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Grand Innovation Prizes to Address Pandemics: A Primer

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The world needs rapid innovation to address the myriad consequences of the COVID-19 pandemic.[1] The sudden onset of the pandemic and its immense human and economic costs suggests that ordinary processes are not enough. The world also needs innovation in innovation generation. Prizes are an important tool for this purpose.

World stock markets have lost *trillions* in value owing to the pandemic, and the decline in stock market value is only a partial estimate of the decline in economic output. Moreover, the decline in output is only a partial estimate of the decline in welfare. Thus, multiple multibillion-dollar prizes are well within the realm of what is economically sensible.

ADVANTAGES OF PRIZES

Prizes have an important advantage in that they can be announced quickly. A billion-dollar prize for a new vaccine against COVID-19, for example, does not require investigating or evaluating scientific hypotheses or scientific teams. It doesn't even require a billion dollars. It requires only a credible announcement and a clear measure of vaccine effectiveness so that candidates can be evaluated and rewarded. To borrow terms from the literature on fiscal and monetary policy, the implementation lag for prizes is low.

Under the America COMPETES Reauthorization Act of 2010, US agencies have the authority and significant funds (up to $50 million, which may be pooled) to create prizes. Section 24 permits any agency head to "carry out a program to award prizes competitively to stimulate innovation that has the potential to advance the mission of the respective agency."[2] The European Commission has also used prizes to combat antimicrobial resistance and to pursue other goals. Thus, there is

significant authority and knowledge in place to implement prizes quickly. A billion-dollar prize or series of prizes is also well within the capabilities of a number of individuals and private organizations throughout the world.

BEST PRACTICES

Prizes work especially well when solutions are hard to find but easy to recognize. A vaccine is hard to find, for example, but relatively easy to test and verify. For the famous longitude rewards of the early 18th century, the British government knew what it wanted: a way to measure longitude. But the experts had failed to solve the problem, and no one knew the best means to solve the problem. Thus, the Parliament of Great Britain offered £20,000 for a solution that could allow measurements of longitude to within half a degree, a relatively easy-to-measure output. More recently, the Defense Advanced Research Projects Agency (DARPA) helped catalyze the autonomous driving industry by running a series of contests and challenges. The prospect of winning prizes spurred technological innovations that were always thought to be at least 30 years away by the auto companies.[3]

Prizes can be open to anyone in the world, an especially valuable property when the solution space is large. An open prize also fits the current situation because everyone in the world wants a solution, and thus, innovation could be stimulated globally. The greatest amount of longitude rewards money was eventually won by John Harrison, a clockmaker with little formal education. Scientific innovation prizes are often won by experts in domains that are unrelated to the field of the problem.[4]

A vaccine or treatment prize could work especially well if it were to replace a patent or other intellectual property. In other words, a condition of the prize could be that the solution is made available to the world as a public good. Note, however, that this condition only makes sense with very large prizes. To increase innovation incentives, the prize should be large enough so that the winner *prefers* the prize to a patent.[5]

A prize need not be lump sum but could be tied to usage. For example, a $1 billion prize for a vaccine plus a $5 payment for every person vaccinated would tie innovation incentives even more closely to social incentives. The Advance Market Commitment for vaccines is a successful example.[6] A prize tied to usage combines the best aspects of a prize and a patent. The prize helps to align incentives with public good production; the usage (patent-like) aspect helps to align incentives with market demand. A related advantage of tying the prize to usage is that less needs to be done up front in specifying the characteristics of the solution. For example, in the Advance Market Commitment, the vaccine had to satisfy certain properties, such as being shelf stable and administrable in developing countries. These details can be key in deciding what satisfies the prize conditions but are less necessary to the extent that the prize is tied to usage.

IMPLEMENTATION PROCEDURES

A prize should be credible, open to the world, and large. These considerations suggest implementation procedures. For the longitude rewards, the British set up the Board of Longitude to assess submissions and set reward amounts. A similar board should be established to define prize outcomes, assess submissions, and offer rewards for solutions to the COVID-19 pandemic. For political credibility, the board should have powerful members, including members from political office or recent political office; it should have US and international members; and it should have scientific credibility, not just on medical science but also on evaluation and prize design. Bill Gates, Barack Obama, and Christine Lagarde, Chinese epidemiologist Zhong Nanshan, economists Joshua Angrist and Tyler Cowen, World Health Organization epidemiologist Assad Hafeez, XPRIZE Director of Prize Management Devin Krotman, and prize researchers Karim Lakhani and Fiona Murray are the types of names to consider. The board should have a significant budget to perform necessary studies.

It's important that the board be independent and have significant authority. Setting the conditions for a prize isn't simple, and in XPRIZE competitions, for example, the exact conditions for winning have evolved during competition.[7] The board must be flexible without being subject to the lawsuits (i.e., rent-seeking) that other government programs face.[8]

A board is needed to establish exactly which prizes to offer. For reasons of exposition, I have assumed that a general "vaccine prize" is an obvious contender, but more finely-tuned prizes may be more useful. A prize can be useful, for example, when the people in a field don't have the knowledge to solve a problem in their field. Netflix, for example, ran a prize to improve the accuracy of predictions about how much someone would enjoy a movie based on his or her movie preferences. (Note that the desired output can be well measured.) Netflix has expertise in delivering movies over the internet, not necessarily in using big data to make predictions, a very general problem with most expertise in computer science and well outside the specific movie domain. Similarly, innovation expert Karim Lakhani and his coauthors used a prize-based contest to solve a problem in computational biology. They found that

> although the solvers were virtually devoid of domain-specific knowledge, abstracting the problem into general algorithmic and mathematical terms allowed a wide range of non-domain experts to address an important, complex problem. These contestants brought to the problem whatever skills and expertise they had or could find, probably yielding a far more diverse toolkit than would be available locally, and generated substantial diversity in technical approaches.[9]

Thus, a board may establish a prize to solve an intermediary problem on the way to a full solution. Indeed, a board may choose to implement a range of prizes—for producing ventilators, for developing Bayesian trial designs that allow researchers to get results faster, for creating websites to allow doctors to securely share treatment information, and for other valuable goals.[10] Different prize goals

may motivate different prize structures. For example, the Netflix prize and many computational prizes have worked as a contest, with competitors posting results on leaderboards. It's possible to structure a contest in stages, with top performers in stage 1 continuing to stage 2, and so forth. A staged design reduces the amount of testing that needs to be done to award a prize and provides time discipline. First- and second-place prizes may be useful to reduce the risk on competitors. Prize design can be complicated.[11]

OPEN-ENDED PRIZES AND GRANTS

A prize is easiest to administer and award when the output can be defined in advance. But there are many other innovations that could be useful to avoid, treat, or deal with a pandemic. With an independent board in place, there can be a set of prizes that are less well defined and relatively agnostic as to the type of solution.

Prizes are meant to stimulate innovation, and they can do so not just through funding but also by drawing attention to and popularizing types of actions that are socially valuable. When we honor people who have rescued others at risk to themselves, we are doing so not primarily because we think the prize stimulates others to act similarly but because we want to broadcast the types of actions that are honorable and because we think people will act for honor. For example, in Italy a hospital faced a shortage of critical valves. Cristian Fracassi brought a 3D printer to the hospital and, in a few hours, redesigned and produced new valves.[12] A prize for this kind of quick and innovative thinking is not meant to motivate quick and innovative thinking directly but to send a message about what kinds of actions are socially valuable and to be widely honored.

Prizes and grants can be complementary. Prizes can be implemented quickly and may surface promising approaches that can then be supported with grants. Similarly, emergency grants may surface where the best places are to award prizes. Thus, prizes should be thought of as a discovery procedure rather than just an innovation incentive.

LIMITATIONS AND CONCLUSION

It's important to be realistic. A prize—even a large prize—is no guarantee of a solution. Experts typically do have the best solutions to problems. The constraint on solutions is often not a lack of brilliant, out-of-left-field ideas, but a lack of capital and time. Innovation is a long-run game. Basic research and testing take years of effort with people trained at the highest levels. Long-term funding of basic research at universities is critical not just because of the knowledge produced by university labs, but because universities train the next generation of scientists who go on to work at private firms. Universities are going to be hard hit by the crisis, and even as they lose students, support for scientific fields should be maintained or increased. Most research and development is done by private firms, and we need to maintain innovation incentives for the long run.

Nevertheless, at this point in time, when we are uncertain about the best ways to combat the COVID-19 pandemic and we want to draw on as many people and on as wide a domain of knowledge as possible, prizes are an important weapon in our arsenal.

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NOTES

1. I thank Pierre Azoulay, David Balan, Karim Lakhani, and Tyler Cowen for comments.
2. America COMPETES Reauthorization Act of 2010 § 24(b), Pub. L. No. 110-69, 121 Stat. 572 (2010).
3. A list of innovation prizes can be found in Knowledge Ecology International, "Selected Innovation Prizes and Reward Programs" (KEI Research Note No. 2008:1, Knowledge Ecology International, Washington, DC, 2008). For an in-depth report on recent space technological prizes, see Luciano Kay, *Technological Innovation and Prize Incentives: The Google Lunar X Prize and Other Aerospace Competitions* (Cheltenham, UK: Edward Elgar, 2012).
4. Lars Bo Jeppesen and Karim R. Lakhani, "Marginality and Problem-Solving Effectiveness in Broadcast Search," *Organization Science* 21, no. 5 (2010): 955–1123.
5. Steven Shavell and Tanguy van Ypersele, "Rewards versus Intellectual Property Rights," *Journal of Law and Economics* 44, no. 2 (2001): 525–47; Michael Kremer, "Patent Buyouts: A Mechanism for Encouraging Innovation," *Quarterly Journal of Economics* 113, no. 4 (1998): 1137–67. Note that DARPA prizes did not require making the solution a public good, although in that case less was at stake than with a vaccine. The prize and buyout processes are distinct, and it may be better to offer a prize for any innovation and then have a separate process for buying the patent rights. For a model in which prizes and patents are complementary, see Alberto Galasso, Matthew D. Mitchell, and Gabor Virag, "A Theory of Grand Innovation Prizes," *Research Policy* 47, no. 2 (2018): 343–62. For further discussion, see also Thomas Kalil, "Prizes for Technological Innovation" (Discussion Paper No. 2006-08, Hamilton Project, Washington, DC, December 2006); Kay, *Technological Innovation*; and Fiona Murray et al., "Grand Innovation Prizes: A Theoretical, Normative, and Empirical Evaluation," *Research Policy* 41, no. 10 (2012): 1779–92.
6. Michael Kremer, Jonathan D. Levin, and Christopher M. Snyder, "Advance Market Commitments: Insights from Theory and Experience" (NBER Working Paper No. 26775, National Bureau of Economic Research, Cambridge, MA, February 2020).
7. For useful descriptions, see Kay, *Technological Innovation*; and Murray et al., "Grand Innovation Prizes."
8. Kalil, "Prizes for Technological Innovation."
9. Karim R. Lakhani et al., "Prize-Based Contests Can Provide Solutions to Computational Biology Problems," *Nature Biotechnology* 31, no. 2 (2013): 108–11.
10. For a small-scale implementation, see Emergent Ventures home page, accessed March 18, 2020, https://www.mercatus.org/emergentventures.
11. Murray et al., "Grand Innovation Prizes"; Kay, *Technological Innovation*.
12. Davide Sher, "[Updating] Italian Hospital Saves COVID-19 Patients' Lives by 3D Printing Valves for Reanimation Devices," *3D Printing Media Network*, March 14, 2020.