EconoFact Chats: COVID-19 and the Economics of Vaccine Development

Chad Bown, Peterson Institute for International Economics

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Michael Klein:

I'm Michael Klein, executive editor of Econofact, a nonpartisan web-based publication of the Fletcher School at Tufts University. At Econofact, we bring key facts and incisive analysis to the national debate on economic and social policies, publishing work from leading economists across the country. You can learn more about us and see our work at www.econofact.org.

Michael Klein:

One of the extraordinary events of the age of COVID was the relatively rapid development and wide scale production of a vaccine. In fact, the development of three different vaccines, by three pharmaceutical companies. As we all remember, in the first months of the pandemic, before the vaccines were available, we were forced into social isolation in the face of this virulent and deadly disease, while morbidity and mortality mounted. With the vaccines, however, we were eventually able to resume something closer to our pre-pandemic lives. But much of the world remains vulnerable, and many countries do not have access to the number of vaccines they need. This threatens not only their own populations, but the entire world, as the unvaccinated offer reservoir for the emergence of new variants of COVID.

Michael Klein:

What are the economic, legal, and political challenges of creating a vaccine in the face of an emerging deadly pandemic? How were these challenges addressed? And what were the successes and shortcomings of these policies? To discuss these issues, I'm very pleased to welcome back to Econofact Chats, Chad Bown of the Peterson Institute for International Economics. Chad is a widely recognized expert on international trade and has over the past two years been an important contributor to the analysis of vaccine production and deployment. Chad, thanks very much for joining me once again on Econofact Chats.

Chad Bown:

Thanks, Michael.

Michael Klein:

Chad, to begin, can you explain why there's an important role for government intervention in the development and production of vaccines...in the terminology of economics, why research and development of vaccines represents what economists call a market failure?

Chad Bown:

To understand market failures, I think it's probably easiest to begin with where markets don't fail. Economists like you and I, we like markets. They're used to match up buyers and sellers and they're pretty useful for most kinds of things. My favorite example is ice cream. I have a willingness to pay for ice cream, there's lots of companies out there that make it. Ben and Jerry's, Haagen-Dazs. We could list probably dozens more. In the end, we interact in a market. I get my ice cream and I'm happy, they sell me ice cream, they're happy, and society's happy. No one goes away unhappy. It's ice cream.

Chad Bown:

But for some things, and vaccines is going to be one of them, markets on their own just aren't enough. Governments need to step in and help, they need to intervene to get us closer to the outcome that ultimately is best for society. One reason for market failures is because of something that economists call externalities, or when the costs or benefits to society of consuming or producing a product are different from the costs or benefits to an individual or to a firm or company for coming up with that product.

Michael Klein:

Chad, in your recent Peterson Institute article titled 'COVID-19 Vaccine Supply Chains and the Defense Production Act' you state that there are both demand side and supply side market failures. What did you mean by that?

Chad Bown:

Maybe let's start with the demand side for vaccines. Here, the argument is the benefits to society; those are for everybody. The benefits to society of vaccines exceed the benefits to any one individual, and that's because, if you have a high enough rate of vaccination, you can actually break the spread of the disease, its transmission. You can help to reduce the stress on a country's medical system. There's lots of social benefits of vaccines in terms of getting rid of the disease. That's why, to encourage people to take vaccines, governments typically intervene. Governments often buy up these vaccines and have them distributed to people either for free or at really low, highly subsidized prices.

Michael Klein:

What about the supply side, Chad?

Chad Bown:

The supply side has other challenges, and these are probably trickier. It could take years, sometimes decades to develop new vaccines. The issue is, imagine you're a scientist, I'm a scientist. Why would I spend my time doing that? First, how am I going to eat? How am I going to pay my bills during this period of time which I'm just researching and I haven't come up with any vaccine? Second, why would I ever bother to spend my time doing that if, as soon as I invented it, somebody else could start manufacturing it and selling it? Or suppose I come up with this idea and I start manufacturing it, but then the government says, "Great, you invented it, but we're not going to compensate you for all those years you spent inventing it. We're only going to pay you for the time and effort you put in starting now when you're making it for us."

Chad Bown:

These are all market failures. The result is, unless you get the government to intervene and change the system, you're not going to have the right incentives and you're going to end up with too few vaccines getting researched, too few getting invented, and too few being manufactured.

Michael Klein:

In the face of these market failures, what are the ways governments have to see the development and production of vaccines and address especially these supply side problems?

Chad Bown:

Over the years, governments have developed a number of different techniques to help this supply side for vaccines. The first obviously is offering subsidies for research and development. Here, think of, say, the

government, the NIH, the National Institutes of Health, offering subsidies for researchers to tackle this problem. Governments have also established patent rights to protect intellectual property. If you invent something, say you're a scientist that works at a pharmaceutical company, you can have the exclusive right to make that vaccine, to profit from it for a period of time, say 5 or 10 or 20 years, that can create private sector incentives to do these kinds of inventions. But then a third, and this has really been pushed by the Nobel Prize winner, Michael Kremer, starting in the early 2000s, is something called an advance market commitment.

Chad Bown:

There, these advance market commitments, the way it works is the government, and remember, the government we've said is going to be the main purchaser of vaccines, the government can make a legal commitment in advance to buy a certain number of doses of a new vaccine. They say upfront, provided the vaccine has these particular characteristics, it's effective, it helps reduce the incidence of the disease, it's safe, and provided you get them to us by this date, then you'll ultimately get paid this amount. The government guarantees that the market will exist at some point off into the future, and that then creates the incentive for scientists and pharmaceutical companies to invest in coming up with a vaccine in the first place.

Michael Klein:

So these are very general outcomes or general rules that you're talking about. Are there particular challenges for the development, production, and distribution of vaccines for COVID?

Chad Bown:

Yes. So COVID-19 obviously was a pandemic and not all vaccines are for pandemics. But with the pandemic, and with this one in particular, we had tens of thousands of people dying every month and trillions of dollars of economic activity being lost. And so really what we needed was to emphasize the need for speed. And the problem is that getting a vaccine from beginning to end is usually a really long and costly process. I think of it as having maybe five steps. The first one is research, or inventing a vaccine candidate. In the case of COVID, the research was actually done pretty quickly. Within a couple of months, there were dozens and dozens of candidates all around the world in clinical trials and they were there because they had been built on decades of prior research. And really important for this research and for some of the vaccines that came about was globalization. The Pfizer bioNtech vaccine, for example, that it's ended up being so successful, well, that one was invented in Germany. The Johnson & Johnson vaccine was co-invented between scientists in the Netherlands and in Boston. The AstraZeneca vaccine was invented at Oxford University in the UK. So the inventions for these COVID vaccines were fairly quick, but the rest of the process would end up taking a lot longer. And the rest of the process is the other four steps.

Chad Bown:

And so the next step in that process is maybe the development through clinical trials. The manufacturing process. So first you have to make the vaccine, say the liquid of a vaccine at one plant, and that requires one set of really specialized equipment. And then it gets shipped off to a completely different plant to have the liquid put into assembly-line style into millions of those tiny little glass vials that are then going to be shipped off and distributed to healthcare workers around the world so that they can administer them safely to people on the ground.

Michael Klein:

How did the United States government implement these strategies to speed up the development and production of vaccines for COVID?

Chad Bown:

If we think back to April 2020. And so this is roughly a month after the World Health Organization has declared COVID a pandemic. The US government announced the creation of something called Operation Warp Speed, and they did this to accelerate the development, manufacturing, and distribution of vaccines.

Chad Bown:

This evolved a number of steps, including very importantly, invoking this thing called the Defense Production Act, or the DPA. And the DPA was a law that had been created during the Korean War to help the federal government deal with emergencies. Initially, obviously for armed conflict, but to be used anytime there was a threat, to say, the national defense. And in the case of COVID the Federal Government used it to write contracts with companies to force them to prioritize making vaccines instead of doing other things.

Chad Bown:

And also importantly, in a world of supply chains where one company doesn't do everything itself. In a world of supply chains, this Defense Production Act was also used to force other companies to prioritize making the inputs that those vaccine sponsor companies would need to actually make the vaccines themselves.

Chad Bown:

So one good example here that I found kind of highlights the importance of this. The company that was ultimately hired to put the vaccines for Moderna and Johnson & Johnson, two very successful COVID vaccines. The company that was hired to put those into those tiny glass vials; well, they were forced under the DPA to free up space in their plant by breaking a contract with a different company, a company that earlier they had promised to bottle a drug to treat thyroid eye disease.

Chad Bown:

So DPA meant companies you're going to prioritize things to do with making vaccines, instead of doing other things.

Michael Klein:

This successfully then led to the production of vaccines by the three companies, I suppose?

Chad Bown:

Yeah, though, I think it's also incredibly important to remember that initially there wasn't just those three companies. Initially the US gave funding actually to seven companies to start. And of those seven only six were successful enough in their early-stage trials so that the US government gave them the big contracts, the ones worth a billion dollars or more to really, really go for it. But casting a wide net was important as, expectedly, not all of those candidate vaccines worked out and for Americans, the now-forgotten vaccine candidates that were funded by the federal government included one from Novavax, from Sanofi, and GSK, and one from AstraZeneca.

Chad Bown:

Ultimately, Pfizer, Moderna and Johnson & Johnson came up vaccines that worked and were authorized by US regulators. But we didn't know that back when all this was beginning in early 2020.

Michael Klein:

Chad, you mentioned five stages of development. After research comes clinical trials and as you also mentioned, that typically takes a very long time. What was done to speed up this stage?

Chad Bown:

So these are the important phase III trials. And in this context, the US government essentially did two things. So first the government paid for a lot of them. And these phase III trials are not only lengthy and take time, but they're also expensive. It costs hundreds of millions of dollars for these things. You have to find, say 40,000 people all over the country, different ages, races, and ethnicities, health profiles, lots of different demographic characteristics.

Chad Bown:

The companies have to manufacture enough doses of their vaccine at that point, as well as a placebo. So, a fake vaccine, and then they randomly allocate to them to all these people. That's the first dose. And then you have to give them a second dose 21 days, or maybe 28 days later. You have to keep track of all these people. For many months you collect and assess all the data that you get on them, on their health outcomes, any side effects they're feeling from the vaccines, all that costs money and requires expertise. And so in a number of instances, the Federal Government paid for that.

Chad Bown:

Second, the government worked with the companies to help coordinate and expedite these trials. Normally these take an incredibly long period of time to get done. And for some of the companies going through this process, ones like Moderna, and Novavax, these were essentially startups. They're basically brand new with this. They've never put vaccines through this process before. And so not only did government financing help, but also technical assistance to make sure these companies followed all of the FDAs, the Food and Drug Administration, the key regulator here, all of their rules and protocols. So that the data got collected and analyzed in the way that ultimately the government regulators would need for them to be able to make decisions about whether any particular vaccine was safe and effective enough to be able to be distributed to the American public.

Michael Klein:

Well, what you describe sounds very daunting and it's impressive that they were able to speed that up. The next stages of manufacturing and distribution involved more companies who were part of the supply chain, as you mentioned, what were some of the particular challenges with this stage, and how did government policy address them?

Chad Bown:

And at this stage, there's six different vaccine candidates that are still in the pipeline and with the exception of Pfizer; so the rest of the five, all of them hired contractors to basically do the production for them. Now, for companies like Moderna, again, a small biotech kind of startup that was because it didn't have any commercial manufacturing facilities of its own to be able to do it. But that wasn't the case for some of the other companies, Johnson & Johnson or Astra Zeneca, right? They are big global pharmaceutical companies. So it's interesting why they hired contractors, but they did. They also needed

to go and find new suppliers of inputs. These were completely new products. They had to set up a supply chain completely from scratch. And that too is expensive and takes time.

Chad Bown:

And again, this pandemic people are dying, time is of the essence. And this process is really hard. Not surprisingly, there were input shortages. All of a sudden, all of these companies are asking for essentially, what are the same specialized inputs at the same time, so demand for the inputs is through the roof. So the Federal Government, again, through use of this thing called the Defense Production Act, there are these amazing stories of logistics experts from the department of defense being embedded into these supply chains, helping to ration scarce inputs from the input supplying companies, right? So they're asking themselves, who do we send this next bioreactor bag or filter that just came off the production line. Do we send it to the plant making the Moderna vaccine, or the Johnson & Johnson vaccine? Who was the last company to get one, who needs the next one? Unprecedented government involvement in these supply chains.

Chad Bown:

Normally, we economists would say use the price mechanism to just allocate these inputs from one company to the next. But here the shortages were so acute that you actually had the government step in and help make sure that they were getting to where they could be of their greatest use. The other thing the US government did is, for five of these vaccine sponsoring companies, it gave them funding early. So they got money in the summer and fall of 2020 to get that manufacturing process and their supply chains started. And this is four to six months before anyone knew whether any of these vaccines, we're going to make it successfully through their phase three clinical trials or not. Normally, setting up one of these supply chains is so expensive that companies wait and they make these big investments only after the uncertainty of that clinical trial has been resolved.

Chad Bown:

And the reason why they do that is because most of the time the vaccines are going to fail in trials, they aren't going to work out. And in that case, if you sunk all that investment, it's going to have been completely wasted. And indeed, in this particular case of COVID, the US government spent a lot of money setting up supply chains for three vaccines in particular, that didn't ultimately work out. So in a sense that money was kind of wasted, but in the end, that was completely okay because the government's diversification strategy meant that they did also spend money on three vaccines that did work out.

Michael Klein:

So, Chad, I don't know if anybody asked you this, but maybe you could turn your research paper into an action movie. What you're describing sounds like a cliff hanger kind of event, and having studied this at the end, are you sort of amazed that it worked out, or you just think that the strategy was so smart that it had to work out?

Chad Bown:

Well, I do think qualitatively, it was the right strategy to do, and if anything was going to work out, it was going to work out. But at the same time, it was such a terrible period that you are still amazed that it did work out as well as it did.

Michael Klein:

And so, as you point out in your research paper, after this initial success, the United States led the world in the production of vaccines.

Chad Bown:

Yeah. And again, by December of 2020, remember, the pandemic has sort of kicked off in December, 2019 in China, January, 2020. And so less than a year later in the United States, the Pfizer and Moderna vaccines are authorized by the Food and Drug Administration for use the Johnson & Johnson vaccine was authorized in February of 2021. The fact that the US government had provided funding for this at risk investment in production, that companies could get their supply chains set up in advance, well, that meant that millions of doses were available almost immediately. So Americans didn't have to then wait another four or six months for the companies to set up their supply chains and get them operational. And what that meant in the real sense of things was the United States became the first country outside of China, to be able to deliver a hundred million doses, 200 million doses, even 250 million doses of vaccines to its population. It was surely amazing.

Chad Bown:

And by the summer of 2021, there was enough doses to vaccinate every American of age who essentially wanted to be vaccinated. Now, this isn't to say that even the United States could not have done better. Researchers will be studying this for years, even at the time, technical experts who modeled this at the Accelerating Health Technologies group suggested that the US should have funded not six vaccine candidates, but 27. So they funded too few and they probably should have spent three times the amount the US government spent, not $18 billion, but over $50 billion. So the US could have done more, and it really did get lucky, but there are important lessons here for the rest of the world to learn from, that initial US approach in 2020.

Michael Klein:

So if this was the topic of a great action movie, we have a sequel as well, because you discuss in your article, subsequently the US fell behind China, India in the European Union, in the production of vaccines. And for various reasons, China and India are special cases that we don't need to get into. But what you note is really striking was how many more doses were produced in Europe relative to the United States, even the really effective mRNA vaccines from both Pfizer bioNtech and Moderna. So do you have an idea of why this happened? Was it policy to blame or were there other factors?

Chad Bown:

That's the really, really big puzzle. According to data from Airfinity, and this is sort of the best data that we have out there publicly; the combination of Pfizer and BioNTech made something like 1.8 billion doses in Europe and only 600 million doses in the US by the end of 2021. Moderna, the numbers aren't as drastically different, but they still did more in Europe compared to the United States. And so I think while there's a number of contributing reasons why this was the case, there's probably two that are really important that I would focus on.

Chad Bown:

The first was essentially the uncertainty over when companies making vaccines in the United States would be allowed to export under the Defense Production Act. So under those contracts that got US plants priority access to all those inputs in 2020, the contracts were written so that the US government owned the doses that were made from those inputs. They were the property of the US government. You couldn't export. The US government kept triggering options from the companies from Pfizer and Moderna for more doses in early 2021. And it was unclear when those inputs that were being used to manufacture those particular doses, when legally they would be permitted to make-

Chad Bown:

When legally they would be permitted to make doses that could be exported. That lack of clarity over when you could export from US plants mattered, because in Europe you didn't have that uncertainty. And so suppose I'm the head of Pfizer, BioNTech or, or Moderna, and it's late in 2020. At this point, I know from the clinical trials, my vaccine is safe and effective. The regulators have authorized it for use. Now I have to make the big decisions about where I'm going to make the next big investments to build out my capacity to export. Do I do it in Europe or do I do it in the United States? Well, this uncertainty at that stage over when you were going to be allowed to export from plants in the United States, that would tilt you in favor of doing those investments in Europe.

Chad Bown:

So I think that uncertainty over exporting the legacy of the 2020 US contracts and policy, that wasn't really clarified in early 2021. And I think that was a big factor. But there was a second separate potential policy failure in 2021 that I think was also important. And that's, I think, a major point that my paper tries to get at. This question of, even though that was the case, could the US government have recontracted with companies in early 2021 under this Defense Production Act to get them to also increase their American production capacity, in addition to what they were doing in Europe.

Chad Bown:

Now, how might they have done this? Well, the idea is remember the logic of those advanced market commitments that we talked about earlier, the ones that the US used in 2020 to ultimately get those early doses by guaranteeing that there would be a market there. The question is, could you reapply that same logic, but to this new setting? So at this stage, there's lots of new orders coming in from foreign governments, from countries like Canada, Japan, Australia. Why not package all of those orders up into bigger orders, present them to the companies as maybe one big order. But also, write a contract that's contingent on the company's adding additional production capacity.

Chad Bown:

So if they add an additional production line, say, that allows them to get the doses produced for everyone more quickly, then the company would get additional funding to cover those costs. So the idea is don't just contract on doses and give the companies flexibility on where to put what order in the queue, but instead contract on capacity. The problem is no one did this. And that, I think, arguably was a policy failure, no one organized it. It was partly a collective action problem. Who should be the one organizing that? Should it be the US government or somebody else?

Chad Bown:

But what you ended up seeing instead was government orders from all these foreign countries, just all got in line and the companies ended up fulfilling them, but on their own timetables. Expanding capacity where they wanted, when they wanted to meet their own profit objectives and not necessarily as largely, and as quickly as society may have wanted to help resolve the problems of the pandemic. So those are my two reasons. But again, why vaccine capacity expanded so little in the United States in 21 is such an important puzzle, that I think we need much more economic analysis and especially data crunching to ultimately get to the bottom of it.

Michael Klein:

So we've been discussing the supply side of vaccines. But of course, there's this demand issue as well. There are high rates of vaccination in the United States and the shortfalls in vaccinations don't seem to be so much from a lack of supply as from a reticence by some people to be vaccinated. So why does it matter

that the production of vaccines in the United States is falling short of the production in other countries when we have enough vaccines, it seems, for those who want to be vaccinated, at least.

Chad Bown:

As of today, that statement is just absolutely true. You're exactly right. Even globally, I think we've now reached the stage in mid 2022, where we have more vaccine doses overall than people are willing to take. So supply is no longer the constraint, but that wasn't the case a year ago, say in the summer of 2021 or really even six months ago. And the key question is what policies would've been required for US manufacturing facilities to have doubled or tripled their output at that stage, say the middle of 2021 to make supplies available to the world even larger? Especially supplies of the highly effective mRNA vaccines from the Pfizer BioNTechs and Modernas of the world that were only being made in Europe and the United States. Most of the world was only going to get those vaccines in particular through exports.

Chad Bown:

Earlier doses for the rest of the world would have meant fewer lost lives, fewer lockdowns and economic losses. Less likelihood, as you mentioned at the top, of the emergence of these new variants that are of concern. So hopefully there are lessons to be learned from this experience and from this research in helping the world to better prepare for next time, should there ever be a next time.

Michael Klein:

Well, there probably will, as we know. And lessons that will be learned. I'm sure some of them will draw from the important research that you've done, Chad. And also the integration of globalization and the creation, distribution, and use of vaccines, which you've also pointed out. So Chad, thank you very much for joining me today on this really important topic, and sharing your insights, which have been very, very valuable.

Chad Bown:

Thanks for having me, Michael.

Michael Klein:

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