Webinar: Encouraging the development and manufacturing of vaccines and diagnostics

WITH MICHAEL KREMER
HARVARD UNIVERSITY

Friday, May 1, 12:30 PM ET
Pre-Registration Required

Intro: MARKUS BRUNNERMEIER

Twitter: @MarkusEconomist
Markus’ intro

- Previous/future webinars
  - Joseph Stiglitz: Evaluating US Response
  - Dani Rodrik: Future of Globalization

- Speakers

Website: http://bcf.Princeton.edu
Vaccine/Tests & Externalities

- Get vaccinated
  - Tradeoff: avoid getting sick vs. -ve side effects
    +
    - don’t infect others
      (+ve externality)

- Internalize externality
  - Command & control
  - Permit not to be vaccinated (tradable?)
  - Pigouvian Tax/subsidy
Vaccine/Tests & Externalities

- Get vaccinated
  - Tradeoff: avoid getting sick \(\text{vs.}\) -ve side effects
  \[\begin{array}{ll}
  & \text{high} \\
  & \text{low} \\
\end{array}\]
  + don’t infect others (+ve externality)
  \[\begin{array}{ll}
  & \text{high} \\
  & \text{low} \\
\end{array}\]

- Internalize externality
  - Command & control
  - Permit not to be vaccinated (tradable?)
  - Pigouvian Tax/subsidy

Moral question/Fairness:
Should rich people be allowed to buy their way out?
Production: Vaccines/Diagnostic

- Externality: Reduced demand $\Rightarrow$ Reduced Supply

- Intervention:
  - Command & Control
  - Subsidize
  - X-Prize

+ uncertain investment (risk premia due to fin. frictions)

Advanced Market Commitments
  - [https://www.who.int/immunization/newsroom/amcs/en/](https://www.who.int/immunization/newsroom/amcs/en/)
Background: All-pay auction

- Prize $100
  - For highest bidder
- Bid & pay $x

Suppose 4 bidders:
- You: $50
  - You bid next: $99
- Others’ bids: $98, $80, $40

POLL01: Yes or No
Background: All-pay auction

- **Prize** $100
  - For highest bidder
- **Bid & pay** $x

Suppose 4 bidders:

- You: $50
  - You bid next: $99

  **POLL01**: Yes or No

- You $99
  - You bid next: $101

  **POLL02**: Yes or No

Others’ bids: $98, $80, $40

Others’ bids: $100, $80, $40
Background: All-pay auction

- Prize $100
  - For highest bidder
- Bid & pay $x

Suppose 4 bidders:
- You: $50
  - You bid next: $99
    - POLL01: Yes or No
- You: $99
  - You bid next: $101
    - POLL02: Yes or No
- You: $102
  - Others’ bids: $101, ....
Vaccine-X-Prize

- Prize $100
  - For highest bidder
- Bid & pay $x

- $100M for vaccine discovery
- $xM in R&D expenditures

Suppose 4 bidders:

- You: $50
  - You bid next: $99

You: $99
  - You bid next: $101

What if social pressure doesn’t allow Pharma companies not to be part of the R&D race?
(Dynamic) Mechanism Design

- How long to stay in the R&D race for a new vaccine? (roll out a diagnostic test)

- Timing games
  - “War of attrition” Bulow & Klemperer, ...
  - with R&D spillovers Reiganum, ...
  - With co-opetition
    - Clock games with Abreu, Morgan
  - ...

+ many other relevant aspects
Patent buy-outs

- Michael Kremers’ 1998 paper
  PATENT BUYOUTS: A MECHANISM FOR ENCOURAGING INNOVATION

- Eliminates monopoly distortion
- Eases adoption and follow-up research

- At what price?

- Notice similarity to Michael’s webinar title!
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Intro: MARKUS BRUNNERMEIER Twitter: @MarkusEconomist
FINANCING A COVID-19 VACCINE

Susan Athey, Stanford
Arthur Baker, Harvard
Owen Barder, Precision Agriculture for Development
Juan Camillo Castillo, Stanford
Michael Kremer, Harvard
Jean Lee, World Bank
Jonathan Levin, Stanford
Christopher Snyder, Dartmouth
Alex Tabarrok, George Mason
IMF estimates $9 trillion loss due to COVID-19 over two years

Suggests ~$375B gain from accelerating development of effective vaccine by one month

Normal vaccine timeline:

- At least 3-4 years from initial testing to commercial use
- Capacity installation only after trials (at least 6 months)
- Firms build limited capacity to serve high income market initially, long delays before roll out to LMICs.
Private incentives to accelerate vaccine development may not correspond with social benefit

- Disease externalities; spillover economic benefits from reduced social distancing, government buyers
- Installing large capacity may put pressure on prices in high-income countries

Back of the envelope calculation:

- Costs of “wasted” capacity vs. benefits of accelerating vaccine?
- If positive, how many vaccines worth large-scale accelerated investment?
Collect data on vaccine candidates by stage of development, technological approach

Estimate chance of success for each, based on historical record, adjustments for production difficulty given accelerated timeline, expert input

Incorporate correlated risks (by platform)

Will refine approach over time

Estimate that 14 candidates necessary for 90% chance at least one vaccine available within 18 months

Implies lots of “wasted” capacity
CALCULATING THE OPTIMAL NUMBER OF VACCINE CANDIDATES

Marginal benefit:
- Marginal increase in probability of vaccine development * $375 billion per month * 6 months advance in vaccine development
- Discounted by 50 percent chance that drug developed that averts 50 percent of COVID-19 costs

Marginal cost:
- $1 per annual unit of capacity (takes into account capacity fungibility)
- Consider case of 6B annual capacity, so can vaccinate 1.5B people within three months.
  - Rough estimate of vulnerable + health workers

Social optimum:
- Equate marginal cost and benefit if invest in 15 vaccines
- Total social benefit ($1.59 trillion) >> total social cost ($90 billion)
STRUCTURING FUNDING

- Consider a model in which mass of firms have private information that low chance of producing vaccine rapidly.

- Suppose impossible to perfectly audit costs.
  - Particularly in context of multi-product firms, repurposing facilities.

- Suggests that may be appropriate to cap reimbursement of capacity expenditures. Consider 80% cap.
PROPOSED FUNDING STRUCTURE

- Provide direct finance to cover 80% of the cost of manufacturing capacity
- Firms are required to cover 20% of capacity cost, so they have skin in the game
- Around $72.5bn for 15 vaccine candidates.
- In return firms agree to provide an option to purchase
  - Two-part pricing to reward firm, while generating static efficiency
- Set “pull” funding to make marginal firm willing to participate.
CALCULATING REQUIRED PULL FUNDING

- Cost for firm to install manufacturing capacity = $1.2bn (20% cost share).
- Production cost borne by firm (if sole successful vaccine) = $4.5bn ($1 per person, 4.5bn people).
- Probability of success for marginal (15th) candidate = 11%
- Probability of getting funding for marginal candidate = 33%
- Firm indifferent whether to invest when pull funding is $39.5bn
- To adjust for risk, incentivize speed, set the price per dose at $35 for the first bn, $5 for the subsequent 3.5bn. Total pull funding of $52.5bn
PULL FUNDING

- $52.5 billion in bonus if vaccines available within 18 months
- Price structure: $35 for the first 1bn, $5 each for subsequent 3.5bn
- If multiple vaccines developed, governments have authority to choose which product or products to purchase.
- Top up vs. price: firm participation constraint
SUPPLY CHAINS: FOR WANT OF A VIAL, THE VACCINE MAY BE LOST.

- The supply chain for vaccines will be under pressure. Glass vials may be a bottleneck.
- Consider investing in production of key inputs?
COULD INTERNATIONAL COOPERATION BE INCENTIVE COMPATIBLE?

- Consider partnership in which each member contributes 0.15% of 2018 GDP ($125bn)
  - World Bank loans for developing countries. IDA? Forgivable if no vaccine?
- Enough capacity would be built to serve all members’ vulnerable population within 3 months, entire population within one year
- Members get first access to vaccine
- Non-members are not subject to price cap
- If a critical mass of countries join, in each country’s national interest to join:
  - Avoid risk that own candidates fail
  - The returns of early vaccination for vulnerable populations are very large.
  - Compatible with extra financing for domestic candidates.
- Arguably incentive compatible early, but not later
LIGHT COOPERATION?

- Deals with foreign firms to finance extra capacity in advance, in order to diversify their portfolio
- Agreement on non-exclusivity?
- Informal coordination on supply chains?
INNOVATIONS TO SPEED VACCINE TRIALS?

- Early revelation of clinical trial data to guide manufacturing decisions
- Testing multiple vaccines together?
- Adaptive trials
- Challenge trials
END
FIRMS CAPTURE A SMALL FRACTION OF SOCIAL RETURNS FROM ADVANCING A VACCINE

- Will argue large scale production capacity is needed to speed up vaccine production.
- Installing capacity is expensive. Firms could serve the same population over a longer period with less capacity.
- Firms must install capacity in advance to produce as soon as a vaccine is ready. Firms bear risk, but benefit is to society as a whole.
- Static distortions: firms might price out countries which value vaccine above marginal cost.
- If firms produce a very high volume of vaccine, they may worry they will need to sell to LICs at lower rates, which might undermine their price margins in HICs.
THE CASE FOR GOING BIG: CAPACITY

- Firms lack incentives to build/repurpose the socially efficient capacity. If firms produce a very high volume of vaccine they may worry they will need to sell to LICs at lower rates which might undermine their price margins in HICs.
Probabilities includes estimates of correlation of risks across candidates within a platform. Data on vaccine candidates from WHO.
Weitzman (2012) has emphasized the importance of limiting global carbon emissions as a kind of insurance to limit tail risks. The same issue of tail risk arises with COVID-19 but over a matter of months and years rather than over many decades.

- Will a treatment make a vaccine less necessary (we assume a 50% probability of reducing value of vaccine by 50%).
- Could COVID-19 dissipate due to weather, beneficial mutation, herd immunity or other factor?
- Could COVID-19 return in the fall in a second wave, as did Spanish flu, worse than the first wave?
- Could detrimental mutations make COVID-19 worse?
- Could COVID-19 turn into an endemic disease requiring annual vaccination?
- Many unknowns and many unknown unknowns.
- The risks justify significant investment even if fortune favors us.
CALCULATING THE OPTIMAL LEVEL OF INVESTMENT

To calculate optimal level of investment, find:

1. N vaccine candidates at which marginal cost = marginal benefit.
2. Push funding required of 500m per month capacity for N vaccine candidates.
3. Pull funding required to induce Nth candidate to participate.
CALCULATING THE OPTIMAL NUMBER OF VACCINE CANDIDATES
HOW DOES THIS FIT WITH MONDAY’S PLEDGING CONFERENCE?

- Donors are seeking to raise $8bn in funding for vaccines, therapeutics and diagnostics. Far too low.
- This has mainly been thought of as a developing country initiative. It is in the interest of developed countries to join and make this much bigger.
- A vaccine could easily cost $500 per person (it would be highly cost-effective at that price if it enabled reopening the economy).
- If the UK bought the vaccine for 50% of the population that would cost UK £10bn. USA might well spend 10 times that.
- Spending some of that money now to help ensure there is sufficient supply would bring a vaccine sooner.
QUANTIFY AND REFINE

- Our approach is to find a quantitative estimate, and refine over time.
- These numbers are not set in stone.
CALCULATING REQUIRED PULL FUNDING

The marginal firm is indifferent about participating where expected cost = expected benefit

- The marginal firm’s expected cost is:
  \[0.2 \times \text{probability of success} + \text{probability of getting funding} \times \text{production cost}\]

- The marginal firm’s expected benefit is
  \[(	ext{probability of success}) \times (	ext{probability of getting funding}) \times \text{pull funding value}\]