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Self-interested motives for income redistribution and access to health care innovation

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August 16, 2005

Abstract

We study the impact of income redistribution on the decisions of a health care innovator and the utility of individuals. We find that income redistribution from rich to poor can increase the quality of medical innovation and the utility of some consumers whose income is reduced through the redistribution. We therefore find a non-altruistic motive for a income transfers that would increase access to health innovations.

JEL Classification: D4, L1, I1.

Keywords: Health Care; Pharmaceuticals; Innovation; Income Distribution

1 Introduction

There is an ongoing debate on how to ensure the Third World access to innovations in the health care. The pharmaceutical companies are criticized for selling the state of the art drugs at prices well above production costs, which the developing countries often cannot afford to pay. The drug companies, on the other hand, argue that the prospect of high profits is a necessary incentive to develop new drugs. Fears of price arbitrage, due to the so called "grey" re-importing, constrain opportunities for price discrimination between high and low income countries. Indeed, it would be in the innovator's best interest to price discriminate if feasible. But the pharmaceutical companies' general reluctance to link individual country prices to the country's income is the best proof that potential price arbitrage (either through parallel trade or external price referencing) is considered a threat to effective price discrimination.

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It has been suggested that the rich-world taxpayers should bear the cost of ensuring Third World access to pharmaceutical innovations (The Economist, February 2001). In April 2001, the UN launched the Global Fund to fight AIDS, Tuberculosis and Malaria, a public-private partnership to raise funds and improve access to the health care resources necessary to combat the most deadly diseases of poverty. As of September 2003, more than \$3 billion have been pledged to the Fund by governments and private donors (www.theglobalfundatm.org). The Fund supports the purchase of commodities, including pharmaceuticals, used in the prevention and treatment of the above mentioned diseases.

The success of such cash transfers requires, however, that the richer nations are willing to participate. This, in turn, depends on the strength of altruism and on the degree of confidence that the donations will be used efficiently or will indeed reach intended beneficiaries.

In this paper we identify a purely self-interested motive behind income transfers to poorer nations. Increased purchasing power in poorer countries may change the firms' optimal pricing and quality of innovations. In this paper, we examine such effects. Specifically, we study the impact of cash transfers from the richer to the poorer countries on the equilibrium values of the quality of innovation, its price and the market coverage. Also, we identify the impact of transfers on the utility of consumers, paying special attention to those who make the transfers. This allows us to measure the potential support for a system of income transfers among the countries.

The characterization we use follows the existing literature on the vertical differentiation with income disparities across consumers (Gabszewicz and Thisse, 1979; Shaked and Sutton, 1982). However, unlike most of the vertical differentiation models, we are not concerned with the strategic interaction between firms but with the strategic interactions between a unique innovative firm, which faces a competitive fringe in the established quality, and an international organization that seeks the support of its members to use income transfers as a tool for increasing access to health care innovation. We view the decision to participate in the international transfer system as a three stage game, in which first, the donors and the recipients commit to an income transfer system; second, the firms choose the qualities and prices for the health care innovations; and third, consumption choices are made by consumers or patients.

Our paper is related more closely to Acharyya (2002), which examines how different income distributions can produce different quality choices by a monopolist and shows that an income redistribution that reduces income inequality can produce either higher or lower optimal quality of a consumption good. More specifically, when the marginal consumer's income is below the income around which a redistribution from the richer to the poorer consumers takes place, the optimal quality will increase. However, if the marginal consumer's income is above the income around which redistribution takes place, there can be a decrease in the optimal quality. The interpretation of income redistribution is that of a mechanism that makes an initially uneven income distribution closer to a uniform income distribution, keeping the same maximum and minimum

incomes. Our paper uses a simpler income redistribution mechanism in which income transfers from the rich to the poor within a uniform income distribution decreases the income variance. This is an attempt to mimic a "Health Fund" in which all countries would participate, either as donors or recipients.

However, the purposes of the present paper and that of Acharyya (2002) are altogether different. The latter was primarily concerned with demonstrating how a monopolist can discriminate between income-constrained consumers who have identical taste or, more importantly, identical marginal willingness-to-pay, and the role of income distribution pattern in such a context. Our concern in this paper is to examine non-altruistic motive of countries in participating in an international transfer scheme that provides low-income countries with access to health care innovation¹. We show that even some net donors have utility gains as a result of the cash transfer, as long as production costs are not too high. Hence, besides altruism, a self-interest motive is identified for donations from the higher to the lower income countries.

A possibly controversial assumption in our paper is that price discrimination is not possible. If price discrimination were feasible, income transfers of the type described in our paper would still increase market access to medicines. However, if *perfect* price discrimination were possible, the self-interest motive for participating in an international transfer system would disappear. Empirical studies show that pharmaceutical prices do differ across countries. However, these differences do not appear to be explained primarily by income-related price differentiation policies (Danzon and Chao, 2000; Scherer and Watal, 2002). Rather, price differences reflect differences in regulatory regimes and the availability of generic/substitute product competition. Our paper focuses on drug innovations for which there is still not generic competitor. Also, in a recent empirical study, Danzon, Wang and Wang (2005) conclude that price spillovers, due to parallel trade and reference price control regimes, negatively affect launch of new drugs. They show that countries that have lower expected prices tend to have fewer products launched and experience longer delays for those products that are launched, after controlling for per capita income.

In addition, there are two reasons why price differences for drug innovations may decrease in the future. The first reason is that, increasingly, countries are adopting "reference price control" regimes. Second, the application of international trade law on intellectual property rights is likely to reduce differences in pharmaceutical prices between rich and poor countries. Our model assumes that only the innovative firm can produce the higher quality medicine through patent protection. Many developing countries have traditionally excluded pharmaceutical products from their Patent Law. Most developed countries' Patent

¹Thus, the present paper is related to Acharyya (2002) only insofar as the result that a redistribution of income may change the quality of innovation in either direction depending on the income class around which the income is redistributed. Here, this result constitutes only the basis of self-interest motives of the consumers and countries in deciding about participation in an international income redistribution scheme. This participation decision and the implementation of the transfer scheme constitute the value additions of the present paper and points of departure from the earlier analyses.

Laws state that parallel imports of patented imports are allowed as long as the patentee has consented to the manufacture or sale of the product elsewhere². Therefore, if a pharmaceutical firm is forced to licence its product in a third country, it would be protected from parallel trade and therefore a price difference could be sustained. This explains low prices for pharmaceuticals in some developing countries with production capabilities where patent laws on medicines are not respected. India is the main example. This, however, is likely to change in the near future as more countries comply with the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement (signed in 1994), which stipulates that all members of the World Trade Organization (WTO) must grant patent protection to all new, patentable pharmaceutical innovations³.

We can, therefore, conclude that even though there might be some level of income based international price discrimination for innovations, this is very unlikely to be perfect. Thus, our assumption of uniform pricing is a reasonable representation of the present and future international markets for drug innovations. As already indicated, our result regarding the donor's willingness to participate in an international transfer system would still hold, though would be weakened, in an imperfect price discrimination environment.

The rest of the paper is organized as follows. Section 2 explains the assumptions and the structure of the model. In Section 3 we provide a solution for the pre-transfer choice of medical care and innovation. Section 4 analyzes the effects of an income transfer on the firm behavior and the consumer utility. In Section 5 we discuss some of the caveats in our analysis. Section 6 concludes the paper.

2 The model

Consider a three stage game as follows. In the first stage, all countries or governments, donors as well as recipients, simultaneously decide about participating in a redistribution or transfer scheme defined below. In the second stage, a single innovating firm chooses the quality and the price of health care innovation. Consumption decisions are made in the final stage.

Whereas the private agents, the monopoly provider of health care and the consumers of health care, maximize their respective payoff functions defined later, the national governments are assumed to act in the best interest of their respective consuming population. That is, decisions of the respective governments to participate in the international transfer scheme reflect collective decisions of their consuming population⁴.

²See europa.eu.int for a detailed explanation of the European law

³Developing countries have 2005 as a deadline for implementing TRIPS. Watal (2000) shows that the predicted result of the application of the TRIPS agreement in India is a significant increase in pharmaceutical prices, which have been amongst the lowest in the world. Indeed, parallel trade is one of the ways in which India is planning to compensate for some of the expected price increases.

⁴We are implicitly assuming that governments are neither corrupt nor inept. However, as Easterly (2001) indicates, for many developing countries this is not a realistic assumption.

As a simplification of analysis, we assume away intra-country income disparity and size differences across countries. But there are cross-country income differences. More precisely, we assume that the world population (or total number of consumers) is uniformly distributed over the world income (y) range $[a, b]$:

$$f(y) = \begin{cases} n & \text{for } 0 < a \leq y \leq b. \\ 0 & \text{otherwise.} \end{cases}$$

where $n(b - a)$ is the total number of individuals in the world. There are more than one way to interpret this distribution function. One interpretation is that countries are arranged according to their per capita income $y \in [a, b]$. Thus, on this interpretation, countries differ not in size (each having a population size n), but in respect of per capita income. These are obviously strong assumptions and are made simply for the purpose of tractability. However, as will be discussed later, having a non uniform world income distribution (or different country sizes as a matter of fact) would not change our results qualitatively.

What is immediate from such an assumption of identical consumers in each country is that an income transfer by a representative consumer belonging to the country with per capita income y will imply income transfers by that country as well. This is because, if a representative consumer in the country with per capita income y supports the redistribution scheme, so does any other (and all) consumer in that country. In other words, the individual decision is the collective (or national government's) decision.

Consider now the following income transfer scheme. Each consumer, regardless of his or her income level, or of the country of residence, will have to contribute a proportion of income to a global fund and receive a lump-sum transfer which is just equal to the per capita aggregate contribution to the fund. Thus, in this scheme, transfers are not unilateral. By adopting such an approach where all individuals (and countries) contribute to the fund and receive transfers, we can avoid pre-determined and arbitrary segmentation of the world income (or countries) as pure donors and recipients. In our scheme, however, individuals and countries can be identified as *net* donors and *net* recipients.

Each consumer with income y decides about participating in this transfer scheme and, on the above set of assumptions, the decision of a country (or its government) is the same. Pure altruism on part of representative consumers may motivate such decisions, but we abstract from such a motive. We focus on the self-interest motives whereby the individual participation decisions are based on gains through the impact of such a redistribution scheme on health care innovation and its price.

The best scenario is of course that where all participants and countries, net donors as well as net recipients, gain. But, as we will show, depending on the probability of illness and the level of income, some individuals may lose. Thus not all governments, given an option, will be willing to participate in the transfer scheme. In such a case, the transfer scheme defined above is implemented

Our paper therefore deals with an ideal world of honest and competent governments.

through majority voting⁵. Of course, even then the enforcement of the transfer scheme cannot be assured. Our purpose here, however, is not to design an enforcement mechanism but to show whether majority of countries can support the scheme based on their selfish pursuits of national welfare improvement. Accordingly, we set aside the enforcement issue by ruling out unilateral defection as an option. Participation in the transfer scheme is assumed to be binding for all countries if other countries vote that they are obliged to participate⁶. In the rest of the paper, therefore, we examine how much support the above transfer or redistribution scheme receives for its implementation through majority voting.

We do not endeavour to find out a majority voting equilibrium as in, for example, Gouveia (1997). Such an equilibrium is defined in the public economics literature as the decision taken by majority voting such that no further majority voting can prefer an alternative solution. Given the purpose of this paper, it is sufficient to show that by majority voting a small, infinitesimally small in fact, redistribution may be preferred to no-redistribution (or zero tax and transfer) scheme. Whether such a small transfer is a majority voting equilibrium, or whether further redistributions, larger than our small one, may be preferred to by majority voting, is altogether a different issue, which we leave open in this paper.

We now proceed to characterize our model formally and analyze whether the above defined transfer may be preferred to no-transfer through majority voting.

2.1 *Consumer preferences and health technology*

A representative consumer with income y derives utility from a composite commodity, C and health, h . Perfect health is indicated by $h = 1$. There is an exogenous probability p that individuals fall ill, which implies a fall in the health level to h_s such that $0 \leq h_s < 1$. Patients have the option of buying any of the available medical treatments, which increases the health level above the illness level.

Utility is maximized subject to a budget constraint, $y = C + c(h)$, where $c(h)$ is the cost of achieving health level h in the illness state, $h_s \leq h \leq 1$. Expected utility for a consumer with income y can then be written as

$$EU = (1 - p)U(y, 1) + pU(y - c(h), h),$$

For simplicity, we assume log-linear utility separable in consumption and health. So,

$$EU = (1 - p) \ln y + p[\ln(y - c(h)) + \ln h].$$

Note that

⁵Majority voting may not always portray a real world institution. But this offers a convenient analytical mechanism to identify preferences of countries for a redistribution scheme.

⁶For example, there might simply be moral obligations on part of countries to adopt the transfer scheme if enough countries support the scheme.

$$MRS_{C,h} = \frac{y - c(h)}{h},$$

and so willingness to pay for health restoration increases with income and tends to infinity as the level of health tends to zero, ruling out corner solutions for cases in which h_s tends to 0.

2.2 *Medical Innovation*

Assume there is an innovation, perhaps a new pharmaceutical. Prior to the innovation, there is only one treatment available which raises health from h_s to \bar{h}^o . We assume that this treatment is supplied competitively at a price $P = c$, where c is the constant marginal production cost. The new treatment raises health to $\bar{h} > \bar{h}^o$. We assume the new treatment has the same marginal production cost as the original treatment but that the innovator must incur an investment cost of $F(\bar{h})$ in order to realize the innovation ($F' > 0$, $F'' > 0$).

We assume only one firm has the knowledge to develop the innovation. Given this, the innovation is assumed to be realized with certainty. These assumptions ensure that we do not have to consider issues of patent races and the 'common pool' problem of *R&D*. The innovating firm will hold a monopoly position in the supply of the new medicine for a limited period, while it is under patent.

3 Pre-transfer choice of medical care and innovation

In this section, we analyze the choice of quality level \bar{h} for innovation by the single innovator and the choice of medical care by the consumers. The utility levels attained by the consumers at the pre-transfer equilibrium will thus constitute their reservation payoffs in deciding about participating in the international transfer scheme as defined above.

In the pre-transfer scenario, we have the following two stage game: in the first stage, the innovator selects the quality of the innovation, measured by the health level it generates and the price; in the second stage, patients select the quality of medical care they want to buy. The solution is found using backward induction.

3.1 *Stage 2: Individuals choose medical care*

A patient has three basic options of treatment resulting in three levels of medical expenditure and providing different levels of health:

$$\begin{aligned} \text{No treatment} &: c(h_s) = 0. \\ \text{Old treatment} &: c(\bar{h}^o) = c. \\ \text{Innovation} &: c(\bar{h}) = P. \end{aligned}$$

Patients with income lower than $\bar{y}^o \equiv \frac{\bar{h}^o c}{\bar{h}^o - h_s}$ prefer no medical care to the original technology:

$$\ln(y - c) + \ln \bar{h}^o < \ln y + \ln h_s \iff y < \frac{\bar{h}^o c}{\bar{h}^o - h_s}. \quad (1)$$

Patients with the income level $\bar{y} \equiv \frac{\bar{h}P}{\bar{h} - \bar{h}^o} - \frac{\bar{h}^o c}{\bar{h} - \bar{h}^o}$ are indifferent old and the new technologies:

$$\begin{aligned} \ln(\bar{y} - c) + \ln \bar{h}^o &= \ln(\bar{y} - P) + \ln \bar{h} \iff \\ \bar{y} &= \frac{\bar{h}P}{\bar{h} - \bar{h}^o} - \frac{\bar{h}^o c}{\bar{h} - \bar{h}^o}. \end{aligned} \quad (2)$$

Therefore, patients with income higher than \bar{y} will buy the innovation. Also note that the indifferent patient's income is increasing in the price and decreasing in the quality of the innovation.

$$\frac{d\bar{y}}{dP} = \frac{\bar{h}}{\bar{h} - \bar{h}^o} > 0. \quad (3)$$

$$\frac{\partial \bar{y}}{\partial \bar{h}} = \frac{\bar{h}^o}{(\bar{h} - \bar{h}^o)^2} (c - P) < 0. \quad (4)$$

3.2 Stage 1: The innovator sets the price and the quality

We now obtain the optimal price and quality of the innovator assuming that price discrimination is not feasible. Note that the expected number of sales of the innovation is $pn(b - \bar{y})$. Given this, the profit function of the innovator is:

$$E[\pi] = pn(b - \bar{y})(P - c) - F(\bar{h}). \quad (5)$$

Differentiating with respect to P and using expressions (2) and (3) we obtain the following first order condition for price optimization:

$$P^* = c + \frac{1}{2} \frac{\bar{h} - \bar{h}^o}{\bar{h}} (b - c). \quad (6)$$

Note that the optimal price is increasing in the quality of the innovation:

$$\frac{dP^*}{d\bar{h}} = \frac{1}{2} \frac{\bar{h}^o}{\bar{h}^2} (b - c) > 0. \quad (7)$$

It can also be easily seen that the equilibrium level of income for the indifferent consumer does not depend on the innovator's quality. Substituting (6) in (2), we get

$$\bar{y}^* = \frac{1}{2}(b + c). \quad (8)$$

However, this property of the optimal indifferent income would not hold if we relax the assumption of production costs being the same for the old and new products.

The first order condition for profit maximization yields:

$$\frac{\partial E[\pi]}{\partial \bar{h}} = -np(P - c) \left(\frac{\bar{h}^\circ}{(\bar{h} - \bar{h}^\circ)^2} (c - P) \right) - F'(\bar{h}) = 0,$$

Rewriting and substituting for P^* from equation (6), we get,

$$np\bar{h}^\circ \left(\frac{1}{2\bar{h}}(b - c) \right)^2 - F'(\bar{h}) = 0. \quad (9)$$

Using (6) to substitute for P^* in the expression for the marginal rate of substitution, we obtain the equilibrium value of the marginal rate of substitution as,

$$MRS_{C,\bar{h}} = \left(y - \left(c + \frac{1}{2} \frac{\bar{h} - \bar{h}^\circ}{\bar{h}} (b - c) \right) \right) \frac{1}{\bar{h}}.$$

which, when evaluated at \bar{y}^* , boils down to

$$\begin{aligned} MRS_{C,\bar{h}}|_{y=\bar{y}^*} &= \left(\frac{1}{2}(b + c) - \left(c + \frac{1}{2} \frac{\bar{h} - \bar{h}^\circ}{\bar{h}} (b - c) \right) \right) \frac{1}{\bar{h}} \\ &= \frac{1}{2}(b - c) \frac{\bar{h}^\circ}{\bar{h}^2}. \end{aligned}$$

Using this value, we can rewrite expression (9) as follows

$$MRS_{C,\bar{h}}|_{y=\bar{y}^*} = \frac{F'(\bar{h})}{pn(b - \bar{y}^*)}. \quad (10)$$

This tells us that profit maximization entails the willingness to pay of the marginal consumer being equal to the marginal cost averaged for all consumers (see Tirole (1988)).

4 International transfer and participation decision

Consider now the simultaneous decision of countries in participating in an international transfer scheme whereby, as we have mentioned earlier, each consumer will have to pay a proportion of income, ty ($0 < t < 1$) and receive a lump

sum amount, T , regardless of her income and of the country she represents. Therefore, the post-transfer income of consumers, y^T , will be

$$y^T = y(1 - t) + T.$$

We assume that the lump sum amount T received by each individual is equal to the per-capita aggregate contribution made by the world population:

$$T = \frac{\int_a^b ntydy}{n(b-a)} = \frac{t(b+a)}{2}.$$

Therefore,

$$y^T = y + t \left(\frac{b+a}{2} - y \right). \quad (11)$$

That is, with the above specification we are basically redistributing income around the mean, $\frac{b+a}{2}$. Also note that t can be interpreted as a measure of the strength of the redistribution. If $t = 1$ there is total redistribution: all individuals will have the mean income. At the other extreme, $t = 0$ represents no redistribution.

As we have mentioned earlier, decision of countries to participate in the transfer scheme is *not* unilateral. The transfer scheme is implemented through majority voting and it is binding for all. That is, if enough countries support this scheme, others participate in the scheme as well even if they may lose. However, under the assumptions specified in section 2 above, how many countries would support the transfer scheme depends on the effect of such a redistribution of the world income on the consumer utility through changes in prices and quality of the health care innovation. In the following subsection we first analyze such effects and then in the subsection thereafter we will examine whether this (small) redistribution or transfer scheme will be preferred to no-transfer situation by majority voting.

4.1 *Effect of income redistribution on prices, quality and consumer utility*

It is easily noticed that the "after redistribution" income y^T is also uniformly distributed and has the following density function:

$$f(y^T) = \begin{cases} \frac{n}{1-t} & \text{for } 0 < a^T \leq y^T \leq b^T. \\ 0 & \text{otherwise.} \end{cases}$$

where,

$$a^T = a(1-t) + \frac{t(b+a)}{2} = a + \frac{t(b-a)}{2}. \quad (12)$$

$$b^T = b(1-t) + \frac{t(b+a)}{2} = b - \frac{t(b-a)}{2}. \quad (13)$$

The expected profits for the innovator with the transfer are

$$E[\pi] = p(P^T - c) \frac{n}{1-t} (b^T - \bar{y}^T) - F(\bar{h}). \quad (14)$$

Profit maximization then yields the optimal price after the redistribution as:

$$P^{T*} = c + \frac{1}{2} \frac{\bar{h} - \bar{h}^o}{\bar{h}} (b^T - c). \quad (15)$$

Note that the maximum post-redistribution income must be above the marginal costs of production, $b^T > c$, for profits to be positive. Also, since $b^T < b$, the transfer will decrease the optimal price for given qualities.

The post-redistribution indifferent income is

$$\bar{y}^{T*} = \frac{1}{2} (b^T + c). \quad (16)$$

Therefore, the transfer will make the indifferent consumer's income lower. Also note that for the whole market to be covered the transfer would have to be such that $\frac{1}{2} (b^T + c) = a^T$. Substituting for b^T and a^T this boils down to,

$$t^* = \frac{2b - 2a + c}{3(b-a)}, \quad (17)$$

For there to be a need for a transfer to ensure universal access, the minimum income needs to be smaller than the equilibrium indifferent income without the transfer

$$t^* > 0 \Leftrightarrow \frac{b+c}{2} > a.$$

Also, unless the mean income is above the marginal production costs, universal access will not be feasible. Our assumption regarding the marginal production costs, however, ensures that this will not be the case

$$t^* < 1 \Leftrightarrow c < \frac{b+a}{2}.$$

Lemma 1 *An increase in the strength of the redistribution, t , has a positive effect on the amount of potential buyers of the innovation as long as the marginal production costs are smaller than the mean income.*

Proof. Follows directly from differentiating the number of potential buyers, $\frac{n}{(1-t)} (b^T - \bar{y}^{T*})$, with respect to the strength of the redistribution, t ■

Note that if the production cost is above the mean income, since the redistribution is mean preserving, an increase in t will decrease the number of consumers who can afford even the production cost of the innovation. Therefore, this will also lower the number of prospective consumers of the innovation.

Lemma 2 *An increase in the strength of the income redistribution will have a positive effect on the optimal quality as long as the marginal production costs are smaller than the lowest income.*

Proof: See Appendix.

The above lemma states that redistribution of income increases the optimal quality as long as $a^T > c$, for which $a > c$ is a sufficient condition. In our model, this means that if the income around which redistribution takes place is higher than the equilibrium indifferent consumer's income, income redistribution will have a positive impact on the equilibrium quality. However, if $a^T < c$, an increase in the strength of the redistributive system will decrease the product's quality. The intuition is as follows. The equilibrium indifferent income being above the mean income indicates that only the richest consumers can afford to buy the innovation. In this case, a mean preserving redistribution from rich to poor would decrease the income of the consumers who could afford to buy the pre-transfer optimal quality. Also, the consumers who receive the transfer will still not be able to buy the innovation at the given prices. In order to compensate for the loss of consumers, the firm will lower the innovation's price and quality.

This result can be extended to a more general class of income distribution and redistribution methods. As can be seen in Acharyya (2002), as long as the indifferent income is below the income around which redistribution from higher to lower incomes takes place, the impact of redistribution on the quality will be positive.

We now analyze the effect of income redistribution on the utility of individuals. Clearly, individuals who receive income as a result of the redistribution will have utility gains independently of whether they buy the innovation, buy the lower quality product or do not buy any health care. Also, some of the low income consumers who chose not to buy the lower quality treatment, will now be willing to acquire it. We are then interested in seeing what happens to the utility of the individuals whose income is reduced through the transfer. As has already been noted, if the income of the consumer who is indifferent between buying the innovation or the lower quality alternative is below the mean income, all donors will consume the innovation in case of illness. The following lemma then specifies the impact of redistribution on the utility of consumers should they become ill.

Lemma 3 *The income redistribution will have a positive impact on the utility of patients who buy the innovation and whose pre-transfer income is lower than Y , where*

$$Y = \frac{b+a}{2} + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^o}{\bar{h}^*} \frac{b-a}{2}. \quad (18)$$

Proof: See Appendix.

Note that $\frac{b+a}{2}$ is the mean income. By the nature of the transfer, all individuals with income smaller than the mean income receive a positive net transfer and all those with income above the mean have to make a positive net transfer. Since Y is above the mean income, even some of the individuals who have to make a positive transfer will have utility gains. But at the same time, since $b > Y$, not all donors will be made better off by the transfer.

Consider now the case in which the mean income, around which redistribution takes place, is below the indifferent income. In this case, there will be a group of consumers who have to give up some income without still being willing to buying the innovation. These consumers will be clearly worse off with our mean preserving redistribution. In the extreme, if the pre-transfer indifferent income is higher than our threshold income, Y , none of the donors will benefit from income redistribution.

$$\bar{y}^* \geq Y \Leftrightarrow \frac{b+c}{2} \geq \frac{b+a}{2} + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^o}{\bar{h}^*} \frac{b-a}{2}.$$

Note that since the marginal consumer's income is an increasing function of production costs and our threshold income is an increasing function of the lowest income in the distribution, very high production costs relative to the lowest income will make it impossible for any donor to benefit from the redistribution.

4.2 *Majority voting*

We are now in a position to determine how much support the international transfer scheme will receive. From the above discussion it follows immediately that all countries whose representative income is lower than the average income $\frac{b+a}{2}$, will vote in favor of the redistribution, independently of the probability of illness. Obviously, these people receive money and so, their utility is higher in the non-illness state. Also, in the illness state, their utility will be higher since the impact of redistribution is that of decreasing health prices and increasing their quality.

Countries with per capita income $b > y > Y$ will oppose the redistribution scheme. If they do not fall ill they clearly loose money with no positive effect. If they do fall ill, money is also lost and they are not compensated by the positive effect in utility though price and quality changes, as shown above.

Finally, the countries with income $Y > y > \frac{b+a}{2}$, will support the redistribution scheme as long as their probability of illness is high enough. If healthy, they lose money with no gain. But, if ill, the negative impact on the utility through the money lost is compensated by the positive effect through price decrease and quality increase.

It is important to note that since

$$Y = \frac{b+a}{2} + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^o}{\bar{h}^*} \frac{b-a}{2} \leq \frac{1}{2} \left(b + \frac{b+a}{2} \right) = \frac{b+a}{2} + \frac{1}{2} \frac{b-a}{2}, \quad (19)$$

if the decision over whether or not to redistribute income is taken by only the donors (who are those with the income levels higher than $\frac{b+a}{2}$) then, by the majority voting rule the redistribution or transfer scheme will not receive enough support. If the decision is taken among all the countries though, enough support is almost certainly going to be gathered as long as the probability of illness is high enough as to make the countries with per capita income $Y > y > \frac{b+a}{2}$ support the small redistribution.

5 Caveats

In the previous section, we have discussed how an income redistribution could be an effective tool to increase access to health innovations. We have shown that even some of the donors would see their utilities increase as a result of income redistribution. The application of the model to Third World access to health innovations is not straightforward, though. A few caveats are in order. First, for our model to be an accurate representation of an inter-country redistribution, we need to assume that per capita income is a good estimate of the purchasing power of the majority within each country. This assumption becomes stronger the greater the intra-country income inequality is. An income transfer designed to help the poor majority gain access to the health care needs to ensure that donations do not fall into the hands of the rich minority⁷. A second, and related, problem with the applicability of our model to inter-country redistribution is our assumption of a uniform distribution of income. It cannot be denied that world income distribution is not uniform (see Milanovic, 2002). With an uneven world income distribution, say a few rich and many poor, there would still be scope for an income redistribution from rich to poor that would benefit some donors as long as the inequality is not too high. But in the case that inequality is very stark, it would be too "expensive" for the rich to persuade the innovator to set a lower price that would grant access to the poor. In this case, altruism would be the sole motive behind an income transfer⁸. The third caveat is that, in reality, income redistribution across the world is voluntary. Our result is relevant by showing that some donors can have a self-interested motivation for voluntary participation in such an initiative. Finally, we have proved that some of the patients who lose income are better off in welfare terms due to the impact on the behavior of the innovator. But this is an ex-post utility analysis. From an ex-ante point of view, this result is weakened if the probability of illness is not high and our model does not apply to a situation where the probability of illness differs across countries. For illnesses with a much higher impact in

⁷It is the case in many poor countries that rich elites prevent aid from reaching the poor majority so as to block the creation of a middle class that could press for democracy and individual rights (see Hillman, 2002).

⁸A discrete consumer type model like, the one used in the quality choice literature by Cooper (1984) and Acharyya (1998, 2005), would still produce results similar to the ones obtained in this paper.

the poorer than in the richer countries, access to innovations would not be an issue as firms would set prices targeting these countries. It is the case, however, that for many such illnesses purchasing power in poor countries may not be enough to encourage firms to invest in *R&D*, which could lead to significant innovations. There is then a need for higher income countries to fund research in this illnesses. However, the motivations for such donations are not captured by our model⁹.

6 Concluding remarks

The access of poorer countries to the innovations in health care is a major concern. The existence of price spillovers constrains price discrimination between higher and lower income countries. As a result, many poorer countries cannot afford to buy state-of-the-art medicines.

In this paper, we have studied the impact of an income transfer from the richer to the poorer consumers on the decisions of the health innovator and the utility of consumers. We find that whenever income redistribution takes place around an income above the marginal consumer's income, the optimal quality of the health care innovation will increase. Also, we have proved that income redistribution will increase the utility of some of the consumers whose income is reduced through the redistribution, as long as marginal production costs are not too high relative to the lowest income. This indicates a way in which the donor countries benefit from transfers to the poorer nations and, therefore, it would encourage potential donors to participate in income transfer systems without altruistic considerations.

A few caveats to our results have been pointed out. The use of a uniform income distribution function is a simplifying assumption. There is still scope for an increase in the utility of donors as long as the income distribution is not too uneven. A self-interested donation is also less likely to arise if the preference for health products or the probability of illness is small. Our model does not allow for differences in the probability of illness across countries.

Finally, we emphasize that income transfers are by no means the only method available to increase access to health innovations. The WTO is trying to implement agreements that would help developing nations to ensure some limited access to medicines in the post-TRIPS Agreement era (see <http://www.wto.org> for a discussion of the difficulties involved in implementing effective price discrimination and an update on the latest agreements and their implementation). At the same time, developing countries that are producers of pharmaceutical products have been looking for alternative methods to avoid predicted price increases in their medicines as they implement the TRIPS Agreement, parallel imports being one of the options.

⁹Kremer (2000a, 2000b) analyzes the optimal provision of incentives for investment in such innovations.

7 Appendix

Proof of Lemma 2. >From equation (14), we can derive the First Order Condition for quality in the presence of income redistribution

$$\frac{n}{1-t} p \bar{h}^\circ \left(\frac{1}{2\bar{h}} (b^T - c) \right)^2 - F'(\bar{h}) = 0.$$

Substituting above b^T from (13), we get

$$\frac{n}{1-t} p \bar{h}^\circ \left(\frac{1}{2\bar{h}} \left(b - \frac{t(b-a)}{2} - c \right) \right)^2 - F'(\bar{h}) = 0.$$

Finally, using the Implicit Function Theorem we get that

$$\text{sign} \left\{ \frac{d\bar{h}^*}{dt} \right\} = \text{sign} \left\{ - \frac{\frac{\partial^2 E[\pi]}{\partial t \partial \bar{h}}}{\frac{\partial^2 E[\pi]}{\partial \bar{h}^2}} \right\},$$

which, assuming the usual concavity of the profit function for an interior solution for quality, is positive if $\frac{\partial^2 E[\pi]}{\partial t \partial \bar{h}} > 0$. Note that

$$\begin{aligned} \frac{\partial^2 E[\pi]}{\partial t \partial \bar{h}} &= \frac{1}{(1-t)^2} \left(b - \frac{t(b-a)}{2} - c \right)^2 + \frac{1}{1-t} 2 \left(b - \frac{t(b-a)}{2} - c \right) \left(-\frac{b-a}{2} \right) > 0 \Leftrightarrow \\ &\frac{1}{1-t} \left(b - \frac{t(b-a)}{2} - c \right) - (b-a) > 0 \Leftrightarrow \\ &\frac{t(b-a)}{2} + a - c > 0 \Leftrightarrow a^T > c. \end{aligned}$$

■

Proof of Lemma 3. In order to prove this lemma we differentiate the utility of the individual in case of illness with respect to the strength of the transfer and we evaluate at $t = 0$. In this manner, we ensure that we are following an individual whose pre-transfer income is y .

$$\begin{aligned} \frac{dU}{dt} \Big|_{t=0} &= \frac{\frac{\partial y^T}{\partial t} - \frac{\partial P^{T*}}{\partial t}}{y^T - P^{T*}} + \frac{\frac{\partial \bar{h}^*}{\partial t}}{\bar{h}^*} = \\ &= \frac{\frac{\partial \left[y(1-t) + \frac{t(b+a)}{2} \right]}{\partial t}}{y^T - P^{T*}} - \frac{\frac{\partial \left[c + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^\circ}{\bar{h}^*} (b^T - c) \right]}{\partial t}}{y^T - P^{T*}} + \frac{\frac{\partial \bar{h}^*}{\partial t}}{\bar{h}^*} = \end{aligned}$$

$$= \frac{\left(\frac{b+a}{2} - y\right) + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^o}{\bar{h}^*} \frac{(b-a)}{2}}{y^T - P^{T*}} + \left(\frac{1}{\bar{h}^*} - \frac{\frac{1}{2} (b^T - c) \frac{\bar{h}^o}{(\bar{h}^*)^2}}{y^T - P^{T*}} \right) \frac{\partial \bar{h}^*}{\partial t}.$$

The second term of the above expression is the effect on utility of a variation in quality induced by the transfer system. Note that the term in brackets within the second term above is equal to zero

$$\begin{aligned} & \frac{1}{\bar{h}^*} - \frac{\frac{1}{2} (b^T - c) \frac{\bar{h}^o}{(\bar{h}^*)^2}}{y^T - P^{T*}} = \\ & = \frac{1}{\bar{h}^*} - \frac{\frac{1}{2} (b^T - c) \frac{\bar{h}^o}{(\bar{h}^*)^2}}{\frac{b^T + c}{2} - \left(c + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^o}{\bar{h}^*} (b^T - c)\right)} = \\ & = \frac{1}{\bar{h}^*} - \frac{\frac{1}{2} (b^T - c) \frac{\bar{h}^o}{(\bar{h}^*)^2}}{\frac{b^T - c \bar{h}^o}{2 \bar{h}^*}} = 0. \end{aligned}$$

Therefore, the sign of the overall effect is given by the sign of the first term which represents the effect on utility of an increase in net income induced by the transfer for given qualities. For this term to be positive, we must have $y < Y$. ■

Acknowledgments

We thank Javier Coto-Martínez, Begoña García-Mariñoso, Owen O'Donnell, Henry Ursprung and two anonymous referees for their helpful comments. The usual disclaimer applies.

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