production despite the costs. This requires an assessment of the scale of investments and actions required and setting priorities for which vaccines can and will be domestically produced. This is a costly and difficult strategy, but it is not impossible (see Box 2).
- Plan for dependence but work to build regional or global agreements that support new innovation hubs with strong political agreements that ensure sharing technology, distributing production, and assuring equitable provision.

Currently, regional and global initiatives aimed at promoting geographical diversification are quite active. For example, PAHO is seeking to build capacity for mRNA vaccine technologies in Latin America. The European Union and others are supporting African initiatives to build the continent's capacity to produce 60 percent of its vaccine demand. The Coalition for Local and Regional Production, Innovation and Equitable Access was launched at a G-20 meeting in Rio de Janeiro as a form of voluntary cooperation to promote access to vaccines and related health technologies. ASEAN has its Vaccine Security and Self-Reliance Strategic and Action Plan (2021–25) aimed at increasing the region's access to vaccines by prioritizing areas of cooperation and supporting manufacturing hubs.

Geographical diversification vaccine manufacturing as envisioned by these initiatives is possible, but it is not easy. Long term trends in the globalization of manufacturing and international cooperation on health, combined with the high costs of building a vaccine manufacturing infrastructure, encourage concentration of production in relatively few centers. Without substantial political effort to create cross-national binding agreements, finance and establish credible commitments to purchase vaccines in the future, and build local capacity to provide stringent regulation of safety and efficacy, the tendency to concentrate vaccine production is likely to continue unchecked.

References

- Adeyi, Olusoji, Prashant Yadav, Raj Panjabi, and Wilfred Mbacham. 2024. "The R21 Malaria Vaccine: Spotlight on Policy Goals and Pathways to African Vaccine Manufacturing." *PLOS Global Public Health* 4 (7): e0003412. <https://doi.org/10.1371/journal.pgph.0003412>.
- Aginam, Obijiofor. 2024. "Regional Cooperation for Health." In *Handbook of Regional Cooperation and Integration*, 311–25. Edward Elgar Publishing. <https://www.elgaronline.com/edcollchap-0a/book/9781800373747/book-part-9781800373747-22.xml>.
- Bonnifield, Rachel, Janeen Madan Keller, Amanda Glassman, and Kalipso Chalkidou. 2019. "Tackling the Triple Transition in Global Health Procurement." *Center For Global Development* (blog). June 17, 2019. <https://www.cgdev.org/better-health-procurement>.
- Bonnifield, Rachel, and Janeen Madan Keller. 2023. "Gavi's AMC for African Vaccine Manufacturing: Start With These Three Foundational Questions." *Center For Global Development* (blog). August 16, 2023. <https://www.cgdev.org/blog/gavis-amc-african-vaccine-manufacturing-start-these-three-foundational-questions>.
- Brown, Stephen, and Morgane Rosier. 2023. "COVID-19 Vaccine Apartheid and the Failure of Global Cooperation." *The British Journal of Politics and International Relations* 25 (3): 535–54. <https://doi.org/10.1177/13691481231178248>.
- DeRoeck, Denise, Saleh A. Bawazir, Peter Carrasco, Miloud Kaddar, Alan Brooks, John Fitzsimmons, and Jon Andrus. 2006. "Regional Group Purchasing of Vaccines: Review of the Pan American Health Organization EPI Revolving Fund and the Gulf Cooperation Council Group Purchasing Program." *The International Journal of Health Planning and Management* 21 (1): 23–43. <https://doi.org/10.1002/hpm.822>.
- Druedahl, Louise C., Timo Minssen, and W. Nicholson Price. 2021. "Collaboration in Times of Crisis: A Study on COVID-19 Vaccine R&D Partnerships." *Vaccine* 39 (42): 6291–95. <https://doi.org/10.1016/j.vaccine.2021.08.101>.
- Ellison, Glenn, and Edward L. Glaeser. 1999. "The Geographic Concentration of Industry: Does Natural Advantage Explain Agglomeration?" *The American Economic Review* 89 (2): 311–16.
- GAVI. 2022. "Expanding Sustainable Vaccine Manufacturing in Africa: Priorities for Support." Geneva: The Gavi Alliance.
- . 2025. "GAVI Alliance 2023 Annual Financial Report." Annual Financial Report. Gavi, the Vaccine Alliance. <https://www.gavi.org/news/document-library/gavi-alliance-2023-annual-financial-report>.
- Glassman, Amanda, Charles Kenny, and George Yang. 2022. "COVID-19 Vaccine Development and Rollout in Historical Perspective." <https://www.cgdev.org/publication/covid-19-vaccine-development-and-rollout-historical-perspective>.
- Good, Elizabeth. 2021. "The World Health Organization and the Response to the COVID-19 Pandemic: How the WHO Failed and Why It Doesn't Matter." *Global Governance in the Age of COVID*. Evanston, IL: Weinberg College Center for International Area Studies, Northwestern University. <https://wccias.northwestern.edu/research-partnerships-initiatives/covid-19-research/the-world-health-organization-and-the-response-to-the-covid-19-pandemic-how-the-who-failed-and-why-it-doesnt-matter.html>.
- Guillen, G., M. Limonta, V. Muzio, G. Lemos, F. Hernández-Bernal, G. China, D. Gonzalez-Roche, et al. 2023. "Cuban Vaccines Abdala and Mambisa Against COVID-19." *International Journal of Infectious Diseases* 130 (May):S9. <https://doi.org/10.1016/j.ijid.2023.04.027>.
- Guzman, Javier, Morgan Pincombe, Prashant Yadav, and Amanda Glassman. 2022. "Expanding Emergency Vaccine Manufacturing Capacity in Latin America and the Caribbean," March. <https://www.cgdev.org/publication/expanding-emergency-vaccine-manufacturing-capacity-latin-america-and-caribbean>.
- Henderson, Donald A., and Bernard Moss. 1999. "Public Health." In *Vaccines*. 3rd Edition. Saunders. <https://www.ncbi.nlm.nih.gov/books/NBK7293/>.
- Mao, Wenhui, Armand Zimmerman, Elina Urli Hodges, Ernesto Ortiz, Galen Dods, Andrea Taylor, and Krishna Udayakumar. 2023. "Comparing Research and Development, Launch, and Scale up Timelines of 18 Vaccines: Lessons Learnt from COVID-19 and Implications for Other Infectious Diseases." *BMJ Global Health* 8 (9). <https://doi.org/10.1136/bmjgh-2023-012855>.
- McCarthy, Michael. 2002. "A Brief History of the World Health Organization." *The Lancet* 360 (9340): 1111–12. [https://doi.org/10.1016/S0140-6736\(02\)11244-X](https://doi.org/10.1016/S0140-6736(02)11244-X).

- Mitchell, Violaine S., Nalini M. Philipose, and Jay P. Sanford, eds. 1993. "Stages of Vaccine Development." In *The Children's Vaccine Initiative: Achieving the Vision*. Washington, DC: National Academies Press (US). <https://www.ncbi.nlm.nih.gov/books/NBK236428/>.
- Montero, David A., Roberto M. Vidal, Juliana Velasco, Leandro J. Carreño, Juan P. Torres, Manuel A. Benachi O., Yenifer-Yadira Tovar-Rosero, Angel A. Oñate, and Miguel O'Ryan. 2024. "Two Centuries of Vaccination: Historical and Conceptual Approach and Future Perspectives." *Frontiers in Public Health* 11 (January). <https://doi.org/10.3389/fpubh.2023.1326154>.
- Mukherjee, Sanjana, Kanika Kalra, and Alexandra L. Phelan. 2023. "Expanding Global Vaccine Manufacturing Capacity: Strategic Prioritization in Small Countries." *PLOS Global Public Health* 3 (6): e0002098. <https://doi.org/10.1371/journal.pgph.0002098>.
- Ortiz-Prado, Esteban, Estefanía Espín, Jorge Vásconez, Nathalia Rodríguez-Burneo, Nikolaos C. Kyriakidis, and Andrés López-Cortés. 2021. "Vaccine Market and Production Capabilities in the Americas." *Tropical Diseases, Travel Medicine and Vaccines* 7 (1): 11. <https://doi.org/10.1186/s40794-021-00135-5>.
- Panzar, John C., and Robert D. Willig. 1981. "Economies of Scope." *The American Economic Review* 71 (2): 268–72.
- Plotkin, Stanley, James M. Robinson, Gerard Cunningham, Robyn Iqbal, and Shannon Larsen. 2017. "The Complexity and Cost of Vaccine Manufacturing—An Overview." *Vaccine* 35 (33): 4064–71. <https://doi.org/10.1016/j.vaccine.2017.06.003>.
- Porter, Michael E. 2000. "Location, Competition, and Economic Development: Local Clusters in a Global Economy." *Economic Development Quarterly* 14 (1): 15–34.
- Savedoff, William D. 2012. "Global Government, Mixed Coalitions, and the Future of International Cooperation." Center for Global Development Essay. Washington, DC: Center for Global Development. <https://www.cgdev.org/publication/global-government-mixed-coalitions-and-future-international-cooperation>.
- Shattock, Andrew J., Helen C. Johnson, So Yoon Sim, Austin Carter, Philipp Lambach, Raymond C. W. Hutubessy, Kimberly M. Thompson, et al. 2024. "Contribution of Vaccination to Improved Survival and Health: Modelling 50 Years of the Expanded Programme on Immunization." *The Lancet* 403 (10441): 2307–16. [https://doi.org/10.1016/S0140-6736\(24\)00850-X](https://doi.org/10.1016/S0140-6736(24)00850-X).
- Tonini, Marlon Daniel L., Raquel O. Lopes, and Maria Letícia C. Barbosa. 2023. "Brazilian National Production of Active Pharmaceutical Ingredients: Regulatory and Strategic Framework." *Anais Da Academia Brasileira de Ciências* 95 (December): e20230321. <https://doi.org/10.1590/0001-3765202320230321>.
- UNICEF. 2024. "UNICEF Annual Report 2023." New York: UNICEF. <https://www.unicef.org/reports/unicef-annual-report-2023>.
- Villanueva, Omar Everleny Perez, and Juan Carlos Albizu-Campos Espiñeira. 2023. "The Development of Cuba's Biotechnology: Mechanisms and Challenges." *Journal of Law, Medicine & Ethics* 51 (S1): 136–47. <https://doi.org/10.1017/jme.2023.119>.
- Yadav, Prashant. 2024. "Insights from India on Expanding Global Vaccine Production." *Think Global Health*, Council on Foreign Relations, February. <https://www.thinkglobalhealth.org/article/insights-india-expanding-global-vaccine-production>.

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