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Incentivizing Innovation: Adding to the Tool Kit

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Executive Summary

Intellectual property rights (IPR) create incentives for research but impose static efficiency losses and other costs. In this essay, we discuss recent proposals of other mechanisms for rewarding innovation and argue that incremental experimentation with mechanisms that supplement rather than replace IPR can help to test and refine these mechanisms without undermining existing institutions. Prizes, such as those recently offered by the X-Prize Foundation, have been successful in spurring research but have typically targeted demonstration projects rather than innovations capable of being used at scale. To spur the creation of products for widespread use, the design of prizes could be usefully extended by conditioning rewards on a market test, as in the recent $1.5 billion pilot Advance Market Commitment (AMC) for a pneumococcus vaccine.

I. Introduction

Economic growth depends on technological progress, and the nonrival nature of scientific knowledge generated by research and development (R&D) implies that institutions beyond competitive markets are required to promote innovation. Intellectual Property Rights (IPR) such as patents are one such institution.

However, there recently has been a resurgence of academic and policy concern over the costs imposed by patents and a renewed interest in alternative policy proposals. In this essay, we discuss some of these proposals and argue that incremental experimentation with mechanisms that would be voluntary alternatives or supplements to IPR could be used to test and refine these mechanisms while at the same time limiting the risk of undermining the expectations of reward critical to the current IPR system.

We first discuss some of the trade-offs arising under patent systems and briefly outline three other mechanisms that have been proposed as

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ways to encourage innovation while also addressing some of the concerns arising under patent systems—prizes, Advance Market Commitments (AMCs), and the proposed Medical Innovation Prize Fund (Sec. II). In Section III, we compare the triggers for reward payments under these mechanisms and argue that the impact of the mechanisms is likely to be sensitive to the design of these triggers. We argue that in contexts where sponsors wish to spur not just demonstration projects but, rather, innovations capable of being used at scale, the design of prizes—such as those recently offered by the X-Prize Foundation—can be usefully extended by conditioning rewards on a market test, as in the recent $1.5 billion pilot AMC for a pneumococcus vaccine. We then review the distinction between voluntary mechanisms (i.e., mechanisms that supplement the current system of IPR) and mandatory mechanisms (i.e., mechanisms that replace the current system of IPR) for rewarding innovation (Sec. IV). Because the current system of innovation relies on firms anticipating that they will receive IPR, we argue that voluntary mechanisms will involve lower risks of undermining expectations that research will be rewarded than would mandatory mechanisms. We then focus on an approach for incremental experimentation within AMC design in more detail (in Sec. V), focusing first on technologically closer products (such as a pneumococcus vaccine) and later on technologically more distant products (such as a malaria, tuberculosis, or HIV vaccine). Section VI concludes.

II. Patents and Other Mechanisms for Rewarding Innovation

Research and development can be promoted either through up-front support for R&D inputs (so-called push programs) or through commitments to reward successful products (so-called pull incentives). There is ample evidence that innovation responds to incentives (Griliches 1957; Schmookler 1966; Hayami and Ruttan 1971; Acemoglu and Linn 2004; Finkelstein 2004; Brunt, Lerner, and Nicholas 2008), and patents are one example of an institution that uses incentives to reward innovation.

Patents provide incentives for innovation by allowing the developers of new products a period of market exclusivity. Patents involve a trade-off between the benefit of providing dynamic incentives for innovation and the cost of providing these incentives in a way that imposes static distortions—that is, because patents make goods more expensive to consumers, at the margin some goods will not be used even when their social value exceeds the cost of production.[1]

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Note that the patent system is fragile in the sense that it is dependent on firms' expectations about future rewards. These expectations may be easier to destroy than to create, in part because a benevolent social planner considering the creation of a new IPR system will face a time-consistency problem. Depending on the difficulty of establishing reputation, a social planner with a reputation for protecting IPR may choose to keep an existing system of IPR in place, while a social planner without a reputation may find that the static costs of maintaining an IPR system exceed the expected dynamic benefits.

The patent system does not result in a first-best outcome, and, under reasonable assumptions, patents are not even the constrained optimal mechanism for a planner facing asymmetric information on the value of new inventions (Chari, Golosov, and Tsyvinski 2008). Yet, one hypothesis for why we have not observed alternative pull institutions expand widely historically is that there have been political economy difficulties in the implementation of alternatives. Jaffe and Lerner (2004) argue that firms engaged in R&D under the patent system face substantial risks of as-yet unknown or untested patents being asserted against them.[2] However, one benefit of patents is that they create at least a rough link between the desirability of a product to consumers and the reward to inventors. Patents thus avoid situations in which some authority has wide discretion to reward nonuseful innovations, whereas alternatives to the patent system could potentially destroy this link and reward rent seeking rather than desired innovation.

As an example, consider the £20,000 prize offered in the 1700s by the British government. The prize aimed to spur the development of a method for ships to determine their longitude while at sea. The Board of Longitude expected astronomers and mathematicians to develop a solution through celestial observations of the positions and motions of heavenly bodies, but, in fact, the solution was developed by a clockmaker named John Harrison. Harrison developed a timepiece that was sufficiently accurate to determine time at the port of departure even on ships subject to usual sources of bias such as moisture and vibration. The committee asked for repeated tests of Harrison's chronometer, and it took 12 years of tests to prove the worth of Harrison's invention to the committee and to reward him with his prize. This example offers several lessons that can guide future attempts to test and refine prize mechanisms. On the one hand, the Longitude prize "worked" in the sense that it was successful in spurring the development of the desired product. On the other hand, at least by some accounts, the prize made it overly complicated for Harrison to collect his prize, both because the chronometer solution did not fit the preconceptions of the

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prize setters and because the process for judging the merits of candidates was not well specified in advance. In her popular book on the subject, Sobel (1996) argued that these delays were unnecessary; others have argued that the Board of Longitude was justified in requiring these tests.

In recent years, there has been a resurgence of interest in both alternatives and supplements to the current system of IPR motivated by the idea that alternative types of mechanisms for rewarding innovation may better mitigate some of the trade-offs arising under the patent system. Below, we briefly outline three mechanisms that have recently attracted attention—prizes (Sec. II.A), Advance Market Commitments (Sec. II.B), and the proposed Medical Innovation Prize Fund (Sec. II.C).[3]

It is worth noting that even though today we view the patent system as integral to supporting our system of innovation, the patent system required both time and trial-and-error to develop. Since the first U.S. Patent Act was put in place in 1790, rules have developed on what is allowed to be patented, who is allowed to file patents, how long patents can be held, and so forth. The patent system has arguably offered examples of failures in both directions—that is, the awarding of rewards to innovations that should not have been rewarded and the denial of rewards to innovations that should have been rewarded—but, over time, the patent system has evolved to overcome at least some types of failures. Other innovation mechanisms such as those described below would similarly require time and trial-and-error to be tested and refined.

A. Prizes

In recent years there has been renewed interest in prizes or commitments to reward innovators who meet a set of technical specifications laid out in advance. For example, the X-Prize Foundation offered a $10 million prize for the first nongovernmental organization to launch a reusable, manned spacecraft into space twice within 2 weeks. This prize was awarded in 2004 to a team led by aircraft designer Burt Rutan and financed by Microsoft cofounder Paul Allen. Similar subsequent X-Prizes were later announced—including the Archon X-Prize in 2006 and the Google Lunar X-Prize in 2007. As another example, in 2008 U.S. Senator John McCain (R-AZ) proposed a $300 million prize for a car battery that would "leapfrog" the abilities of current hybrid and electric cars.

Prizes have historically focused on providing incentives for demonstration projects rather than products ready to be used at scale, and thus have tended not to focus on promoting access to new technologies

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conditional on successful development. That said, prizes could promote access if they included requirements for patents to be placed in the public domain or for a product be sold at a particular price.

Many prizes involve cash payments, but the fast-track regulatory approval incentive proposed by David Ridley, Henry Grabowski, and Jeffrey Moe (2006), and recently implemented in the United States, can also be considered a prize. In exchange for developing a treatment for a neglected disease, this pull incentive rewards pharmaceutical companies by fast-tracking regulatory (e.g., FDA) approval on either targeted products (i.e., the drugs to treat neglected diseases) or other, more profitable medicines (the program uses vouchers that are transferable both across products and across firms). To the extent that fast-track regulatory approval has no adverse effects, this provides an incentive to pharmaceutical firms at very low cost.

B. Advance Market Commitments

Advance Market Commitments are similar to prizes but condition reward payments on use of the product (a feature we refer to as a "market test," described below). We here focus on the application of AMCs to the case of vaccines for neglected diseases concentrated in poor countries, because policy discussions of AMCs have largely focused on that application. For additional discussions of AMCs, see Kremer (2001a, 2001b), Kremer and Glennerster (2004), and Barder, Kremer, and Levine (2005).

Under an AMC, one or more sponsors legally commit—in advance of product development and licensure—to underwrite a guaranteed price for a maximum number of predefined purchases of the vaccine. Vaccines are eligible if a committee deems that they fulfill a set of technical specifications laid out in advance, such as the maximum number of needed doses, the required level of efficacy in a certain population, and so forth. Sponsors guarantee to provide a top-up payment (say, $15 per treatment) conditional on poor countries expressing demand for a given product and paying (or other qualified purchasers, paying on their behalf) a low, relatively affordable price (say, $1 per treatment). The higher, guaranteed price provides a return for developers of the product, and, in exchange, these developers agree to a cap on the long-run price that they charge for the product (or agree to license the technology to other manufacturers). If no suitable product is developed, no AMC payments would be made.

Italy, the United Kingdom, Canada, Norway, Russia, and the Bill and Melinda Gates Foundation recently announced a $1.5 billion pilot AMC for a pneumococcus vaccine suitable for children in the developing

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world.[4] United Kingdom Prime Minister Gordon Brown has suggested that this be the first in a series of AMCs to encourage the development of vaccines against diseases affecting the developing world.

C. Medical Innovation Prize Funds

Under the Medical Innovation Prize Fund proposal, described by Love (2005), developers of new products would be financially rewarded through payments from a Medical Innovation Prize Fund rather than through market exclusivity.[5] Generic companies would be allowed to freely compete.

Love (2005) proposes that the total size of the fund be 0.5% of U.S. gross domestic product and that this be shared across new products based on the estimated incremental health benefits, although he also notes that some of the fund could be earmarked for priority projects, such as neglected diseases and orphan drugs. Note that in contrast to AMCs, which focus on a specific product, the proposed Medical Innovation Prize Fund covers a much wider domain (virtually all pharmaceutical research). The payments to participating firms are proposed to be paid out over 10 years and to be based on the estimated incremental health benefits of new products. A version of this proposal was introduced in the U.S. House of Representatives in 2005 by Representative Bernard Sanders (I-VT) in HR 417—the Medical Innovation Prize Act of 2005.

To preview the argument made in the remainder of this essay, we propose the following agenda for incremental experimentation with such alternative mechanisms. To lower the risks of undermining expectations that research will be rewarded, we propose initially experimenting with voluntary mechanisms that supplement the current system of IPR rather than mandatory mechanisms that would replace the patent system. Prizes for demonstration projects, such as those recently offered by the X-Prize Foundation, are a natural starting point. To move prizes closer to a point where they stimulate research on innovations capable of being used at scale, it will be useful to experiment with different ways of incorporating market tests into reward payments—as, for example, with the pilot AMC. Experimentation with AMCs will likely also inform the design of other mechanisms incorporating more complex ex post reward triggers, such as the proposed Medical Innovation Prize Fund. Based on the results of such experimentation, mandatory mechanisms could then be better assessed.

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III. Designing Mechanisms to Encourage Innovation: Triggers for Reward Payments

Ideally, mechanisms for rewarding innovation would credibly commit to reward appropriate innovations while not committing sponsors to pay for innovations that end up not being useful or desirable.[6] The design of triggers for reward payments needs to balance these objectives.

In this section we discuss three potential elements of a system for triggering reward payments: fulfillment of technical specifications set ex ante (Sec. III.A); measures of ex post use, willingness to pay, or impact (Sec. III.B); and ex post discretion (Sec. III.C). As we discuss below, most mechanisms will use a combination of two or three of these triggers.

A. Ex Ante Technical Specifications

Technical specifications set ex ante are a feature of many prizes. For example, the Wolfskehl Prize, established in 1908, pledged to reward the first person to prove Fermat's Last Theorem. For such mathematics prizes, sponsors can very clearly describe in advance what they are looking for. A series of prizes established in 1959 by Henry Kremer sought to encourage innovation in human-powered flight by offering prizes for demonstration projects, including the first human-powered aircraft to fly a figure eight around two markers one-half mile apart, starting and ending the course at least 10 feet above the ground.

If the aim is not just to encourage proofs of mathematical theorems or demonstration projects but, instead, to encourage applied innovations that will see widespread use, it may be difficult to lay out all relevant criteria as ex ante technical specifications. Moreover, in some cases—such as for Post-it Notes or the graphical user interface (referred to as GUI) technology—the sponsor likely could not have described the product specifically enough in advance for this type of reward trigger to be useful.

B. Metrics of Ex Post Use, Willingness to Pay, or Impact

One issue with basing reward payments solely on technical specifications set ex ante is that products may be developed that, in a strict sense, meet the technical specification but for some reason are not desirable to consumers. The aviation prizes discussed above, for example, were primarily intended to provide incentives for demonstration projects—not for the production of commercially usable products. Although demonstration

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projects may be the explicit goal of some mechanisms, for those mechanisms that aim to spur the development of products that would be desirable for consumers, it may often be useful to base reward payments, at least in part, on some measure of ex post valuation of the product by consumers.

Under AMCs, the reward to the company is not paid simply for development of a product that meets a set of technical specifications but, rather, is tied to actual adoption and use of that product. In the case of vaccines, the practical implementation of this requirement is eased, in that vaccines used in poor countries are largely purchased through governments and these vaccine purchases can be tracked relatively easily. Basing AMC payments in part on this measure of ex post use provides incentives for companies to focus their R&D efforts on products that actually would be used rather than on a product that somehow fits a set of predecided technical specifications but is not a good fit with what developing countries need or want.

Medical Innovation Prize Funds propose basing reward payments on the measured incremental health benefits. This requires ex post assessment not only of use but of social value per user. AMCs for vaccines that did not previously exist offer a relatively easy case by which to calculate the total social value of the vaccine: the total social value of the vaccine is equal to the number of users multiplied by the benefit per user, the latter of which can be thought of as efficacy of the vaccine multiplied by the expected burden of the disease to an individual (which can be estimated ex ante). However, in most other cases, a given product will be a substitute for and/or complement to other products currently on the market and may be effective for some patients but not others. Appropriately calculating the incremental health benefits of a new technology ex post would require taking into account these factors, thereby leaving considerable room for discretion. Small-scale experimentation by decision makers with various ways of valuing new products under such a mechanism likely would be valuable.

C. Ex Post Discretion

Essentially any mechanism for rewarding innovation will involve some sort of ex post discretion.[7] However, mechanisms vary in how much ex post discretion is allowed and to whom ex post discretion is allocated.

The issue of how much ex post discretion to allow can be thought of along a continuum. For example, a committee given a relatively high amount of discretion is used to award the Nobel Peace Prize, whereas the committee that awards the Nobel Prize for chemistry has more limited

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discretion, given the bounds of the field within which the prize must be relevant. The committee for the Wolfskehl Prize mentioned above had even less discretion.

Decision makers may have incentives to reward based on different criteria ex ante relative to ex post. Ex ante the committee may want to reward innovation, but ex post the committee may have other preferences. For example, the committee could prefer to reward those who are likely to make the best use of the prize money going forward. Committees could also be subject to political capture or could choose to "raise the bar" ex post. The Longitude example, discussed above, illustrates some of these potential problems.

One way to address the potential concern of committees raising the bar ex post is to require that the committee award a certain amount of money within a given time frame. Such a requirement is often used in architectural contests, where a committee must choose a winner to award a given contract to by a specified deadline. In architectural contests, committees are relatively certain to receive a sufficient number of high-quality entrants such that choosing the best entrant will likely not result in a poor outcome. Thus, although a payment would have to be made no matter what, the risk that the committee will have to award the contract to an undesirable proposal is low.

However, in other contexts this may be more of a concern. With very challenging technological goals, such as the development of an HIV vaccine, the probability that no firm would have a high-quality vaccine available at a given deadline is much higher. Moreover, in markets with a small number of firms, the firms could potentially collude to slow innovation.

The proposed Medical Innovation Prize Fund uses a version of this type of requirement, but for several reasons this type of requirement is less of a concern in that context. For the proposed Medical Innovation Prize Fund, there is a commitment to award a certain amount of money each year, but the scope of coverage is great enough—covering virtually all pharmaceutical research—to smooth out variations in the arrival of eligible products and to minimize opportunities for collusion across firms.

Basing reward payments in part on ex post use is one way of leaving ex post discretion relatively more in the hands of consumers instead of in the hands of a committee, and doing so can limit the amount of discretion given to a committee and also help address concerns of time-inconsistency problems or political capture. The ex post use measure ideally would be objective and difficult for participating firms to manipulate.

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In the case of AMCs for vaccines, as discussed above, vaccines used in poor countries are largely purchased through governments, and these vaccine purchases can be tracked relatively easily. However, in the case of the proposed Medical Innovation Prize Fund, measurement of the value of a product (rather than the use of a product) is much less clear, and this may introduce substantial opportunities for ex post discretion, which potentially could lead to both static costs of rent seeking and dynamic losses from inappropriate incentives. Consider as an example the value of a new drug that extends life for a terminal patient by 6 months, during which time the patient is still disabled and requires care by medical providers. The value of these 6 months is then not simply the value of 6 months of a statistical life but, rather, this amount less the value of capital and labor inputs that are required for the patient over that period. Such calculations may be quite difficult.

Problems may also arise when trying to assess how to divide reward payments across complementary innovations. Consider the example where a new medical innovation requires two technologies. Assume that the first technology, A, has high, fixed R&D costs and is sold by a monopolist. Assume that the second technology has a relatively low cost of development and production and that any of 15 substitute products would be suitable (1, …, 15, indexed by production costs where 1 has the lowest production costs and 15 has the highest production costs). Under the proposed Medical Innovation Prize Fund, a committee would need to decide how to distribute rents across A and one of the 1–15 substitute products but would likely not know that it was relatively low cost for innovators to develop the latter product. Mistakes in the division of rewards between innovators could cause distortions of R&D investments for the two complementary products.

IV. Mandatory versus Voluntary Institutions

Public policies to provide incentives for innovation can either be voluntary—so that firms could continue to rely on existing IPR systems—or be mandatory—in the sense that firms would no longer have access to the IPR system that is currently in place. Both X-Prizes and AMCs are voluntary mechanisms, whereas the Medical Innovation Prize Fund proposal is a mandatory mechanism.

Mandatory programs such as the proposed Medical Innovation Prize Fund would replace the current IPR system. Whether the incentives provided by such an alternative system would be higher or lower than

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the level of incentives provided by the current IPR system would be a function of the size of the prize fund. Voluntary programs such as X-Prizes and AMCs, on the other hand, would supplement the current IPR system and thus at least weakly increase the total available incentives for R&D—since, if the price in a voluntary program were set low enough such that firms would realize lower revenue if they chose to participate than they would realize if they chose not to participate, presumably firms would select out of participating in the voluntary mechanism.

Because, as argued above, the current system of IPR depends on firms' expectations of future rewards, experimenting with voluntary mechanisms involves lower risks than with mandatory mechanisms. If an experiment with a voluntary mechanism shows promise, it can be refined and applied in a broader range of settings; if it fails, the voluntary mechanism can either be revised or abandoned. In contrast, if an experiment with a mandatory mechanism fails, it may shake the confidence of R&D investors, who may be concerned that IPR will disappear and that no adequate alternative incentives will take its place to reward them for their investments. Mandatory mechanisms for encouraging innovation cannot be costlessly turned on and off because of the dynamic element inherent in any market in which firms make long-term R&D investments.

V. Design Issues for Early and Late Stage Advance Market Commitments

We argued above that although prizes such as those recently offered by the X-Prize Foundation are a natural starting point for encouraging innovation, in many contexts the design of prizes could be usefully extended by conditioning rewards on a market test. Because AMCs are a voluntary mechanism that incorporates one type of market test, experimentation with AMCs can likely inform the design of other mechanisms incorporating more complex ex post reward triggers, such as the proposed Medical Innovation Prize Fund. In this section, we discuss one approach for incremental experimentation within AMCs in more detail, focusing on how initial experimentation with AMCs for technologically closer products (such as a pneumococcus vaccine) can inform the design of AMCs for technologically more distant products (such as a malaria, tuberculosis, or HIV vaccine). We also discuss important differences between AMC design for technologically closer and more distant products.

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In an early policy report on AMCs by the Center for Global Development in Washington, DC (Barder et al. 2005), it was argued that AMCs could likely be applied cost-effectively to both technologically closer products and to technologically more distant products. Policy makers suggested initially focusing on a technologically closer product, which motivated the pilot pneumococcal vaccine AMC. One motivation for this initial focus on technologically closer products could be that AMCs for technologically closer products are "simpler" in the sense that they primarily seek to speed adoption and diffusion of new vaccines, whereas AMCs for technologically more distant products seek to accomplish this goal and also to more directly spur new R&D investments into candidate vaccines.

However, there are several substantive differences between how an AMC should be designed for technologically closer products relative to technologically more distant products, two of which we discuss below: the appropriate price provided to developers (Sec. V.A) and the appropriate role for demand guarantees (Sec. V.B). For more discussion of these issues, see Kremer, Levin, and Snyder (2008).

A. Setting Prices under an AMC

A first difference between designing AMCs for technologically closer and technologically more distant products arises in thinking about how vaccine prices under an AMC should be set. For a technologically closer vaccine like pneumococcus, much of the R&D has already been completed, and the challenge is primarily one of designing a long-term procurement contract that will incentivize a small number of specific firms that have the necessary expertise to construct the large-scale capacity needed to serve the world's poorest countries as well as the rich- and middle-income world. If policy makers knew how much it would take to get the one or two specific firms that can currently produce childhood pneumococcus vaccine or are likely to be able to do so in the near future to participate in an AMC, they would set the AMC price at that level but no higher. This highlights a trade-off between the risks of setting the price too high or too low. The risk of setting the price too high is that more will be spent on the AMC mechanism than is necessary. The risk of setting the price too low is that firms will not build the capacity needed to serve poor country markets and that the historically typical 10–15-year lag between the introduction of vaccines in rich countries and their widespread use in poor countries will continue, likely resulting in the loss of millions of lives of children in poor countries.

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Many factors are relevant in thinking conceptually about what price would induce firms to participate in the pneumococcus AMC mechanism. At first blush, a price equal to the cost of production may seem reasonable. However, a firm's reservation price may differ from its production cost. On the one hand, firms may realize public relations benefits from selling a product that addresses a major health need of individuals in poor countries. On the other hand, firms may fear that if they sell the vaccine at a low price in the poorest countries (like Mozambique) then governments in middle-income countries like Brazil will demand lower prices as well. This could set up a trickle up of lower prices that could put a serious dent in firms' revenues from middle- and high-income country market sales that represent a different order of magnitude of potential revenue relative to sales under an AMC.

Such concerns are likely very salient to firms. For example, after Senator Paula Hawkins (R-FL) asked a major vaccine manufacturer how it could justify charging nearly three times as much to the U.S. government for vaccines as to foreign countries, U.S. manufacturers stopped submitting bids to UNICEF to supply vaccines (U.S. Congress, Senate 1982; Mitchell, Philipose, and Sanford 1993). When President Bill Clinton announced his plan to immunize all children against a standard list of diseases in 1993, he said, "I cannot believe that anyone seriously believes that America should manufacture vaccines for the world, *sell them cheaper in foreign countries*, and immunize fewer kids as a percentage of the population than any nation in this hemisphere but Bolivia and Haiti" (Mitchell et al. 1993; emphasis added). In the face of such statements, potential risks facing firms seem real.

Setting a price under an AMC is different in the case of technologically more distant products where no firm has a clear lead. For a technologically more distant vaccine like HIV, the goal of policy makers is to design an AMC that will attract a socially efficient amount of research effort to search for the vaccine. Setting the price paid under an AMC in this case is not so much about guessing what firms' production costs will be in the future as it is a question of determining the social value of a new vaccine. To the extent that there are multiple potential entrants, rather than a fixed set of firms with a technological lead, setting a higher price will not provide rents to incumbents but will instead attract more R&D effort. Theoretically, there is a danger of encouraging "too much" R&D in the sense of duplication of research activities. However, it is often appropriate to pursue many different leads simultaneously in searching for solutions to important problems. Moreover, there are in practice many products where the current level of R&D effort is below the social optimum.

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B. Role of Demand Guarantees

A second difference between AMC design for close and distant vaccines arises over whether donors should guarantee some portion of demand. A general principal of contracting or mechanism design is that whoever is best placed to affect a risk should, all else being equal, bear that particular risk. For earlier stage products, firms still have opportunities to affect product characteristics and thus should bear more risk—implying that demand guarantees would be less appropriate. For later stage products, the situation is quite different. Once a product has already reached the stage where pneumococcus vaccines currently are, product characteristics are relatively fixed, whereas the donor community still has the opportunity to influence demand.

For a technologically close product, like a pneumococcus vaccine, it is fairly clear what a product will look like, and the main problem is to incentivize capacity construction. Firms will be more inclined to build capacity if they know they will be able to sell a volume that will utilize that capacity, and donors may thus be able to get away with a slightly lower price if they guarantee demand. On the other hand, it would not make sense to guarantee demand for a vaccine that is still very technologically distant, since otherwise a firm might wind up creating a vaccine that complies with a list of technical specifications but that no countries would want, and donors might wind up having to buy the vaccine. For technologically distant products, donors to AMCs arguably should condition payments on countries being willing to use the product and on some buyer being willing to make a modest copayment (as proposed above) so as to create incentives for firms to develop vaccines desirable to consumers. Once a particular product is developed and the problem shifts to one of capacity construction, donors could then move into a phase in which they would guarantee a portion of demand. AMCs also could be linked specifically to capacity installation by firms.

VI. Conclusion

Technological progress is a key determinant of economic growth. Finding ways to improve institutions to encourage technological progress potentially could do more to encourage economic growth than virtually any other area of public policy. While the patent system offers one mechanism for rewarding innovation, it involves some important trade-offs. In this essay, we argue that incremental experimentation can help to test and refine new mechanisms to encourage R&D.

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Experimentation and trial and error over time will likely be necessary to develop and refine new mechanisms to encourage innovation. But the potential payoffs to adding new mechanisms to our tool kit for encouraging innovation are immense, and thoughtful experimentation with several mechanisms would be valuable.

Endnotes

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1. Other trade-offs may arise with patents as well. For example, patents may potentially deter downstream innovations in contexts where innovation is cumulative, in the sense that many innovators will build on prior developments and discoveries. Similar issues can arise in contexts where there are complementarities across innovations in a broader sense; for more discussion see, e.g., Merges and Nelson (1990), Scotchmer (1991), Heller and Eisenberg (1998), Murray and Stern (2007), and Bessen and Maskin (forthcoming).
2. Lemley and Shapiro (2005) argue that in this sense patents do not confer upon their owners a right to market exclusivity but rather confer a right to try to exclude others by asserting the patent in court.
3. Another approach is a patent buyout, in which a patent is purchased and placed in the public domain (see Kremer 1998).
4. It is worth giving a brief background on pneumococcal diseases. Although not as well known as malaria or HIV, pneumococcal diseases kill more than 1.6 million people annually, including up to 1 million children under age 5. In rich countries, child deaths from pneumococcus are rare, but in poor countries pneumococcus is a leading cause of child mortality. Pneumococcal vaccines for adults have existed for some time, but it is important to protect children as well, both because of the high death toll among children and because children are important in spreading the disease. A pneumococcal vaccine that protects children against some strains of bacteria has been available in the United States for several years. However, the cost per dose of pneumococcus vaccine in the United States is approximately $65, far out of reach of poor countries. In addition, existing versions of the vaccine are optimized to cover the strains of the diseases common in the United States and do not provide protection against some key strains common in poor countries. Two pneumococcus vaccines were recently licensed (from different suppliers), after the announcement of the $1.5 billion pilot AMC, although before the legal details of the contract were fully in place.
5. Aidan Hollis, Thomas Pogge, and others have advocated a Health Impact Fund proposal, which is similar to a voluntary version of the proposed Medical Innovation Prize Fund.
6. Many of the examples in this section are drawn from Kremer and Glennerster (2004). Portions of this and later sections also draw in part on a previous paper written by the authors for the German Marshall Fund of the United States (Kremer and Williams 2008); those portions of this essay are adapted with permission from the German Marshall Fund of the United States.
7. For example, when ex ante technical specifications are used as a reward trigger, they will almost always need to be combined with some sort of committee to make an ex post decision about whether the technical specifications have been met. In the case of the patent system, ex post discretion is essentially left in the hands of the legal system (judges and jurors).

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