

# Optional Rewards for New Drugs for Developing Countries

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**NB:** This paper is a work in progress. Please check against the most recent version at <http://econ.ucalgary.ca/fac-files/ah/drugprizes.htm>

## Abstract

This paper proposes an optional reward system as a method for stimulating pharmaceutical innovation for diseases endemic to developing countries while also enabling access to the resulting drugs. The essence of the proposal is to offer rewards to drug innovators who relinquish their patent rights, with the reward to be based on the incremental health effects of the innovation in developing countries. The proposal offers the opportunity for innovators to be appropriately rewarded, with free entry into the system ensuring that the rewards will be on a suitable scale. Since the reward system is optional, it must confer a net benefit on drug innovators. The nature of the system also ensures that the rewards will be directed automatically towards innovations with high therapeutic value but which are not profitable to develop under the patent system. The system is scaleable, with greater rewards expected to induce more innovation. The paper presents an economic model to explore how the optional reward system complements the patent system.

## 1 Introduction

The incentives for research and development into drugs for diseases primarily affecting the poor in developing countries are inadequate. The core, underlying problem is that while development of new, safe, and effective drugs is very expensive, sales to sick people in low-income countries do not provide a large revenue stream. Setting drug prices high limits sales to the wealthiest people; setting prices low enough to attract more sales means that there is too small a profit margin to pay for the upfront costs of drug development. The result is that drugs which would have their primary market in developing countries are never developed, or, if they are developed, may be priced so high as to be inaccessible to sick people and their governments. This paper proposes a reward system addressing these twin problems of *access* and *incentives*.

Other proposals have gone partway towards a solution for these urgent problems. Most recently, Kremer and Glennstetter (2004) and the Center for Global Development (2004) have described in detail a plan for “Advanced Purchase Commitments” for vaccines, which would commit a global body to pay a fixed subsidy per vaccine delivered

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for certain diseases, if the vaccine meets pre-specified technical requirements and is priced below some level. This would help to solve both access and incentive problems, and is well suited to products whose technical characteristics can be described in advance, but is inapplicable to innovations whose technical properties are still unknown. Other proposals have attempted to address the incentive problem through special bonuses paid to firms which develop drugs for neglected diseases. GlaxoSmithKline has proposed a system of transferable exclusivity, which would allow a firm to extend its patent on a drug for rich countries<sup>1</sup>; Ridley, Grabowski, and Moe (2004) have proposed a more modest reward: priority review for a selected rich country drug in exchange for developing a neglected disease drug. Moran (2005) suggests auctioning “fast-track” rights for approval, with the proceeds to be used to support neglected disease research. These proposals do not address the access problem, but help to increase research on neglected diseases by offering special privileges in developed country drug markets.

This paper’s contribution is the following. First, it develops a simple theoretical model to explore the properties of an optional reward system in which rewards are based on the relative social value of an innovation; and second, it describes a specific method of identifying the *relative* social value of a medicine. Together, these constitute a proposal for a practical reward system for medicines for developing countries. The essence of the proposal is as follows. An international fund pay-out fixed at, say, \$1bn per year would be established. Any drug company could obtain a share of this pay-out by open licensing of the patents for a drug in all developing countries. Rewards would be allocated based on the share of total estimated incremental therapeutic benefit of these drugs, for some fixed period. The international fund, jointly supported through commitments of donor nations and perhaps other donors, would determine the amount to be paid, using information submitted by the companies involved and other sources.

The principle benefits to this scheme are as follows. First, it would create an incentive for R&D for drugs which, though commercially unviable under the current system, would have large incremental therapeutic benefits. Second, the scheme is complementary to the existing patent system, including the agreements on medicines achieved in the Doha round of the TRIPS agreement, as well as other proposals such as the vaccines Advance Purchase Commitment scheme. Third, it would enable drugs to be sold at average production cost to governments and other buyers in developing countries. Fourth, it is scaleable: whatever the size of the fund, it will increase incentives for drug development, and will consistently offer the largest incremental incentives for the drugs with the greatest therapeutic impact but the least commercial value. Fifth, because it is best at rewarding drugs with high therapeutic impact but little commercial value, it is directed particularly at drugs for the poorest people.

Optional rewards have recently been proposed by Shavell and van Ypersele (2001) and Abramowicz (2003). They make many similar points concerning the benefits of the optional approach, particularly focusing on the observation that a reward system allows for the elimination of deadweight losses from monopoly pricing. This paper, however, is further reaching and more limited than theirs. It is further reaching since it proposes a specific mechanism for government to determine the level of rewards to be offered, and shows how market measures of value may be inadequate; but more limited in that the mechanism prescribed applies only to medical innovations. This paper also

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<sup>1</sup> “Glaxo tells Blair to press G8 for Patent Reform.” *The Independent*, November 29 2004.

shows how an optional reward for which firms compete can be used to turn information on *relative* social value into information on appropriate financial rewards.

### 1.1 Innovation for neglected disease drugs

Neglected diseases are typically neglected because there are no profits to be made from medicines for them, even if candidate drugs were readily available. The problems involved in trying to make profits in developing country pharmaceutical markets are many and complicated. Buyers in developing country markets lack the income or wealth to pay much for medicines. Often they are too young, too old, or too sick to have an income sufficient to pay for more than food. Typically they have no insurance, or very limited insurance. At the same time, developing country governments lack the financial resources to pay for expensive drugs. In addition, under WTO agreements, countries can impose compulsory licenses to allow generic production so that in the event that a really successful therapy is developed, the patentee may never be able to make any meaningful sales in developing countries. Thus, while from the perspective of donors and international agencies the value of a medicine may be high, the patentee may be unable to appropriate very much of the social value of a medicine. It is this set of problems that the proposal in this paper addresses.<sup>2</sup>

### 1.2 Appropriability

Appropriability is the ability of a firm to capture the “surplus” (or value) its innovation creates. The patent system is at heart a system of increasing the appropriability of an innovation. It does this through the grant of an exclusive use of the patented innovation for some period. However, even patentees are generally unable to fully appropriate the surplus in a market. There are a number of reasons why appropriability is imperfect.

#### Imitation

Other firms can imitate around a patent during its term – in pharmaceuticals, this phenomenon occurs as “me-too” drugs – and can imitate exactly after patent expiry. This evidently reduces the ability of firms to fully appropriate surplus from an innovation. Note that it may also lead to excessive (i.e. greater than one) appropriation in the case of me-too drugs which capture profits from an incumbent while adding little in terms of therapeutic options. (This is essentially the case of entry which is excessive from a social perspective because the “business-stealing effect” dominates the benefits from product diversity, as described by Mankiw and Whinston, 1986.)

#### Imperfect price discrimination

The value of a product varies with each consumer, so that unless firms are able to vary their prices by consumer – to price discriminate perfectly – it will not be possible to

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<sup>2</sup> There are a number of other obstacles to the profitability of pharmaceutical firms in developing countries. For example, some countries do not have enough physicians to diagnose, prescribe, or follow up. Pharmacy mark-ups can be very large when prices are unregulated and pharmacies have local monopolies. Supply-chain control may be weak, allowing counterfeit products to capture a significant share of sales, harming both patients and the genuine supplier. Many countries impose heavy import tariffs or other taxes on medicines. These problems will require other solutions.

capture the entire surplus even in the absence of competitors. Assuming an inability to price discriminate, appropriability will typically be less when the demand curve is more convex to the origin. As Hollis and Flynn (2005) show, such convexity is likely to be relatively high in markets for essential drugs in developing countries because of the nature of the income and wealth distributions. In turn this implies that such markets will have a low degree of appropriability.

### Externalities from infectiousness

Drugs for infectious diseases create positive externalities, since an infected person can unintentionally infect others. Many of the most important neglected diseases in developing countries are infectious diseases. While governments and NGOs may consider such externalities, it is unlikely that most individuals fully incorporate them in their drug purchase decisions, again implying low appropriability of social surplus.

### Positive externalities from altruism

There are important altruism externalities in markets for medicine. The demand curve of very poor, sick individuals for drugs may be extremely low because of income constraints. From the perspective of potential donors, the value of an individual's life may be far above his ability to pay for medicine, which is the "market" value of his life. In these circumstances, there is a positive externality from consumption of the product on the potential donor. Thus social value can be much greater than the integral of the market demand.<sup>3</sup> If the donor could give some money to the individual, then the demand curve might rise. But since transactions costs of identifying poverty-stricken, sick individuals are very high (and because of moral hazard concerns) a simple transfer of cash to the individual is impractical. Another solution is for the donor to subsidize the product – but actual or prospective subsidies give an incentive for the patentee to increase the price, so that the subsidy may end up increasing the profits of the patentee instead of decreasing the price to consumers.

While appropriability is imperfect in all markets, as the above discussion suggests, pharmaceutical markets in developing countries have some special features which make it likely to be particularly low. The convexity of the demand curve, altruistic interest in health status of poor people, and the positive externality of drugs for infectious diseases, all contribute to this important problem. Of course, if appropriability, even given the patent system, is low, then the patent system as currently implemented is not likely to provide adequate incentives for innovation in this area. The following sections therefore describe how the patent system can be supplemented by an optional reward scheme, which, as I show in section 3, can be implemented in pharmaceutical markets.

## **2 A model of an optional reward scheme**

This section presents a simple model whose purpose is to show how an optional reward system relates to the patent system. The model is simplified to have an innovation stage, in which firms invest in research, and then, for research which is (stochastically) successful, a market stage. Each market is characterized by a total possible surplus  $S_i$  in

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<sup>3</sup> For a helpful analysis of the externalities involved in health care systems generally, see Evans (1984).

case an innovation is made, and a variable  $A_i \geq 0$  representing the share of  $S_i$  which can be appropriated by the innovator. Achieving  $S_i$  would require pricing at marginal cost and incorporating all relevant externalities. Appropriability varies between markets because of market structure, patentability, patent laws, the shape of demand, social versus private value, and so on. It is not necessary to specify the distribution of markets with respect to expected surplus and appropriability.

The timing of the model is as follows. In stage 1, firms invest in innovating. Firm  $j$  will be successful in developing an innovation in market  $i$  with probability  $n(r_{ij})$ , where  $n$  is the probability of making a breakthrough in a market, and  $r_{ij}$  is the level of research spending in field  $i$  by firm  $j$ .  $n'(r_{ij}) > 0$ ;  $n'(0) \geq 0$ ;  $n''(r_{ij}) \leq 0$ . After the investments have been made, some investments will be successful in the breakthrough.

An innovation leads to the exploitation of a given market in the second stage and some of the social value from each innovation can be appropriated. If two or more firms are successful in innovating in the same field, they will each be able to appropriate only a fraction of social surplus. Thus private gross profits after marginal costs of production, but without considering research spending  $r_i$ , are given by  $\pi_i = A_i S_i$ . ( $A_i$  will generally be between 0 and 1, but may be greater than 1. For example, consider an innovation which largely duplicates an existing technology and therefore adds little social value; if it captures some market share from the incumbent, its profits may represent an appropriation of social value greater than one.)

Some caveats are appropriate. Both  $S_i$  and  $A_i$  will in general depend on research spending in all markets, since there may be complementarity or substitutability between innovations. I assume, for the purpose of making the notation more transparent, that  $n(\bullet)$  is the same for all fields; however, in practice one would expect it to be different for each firm and field. This assumption is innocuous, however, since what is really important is the *relationship* between  $n'$  and  $S_{ij}$ . Thus the function  $n(\bullet)$  can be thought of as having undergone a suitable normalization in this paper.

In the following sections, I compare three different systems for inducing innovation.

## 2.1 The baseline: R&D under the patent system

Research spending by firm  $j$  is determined by equating the expected marginal private benefits and the marginal private costs of  $r$ :  $n'(r_{ij}^*) \bar{A}_i \bar{S}_i = 1$ , where the bar above a variable denotes its expected value. This equation implicitly defines the privately optimal amount of research in each field. Investment will be made only in fields for which  $n'(0) > \frac{1}{\bar{A}_i \bar{S}_i}$ . Evidently, research investment will be attracted only to fields in which both

$\bar{A}_i$  and  $\bar{S}_i$  are sufficiently high.

Unfortunately, markets for drugs for neglected diseases in developing countries are likely to be characterized by low appropriability. Thus, the patent system offers little incentive for development of drugs for such diseases.

## 2.2 R&D under a mandatory reward system

Now consider, as an alternative to the existing market with patents, a reward system as discussed in Hollis (2005). In this market, innovators must offer an open license for their innovations, and government rewards them with a share of a fixed fund  $R$ , based on the social surplus actually generated. The open license means that the innovator will not generally make significant profits from selling the product: the innovator's profits are derived from the reward. I discuss in Section 3 a method for identifying the social surplus of an innovation without reference to its price; for now, however, we will simply assume

this to be possible. The share  $\frac{S_{ij}}{\sum_j \sum_i S_{ij}}$  of the reward which each firm receives for any

given innovation is equal to its share of the total surplus generated by all firms in all fields in which research investment was successful. For a given fixed reward fund  $R$ , investment will occur up to the point where the expected marginal profit from the reward equals the marginal cost of investment. Assuming that any firm's share of total rewards is relatively small, this implies that the privately optimal amount of investment  $r_{ij}$  is

implicitly identified by  $n'(r_{ij})R \frac{\bar{S}_{ij}}{\sum_j \sum_i \bar{S}_{ij}} = 1$ . The marginal market which will induce

investment under the reward system is determined by  $n'(0)R \frac{\bar{S}_{ij}}{\sum_j \sum_i \bar{S}_{ij}} = 1$ . Research

spending is optimally allocated, given the total rewards available, in the sense that research is directed to the fields which have the highest expected social value per dollar of research investment, and fields in which an innovation would have greater social value will receive higher research investment. Notably,  $A$  is irrelevant in the mandatory reward system.

There are three key differences between the patent and mandatory reward systems, offering trade-offs in multiple dimensions. First, while fields with high  $S$  and high  $A$  will induce research spending in both systems, the fields with high  $S$  but low  $A$  will be developed only in the reward system. Thus there is, from a social perspective, a better allocation of research spending in the reward system. However, by choosing  $R$ , government determines the total amount of spending on research: this total may be better or worse than under the patent system. It is widely believed that the patent system creates inadequate incentives for innovation, since the innovator is unable to fully appropriate social surplus. Thus if the reward system led to less (or much more) research than the patent system, that could be undesirable.

Second, in the patent system, monopoly pricing creates deadweight losses – that is to say, some people may not purchase the product even though their valuation of the product is above the marginal cost of production. The reward system allows for competitive production, which implies pricing at approximately average production cost, and a reduction in deadweight losses. However, government rewards need to be financed, which implies deadweight losses through the tax system. Generally, deadweight losses are likely to be less in the tax system because the burden of taxation is spread more evenly across different commodities and income.

Third, in the reward system, the government needs to use some non-price method for determining the social value of an innovation, while in the patent system this occurs automatically through prices. Generally, it is believed that market prices are likely to be relatively efficient at sorting out relative social values, since markets effectively incorporate unobservable individual preferences. Pharmaceutical markets, however, may not work very well because of significant informational problems, externalities, and market power, as discussed in Hollis (2005). In these circumstances, it is possible that a non-price determination of social value may be preferable; section 3 below discusses this comparison at greater length.

### 2.3 An optional reward system

Now consider a third case in which the patent system is available and the reward system is offered as an option, where accepting the reward entails offering an open license of the patent. Given the presence of the patent system, not all innovations with high social value will be offered into the reward system. Those with relatively high appropriability will find it more profitable to exploit the patent. To understand the effect of an optional reward, we must first determine whether a firm with an innovation will choose to accept the reward or to exploit the patent.

We begin by defining the total social surplus of innovations rewarded by the fund as  $\Omega^R = \sum_j \sum_i S_{ij}^R$ , where  $S_{ij}^R$  is the social surplus from an innovation which the patentee has offered into the reward system. A firm will choose to exploit the patent only if  $R \frac{S_{ij}}{\Omega^R} < A_i S_{ij}$ , which implies an isoprofit frontier between the patent system and the reward system at  $A^R \equiv \frac{R}{\Omega^R}$ . Along this isoprofit frontier  $A^R$ , the appropriability of project  $i$  under the patent system is equal to the effective appropriation by the firm of social surplus through the reward payment.

The lowest value market which will induce investment under the reward system is determined by  $S^{\min} = \frac{\bar{\Omega}^R}{n'(0)R}$ . Consider the intersection of  $S^{\min}$  and the locus of  $(A_i, S_i)$

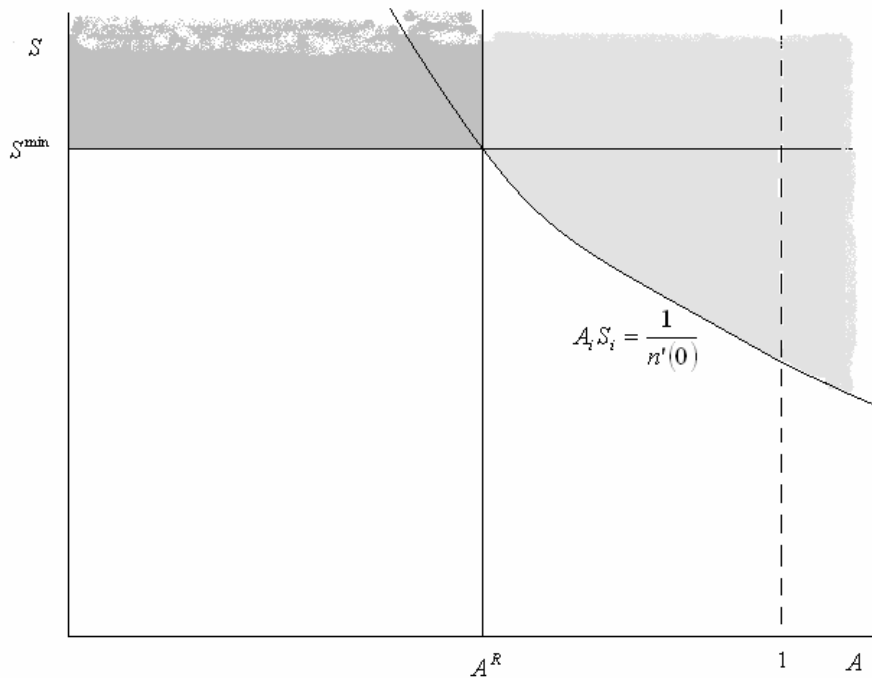
which is exactly sufficient to induce investment under the patent system  $A_i S_i = \frac{1}{n'(0)}$ . At

the intersection,  $A_i = \frac{R}{\Omega^R}$ . Notice that this is at  $A^R$ .

This characterization allows us to draw a diagram of how the optional reward system interacts with the patent system, as shown in Figure 1. Fields with parameters in the darker shaded area will have some investment into research, and if successful innovations arise, the firms will choose the reward system for those innovations. Note that the innovations which are induced by the reward system are those with high social value and low appropriability. In fields above the curved locus  $A_i S_i = \frac{1}{n'(0)}$  and to the

right of  $A^R$ , investment in innovation is rewarded through the patent system. Fields below  $A_i S_i = \frac{1}{n'(0)}$  and  $S^{\min}$  will not attract research investment.

Figure 1  
Innovation under an optional reward system



Notes: The dark shaded area indicates markets in which investment into innovation is induced by the optional reward system, while the light shaded area indicates markets in which the patent system is preferred by innovators. The substitution between the patent system and the reward system is relatively small unless the reward system offers very large rewards. The optional reward system induces investment into markets with high social value but which are unprofitable because of low appropriability.

It is noteworthy that the overlap between the reward system and the patent system is relatively small, if the  $R$  is not extremely large. Innovations with high  $S$  and high  $A$  will continue to use the patent system, since the effective appropriation of social surplus under the reward system is competed downwards by projects which have low appropriability under the patent system. Those projects which have relatively high appropriability under the patent system will always do better using that system, so that the reward system will complement, rather than substitute for, the patent system. This in turn implies that the reward system will, through the choices of firms, automatically reward firms which have projects with relatively low appropriability under the patent system, and relatively high social value. Thus the incentives to invest created by the reward system are focused on possible innovations which are of the greatest social value and which would not be

developed under the patent system: that is to say, the optional reward system automatically directs research investment towards important neglected diseases. From the perspective of governments which would fund a reward system, this should be a very attractive proposition.

Another interesting feature of the optional reward system is that it obviates the need to worry about how much to pay for a given innovation: rewards are automatically determined by the share of social surplus created by the given innovation. That implies that a measure of relative social value not denominated in dollars would be adequate to determine a financial award. At the same time, however, on average the rewards paid are guaranteed not to be excessive, in the sense that by construction the appropriation of social surplus through the reward system is equal to  $A^R$ , which is within the level of appropriability that the patent system allows.

In addition, it is not necessary to know exactly how large total rewards should be. The size of the rewards should be large enough to justify the cost of obtaining information on social surplus, and not so large as to eliminate use of the patent system. If all firms are choosing the reward system over exercising their patent rights, that implies that rewards are entirely substituting for the patent system and indicates that the reward *may* be encouraging too much research. (It is not necessarily inducing too much; since we don't know the appropriate amount of research investment in the economy, it is hard to say. However, we would know that the reward system was inducing research on projects which would not have had sufficiently high social surplus as to be induced by the patent system.) The amount of the reward is flexible upwards over time; no firm would be hurt by an increase in the amount of the reward. However, a commitment of a minimum amount is required for some period of time going forward; a firm which invests in research on the basis of a reward in the future requires and deserves some assurance that the reward will be there. If the reward system did not offer a guarantee of continuing payments far out into the future, the incentives for undertaking research into fields with low appropriability would be very limited.

Since the reward system is a complement to – rather than a substitute for – the patent system, it increases overall investment into research. Consider other ways of increasing research, such as extending patent life, transferable intellectual property rights, or priority review vouchers. Those approaches increase the appropriability of a given investment, in effect shifting all markets (but not the lines) to the right in Figure 1. This would encourage research investment, but the net impact on consumers is uncertain, as they would benefit from more innovation, but at greater cost. In those schemes, the increase in incentives to undertake research extends through the entire area above (and just outside) the curved locus  $A_i S_i = \frac{1}{n'(0)}$ , including those areas of innovation which

have high social surplus and high appropriability under the patent system. Thus firms which are developing very profitable products would be rewarded even more. Consider how this compares to increasing the incentives for research through an optional prize system. New research expenditures are targeted to the area above  $S^{\min}$  and to the left of  $A_i S_i = \frac{1}{n'(0)}$ , i.e. at research with high social value but low appropriability. By

construction, rewards are not excessive. And deadweight losses are relatively small since they arise from the general tax system instead of from high prices on individual products.

### 3 How to make rewards depend on relative social value

While the attractions of a prize system, in which prizes are based on social value, over the patent system have been recognized by others (notably Gallini and Scotchmer, 2001), what has been lacking is a methodology for implementation. There have been two general classes of methods for determining prizes or rewards. First, some proposals or actual prizes have identified a specific target which would be rewarded with a prize of a certain dollar value. For example, the “Ansari X prize” of \$10m was offered for the first privately funded orbital vehicle which could make two trips within fourteen days. Kremer and Glennstetter (2004) have proposed a purchase commitment fund for vaccines, in which vaccines meeting certain pre-specified technical and price requirements would be eligible to receive a subsidy per vaccine delivered. The practical objection to these kinds of prizes is that it must be possible to specify in advance the technical requirements to be met by the innovation. This makes it difficult to offer rewards for innovations which do not completely meet the prize requirements, but which may be very valuable. It also makes it very difficult to reward innovations whose technical requirements cannot be easily described in advance, a common problem for innovations which have not yet been developed.

The second general class of solution is to use the market to provide evidence on the private value of the innovation, and then to reward the patentee based on this evidence, while requiring the patent to be freely licensed. Kremer (1998) and Guell and Fischbaum (1995) suggest different versions of such a patent “buy-out” system. There are two important problems with this sort of payment scheme. First, it introduces no *additional* incentive for innovation, since the prize simply replaces the profits earned from the patent. (Thus, in terms of drugs in developing countries, this eases only the access problem but not the incentive problem.) Second, such an approach will typically encounter all kinds of difficulties in determining how much to pay for a given innovation. Under these proposals, it is not possible to rely on a relative measure of value: it is necessary instead to know the dollar amount that is to be paid directly.

In this paper, I propose a third class of rewards, based on *relative* social value without reference to private valuations and without specifying technical characteristics in advance. Relative social value is all that is required in the optional reward system described above. The difficulty, of course, is to find a measure of relative social value without reference to price, since the reward system removes the opportunity to observe the monopoly price. Rewards can therefore only be based on (1) the quantity purchased and (2) the observable characteristics of the product. In general, observable characteristics will be inadequate to create any measure of social value. However, where the observable characteristics reflect social value in some meaningful sense and can be measured in a single dimension, the combination of quantity and observable product characteristics can arguably create a measure of relative social value for each innovation.

Most prescription pharmaceuticals fit these criteria, since their chief purpose is to improve health outcomes. The effect of a given product on health outcomes can be imperfectly measured and imperfectly aggregated into a measure such as “Quality-Adjusted Life Years” (QALYs). (The fact that the measurement and aggregation is

imperfect should not cause too much queasiness: the price system is also imperfect at measuring value and aggregating it, a point which is discussed more below.) That is to say, within the field of pharmaceuticals – or medical products more generally – the relative social value of an innovation can be measured without reference to price. Then, as shown in Section 2, by allowing firms to choose between the reward system and the patent system, relative social value becomes adequate to determine a financial reward. The remainder of this section focuses on how well pharmaceutical product data can be used a proxy for relative social value.

The first requirement is to be able to measure the average effect of an appropriately prescribed pharmaceutical on a range of health outcomes. Health is multi-faceted: for example, a drug might relieve the pain and increase the mobility of arthritis sufferers, while also increasing their risk of a heart attack. Regulatory authorities such as the FDA try to observe all these effects both in pre-approval clinical testing and in post-approval epidemiological studies. In general, the decision to approve the marketing (and to permit the continued sale) of a drug is based precisely on these types of effects on health outcomes. It is well known that the approval process is imperfect, and it must certainly be the case that the observer can only imperfectly measure the effects of a drug on health outcomes.

The second step in this process is to aggregate health outcomes into a single measure. This is not a trivial step since it requires the observer to balance the merits of different health states and the outcomes of different people. The kinds of difficulties encountered here are formidable: Is it equally valuable to extend the life of a ninety-year old and a five-year old by one year? How should we treat gains in health status which will occur in the distant future? How should disability be treated, without discounting the value of life of a disabled person? How should we value a reduction in the probability of death compared to an increase in nausea and dizziness? Using a variety of hedonic estimates and “willingness to pay” studies, health researchers have attempted to sort out the relative values of different health states. Not everyone has the same valuations, and the problems inherent in hedonic estimation are well known. However, it is possible to obtain a standardized measure of the health impact of a drug treatment, denominated in terms of QALYs or a similar measure.

QALYs have been recommended as the standard measure of healthcare outcomes by a task force of experts organized by the U.S. Public Health Service (Gold et al, 1996). Similarly, the OMB has recently been encouraging a greater use of cost-effectiveness analysis (using QALYs, DALYs, willingness-to-pay indices, etc.) in all regulatory decision-making by US government departments.<sup>4</sup> There is very extensive experience with evaluating QALYs related to drug treatments, since a large number of governments and other insurers all over the world use such an approach to determine inclusion of drugs on formularies, but this does not mean that the approach has been perfected, by any means. Drug companies have also used QALY-type analysis themselves in order to demonstrate economic effectiveness of treatments (Davidoff, 2001). Indeed, to the extent that organizations funding the reward proposed below are interested in rewarding

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<sup>4</sup> See, for example, the speech by John Graham, Administrator of the Office of Information and Regulatory Affairs at the OMB on May 21 2002, available at [http://www.whitehouse.gov/omb/infoereg/graham\\_speech052102..pdf](http://www.whitehouse.gov/omb/infoereg/graham_speech052102..pdf), last accessed June 1, 2004.

pharmaceutical innovations based on their health effects, this is the obvious and direct measure to use.

Krupnick (2004) provides an up-to-date summary of issues related to QALYs and similar measurements. For an analysis of the theoretical validity of QALYs, see Doctor *et al.* (2004). A recent OECD study by Dickson, Hurst, and Jacobzone (2003) offers a guardedly positive analysis of the use of pharmaco-economic analysis, concluding that it is a “useful decision-making tool” but that there are difficulties relating to the quality of assessments, shortages of qualified staff, off-label use of drugs, and biased studies.

### 3.1 Comparing the imperfections of prices and QALYs

Given the obvious imperfections involved in measuring relative social value using QALYs, the question naturally arises of whether this methodology is simply too flawed to be of use. However, it is not enough to observe that QALYs are imperfect: prices are also imperfect as a measure of the social value of an innovation. So a more reasonable question to ask is how QALYs compare to prices.

A useful starting point for this comparison is to ask how well prices reflect social valuation. Prices will be effective in aggregating information about hidden consumer values through the revealed choice of purchasing where (1) consumers are well-informed about what they are purchasing and (2) they pay the full price of the product. But pharmaceutical markets do not fit this description.

First, pharmaceutical markets suffer from very complex agency problems. Doctors, who bear none of the cost, do the prescribing. Insurers, who do not see the patient, do the paying – in developing countries, the payer is often government or an NGO or international institution. The consumer, who takes the drug, typically pays only a fraction of the price. Thus it is not obvious that the revealed preference for the drug choice – determined by the doctor’s prescription – is really sensitive to the price.

The informational problems in pharmaceutical markets are also severe. At one level, the informational problems are those which lead to agency problems: consumers are unaware of their options and how different therapies would likely perform; doctors are insensitive to price and often unaware of it; and insurers do not have enough information about patients to guide prescribing. But at another level, let us suppose briefly that all these problems disappeared, and that the market consisted of a doctor without insurance who prescribed for herself. On what basis would she do this prescribing? Naturally, her best source of information would be studies of the effects of the drugs, perhaps summarized in terms of QALYs. That is to say, decisions on prescribing are likely to be based on the same information available to a rewards authority.

Prescription medicines are characterized by economists as either “credence goods” or “experience goods” and consumers and doctors are unable to determine in advance whether the product will work for them, and may even be unable to tell after taking the medicine whether it worked or not. Generally, medicines are only effective and safe in a probabilistic sense: there will typically be some patients for whom a given medicine works well, which is why large-scale trials are generally necessary. The information from a doctor’s personal experience of a given medicine is useful, but probably not a better guide to prescribing than the information revealed in the large scale trials which is summarized in QALY-type analyses. In this sense, prices depend on QALY-type information, and so the information revealed by prices is a signal of QALY

information. Thus, an argument that QALY information is of inadequate quality to provide reliable signals about the value of innovation is probably also revealing the same problem in the price system.

Drugs are not like automobiles, whose styling, feel, and features consumers evaluate privately. With cars, consumers are better able to know how much they personally value those attributes than an outside authority is. With drugs, consumers obviously are not the best informed about which drug is best for them and they defer to an outside authority, the doctor; and the information about drug attributes which doctors use to make prescribing choices is observable – and probably with less error – by a rewards authority. Thus, (1) patients possess and use very limited private information about their preferences over the attributes of medicines and largely rely on doctors to exercise professional judgement over which medicine would be best, usually uninformed by price; and (2) the professional judgement of doctors relies largely on expert studies describing health effects of medicines which are available to the rewards authority. Given the lack of private information over preferences, then, it appears that there is no reason to believe that prices are more likely to reflect the social valuation of a new drug than information on health effects summarized in QALYs, even without considering the serious agency problems in pharmaceutical markets.

There are other reasons to think that price is inferior to QALYs as a measure of relative social value in pharmaceutical markets. First, many drugs are priced in ways that are incompatible with well-functioning markets. Nexium, a prescription anti-ulcer medicine, has been able to generate billions of dollars in sales worldwide despite being allegedly therapeutically identical to generic omeprazole and much more expensive. If the price system worked well, Nexium should apparently be priced the same as drugs with identical characteristics. The kinds of criticisms typically levelled against QALYs is that they are likely to make mistakes: but it is hard to conceive of QALY measurements which show less discernment of real health impacts than prices.

Second, the price system tends naturally to imply higher valuations of drugs which are consumed more by wealthy people. Thus it is more profitable to develop another drug treating erectile dysfunction than it is to develop a drug for Chagas disease, which affects millions of people and leads to severe heart and intestinal damage. The reason for this is that millions of people who suffer from erectile dysfunction are willing and able to pay a high price for their medicines, whereas sick people in poor countries tend not to have the ability to pay much for medicines. From the perspective of donors such as international aid agencies which are funding health interventions, of course, impact on health outcomes is much more relevant than how much people are able to pay. A measure of value which relies on prices will typically give greater weight to the welfare of the rich over that of the poor, which is hardly consonant with the objectives of an aid agency!<sup>5</sup>

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<sup>5</sup> Consider, for example, what would happen if a hospital in a wealthy part of Johannesburg were compared against a hospital in Soweto. If the only measurement were how much patients were willing to pay for the services rendered, it would turn out that for a given treatment, the hospital in Johannesburg gave much more valuable services. But why should the life and health of a rich person be of greater value than the life and health of a poor person? From the perspective of the market, the answer is simply given by willingness and ability to pay. But from the perspective of an outside observer – a donor living in Germany, for example – there is no obvious reason to favor one over the other, and the QALY measurement of social value seems much more appropriate.

Third, QALYs can in principle give much more information. A drug which affects a variety of people in different ways will have that information aggregated into its QALY measurement, which is therefore in effect an integral over the medical impacts. Price can only measure value at one point on the demand curve, and discards information at other points. For example, suppose that 5% of people using a medicine expect to receive very large health benefits, while 95% expect to receive quite small benefits. Under the price system, the firm must price the medicine very high, but capture small sales, or very low, but capture large sales. Neither will fully represent the true available benefits. Using a QALY measurement, the rewards authority can make the rewards depend on both high and low health-impact users. And we have already discussed above some of the problems of the price system when there are externalities relation to contagion and altruism, effects which the QALY measurement can fully account for.

Finally, it is worth observing that the use of QALY-type measurements is not a radical experiment. Most national health insurance agencies use a system of measuring whether pharmaceuticals offer “value for money” which of course implies that they are able to make some measurement of value independent of money, typically using a QALY-type analysis. While these attempts at measuring value using health impacts have attracted much well-deserved criticism, QALYs have continued to be employed because there is no plausible alternative for determining which pharmaceuticals to insure – or to put it another way, QALYs and similar measures of health impact remain the bronze standard of measuring social value of medicines (recognizing that no gold and silver standards are available).

## 4 The Mechanism

Using the insights from the discussion above, this section describes a mechanism for the proposed optional reward system. When a drug was approved for use in a country and the patent owner agreed to enter the reward scheme, it would be registered by a firm, normally by the owner of related patents required in the production of the drug.<sup>6</sup> An International Pharmaceutical Innovation Fund (IPIF) would make payments to registrants, and in exchange for such payments, registrants would agree to grant zero-priced licenses for all listed patents when used to sell the drug in a developing country. The payments would be annual for, say, twelve years following registration of the drug.<sup>7</sup>

Payments from the IPIF would be made based on the proportion of points attributable to a drug. Each patented drug in the reward system would be given points reflecting the gain in average therapeutic value less costs of treatment over that of the next best pre-existing treatment, for *all* units of the drug consumed in developing countries in a given year. Each registrant would obtain a payment equal to the total reward fund multiplied by its share of the total points allocated. The total amount

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<sup>6</sup> It is possible that a registrant might not own all the required patents, in which case registration would require the registrant to obtain a license to the patents from the patentee.

<sup>7</sup> Twelve years would be about equivalent to the average effective duration of patent protection on drugs. Patents are valid for twenty years, but in the case of drugs, clinical trials and the approval procedure typically takes up around eight years. An alternative approach is to make payments during the time of the outstanding patents on the drugs. But this would then require the rewards authority either to have expertise in determining which patents were essential to the production of the drug, and which could or could not be invented around, or to create a mechanism to incentivize firms to reveal incomplete or invalid patents.

available to be paid should be fixed, with the share of the payment to each registrant being determined by its share of points.

More formally, the points allocated to medicine A in each year should be  $\sum_k [(vQALY_k^A - c_k^A) - (vQALY_k^B - c_k^B)] q_k^A$ , where  $k$  indicates the different possible conditions treated by a drug,  $q_k^A$  indicates the amount of medicine A sold to treat condition  $k$ ,  $v$  is the standardized “dollar value” of one QALY,  $QALY_k^A$  is the average therapeutic benefit (in terms of QALYs) of a single unit of drug A when used for condition  $k$ , and  $c_k^A$  is the per-pill treatment cost using medicine A (including the price of the medicine).  $QALY_k^B$  and  $c_k^B$  are the corresponding therapeutic benefit and cost of the most effective pre-existing treatment not using medicine A, for each condition  $k$ , which is not produced by the registrant of drug A.

Note that it is necessary to subtract the cost of treatment – including the cost of the drug itself – from the calculation of gain. This would, for example, allow a new drug which had a lower cost of treatment but the same therapeutic impact, to be rewarded for the cost reduction. It is for this reason that it is necessary to revalue the QALYs into a dollar form. However, the “dollar value of a QALY” would be the same for all drugs and for all countries, so that it need not be measured perfectly: changing it would leave the relative valuations of QALY impacts unchanged, but would result in a different share of total rewards being allocated to cost-reducing or cost-increasing innovations.

The registrant would obtain points for every sale of its drug, no matter who produced or sold the product, so that the reward is really for the innovation, clinical testing, and marketing of the drug. In principal, the innovator need not produce or sell the drug at all, though it would have an incentive to market the drug so as to increase the volume of sales on which it could earn points.<sup>8</sup> Evaluation of the QALY value of a drug could be undertaken as needed, based on the available information about a drug. Normally, a firm could estimate the QALY value of its drug before deciding whether to enter the reward system. In some cases, drugs are given for a variety of different conditions, and so the therapeutic value, as well as the next best therapies, would be different for different conditions. This implies that it would be useful to obtain evidence from prescribing doctors on what conditions drugs were prescribed for, through random sampling of doctors.<sup>9</sup>

Since any drug that entered the reward system could be generically produced, prices should be expected to fall to approximately average production cost, which in the case of most pharmaceuticals is close to marginal cost. This would enable more widespread access than the patent system. In order to help track total sales of the drug, all licensees of the registrant would be obliged to make regular reports of sales and pricing data.

<sup>8</sup> It is very important that the registrant should maintain an interest in promoting the drug, as Kieff (2001) has pointed out.

<sup>9</sup> This would be particularly important for some drugs which have extensive off-label uses (uses for which the FDA has not approved the product). There are claims that up to half of all prescriptions are written for off-label uses. “How Drug Directory Helps Raise Tab for Medicaid and Insurers”, *Wall Street Journal* Oct. 23, 2003. IMS Health already conducts in the US a survey of this sort entitled the “National Disease and Therapeutic Index.”

Note that the rewards are given for the net *incremental* therapeutic benefit over the best pre-existing therapies, rather than for the net benefit compared to no therapy at all (although it is possible that in some case the best pre-existing therapy is no treatment). This creates incentives for innovation which are aligned with social welfare.

## 5 Discussion

This section briefly discusses a number of issues regarding the proposal.

### 5.1 Measurement of quantities

A pressing problem is that of measuring how many units of a drug had been consumed. The problem is that in many developing countries, the system of controls on recording how many units of a drug have been prescribed or sold at the retail level is incomplete, and only estimates are likely to be available. A firm which was receiving a reward per pill consumed would have an incentive to over-estimate the number of pills sold or consumed. It would therefore be important to create mechanisms to monitor sales and use, and to penalize abuses of the system.

### 5.2 Reversibility

A decision to enter the reward system would have to be irreversible, since once a drug was in the reward system, generic manufacturers would start producing it. If the patentee could simply pull the drug back out, it would impose unreasonable set-up costs on the generic manufacturers. This uncertainty would lead to less than the optimal amount of generic entry. However, there seems no reason why a firm could not start off by using the patent system, and then enter the reward system later with a reduced period of rewards, provided there was still some time left in its patent.

### 5.3 What would it cost?

One of the attractive features of this approach is that it is scaleable. In general, it will attract drugs which have high social surplus but low appropriability. These are the drugs which can make the most from the rewards and the least (given their social value) from the patent system. Therefore annual rewards could be \$500m or \$5bn – in either case they would add incrementally to the incentives for research into drugs for diseases that affect developing countries.

### 5.4 Should the fund pay rewards for all drugs?

Drug companies already obtain substantial profits from drugs which treat conditions common in rich countries. It is unlikely that the proposed system could add much of an incentive for research into such drugs, even if they were widely used in developing countries. On the other hand, incentives to perform research on diseases common mainly in developing countries, such as tuberculosis, chagas, and malaria, are obviously very inadequate. Therefore, to make the most of the additional incentives, it might be useful, at least if the total available reward was relatively small, to limit the payment of rewards to drugs relevant to a list of pre-specified diseases which were endemic in developing countries but not in developed countries. Limiting the list would require some arbitrary distinctions, but this need not be a problem as long as the list is clear in advance.

There would certainly be a risk of parallel trade (also sometimes know as “gray market” exports) in global drugs which were priced low in developing countries under the proposed system. The expected flow of goods would be from developing countries to high-priced markets. This risk would in general be likely to reduce the private incentive to offer drugs for global diseases into the reward system. This might in effect automatically lead to a focus of the reward system on drugs common only in developing countries, even without any restriction of the eligible diseases.

### 5.5 Bureaucratic/Political Control of the IPIF

Putting a large reward system in the hands of a bureaucracy is fraught with risks. Experience with regulated industries suggests that bureaucracies are liable to collude with regulated firms (“regulatory capture”); political interference leads to questionable decision-making; and government agencies may lack well-defined objectives and cost-saving incentives, leading to bureaucratic inefficiency. It is possible to mitigate some of these problems, but not, perhaps, to avoid them altogether. The fixed total payout of the IPIF would lead to a zero-sum game so that firms would compete to obtain points. In these circumstances, collusion seems more difficult to sustain, although direct bribes by individual firms to IPIF employees could always be a risk. Brill-Edwards (1999) discusses some problems with regulatory capture in the context of pharmaco-economic evaluation.

There would also need to be a substantial investment in analysis of health outcomes and health economics by an “International Pharmaceutical Innovation Fund Agency” to enable a reasonable allocation of points. With hundreds of significant drugs under patent at any given time, substantial resources could be required for estimating QALYs and costs for all these medicines.

## 6 Summary

This paper has proposed an optional reward fund for pharmaceutical innovations for developing countries. The proposal offers a way to reward firms which develop valuable innovations while preserving access to the medicines by the poor. The optional nature of the proposal means that innovations with very high market value would continue to use the patent system; but drugs with high therapeutic value but relatively low market value would opt for the reward system. The system thus rewards exactly the sort of innovations which at the moment are most desired but for which research incentives are lacking. The rewards would need to be funded – perhaps by governments in developed countries and charitable institutions – but offer a novel way to create incentives while preserving access. The nature of the rewards, for which firms would compete, automatically ensures that on average rewards would be adequate, but not excessive.

This paper is only the first effort at considering this sort of system, and much more work remains to be done. Some obvious questions include the following. How large should total rewards be? Would the system face excessive costs of evaluating therapeutic benefits? How could the system be gamed? What would be the effect of limiting rewards to only some (presumably neglected) diseases? Which countries should be included, and should a life year in each country be valued the same? What would be required to ensure a reasonable estimate of volume of drugs produced? Where should patents be registered? What system of governance would be workable? Is there a way to minimize the extent of

countries using their regulatory systems to shift rewards towards domestically favored firms? Can the approach be usefully extended to developed countries also?

## 7 References

- Abramowicz, M., 2003, "Perfecting patent prizes." *Vanderbilt Law Review*; Jan 2003; 56(1): 114-236.
- Brill-Edwards, N., 1999, "Canada's Health Protection Branch: Whose Health, What Protection?" in *Tales from the Other Drug Wars*, ed. M. L. Barer et al. (Vancouver: Centre for Health Services and Policy Research), 39–54.
- Davidoff, F, 2001. "The Heartbreak of Drug Pricing." *Annals of Internal Medicine* 134: 1068-1071.
- Dickson, M., J. Hurst and S. Jacobzone, 2003, "Survey of Pharmacoeconomic Assessment Activity in Eleven Countries." OECD Health Working Papers No. 4.
- Evans RG, 1984. *Strained Mercy: The Economics of Canadian Health Care*. Toronto, Butterworths.
- Gallini, N., and S. Scotchmer. 2001. "Intellectual Property: When is it the Best Incentive Mechanism?" *Innovation Policy and the Economy* 2: 51-78.
- Gold, M. R., Siegel, J. E., Russell, L. B., and Weinstein, M. C. (1996). *Cost-effectiveness in Health and Medicine*. New York: Oxford University Press.
- Guell R. and M. Fischbaum, 1995, "Toward allocative efficiency in the prescription drug industry." *Milbank Quarterly* 73: 213-229.
- Hollis, A., 2005, "An efficient reward system for pharmaceutical innovation." Mimeo, available at <http://econ.ucalgary.ca/fac-files/ah/drugprizes.pdf>.
- Hollis, A. and S. Flynn, 2005, "An Economic Analysis of Compulsory Licensing for Needed Medicines." Mimeo, Department of Economics, University of Calgary.
- Kieff, F. Scott, 2001. "Property Rights and Property Rules for Commercializing Inventions." *Minnesota Law Review* 85: 697-754.
- Kremer, M., 1998. "Patent Buyouts: A Mechanism for Encouraging Innovation." *Quarterly Journal of Economics* 113: 1137–67.
- Kremer, M. and R. Glennerster, 2004. *Strong Medicine: Creating Incentives for Pharmaceutical Research on Neglected Diseases*. Princeton NJ: Princeton University Press.
- Krupnick, A., 2004. "Valuing Health Outcomes: Policy Choices and Technical Issues." Resources for the Future, Washington.

Mankiw, N.G. and M. Whinston, 1986. "Free Entry and Social Inefficiency." *Rand Journal of Economics* 17(1): 48-58.

Moran, M., 2005. "Fast Track Options as a fundraising mechanism to support R&D into Neglected Diseases." Mimeo, London School of Economics.

Ridley, D., H. Grabowski, J. Moe, 2004. "Developing Drugs for Developing Countries." Mimeo, Duke University.

Shavell, S. and T. van Ypersele, 2001, "Rewards vs. Intellectual Property Rights." *Journal of Law and Economics*, XLIV: 525-547