

# INCOME REDISTRIBUTION AND ACCESS TO INNOVATIONS IN HEALTH CARE

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## Abstract

We study the impact a redistribution of income has on the decisions of a health care innovator and the utility of consumers. We find that income redistribution from rich to poor increases the quality of the medical innovation, reduces its price and increases the utility of some of the consumers whose income is reduced through the redistribution.

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## 1. Introduction

There is an ongoing debate on what should be, if any, the best way to ensure Third World access to innovations in health care.

Pharmaceutical companies are subject to constant criticism for selling their state of the art drugs at a price which is well above the production costs, high prices which Third World countries cannot afford to pay. Drug companies defend themselves by arguing that the increasingly expensive development of new drugs could not take place if they did not have the prospect of future high profits.

Fears of price arbitrage, due to the so called "grey" re-importing, prevent firms from price discriminating between higher and lower income countries. There has been some suggestion that it is rich-world tax payers who should bear the cost of allowing the Third World access to drug innovations (The Economist, February, 2001).

In this paper, we propose one possible mechanism through which richer countries can help poorer countries to have access to innovations in medical care: income transfers. Our objective is to study the role of the income redistribution from richer to poorer consumers in providing incentives for innovation, equilibrium prices and market coverage and the utility of individual consumers.

The characterization we use to study the above issues follows from both the health literature and the existing literature on vertical differentiation with income disparities across consumers (Gabszweicz and Thisse (1979) and Shaked and Sutton (1982) are two early examples). However, unlike in most of the vertical differentiation models, we are not concerned with analyzing the strategic interaction between firms in the presence of income disparities. Our aim is to analyze the strategic interactions between a unique innovative firm which faces a competitive fringe in the established quality and a health care system which attempts to use income redistribution as a tool for increasing access to the health care innovation.

The issue of income redistribution in a vertical differentiation model with a monopoly has been studied recently by Acharyya (2000). Using a linear utility function (as in Tirole 1988), he examines how a change in the income distribution can affect the quality choice of a monopolist. He proves that an income redistribution cannot only increase but also decrease the optimal quality provided by the monopolist. In our paper, we use a nonlinear characterization of the utility of consumers which is closer to the original Shaked and Sutton (1982). We use a simple redistribution function which allows us to examine the effect of income on the individual's utility, through its effect on prices, quality and the consumer's

income.

Also, differently from Acharya (2000) we discuss the effect of the government's lack of commitment to a pattern of income redistribution prior to the firm's decision over prices and quality of the innovation.

In this paper, we prove that when the government can commit to income redistribution prior to the quality and price decisions of the health care innovator, the equilibrium quality is increased, the equilibrium price for the innovation is lower and more patients buy the innovation. This will leave all patients whose income is not too high with a higher utility than in the absence of income redistribution. Even some of the patients who lose income through the redistribution and would be buying the innovation without it, will have a higher utility after the income redistribution.

The paper is organized as follows. Section 2 explains the basic assumptions and solution to the basic non redistributive model. Section 3 introduces and analyzes the effects of an exogenous income redistribution on firms behavior and consumer utility. Section 4 concludes the paper.

## 2. The Benchmark Model

In this section, we introduce the basic assumptions and structure of our benchmark model without redistribution.

### 2.1. Consumer preferences and health technology

Utility is derived from a composite commodity,  $C$  and health,  $h$ . Perfect health is indicated by  $h_1 = 1$ . There is a probability  $p$  that individuals fall ill, this implies a fall in health level to  $h_2$  such that  $0 < h_2 < h_1$ .

We will denote ill individuals as 'patients'. Patients have the option of buying any of the available medical treatments which increase health above the illness level.

We assume individuals' incomes,  $y$ , are uniformly distributed between  $a$  and  $b$ . The frequency function of the uniform distribution is:

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

where  $n(b - a)$  is the total number of individuals in the economy.

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. Expected utility for a consumer with income  $y$  can then be written as

$$EU = (1 - p) U^1(y, 1) + pU^2(y - c(h), h).$$

We use a stylized model, with specific functional forms for the sake of simplicity

$$U^1(y, 1) = \ln y,$$

$$U^2(y - c(h), h) = \ln(y - c(h)) + \ln h.$$

This utility function is similar to the one used in the some of the recent health care innovation literature (see e.g., Goddeeris (1984a and 1984b)).

Note that

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

which means that the willingness to pay for health restoration increases with income and tends to infinity as the level of health tends to zero. The latter implies that there can be no corner solutions for cases in which  $h_2$  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  $h_2$  to  $\bar{h}^o$ . We assume that this treatment is supplied competitively at a price  $P = c$ , where  $c$  is a 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 a fixed 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. However, the increase in quality due to the innovation will be a function of the amount of R&D invested. 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. Given this, and the greater effectiveness of the new medicine, the monopolist can charge a price,  $P > c$ .

### 2.3. Timing of Decisions and Solution

In this section, we consider the following two stage game: in the first stage the innovator firm decides on the degree of innovation, i.e.  $\bar{h}$  and the price; in the second stage, the patients select the quality of medical care they want to buy. The solution is found using backward induction.

#### 2.3.1. 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:

$$\begin{aligned} \text{No treatment} : c(h_2) &= 0. \\ \text{Old treatment} : c(\bar{h}^o) &= c. \\ \text{Innovation} : c(\bar{h}) &= P. \end{aligned}$$

We assume that all patients prefer the original technology to no medical care. That is,

$$\ln(y - c) + \ln \bar{h}^o > \ln y + \ln h_2 \iff \frac{y - c}{y} > \frac{h_2}{\bar{h}^o}. \quad (2.1)$$

This condition means that the original treatment is sufficiently cost effective to be purchased by everyone and requires that the lowest level of income is higher than the per unit production cost,  $a > c$ .

We can now find the income,  $\bar{y}$ , which makes a consumer indifferent between the old and the new technologies

$$\begin{aligned} \ln(\bar{y} - c) + \ln \bar{h}^o &= \ln(\bar{y} - P) + \ln \bar{h} \iff \\ \bar{y} &= \frac{\bar{h}P}{\bar{h} - \bar{h}^o} - \frac{\bar{h}^o c}{\bar{h} - \bar{h}^o}. \end{aligned} \quad (2.2)$$

Patients with income higher than  $\bar{y}$  will buy  $\bar{h}$  for the given prices and qualities, also note that the "indifferent" patient's income is increasing in the price and decreasing in the quality of the innovation.

$$\frac{d\bar{y}}{dP} = \frac{\bar{h}}{\bar{h} - \bar{h}^o} > 0. \quad (2.3)$$

$$\frac{\partial \bar{y}}{\partial \bar{h}} = \frac{\bar{h}^o}{(\bar{h} - \bar{h}^o)^2} (c - P) < 0. \quad (2.4)$$

Note that, if we define  $P = c + \mu$ , then we can rewrite (2.2) as

$$\bar{y} = c + \mu \frac{\bar{h}}{\bar{h} - \bar{h}^o}, \quad (2.5)$$

here,  $\mu$  can be interpreted as the innovator's mark up.

### 2.3.2. Stage 1: The innovator sets price and quality

Let us first assume that price discrimination is not possible. This involves the following assumptions:

- Production technology does not allow discrimination through offering price-quality packages.
- Incomes cannot be observed or incomes can be observed but arbitrage opportunities and/or law prevent charging different prices.

Note that the expected number of sales of the product with quality  $\bar{h}$  are  $pn(b - \bar{y})$ . Given this, the profit function of the innovator is:

$$E[\pi] = pn(b - \bar{y})(P - c) - F(\bar{h}). \quad (2.6)$$

Differentiating with respect to  $P$  and using expression (2.2) and (2.3) we obtain the following first order condition for price optimization:

$$b - \left( \frac{\bar{h}}{\bar{h} - \bar{h}^o} P - \frac{\bar{h}^o}{\bar{h} - \bar{h}^o} c \right) - (P - c) \frac{\bar{h}}{\bar{h} - \bar{h}^o} = 0,$$

$$P^* = c + \frac{1}{2} \frac{\bar{h} - \bar{h}^o}{\bar{h}} (b - c). \quad (2.7)$$

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

$$\frac{dP^*}{d\bar{h}} = \frac{1}{2} \frac{\bar{h}^o}{\bar{h}^2} (b - c) > 0. \quad (2.8)$$

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 (2.7) in (2.2), we get

$$\bar{y}^* = \frac{\bar{h}}{\bar{h} - \bar{h}^o} \left( c + \frac{1}{2} \frac{\bar{h} - \bar{h}^o}{\bar{h}} (b - c) \right) - \frac{\bar{h}^o c}{\bar{h} - \bar{h}^o},$$

which, after simplifying gives

$$\bar{y}^* = \frac{1}{2} (b + c). \quad (2.9)$$

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 product.

Now, we derive the first order condition for quality optimization:

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

rewriting and substituting for  $P^*$  from equation (2.7), we get,

$$np\bar{h}^o \left( \frac{1}{2\bar{h}} (b - c) \right)^2 - F'(\bar{h}) = 0. \quad (2.10)$$

Note that using (2.7) to substitute for  $P^*$  we obtain the equilibrium value of the marginal rate of substitution

$$MRS_{C,\bar{h}} = \left( y - \left( c + \frac{1}{2} \frac{\bar{h} - \bar{h}^o}{\bar{h}} (b - c) \right) \right) \frac{1}{\bar{h}_2}.$$

Evaluating this at  $\bar{y}^*$

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

Using the above, we can rewrite expression (2.10) as follows

$$\Leftrightarrow MRS_{C,\bar{h}}|_{y=\bar{y}^*} = \frac{F'(\bar{h})}{pn(b-\bar{y}^*)}. \quad (2.11)$$

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 (as in Tirole, 1988).

## 2.4. Welfare analysis

We define social welfare as the sum of consumer and producer surplus. Maximization of social welfare requires marginal cost pricing,  $P = c$ . Then, all consumers would buy the innovation since  $\bar{h} > \bar{h}^o$  and the price is the same.

### 2.4.1. Quantity comparisons

The socially optimal quantity is  $pn(b-a)$ . Therefore, the quantity provided is sub-optimal, provided that  $\bar{y}^* > a \Leftrightarrow b-2a > -c$ . A sufficient condition for this is  $b \geq 2a$ . Note that, if all individuals had the same income the quantity produced by the innovator would be optimal, the reason being that, as individual demands are unitary if all individuals have the same income the firm can appropriate all the consumer surplus in which case the quantity produced coincides with the social optimum.

### 2.4.2. Quality comparisons

Let us first derive the reservation price,  $P_y$ , for an individual with income  $y$ , i.e., the price that makes this individual, if ill, indifferent between buying the innovation or the old treatment. This is

$$P_y = y \frac{\bar{h} - \bar{h}^o}{\bar{h}} + c \frac{\bar{h}^o}{\bar{h}}.$$

Therefore, if we set  $P = c$  in order to achieve the socially optimum quantity, patient with income  $y$  obtains consumer surplus:

$$CS_y = (y - c) \frac{\bar{h} - \bar{h}^o}{\bar{h}}.$$

Note that, since we have assumed that  $a > c$ , all patients will get some consumer surplus. At  $P = c$ , producer surplus is equal to  $-F(\bar{h})$ .

Note that with no insurance, it is not possible for an innovation to reduce welfare. Innovations are paid for out of pocket by individuals who are ill, there is no cost sharing by the healthy. If the cost of an innovation exceeds its benefit, it will not be purchased (and therefore not produced). We can then restrict our welfare analysis to the sum of expected patient and producer surplus:

$$E[W] = pn \left( \int_a^b (y - c) \frac{\bar{h} - \bar{h}^o}{\bar{h}} dy \right) - F(\bar{h}).$$

Maximizing the above with respect to  $\bar{h}$  we obtain the First Order Condition that defines the social planner's optimal level of quality:

$$\frac{\partial E[W]}{\partial \bar{h}} = p \left( \frac{\bar{h}^o}{\bar{h}^2} \right) n \int_a^b (y - c) dy - F'(\bar{h}) = 0. \quad (2.12)$$

which can be rewritten as

$$pn \left( \frac{\bar{h}^o}{\bar{h}} \right) \int_a^b MRS_{C,\bar{h}}^y dy = F'(\bar{h}). \quad (2.13)$$

This is close to the Samuelson rule for efficient provision of a public good, the difference being the multiplication of the  $\frac{\bar{h}^o}{\bar{h}}$  term.

Once an innovation has been established through the fixed investment cost, the marginal cost of supplying the higher, rather than the lower, level of quality is zero.

Comparing equations (2.11) and (2.13), we see that while the monopolist is concerned with the marginal value of quality to the marginal consumer, the social planner is concerned with the marginal value to the average consumer (Tirole, 1988).

Equation (2.12) can be compared with equation (2.10), in order to prove whether the welfare maximizing level of quality will be higher or lower than the level provided by the firm. The welfare maximizing quality will be higher than the firm's profit maximizing quality if and only if

$$np\bar{h}^o \left( \frac{1}{2\bar{h}} (b - c) \right)^2 < p \left( \frac{\bar{h}^o}{\bar{h}^2} \right) n \int_a^b (y - c) dy$$

This clearly holds for  $a > c$ .

### 3. Effect of Income Redistribution on Prices, Quality and Consumer Utility

In this section, we consider the effect of an exogenous mean preserving spread redistribution of income between individuals on prices and quality of the innovation and consumer utility. Each consumer will have to pay a proportion of income,  $ty$  ( $0 < t < 1$ ) and receive a lump sum,  $T$ . Therefore, the after transfer income of consumers,  $y^T$ , will be

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

We assume that the lump sum received by each individual is equal to the per-capita income tax raised

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

Therefore,

$$y^T = y + t \left( \frac{b + a}{2} - y \right). \quad (3.1)$$

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, while  $t = 0$  represents no redistribution.

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

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

Here,

$$a^T = a(1-t) + \frac{t(b+a)}{2} = a + \frac{t(b-a)}{2}. \quad (3.2)$$

$$b^T = b(1-t) + \frac{t(b+a)}{2} = b + \frac{t(a-b)}{2}. \quad (3.3)$$

The expected profits for the innovator with the transfer are

$$E[\pi] = p(P^T - c) \frac{n}{1-t} (b^T - \bar{y}^T) - F(\bar{h}). \quad (3.4)$$

It is easily noticed that after the redistribution, the new optimal price is:

$$P^{T*} = c + \frac{1}{2} \frac{\bar{h} - \bar{h}^o}{\bar{h}} (b^T - c). \quad (3.5)$$

Note that the maximum after redistribution income must be above marginal costs of production,  $b^T > c$ , for profits to be positive.

The after redistribution indifferent income is

$$\bar{y}^{T*} = \frac{1}{2} (b^T + c). \quad (3.6)$$

Therefore, as  $b^T < b$ , the transfer will decrease the optimal price for given quantities and so it will also 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  $b^T$  and  $a^T$  this is equivalent to

$$t^* = \frac{2b - 2a + c}{3(b - a)}, \quad (3.7)$$

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 maximum minimum income with transfer, i.e., the mean income, is above the marginal production costs, universal access will not be feasible, our assumption over marginal production costs ensures that this will not be the case

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

**Lemma 3.1.** *An increase in the strength of the redistribution,  $t$ , has a positive effect on the amount of potential buyers of the innovation.*

**Proof.** Simply by differentiation the after number of potential buyers,  $\frac{n}{(1-t)} (b^T - \bar{y}^{T*})$ , with respect to the strength of the redistribution,  $t$ ,

$$\frac{\partial}{\partial t} \left[ \frac{n}{(1-t)} (b^T - \bar{y}^{T*}) \right] > 0 \Leftrightarrow \frac{1}{(1-t)} \left( \frac{a-b}{2} \right) + \frac{1}{(1-t)^2} \left( b + \frac{t(a-b)}{2} - c \right) > 0,$$

which is clearly positive as long as  $c < \frac{b+a}{2}$ . ■

Note that if the production cost is above the mean income, as the redistribution is mean preserving, an increase in  $t$  will decrease the amount of consumers who can afford even the production cost of the innovation therefore, as well decreasing the amount of prospective consumers of the innovation.

**Lemma 3.2.** *An increase in the strength of the redistribution,  $t$ , has a positive effect on the optimal quality.*

**Proof.** From equation (3.4), we can derive the First Order Condition for quality in the presence of income redistribution

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

Substituting above  $b^T$  from (3.3), we get

$$\frac{n}{1-t} p \bar{h}^o \left( \frac{1}{2\bar{h}} \left( b - \frac{t(b-a)}{2} - c \right) \right)^2 - F'(\bar{h}) = 0. \quad (3.8)$$

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

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

Therefore, redistribution of income increases the optimal quality, given our initial assumption that  $a > c$ . This result replicates Acharyya (2000). There, if the income around which redistribution takes place is higher than the equilibrium indifferent income,  $\bar{y}^*$ , income redistribution will have a positive impact on the equilibrium quality and negative otherwise. Note that in our case, redistribution takes place around the mean income,  $\frac{b+a}{2}$ , therefore  $a > c$  implies that the equilibrium indifferent income is below the mean income,

$$\bar{y}^* = \frac{b+c}{2} < \frac{b+a}{2}.$$

A simplified version of our model could be to simply take two discrete consumers or groups of consumers, rich and poor and analyze the effect of a simple transfer from rich to poor. Note that, if only rich could have access to the innovation without the transfer the equilibrium indifferent income would be the rich consumer's income and clearly the mean income would be below that, therefore, changing the result on quality. We can then see how having a continuum of incomes makes our model more general.

In the following lemma, we analyze the effect of income redistribution on the patient's utility.

**Lemma 3.3.** *An increase in the strength of the redistribution,  $t$ , will have a positive impact on the utility of patients whose pre-transfer income,  $y$ , is lower than  $Y$ , where*

$$Y = \frac{b+a}{2} + \frac{1}{2} \frac{\bar{h}^* - \bar{h}^o}{\bar{h}^*} \frac{b-a}{2}. \quad (3.9)$$

**Proof.**

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

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 with that second term is actually equal to zero

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

Therefore, the sign of the overall effect is given by the sign of the first term which is 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  $y < Y$ . ■

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  $Y > \frac{b+a}{2}$ , for given qualities, even some of the individuals who have to make a positive transfer are better off afterwards due to the decrease in price.

Also note that  $b > Y$ , i.e., not all individuals will be made better off by the transfer. However, as  $Y$  is increasing in optimal quality, the fact that the optimal quality is increasing in the strength of the redistribution increases the number of consumers who are likely to benefit from the redistribution.

There are a few caveats we should make on the above result though. Although we have proved that some of the patients whose income is reduced through the redistribution of income are still better off due to the impact on the behavior of the innovator, 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. Clearly, individuals who do not become patients and whose income is above the mean will suffer from income redistribution. Also, if the weight on health in the utility function was small the result would be weakened for the same reasons, although it seems logical that health more than any other "good" carries such a weight in the utility function.

A second caveat to our result comes from the possibility of allowing richer patients to opt out from a redistributive system. As suggested in Gertler and Solon (1998), this could be a way for the innovator to identify higher income consumers and therefore discriminate in prices between the two groups. It can be argued that this would certainly decrease the incentives of richer patients to opt out.

Finally, we should discuss how our results would be affected by the inability of the government to commit to an income redistribution prior to the firm deciding on the optimal quality and prices. In this case the timing of our health innovation game would be different, instead of having an exogenous redistribution, redistribution would take place after the firms decide on quality and prices and before patients take their purchasing decisions.

In this case, the firm will introduce the government's redistribution system into its decision problem and act strategically accordingly. If the government redistributes income such that universal access to the innovation is achieved, the income of the lowest income consumer after the transfer will be given by

$$a^T = \frac{\bar{h}P^T - \bar{h}^o c}{\bar{h} - \bar{h}^o}.$$

The  $t$  that ensures this is given by

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

Note that  $\frac{dt}{dP^T} = \frac{2}{b-a} \left( \frac{\bar{h}}{\bar{h} - \bar{h}^o} \right) > 0$

Now the innovator knows that the health system will take prices and qualities as given and it will redistribute income so that the indifferent income is the lowest income,  $a^T$ . If the innovator introduces this information into its profit function, he obtains

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

That is, the profit function becomes increasing in prices. The innovator would then set the highest price it can, this price will be that which forces total redistribution i.e., the price that makes the mean income patient indifferent between buying the innovation or not. This price leaves all consumers indifferent between buying the innovation or not, as it forces total redistribution.

## 4. Concluding Remarks

Third World access to innovations in health care is a major concern among international health organizations. The existence of price arbitrage prevents pharmaceutical companies from price discriminating between higher and lower income countries. As a result, poorer countries cannot afford to buy state of the art medicines.

This has started a debate on how to ensure a wider access to innovations in health care. One possible solution would be to transfer money to poorer countries.

In this paper, we have studied the impact of an income redistribution from richer to poorer consumers on the decisions of the health innovator and the utility of consumers. We find that income redistribution increases the quality of the medical innovation, reduces its price and even increases the utility of some of the consumers whose income is reduced through the redistribution. This could be

seen as one way in which even donor countries could benefit from transfers, apart, of course, from humanitarian considerations.

However, we have pointed out a few caveats to our results which should be considered. A lower probability of illness would make the increase in donor's utility less likely. Therefore, this model cannot be applied to medicines for illness whose likelihood is much smaller in richer countries. There is however a literature which deals with this specific topic (see e.g., Kremer (2000a) and (2000b)).

There is as well the issue of commitment, if income transfers with the objective of increasing access could be internalized by pharmaceutical companies, they would behave strategically setting prices in order to extract the maximum possible share of consumer surplus.

Paradoxically, it is the richest groups of consumers who are less likely to benefit from the transfers, could this be an explanation of why the richest countries seem sometimes to be less prone to contribute to such causes?.

## 5. REFERENCES

- Acharyya, R. (2000) Income Distribution, Monopoly and Quality Distortion, Mimeo, Jadavpur University.
- Gabszweicz, J. J. and Thisse, J.F. (1979) Price Competition, Quality and Income Disparities. *Journal of Economic Theory*, 20, 340-359.
- Goddeeris, J.H. (1984a) Insurance and Incentives for Innovation in Medical Care. *Southern Economic Journal*, 51, 530-539.
- Goddeeris, J.H. (1984b) Medical Insurance, Technological Change and Welfare. *Economic Enquiry*, 22, January, 56-67.
- Kremer, M. (2000a) Creating Markets for New Vaccines Part I: Rationale. *NBER Working Paper* No. W7716, May 2000.
- Kremer, M. (2000b) Creating Markets for New Vaccines Part II: Design Issues. *NBER Working Paper* No. W7717, May 2000.
- Shaked, A. and Sutton, J. (1982) Relaxing Price Competition through Product Differentiation. *Review of Economic Studies* 49, 3-13.
- Tirole, J. (1988) The Theory of Industrial Organization. MIT Press, Cambridge.