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# Income Based Price Subsidies and Parallel Imports

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# Income based price subsidies and parallel imports*

Rajat Acharyya† and María D. C. García-Alonso‡

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**Abstract**

We present a policy game where a Rich country has a higher capacity than a Poor country to commit to certain elements of health policy such as providing income related price subsidies and allowing parallel imports (PI). When allowing PI is not a choice for the Poor country, the Rich country allows PI and both countries provide a subsidy to their poorer buyers as the subgame perfect equilibrium policies. However, when the Poor is able to PI a different equilibrium may arise. We show that the ability of the Poor to allow PI might increase welfare in this country even if it is never implemented. We also prove that as the Poor country gets richer, it will not be in their best interest to sign an agreement with the Rich to commit to not allowing PI.
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# 1 Introduction

This paper examines welfare-maximizing policy choices by a Rich and a Poor country to ensure universal coverage of a patented drug by a price-setting pharmaceutical firms when the two countries interact with each other strategically. The policy options for the national governments that are considered here is whether to allow parallel import of a patented drug and whether to provide an income-based price subsidy to the poorer buyers of the drug.

The concern for poorer buyers not getting access to patented drugs due to the possibility of cross-country price discrimination by patent-holder firms under the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) has motivated the World Trade Organization (WTO) to allow countries to implement their own rules of exhaustion of patent rights once an on-patent drug is marketed. Under Article Six of the TRIPS agreement, countries can allow parallel imports (henceforth, PI) of an on-patent drug from the low-priced countries without the permission of the patent-holder firm. The Doha declaration also reflects similar concern: "The effect of the provisions in the TRIPS Agreement that are relevant to the exhaustion of intellectual property rights is to leave each Member free to establish its own regime for such exhaustion without challenge, subject to the Most Favoured Nation (MFN) and national treatment provisions of Articles 3 and 4 (of the TRIPS Agreement)". Within these provisions, the national policies on PI are observed to vary widely across both rich and poor countries [Maskus (2001)]. Whereas Japan allows international exhaustion and the EU allows regional exhaustion of patented goods, USA allows only national exhaustion of patents and copyrights to protect the interests of their multinational company (MNC) exporters. Australia generally permits parallel imports in trademarked goods but patent owners may block them. Among the developing countries, Argentina, India, New Zealand, Thailand, Singapore and South Africa have recently enacted laws permitting international exhaustion of patent rights for drugs, enabling parallel import of patented drugs. Furthermore, USA and EU have imposed so called *TRIPS-Plus provisions* as part of bilateral Free Trade Area (FTA) negotiations with developing countries. Among these clauses there is the commitment required on part of the developing country trade partner not to allow parallel imports. These international rules and mandates are specially relevant for pharmaceutical markets where it has been argued that PI has or could been used as a means of increasing access to medicines to the poor, not just the poor in Rich countries but, also the poor in Poor countries [Scherer and Watal (2002)].

Another element of national policies on universal access to health care that is also observed to vary widely across countries is price subsidies on pharmaceuticals for lower income groups. Examples of this are the exemptions applied to medicines for children and pensioners in the UK. In the US, Medicaid covers poorer sections of society. In India, and other developing countries, essential drugs to fight diseases like tuberculosis, malaria, polio and hepatitis are often distributed fully subsidized to the poor through the public health care systems. But the coverage is often very poor. The investment by the public sector for health in India has been inadequate, so much so that the state has never committed more than 1% of GDP to the health sector in the present decade, compared to 6-7% of GDP accounting for public health expenditure in UK and USA. In China, on the other hand, public health expenditures have been around 1.7% of its GDP, less than 50 percent of what private health expenditures amount to. There is thus a serious concern that the coverage, scope and extent of public expenditure and subsidies should be raised many-fold.

These observations throw up quite a few research questions relevant to the national policies on universal access to health care. The research questions that we specifically address here are the following. First, what are the optimal national policies on universal access to health care – PI or subsidy or a combination of both? This issue is of particular relevance because budget pressures often mean that there is usually a cost benefit analysis done before a government decides whether or not to provide subsidies that would ensure universal coverage. Second, do these policies differ across a Rich and a Poor country? If so, how does a Poor country react in terms of formulation of its own optimal national policies on universal access to health care to an optimal choice by the Rich country? Would it be relevant for a Poor country to allow PI of the patented drug from the Rich country, if it could do so?

Though there are separate and disjoint analyses of welfare implications of PI and of decisions over providing subsidies, to the best of our knowledge, neither the choice between PI and subsidy as alternative national policies on universal access to health care has been analyzed, nor the possibility of allowing PI and providing subsidy as optimal national policy has been explored in the existing literature. The present paper aims at bridging this gap in the literature in addressing the specific issues mentioned above. A useful early survey and discussions of issues related to parallel imports can be found in Maskus (2001). Ganslandt and Maskus (2007) also give a detailed description of the literature on price arbitrage and price discrimination in the context of pharmaceutical markets.

Two papers deserve particular mention in our context. With no within-country income disparity, Richardson (2002) has established that when the poor countries are unable to restrict PI, the richer countries undo price discrimination by a patent holder MNC by allowing PI of the patented drug from low-priced poor countries. In an earlier analysis, Malueg and Schwartz (1994) demonstrated that global welfare under discriminatory pricing is lower than that under uniform pricing (as a consequence of PI being allowed by the richer countries) for small cross-country demand dispersions, but it is higher for very large dispersions because some markets are not served under uniform pricing.

In the context of price regulation, Ganslandt and Maskus (2007) use a dynamic general equilibrium model to analyze the impact of price controls on the firm's incentives to innovate. Jelovac and Bordoy (2005), on the other hand, analyze the impact of parallel imports on global welfare. Their paper considers a two country world where patients are reimbursed an exogenous proportion of the price they pay for medicines, which can be seen as a standard price subsidy, or alternatively, can be interpreted as the co-payment of patients to an insurance company. A more developed insurance system policy can be found in Garber et al. (2006) that analyzes the impact of insurance policies on the firm's incentives to innovate in a closed economy. However, in both Garber et al. (2006) and Jelovac and Bordoy (2005) the heterogeneity across patients comes entirely from the valuation for the pharmaceutical innovation in terms of its efficacy being different for each patient, instead of from income heterogeneity, the price subsidy is the same for all consumers within a given country. As discussed in García-Alonso and García-Mariñoso (2008), the efficacy of medicines varies with each medicine and thus it is difficult to design general price regulation policies that would depend on the efficacy of different medicines across patient groups. Ex ante income heterogeneity within a given market is presented in Acharyya and García-Alonso (2008) as the motive for the design of income related price subsidies by two otherwise identical national governments to ensure market access for poorer buyers and influence the choice of innovation level by a pharmaceutical firm.

At the interface of these two disjoint but related literatures, our paper considers strategic interaction between a Rich and a Poor country in designing their optimal national health care policies that aim at ensuring market access for their respective poorer buyers, which is usually emphasized by the policy makers as an important objective of national health policies. Given such a context, the relevant policy options that we consider here are allowing PI and providing income-based price subsidies.[1] We think of the richer country as having a national pharmaceutical company that sells drug innovations both domestically and internationally, and committing first to its national policy: whether to allow PI and to provide subsidy to its poorer buyers. The type of drugs we have in mind are in patent drug without generic competitors in the Poor country. The poorer country acts as a follower in policy setting relative to the richer country. More specifically, we construct a multiple stage game with the following timing: First the Rich country decides whether or not to allow PI and also the price subsidy it will provide to the poorer within the population to allow them to afford drug innovations. Second, the poorer country chooses the price subsidy and PI policy. Third the MNC chooses prices and hence, market coverage across countries. The timing of our game aims to reflect the international view following the Doha Agreement that lower income countries should have flexibility to set their health policies to allow market access to medicines. However, we also consider the case where the poorer country does not have an option to PI, this aims to capture the TRIPS plus provisions to which we earlier referred.

[1] Knox and Richardson (2002) and Hur and Riyanto (2007) consider strategy choice of a high-price country over allowing PI and imposing a tariff, with the low-price (exporting) country being policy inactive. However, given our focus on health care markets and national health policies, where market access for the poor to a newly innovated drug is a major argument, tariff policy that raises the price of imported drugs is not a relevant policy option. Moreover, we allow for both countries to be policy active in the subsidy that they choose, and later allow for the possibility that both countries may have incentive to PI.

As will be later discussed, we consider countries with different but, not extremely different income distributions, in the precise sense defined later, such that it is profitable for the MNC to cater to at least the richer buyers in both the countries, and countries which are seen as poorer because the purchasing power of the richest group within the country is not as significant as that of the rich country. An example of countries we have in mind as Poor and Rich could be India and USA.

In this context, we obtain the following results. When the Poor country cannot allow PI, and has only the choice regarding whether to provide a subsidy or not to its poorer buyers, the Rich allowing PI and providing subsidy to its poorer buyers and the Poor providing subsidy to its poorer buyers are the subgame perfect strategy choices. This result is easy to comprehend. There are two sources of welfare gains for the Rich country according to the specification of total welfare in our model. First is the net surplus for the richer buyers there, and second is the profit of the pharmaceutical firm. Typical of the self selection models, the poorer buyers are always made indifferent between buying or not, hence their net consumer surplus is always zero. A subsidy induces the firm to cater to the poorer buyers in the Rich country by lowering the price there, which leaves the richer buyers with a higher net surplus. Parallel imports allowed by the Rich country benefits the richer buyers further as now the firm is forced to charge the same lower price that it charges in the Poor country. This reconfirms the result established in the existing literature that richer countries gain from allowing parallel imports of patented goods from the poorer countries. Thus, the richer buyers in the Rich country gains from both subsidy provided to the poorer buyers there and parallel imports allowed by their government. As will be later seen, the loss of profit for the firm from parallel imports, on the other hand, is partly compensated as the Rich country induces the Poor country to provide maximum possible subsidy to its poorer. Note that, given that the Rich country subsidizes its poorer buyers, the Poor country can ensure market access for its own poorer buyers only by providing a subsidy.

Subsidies provided by the Rich country open up the possibility of PI by the Poor as well. In the existing literature, this had never been the case, and PI had always been from the Poor to the Rich country, because the patent-holder MNC would charge a higher price in the Rich country than in the Poor country under cross-country price discrimination. In this paper, there is a possibility of PI from the Rich to the Poor country because subsidies in the Rich country may potentially make drug prices lower there. To account for this possibility, in an extension of the benchmark model we allow the Poor country to be policy active in PI as well. This constitutes another major departure of this paper from the existing literature. Note that, despite PI being allowed by a low-income country (such as India in our example), for a patented drug to be actually parallely imported from the high income country, the price of that drug must be higher in the low income country than in the high income country. We consider the restrictions on cross-country income differences in the sense defined later that ensure that if Rich country subsidizes and the Poor country does not, then the price of the drug in the Poor country would be higher and hence it would have incentives to allow PI. In such a context, we show that, if PI by the Poor from the Rich is a possibility, it will also be better for the Poor to subsidize and hence not to allow PI as then their prices will never be higher than in Rich. More interestingly, in some cases of within-country income distribution being sufficiently unequal, such as the income of richest buyers in the Poor country exceeding a critical level, the Rich induces the Poor to subsidize rather than PI by committing itself not to allow PI.[2] But, if the within-country income distribution is not too unequal, the same SPNE policy choices prevail as in the case when the Poor country cannot allow PI. However, the threat that the Poor country can allow PI, changes the welfare levels obtained by the two countries. The welfare of the Poor now rises whereas that of the Rich falls compared to what they could have achieved through similar policy choices earlier. Our results show that the global level of welfare across the two countries is the same in all the candidates for SPNE that involve both countries implementing a subsidy to induce universal coverage. Thus, the Poor country's ability to allow PI and subsidy policy of the Rich making it feasible essentially redistribute welfare across trading nations.

Our distinction between the benchmark case and its extension in terms of the Poor country's ability to allow or implement PI can be put in the perspective of international trade policy rules adopted by some Rich countries. As mentioned earlier, a Poor country is often obligated not to allow PI despite having incentives to do so when bilateral free trade agreements with a Richer trading partner include TRIPS-Plus clauses. This leaves the Poor country with only price subsidies (or price regulations) as relevant policy choice to ensure universal coverage of a patented drug as we consider in the benchmark case. The extended model where we allow the Poor country to choose between providing price subsidy and implementing PI, whenever there is such a scope, essentially replicates the scenario where our bilateral trade policies of a Poor country and a Rich country are not constrained by TRIPS-Plus clauses. Such a policy choice scenario also sheds light on a relevant issue of whether bilateral trade agreements need to be conditioned by inclusion of TRIPS-Plus clauses at all.[3] In particular, can a Rich country (like USA) induce a Poor country not to implement PI through its own policy choices instead of making the Poor commit through a TRIPS-Plus clause included in the trade negotiations? Interestingly, we find that it would only be in the best interest of the Rich country to persuade the poor to enter into an agreement in which both countries commit to no PI if the SPNE that arises in the case where the Poor can PI is the one where the Rich is better off committing to no PI so as to induce a subsidy by the Poor.

Another policy implication of our research comes from the income condition

[2] Note that here we do not consider any budgetary constraints for the national government in the Poor country in implementing the subsidy programme to ensure market access for the poor there. Of course, such a budget constraint per se may dictate Poor countries to choose PI implicitly over subsidy when subsidies provided in the Rich country makes drug prices relatively lower there than in the Poor country.

[3] Many FTA negotiations including the India-USA and India-EU FTA negotiations are taking unusually longer times to be completed and signed because of such conditionalities of TRIPS-Plus clauses.

that determines the SPNE in the case where the Poor country can PI: A higher top income in the Poor country will induce the Rich to commit to not PI. In the run up to the US general election, Barak Obama committed to allowing PI of pharmaceuticals. But, this promise was later dropped amidst the wake of the financial crisis that has affected growth rates in developed countries. However, even during this financial crisis, countries such as India and China have continued to experience significant (though lower) growth rates. This situation may have edged the SPNE policy in the US to the case where committing to not PI is the SPNE. Additionally it may have increased the incentives to try to negotiate TRIP-plus clauses in bilateral FTA negotiations.

The rest of the paper is organized as follows. Section 2 introduces the model structure and considers the case where the Poor country does not have the ability to PI. Section 3 extends the model to the case where PI becomes an option for the Poor country. Finally, section 4 presents the conclusions to the paper.

# 2 Analytical framework

Consider two countries that we call Poor (country 1) and Rich (country 2). In each country there are two income classes denoted by income levels $y_{Rj}$, $j = 1, 2$, and $y_T : y_{R2} > y_{R1} > y_T$. Thus, we assume that whereas the rich people have different incomes in the Rich and the Poor countries, poor people earn the same income everywhere. We simplify our analysis further by assuming that the population size of the two income classes $n_R$ and $n_T$ are the same in both the countries. As mentioned earlier, the example of countries that we have in mind is India and USA. Whereas GDP per capita is higher in the US than in India, income inequality is also higher. Of course, there are other relatively low income countries that have less income disparity as reported in Table 1 that may also qualify as examples of our Poor country. Note that notwithstanding quite a large difference between per capita incomes in USA and in India, incomes of richest Indians is not far below that of richest Americans. This is important because as we have mentioned above and will show later, for highest income levels in the two countries not too different from each other, the MNC will serve at least the richest buyers in the Poor country. This condition is similar to what Malueg and Schwartz (1994) specifies as small cross-country demand dispersions. We limit our discussion to this case of both countries being served (albeit partially).

| | Per Capita income PPP | Avg. Gini |
|---|---|---|
| Country | 2005 | 1992-2007 |
| USA | 39711 | 40.80 |
| Canada | 35065 | 32.60 |
| New Zealand | 24718 | 36.20 |
| Korea Republic | 22783 | 31.60 |
| Brazil | 8505 | 55.00 |
| South Africa | 8504 | 57.8 |
| Egypt | 4319 | 32.10 |
| China | 4076 | 41.50 |
| India | 2234 | 36.80 |
| Pakistan | 2184 | 31.20 |
| Bangladesh | 1069 | 31.00 |

Table 1: Per Capita Income(PPP,US$) and Income Inequality in Selected Countries. Source: Compiled from World Development Indicator 2009 and Human Development Report 2008.

The government in each country $j$ can set an income based price subsidy to the poor buyers for the consumption of the pharmaceutical innovation. We consider it to be a specific subsidy $\gamma_{Tj}$, $j = 1, 2$. The Rich also decides about allowing parallel imports of a patented drug from the Poor. Parallel imports allow traders in Poor to buy the patented drug from the market and resell it to the Rich without the permission of the patent-holder firm. We assume costless arbitrage and trading so that parallel imports, if allowed, would result in convergence of prices of drugs across different markets when otherwise the price of the drug is higher in the Rich. Later we will discuss the possibility and optimality of PI allowed by the Poor as well. We make an ex post analysis here in the sense that quality of the health drug is exogenously given. A single MNC has already developed a drug and can produce it without incurring further production costs. The patent for the drug confers upon the MNC a monopoly right over its exclusive production. But the assumption of zero cost implies that if all income groups are served at all, it is optimal for the MNC to provide a uniform menu – developing only one quality of the drug and charging a uniform price – to different income groups in each country.[4] Monopoly right for the patented drug, however, creates scope for market-based or cross-country (price) discrimination (MBD) for the MNC, though its ability to discriminate may be limited by parallel trading allowed by the countries. The MNC is located in the Rich.

All consumers everywhere value the innovated quality of the drug as it directly benefits them in terms of better effectiveness of curing the disease for

[4]More generally, Acharyya (1998, 2005) has shown in the context of endogenous quality choice of a monopolist facing a heterogenous group of buyers, that as long as the marginal cost of production is not rising too fast, it is not optimal for the monopolist to offer a separting or discriminating price-quality menu.

which it is used. But, though every consumer values a higher quality drug more than a lower quality drug, these valuations vary across consumers with different incomes. More precisely, following the literature on quality choice we assume that richer buyers attach an even higher valuation to a better quality drug relative to a lower quality drug than do the poorer buyers. This means that the marginal willingness-to-pay for a quality varies across different income levels in each country.[5] Assume that such a preference relationship is linear in income and quality so that if a consumer purchases a drug of quality $s$ developed by a pharmaceutical MNC, she gets a gross utility of $y_i s$, $i = R, T$. Each consumer buys, if at all, only one unit of the drug. Let the reservation utility of a buyer of income $y_{ji}$ be zero. Thus, by the individually rational (IR) constraint, a representative consumer of type $i$ in country $j$ buys the drug if its gross utility is higher than the subsidized price $P_j - \gamma_{Tj}$:

$$y_i s \geq P_j - \gamma_{Tj}, \ i = R, T. \tag{1}$$

Note that despite within-country income disparity, costless arbitrage in each country prohibits the MNC to price discriminate between a rich and a poorer buyer belonging to the same country. The government in each country maximizes total welfare net of subsidies provided, if at all. For the Rich, the total (net) welfare is the sum of consumers' surplus $CS_2$, and MNC profit $\pi$, less the amount of subsidy:

$$W_2 = CS_2 + \pi - n_T \gamma_{T2}. \tag{2}$$

For the Poor country, the total (net) welfare is the sum of consumers' surplus $CS_1$, less the amount of subsidy:

$$W_1 = CS_1 - n_T \gamma_{T1}. \tag{3}$$

The consumer surplus is the sum of net surpluses for the relevant income groups. When all buyers are served in a particular country, say Poor, by the MNC, consumers surplus there amounts to,

$$CS_j = n_T \left( y_T s - P_j + \gamma_{Tj} \right) + n_R \left( y_{Rj} s - P_j \right). \tag{4}$$

However, given the standard result in the self-selection models of this kind, when the MNC caters to both the rich and the poor buyers in a particular country, it prices the drug in a way to push the poorest buyers to their reservation utility and thereby extract all surplus from them.[6] Hence, $CS_j = n_R \left( y_{Rj} s - P_j \right)$.

[5] Here we follow the specification used in our earlier analyses [Acharyya and Garcia-Alonso (2006, 2008)]. See Gabszweicz and Thisse (1979) and Shaked and Sutton (1982) for relating the marginal willingness-to-pay for a quality to income levels of consumers in the context of endogeneous quality choice. An alternative basis of differences in the marginal willingness-to-pay for a quality can be taste diversities, rather than income disparities, as in Mussa and Rosen (1978). Of course, one might argue, and this may be particularly relevant for health care, that rich and poor alike have the same marginal willingness-to-pay for a particular quality but different ability to pay [see Acharyya (2005), for example]. We, however, abstract here from such distinction between willingness and ability to pay.

[6] See Cooper (1984), for example.

We consider the following multiple stage game to describe the time structure of decisions made by different agents in the benchmark case is as follows. First the Rich chooses whether to allow PI or MBD unilaterally and chooses a subsidy level. In the second stage the Poor chooses a subsidy level, if at all. Next, the MNC sets price – uniform price or country-specific discriminatory prices – depending upon the choice by the Rich over allowing PI or MBD, and finally consumption decisions are taken by the potential buyers in each country according to the individual rationality constraint (1). We use backwards induction to find the SPNE of this game.

We assume throughout the paper that the income distribution parameter is such that without a subsidy being given (or parallel imports being allowed), the MNC does not cater to the poor in either country,[7] i.e.,

$$\frac{n_T}{n_R} < \frac{y_{R1} - y_T}{y_T} < \frac{y_{R2} - y_T}{y_T} \Longrightarrow (n_T + n_R)\, y_T < n_R y_{R1} < n_R y_{R2}. \tag{5}$$

Furthermore, we confine ourselves with the case where it is still profitable for the MNC to serve both the Rich and Poor countries when the Rich allows PI. This requires that rich buyers in the Rich country are not too rich in the following sense:

$$2y_{R1} > y_{R2}. \tag{6}$$

In the benchmark model, we do not consider PI as a choice for the Poor, but will later examine how does that choice whenever there is a scope of gaining from such a choice, alters the SPNE of the game. We solve the model by backward induction, and given (1) above and the profit-maximizing pricing rule, we begin with the second-stage choice over the subsidy level by the Poor.

## 2.1 Poor country's subsidy policy

### 2.1.1 Rich country allows PI

Let us begin with the Rich unilaterally allowing PI. There are two sub-cases concerning the choice of subsidy by the Rich. First, the Rich does not provide any subsidy, and the second, the Rich provides a subsidy. Given the choices of PI and no-subsidy by the Rich in the first sub-case, the Poor country's options are either to provide no-subsidy or to provide a subsidy to its poorer buyers. If the Poor does not provide any subsidy, then given our assumption in (5) the MNC caters only to the rich buyers in each country by charging a uniform price $P^{ND} = y_{R1}s$ (in what follows the superscript $ND$ will denote the case where the firm cannot discriminate against the Rich country). Costless arbitrage from Poor to Rich country when the Rich allow PI prevents the MNC to charge a price in the Rich country which is higher than that charged in the Poor country. Thus, the MNC extracts all surplus from the rich buyers in the Poor resulting in

[7] See Acharyya and Garcia-Alonso (2008) for further explannation of this condition.

total welfare there as $W_1^{ND} = 0$ but leaves the rich buyers in the Rich country with strictly positive net surplus resulting in the total welfare in the Rich as,

$$W_2^{ND} = n_R(y_{R2} - y_{R1})s + 2n_R y_{R1} s = n_R(y_{R2} + y_{R1})s. \tag{7}$$

If, on the other hand, the Poor provides a subsidy, the only subsidy that will result in a welfare level different from zero would need to induce the MNC to fully cover the Poor country. To achieve this, the subsidy must be such that

$$(2n_R + n_T)(y_T s + \gamma_{T1}^{ND}) \geq 2n_R y_{R1} s. \tag{8}$$

Note that when the Poor provides a subsidy $\gamma_{T1}^{ND}$ to its poorer buyers, the MNC can charge a price $(y_T s + \gamma_{T1}^{ND})$ to fully cover the Poor country market resulting in a profit of $(n_R + n_T)(y_T s + \gamma_{T1}^{ND})$. But, the same price it must charge to the richer buyers in the Rich country because it allows PI from the Poor country, resulting in a profit of $n_R(y_T s + \gamma_{T1}^{ND})$. Thus, the total profit that the MNC can earn from fully covering the Poor and partially covering the Rich country is $(2n_R + n_T)(y_T s + \gamma_{T1}^{ND})$, and for a subsidy provided by the Poor country to actually induce MNC to fully cover this market, this profit must at least be as large as the profit that the MNC could ensure for itself by partially covering both the countries, $2n_R y_{R1} s$. From this condition follows the minimum subsidy that the Poor must provide and the corresponding price level as:

$$\gamma_{T1}^{ND} = \frac{2n_R}{2n_R + n_T} y_{R1} s - y_T s \tag{9}$$

and

$$P^{ND}(\gamma_{T1}^{ND}) = \frac{2n_R}{2n_R + n_T} y_{R1} s. \tag{10}$$

Note that without Rich subsidizing its poor buyers, PI per se cannot ensure full market coverage by the MNC there as $y_T s < P^{ND}(\gamma_{T1}^{ND})$. However, the lower price achieved through PI still benefits the rich buyers since $P^{ND}(\gamma_{T1}^{ND}) < P^{ND}$, resulting in welfare levels,

$$W_1^{ND}(\gamma_{T1}^{ND}) = n_T \left[ y_T - \frac{n_R}{2n_R + n_T} y_{R1} \right] s, \tag{11}$$

$$W_2^{ND}(\gamma_{T1}^{ND}) = n_R y_{R2} s + \frac{2n_R[n_T + n_R] y_{R1}}{2n_R + n_T} s. \tag{12}$$

Note that the Poor will have a positive welfare with the subsidy as long as its rich consumers' income is not too high

$$W_1^{ND}(\gamma_{T1}^{ND}) > 0 \; iff \; y_{R1} < \frac{(2n_R + n_T) y_T}{n_R} \equiv y^*. \tag{13}$$

Hence, if the Rich commits to PI (but, no subsidy), the Poor country will subsidize its poor group as long as its rich group's income satisfies conditions (5) and (13):

$$\frac{(n_R+n_T)y_T}{n_R} < y_{R1} < \frac{(n_R+n_T)y_T}{n_R} + y_T \equiv y^*. \tag{14}$$

We now consider the case when the Rich provides a subsidy (given its choice of PI) that would ensure full coverage there. Once again costless arbitrage from Poor to Rich country ensures the MNC cannot charge a price in the Rich country which is higher than that charged in the Poor country. Note that regardless of the Poor country's response to the Rich setting a subsidy, by similar logic as above, the minimum subsidy $\gamma_{T2}^{ND}$ that will induce the MNC to set a price that will cover all consumers in the rich country should be such that,

$$(n_R+n_T)(y_T s+\gamma_{T2}^{ND}) \geq n_R y_{R1} s. \tag{15}$$

The MNC will then charge a price $P^{ND}(\gamma_{T2}^{ND}) = \dfrac{n_R}{n_R+n_T} y_{R1} s$ to all buyers in the Rich country. Note that since we are assuming in this section that the Poor cannot allow PI, a higher price can indeed be charged by the MNC in the Poor country, depending on its choice of subsidy level. Given the PI and subsidy choice by the Rich, if the Poor does not subsidize, the price that the MNC charge there still remains $y_{R1}s$, which is of course higher than $P^{ND}(\gamma_{T2}^{ND})$. This results in Poor country welfare $W_1^{ND}(\gamma_{T2}^{ND}) = 0$. It is immediate that the Poor country can gain from allowing PI as well but we will abstract from such an option till the next section. The Rich country welfare equals,

$$W_2^{ND}(\gamma_{T2}^{ND}) = n_T y_T s + n_R y_{R2} s. \tag{16}$$

Now, when the Poor country subsidizes, setting the minimum subsidy $\gamma_{T2}^{ND} = \dfrac{n_R}{n_R+n_T} y_{R1} s - y_T s$ that ensures full market coverage may not be optimal for the Rich country because its welfare is increasing in its own subsidy, everything else remaining the same. As shown in the appendix, the minimum subsidy provided by the Poor to ensure full market coverage there is increasing in the subsidy given in the Rich country, and a higher subsidy in the Poor means a greater profit for the MNC and hence a higher welfare for the Rich:

$$W_2^{ND}(\gamma_{T1}^{ND},\gamma_{T2}^{ND}) = n_R y_{R2} s + n_T y_T s + (n_R+n_T)\left(\gamma_{T1}(\gamma_{T2}) + y_T s\right). \tag{17}$$

Hence, given the welfare-maximizing objective of the Rich-country government, it is optimal for the Rich to provide an even higher subsidy than $\gamma_{T2}^{ND}$. However, since the welfare of the Poor is decreasing in its own subsidy, in setting a higher subsidy than $\gamma_{T2}^{ND}$ the Rich must make sure that the Poor gets at least the same welfare it would get if it decided not to provide a subsidy, that is, non-negative net welfare. Hence, maximum subsidy $\gamma_{T1}^{ND\max}$ that the Rich can induce the Poor to provide must be such that:

$$\begin{aligned} W_1^{ND}(\gamma_{T1}^{ND},\gamma_{T2}^{ND}) &= n_R(y_{R1}s - (\gamma_{T1}+y_T s)) - n_T\gamma_{T1}^{ND\max} = 0 \\ &\Leftrightarrow \gamma_{T1}^{ND\max} = \frac{n_R s\,(y_{R1}-y_T)}{n_R+n_T}. \end{aligned} \tag{18}$$

Such a maximum subsidy by the Poor can be induced by the following subsidy by the Rich:

$$\gamma_{T2}^{ND\max} = \frac{n_R(y_{R1} - y_T) + n_T y_T}{n_R + n_T} s. \tag{19}$$

It is important to note that although the Rich country commits to a subsidy $\gamma_{T2}^{ND\max}$, the price that will prevail in both countries will be $P^{ND}\left(\gamma_{T1}^{ND\max}\right) = \frac{(n_R y_{R1} + n_T y_T) s}{n_R + n_T}$ due to price arbitrage allowed by the Rich through PI. Therefore, the maximum net welfare that the Rich can ensure for itself along with full market coverage by setting $\gamma_{T2}^{ND\max}$ is,

$$W_2^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) = n_R y_{R2} s + n_R y_{R1} s + 2 n_T y_T s. \tag{20}$$

Although the Poor country gets the same welfare from subsidizing and not subsidizing, $W_1^{ND}(\gamma_{T2}^{ND}) = W_2^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) = 0$, we assume (as a tie breaking rule) that it subsidizes because that ensures market access for the poorer buyers there. In the Appendix we present tables that summarize the main welfare levels described above.

### 2.1.2 Rich country does not allow PI

We now consider the case where the Rich does not allow PI. Thus, the MNC can price discriminate across the Poor and the Rich countries since PI is assumed to be not possible for the Poor in this section. Once again we have two sub-cases: First is that the Rich does not provide subsidy, and the second, it does. Given that the Rich does not allow PI and does not provide a subsidy to its poorer buyers, if the Poor country does not provide a subsidy either, the MNC charges discriminatory prices to only the rich buyers in both countries, $P_1^D = y_{R1}s$ in the Poor and $P_2^D = y_{R2}s$ in the Rich, resulting in $W_1^D = 0$ and

$$W_2^D = n_R(y_{R1} + y_{R2}) s. \tag{21}$$

When the Poor subsidizes, the minimum subsidy that will induce the MNC to fully cover the Poor country must be such that,

$$(n_R + n_T)(y_T s + \gamma_{T1}^D) \geq n_R y_{R1} s \tag{22}$$

resulting in subsidy and price levels:

$$\gamma_{T1}^D = \frac{n_R}{n_R + n_T} y_{R1} s - y_T s, \tag{23}$$

$$P_1^D(\gamma_{T1}^D) = \frac{n_R}{n_R + n_T} y_{R1} s. \tag{24}$$

The subsidy makes the price in the Poor country lower and its welfare level higher:

$$W_1^D(\gamma_{T1}^D) = CS_1 - n_T\gamma_{T1}^D = n_T y_T s. \tag{25}$$

Under market segmentation, the price charged in the Rich country is still $P_2^D = y_{R2}s$, and the lower profit for the MNC from selling the drug in the Poor country is compensated by the larger number of buyers (in fact all) being able to buy the drug, so that the Rich country welfare remains the same as the one specified in (21). Therefore, it is better for the Poor country to subsidize when the Rich does not allow PI and does not subsidize.

Now consider the sub-case where the Rich chooses a subsidy that would ensure full coverage in the rich country. Note that, given the market segmentation, regardless of whether the Poor subsidizes or not, the subsidy that ensures market coverage in the Rich country and hence welfare is the same:

$$W_2^D(\gamma_{T1}^D, \gamma_{T2}^D) = W_2^D(\gamma_{T2}^D) = n_T y_T s + n_R(y_{R1} + y_{R2})s. \tag{26}$$

If the Poor subsidizes, then proceeding as before it can be checked that it now gets a strictly positive net welfare $W_1^D(\gamma_{T1}^D, \gamma_{T2}^D) = n_T y_T s > 0$. Thus, the Poor chooses Subsidy when Rich chooses Subsidy (and does not allow PI). Note that the welfare of the Poor is the same regardless of whether or not the Rich subsidizes when there is market segmentation, $W_1^D(\gamma_{T1}^D) = W_1^D(\gamma_{T1}^D, \gamma_{T2}^D)$, but, it is better for the Rich to subsidize since $W_2^D(\gamma_{T1}^D, \gamma_{T2}^D) = W_2^D(\gamma_{T2}^D) > W_2^D(\gamma_{T1}^D)$. A summary of relevant welfare levels is provided in Table A2 in the Appendix.

The following lemma summarizes the second-stage choice of the Poor country discussed above:

**Lemma 1:** *For $y_{R1} < y^*$, the Poor provides Subsidy to its poor buyers regardless of the strategy choice of the Rich. For a larger within country income disparity, the Poor subsidizes its poorer buyers under market segmentation regardless of whether the Rich subsidizes or not, but does not subsidize under PI unless the Rich subsidizes as well.*

Given our assumption in (5), regardless of what strategy choice the Rich country makes, the Poor country cannot ensure full market coverage without providing a subsidy. Under market segmentation, the subsidy amount required to ensure this is small enough to make net welfare positive as specified in (25). However, when the Rich country allows PI, the MNC cannot price discriminate across the markets. Thus, if it prices the drug in a way to enable the poor buyers in the Poor country to buy it, then it has to charge the same lower price in the Rich country as well. This entails a greater loss of profit compared to what it could achieve under market segmentation. Consequently, a larger amount of subsidy would be required under PI to induce the MNC to cater the poor buyers in the Poor country. The larger is the income disparity in the Poor country (i.e., larger is the income level of the rich there compared to those of the poor), higher is the loss of profit and hence the larger is the minimum subsidy that the Poor country should provide to ensure full coverage. Thus, the net welfare for the Poor is decreasing in the income disparity there, and being negative for income disparity higher than a threshold in the sense that $y_{R1} > \dfrac{(2n_R + n_T)y_T}{n_R} \equiv y^*$.

## 2.2 Rich country's subsidy and PI policies

We now examine the optimal choice of the Rich given the choices of the Poor. Given Lemma 1 above, as long as $y_{R1} < y^*$, we just need to compare $W_2^D(\gamma_{T1}^D, \gamma_{T2}^D)$ and $W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max})$ to find out the Rich country's decision regarding whether to allow PI or not. For $y_{R1} > y^*$, the relevant welfare levels for the Rich are $W_2^D(\gamma_{T1}^D, \gamma_{T2}^D)$ and $W_2^{ND}(\gamma_{T1}^{ND})$. First of all, it is straightforward to check that,

$$W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) > W_2^D(\gamma_{T1}^D, \gamma_{T2}^D). \tag{27}$$

Second,

$$W_2^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) > W_2^{ND}(\gamma_{T1}^{ND}) \text{ if } \ y_{R1} < \frac{2\left(2n_R + n_T\right)y_T}{n_R} = 2y^*. \tag{28}$$

These welfare ranking lead us to the following lemma.

**Lemma 2:** *For all $y_{R2} \in (y_{R1}, 2y_{R1})$, the Rich country chooses to PI and subsidize (PI & S).*

**Proof:** See appendix.

Figure 1 illustrates the relevant income ranges and the first-stage choice of the Rich country as stated in Lemma 2. Given the parametric configurations, there are three relevant ranges: I, II and III. In region I, the following inequalities hold: $W_2^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) > W_2^D(\gamma_{T1}^D, \gamma_{T2}^D) > W_2^{ND}(\gamma_{T1}^{ND})$. In regions II and III, we have $W_2^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) > W_2^D(\gamma_{T1}^D, \gamma_{T2}^D) > W_2^{ND}$ . Hence the claim in Lemma 2 .

The following proposition follows from Lemmata 1 and 2:

**Proposition 1**: *As long as $y_{R2} \in (y_{R1}, 2y_{R1})$, the Rich allowing PI and providing subsidy to its poorer buyers and the Poor providing subsidy to its poorer buyers, $\{(PI \,\&\, S) \rightarrow S\}$, are the SPNE strategy choices.*

This result is easy to comprehend. There are two sources of welfare gains for the rich country according to the specification of total welfare. First is the net surplus for the richer buyers there, and second is the profit of the pharmaceutical firm. A subsidy induces the firm to cater to the poorer buyers in the Rich country by lowering the price there, which leaves the richer buyers with a higher net surplus. Parallel imports allowed by the Rich country benefits the richer buyers further as now the firm is forced to charge the same lower price that it charges in the Poor country. This reconfirms the result established in the existing literature that richer countries gain from allowing parallel imports of patented goods from the poorer countries. Thus, the richer buyers in the Rich country gains from both subsidy provided to the poorer buyers there and parallel imports allowed by their government. The loss of profit for the firm,

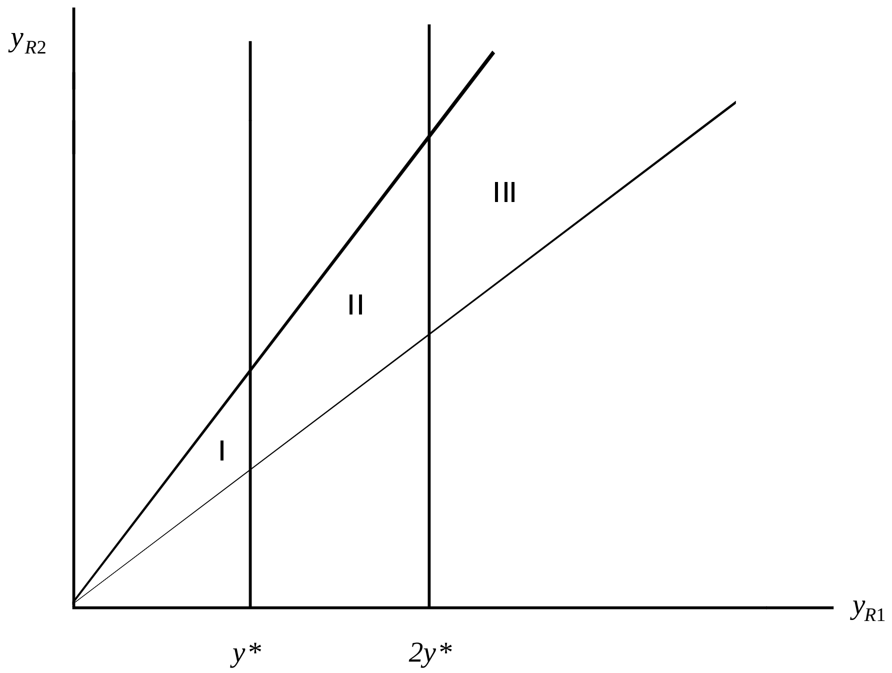


Figure 1: SPNE Strategy Choice for $y_{R2} \in (y_{R1}, 2y_{R1})$

on the other hand, from parallel imports is partly compensated as the Rich country induces the Poor country to provide maximum possible subsidy to its poorer. Hence, given that the Poor chooses subsidy whenever the Rich does so, the welfare is maximum for the Rich from the policy pair PI and subsidy.

# 3 Poor country is able to implement PI

As pointed out above, there may be incentives for the Poor country to allow parallel imports when a unilateral subsidy provided by the Rich country induces the MNC to charge a lower price in the Rich country. In this section we discuss the implication of such a choice by the Poor country for the strategy choice for the Rich and for the SPNE of the game. Once again we begin with the second stage choice.

## 3.1 Poor country's subsidy policy

### 3.1.1 Rich country allows PI

When the Rich country does not provide any subsidy, there is no scope or gain from allowing parallel imports by the Poor country since as discussed earlier, parallel imports by the Rich results in a uniform price $y_{R1}s$. The only case where the Poor country's ability to PI affects our results above is when the Rich country's subsidy ensures full coverage. In this case, the condition that will persuade the MNC to fully cover the Rich country when the Poor does not subsidize is

$$(2n_R + n_T)(y_T s + \gamma_{T2}^{ND}) \geq 2n_R y_{R1} s. \tag{29}$$

Note the difference of this condition with the earlier one $(n_R+n_T)(y_T s+\gamma_{T2}^{ND}) \geq n_R y_{R1} s$ when PI could not be allowed by the Poor. In such a case, the MNC could charge the price $y_{R1}s$ to rich buyers in the Poor country even if the price charged to (all) buyers in the Rich country, $y_T s + \gamma_{T2}^{ND}$, was lower. Thus, it could get $n_R y_{R1} s + (n_R + n_T)(y_T s + \gamma_{T2}^{ND})$ as profit from partially covering the Poor (when it did not subsidize its poorer buyers) and fully covering the Rich country. But when the Poor also allows PI (from the Rich country), the MNC must charge the price $y_T s + \gamma_{T2}^{ND}$ to the (rich) buyers in the Poor as well. Hence, now its profit from partially covering the Poor and fully covering the Rich country is $(2n_R + n_T)(y_T s + \gamma_{T2}^{ND})$. The minimum subsidy that would induce the MNC to actually fully cover the Rich country must therefore be such that this profit is at least as large as the profit $2n_R y_{R1} s$ that the MNC could get from universal partial coverage. The strict equality in the above condition thus defines the minimum subsidy level as $\gamma_{T2}^{ND} = \dfrac{2n_R}{2n_R + n_T} y_{R1} s - y_T s$ and the resulting price level as $P^{ND}(\gamma_{T2}^{ND}) = \dfrac{2n_R}{2n_R + n_T} y_{R1} s$. Since this price is lower than $y_{R1}s$, the Poor country does indeed gain by allowing parallel import from the Rich country. The corresponding welfare levels are

$$W_2^{ND}(\gamma_{T2}^{ND}) = n_R y_{R2} s + n_T y_T s + \frac{2n_R y_{R1} s}{2n_R + n_T} n_R, \tag{30}$$

$$W_1^{ND}(\gamma_{T2}^{ND}) = \frac{n_R n_T y_{R1} s}{2n_R + n_T}. \tag{31}$$

As already discussed, an alternative for the Rich country is to induce the Poor country to provide a subsidy as well. In the present case, to induce full coverage, the poor country must set a subsidy $\gamma_{T1}$ such that

$$2(n_R + n_T)(y_T s + \gamma_{T1}) = (2n_R + n_T)(y_T s + \gamma_{T2}) > 2n_R y_{R1} s, \tag{32}$$

resulting in subsidy level

$$\gamma_{T1} = \frac{(2n_R + n_T)(y_T s + \gamma_{T2})}{2(n_R + n_T)} - y_T s < \gamma_{T2}. \tag{33}$$

However, by similar logic as above, the Rich can induce the Poor to provide a maximum subsidy that will make it indifferent between ensuring full coverage through subsidy or just giving up on full coverage and simply benefiting for PI from Rich country:

$$\begin{aligned} W_1^{ND}(\gamma_{T1}^{ND}, \gamma_{T2}^{ND}) &= n_R(y_{R1} s - (\gamma_{T1} + y_T s)) - n_T \gamma_{T1} = \\ &= W_1^{ND}(\gamma_{T2}^{ND}) = n_R(y_{R1} s - (\gamma_{T2} + y_T s)) \Leftrightarrow \gamma_{T2} = y_T s. \end{aligned} \tag{34}$$

Hence, if Rich country wants to induce subsidy in Poor, the maximum subsidy that can be set is $\gamma_{T2}^{ND\max} = y_T s$ which induces the Poor to provide the maximum subsidy[8] $\gamma_{T1}^{ND\max} = \frac{n_R y_T s}{n_R + n_T}$. The welfare levels would, thus, be:

$$W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) = n_R y_{R2} s + 2\left(n_R + n_T\right) y_T s, \tag{35}$$

$$W_1^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) = n_R(y_{R1} s - 2y_T s) \tag{36}$$

The relevant welfare levels are summarized in A3 in the Appendix. Comparing the relevant welfare levels, first, it is straightforward to check that,

$$W_1^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) > W_1^{ND}(\gamma_{T2}^{ND}) \; iff \; y_{R1} < \frac{\left(2n_R + n_T\right) y_T}{n_R} \equiv y^*, \tag{37}$$

[8] Note that the Rich country will be able to induce a higher subsidy on the Poor country as long as

$$\gamma_{T2}^{ND} = \frac{2n_R}{2n_R + n_T} y_{R1} s - y_T s < \gamma_{T2}^{ND\max} = y_T s \Leftrightarrow y_{R1} < \frac{\left(2n_R + n_T\right) y_T}{n_R} \equiv y^*.$$

Otherwise, even the lowest subsidy that the Rich can set to ensure full coverage will not induce the poor to subsidize.

which is also the condition for $W_1^{ND}(\gamma_{T1}^{ND}) > 0$ as discussed earlier.

Second,

$$W_2^{ND}(\gamma_{T2}^{ND}) < W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) \Leftrightarrow y_{R1} < \frac{(2n_R + n_T)\,y_T}{n_R}\frac{(2n_R + n_T)}{2n_R}. \tag{38}$$

This condition is ensured by $y_{R1} < \dfrac{(2n_R + n_T)\,y_T}{n_R} \equiv y^*$. Hence, as long as it is feasible for the Rich to induce a higher subsidy on the Poor country ($y_{R1} < y^*$), it will still be welfare improving for the Rich to do so and the Poor will decide subsidy over PI. In the case when $y_{R1} > y^*$, as evident from the Table A3 and the welfare discussion above, it will not be possible to induce the Poor to subsidize because by not subsidizing it can ensure for itself at least a non-negative welfare when the Rich does not subsidize its own poorer buyers ($W_1^{ND} = 0 > W_1^{ND}(\gamma_{T1}^{ND})$), and a higher positive welfare when the Rich subsidizes ($W_1^{ND}(\gamma_{T2}^{ND}) > W_1^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right)$). Hence, the relevant welfare comparisons for the Rich in this case will be between $W_2^{ND}(\gamma_{T2}^{ND})$ and $W_2^{ND}$. It is easy to check that $W_2^{ND}(\gamma_{T2}^{ND}) < W_2^{ND}$ because in this case $y_{R1} > y^*$.

### 3.1.2 Rich country does not allow PI

Once again, the only case where it might be advantageous for the Poor country to PI is when the price in the Rich country might be lower. When the Rich country does not allow parallel imports, this will only happen when the Rich country provides a subsidy but the Poor country does not. This means that unlike the case when the Poor could not PI the welfare outcomes will be different depending on whether the Poor subsidizes or not as a response to the Rich providing a subsidy:

When the Poor country does not subsidize its poorer buyers, a subsidy by the Rich will ensure full market coverage there if (as Poor will implement PI to benefit from lower priced goods in the Rich),

$$(n_R + n_T)(y_T s + \gamma_{T2}) + n_R(y_T s + \gamma_{T2}) \geq n_R s\,(y_{R1} + y_{R2})\,. \tag{39}$$

The minimum subsidy level to ensure full market coverage thus equals $\gamma_{T2}^{D} = \dfrac{n_R s\,(y_{R1} + y_{R2})}{2n_R + n_T} - y_T s$. Note that this subsidy is higher than the case where PI by Poor country was not a possibility subject to the following condition:

$$\gamma_{T2}^{D} = \frac{n_R s\,(y_{R1} + y_{R2})}{2n_R + n_T} - y_T s > \frac{n_R s y_{R2}}{n_R + n_T} - y_T s \Leftrightarrow n_R y_{R2} < (n_R + n_T)\,y_{R1}. \tag{40}$$

This is also the condition for it to be beneficial for the poor country to PI at the level of subsidy needed to persuade the firm to fully cover the rich despite the poor's PI. The interpretation of this condition is simple. If the firm prefers to cover all in the Rich country at price $y_{R1}s$ rather than just cater to the rich buyers there at price $y_{R2}s$, it will be easier to persuade the firm to fully cover all in the Rich country despite the PI from the Poor, rather than setting a subsidy that results in a price which makes it not optimal for the Poor to PI. A *cheaper* way to set the subsidy that ensures full coverage might be to ensure that it is not optimal for the poor to PI:

$$n_R(y_T s + \gamma_{T2}^D) = n_R s y_{R1} \Longleftrightarrow \gamma_{T2}^D = s\left(y_{R1} - y_T\right). \tag{41}$$

Note, however, that,

$$\frac{n_R s\left(y_{R1} + y_{R2}\right)}{2n_R + n_T} - y_T s < y_{R1}s - y_T s \Leftrightarrow n_R y_{R2} < \left(n_R + n_T\right) y_{R1}. \tag{42}$$

As long it is cheaper for the Rich not to prevent PI by the Poor, the Poor will obtain a positive welfare rather than zero:

$$W_1^D\left(\gamma_{T2}^D\right) = n_R s\left(\frac{\left(n_R + n_T\right) y_{R1} - n_R y_{R2}}{\left(2n_R + n_T\right)}\right) > 0 \Longleftrightarrow n_R y_{R2} < \left(n_R + n_T\right) y_{R1}. \tag{43}$$

In other words, only when $n_R y_{R2} < \left(n_R + n_T\right) y_{R1}$, the ability of the Poor to allow PI will make a difference to its welfare level and hence to our results in this section. In what follows, we reexamine the SPNE choices under this condition. Note that this condition does not contradict the earlier assumption that $y_{R2} < 2y_{R1}$.

When the Poor provides a subsidy (but does not allow PI), a subsidy by the Rich will ensure full market coverage there if

$$(n_R + n_T)(y_T s + \gamma_{T2}) \geq n_R s y_{R2}. \tag{44}$$

Given the subsidy of the Rich, to ensure market coverage in its own country the Poor country should provide a subsidy such that the MNC prefers to cover all in the Poor country at price $(y_T s + \gamma_{T1})$ rather than just cover the rich there at the price that is prevalent with PI being allowed by Poor, which is the Rich country price $(y_T s + \gamma_{T2})$ :

$$(n_R + n_T)(y_T s + \gamma_{T1}) \geq n_R(y_T s + \gamma_{T2}) \Leftrightarrow \gamma_{T1}^D = \frac{n_R(y_T s + \gamma_{T2})}{n_R + n_T} - y_T s. \tag{45}$$

It is interesting to note that unlike in the case where the Poor could not PI, the subsidy that ensures full coverage in the Poor is now related to the Rich subsidy. This results in price level $P_1^D = \dfrac{n_R(y_T s + \gamma_{T2})}{n_R + n_T}$ in the Poor country, with corresponding welfare level

$$W_1^D\left(\gamma_{T1}^D,\gamma_{T2}^D\right) = n_R\left(sy_{R1}-\frac{n_R(y_Ts+\gamma_{T2}^D)}{(n_R+n_T)}\right)-n_T\left(\frac{n_R(y_Ts+\gamma_{T2}^D)}{(n_R+n_T)}-y_Ts\right)= = n_Rsy_{R1}+n_Ty_Ts-n_R(y_Ts+\gamma_{T2}^D). \tag{46}$$

The above is positive for $n_Ry_{R2} < (n_R+n_T)\,y_{R1}$, which is our working assumption. However, from (45) it is immediate that unlike the previous case where the Poor could not allow PI, the Rich can induce the Poor to provide a higher subsidy by providing itself a higher than minimum subsidy. As shown in the appendix, the maximum subsidy that the Rich country must set is

$$\gamma_{T2}^{D\max}=\frac{n_Rsy_{R1}+y_Ts\,(n_T-n_R)}{n_R} \tag{47}$$

which, in turn, induces a maximum subsidy in the Poor country as,

$$\gamma_{T1}^{D\max}=\frac{n_R(y_Ts+\gamma_{T2}^D)}{n_R+n_T}-y_Ts=\frac{n_R\,(y_{R1}-y_T)}{n_R+n_T}s. \tag{48}$$

Hence, welfare levels are

$$W_2^D(\gamma_{T1}^{D\max},\gamma_{T2}^{D\max}) = n_Ry_{R2}s+n_Ty_Ts+(n_R+n_T)\left(\frac{n_R\,(y_{R1}-y_T)}{n_R+n_T}s+y_Ts\right)= = n_Ry_{R2}s+n_Ry_{R1}s+2n_Ty_Ts, \tag{49}$$

$$W_1^D\left(\gamma_{T1}^{D\max},\gamma_{T2}^{D\max}\right)=0. \tag{50}$$

Note that

$$\gamma_{T2}^{D\max} = \frac{n_Rsy_{R1}+y_Ts\,(n_T-n_R)}{n_R}>\gamma_{T2}^D=\frac{n_Rs\,(y_{R1}+y_{R2})}{2n_R+n_T}-y_Ts\Leftrightarrow \Leftrightarrow n_R\frac{(n_R+n_T)\,y_{R1}-n_Ry_{R2}}{(2n_R+n_T)}+n_Ty_T>0. \tag{51}$$

This is ensured by the condition that makes PI relevant: $(n_R+n_T)\,y_{R1} > n_Ry_{R2}$.

It can also be checked, if the Poor does not subsidize its poorer buyers, the price that prevails is $P^D(\gamma_{T2}^{D\max})=y_{R1}s+\dfrac{n_T}{n_R}y_Ts>y_{R1}s$. Hence, there would be no scope for the Poor to allow PI from the Rich, resulting in $W_1^D(\gamma_{T2}^{D\max})=0$. The welfare for the Rich then would be

$$W_2^D(\gamma_{T2}^{D\max})=n_Ty_Ts+n_Ry_{R2}s+n_R\frac{n_Rs\,(y_{R1}+y_{R2})}{(2n_R+n_T)}. \tag{52}$$

That is, given that the Rich sets the maximum subsidy under market segmentation, the Poor country is indifferent between providing the corresponding maximum subsidy $\gamma_{T1}^{D\max}$ and not providing any subsidy at all. However, once again the tie-breaking rule that we apply here is that the Poor will provide the maximum subsidy because that will ensure market access to the innovated drug for its poorer buyers. Table A4 in the Appendix summarizes the relevant welfare levels.

Note that $W_2^D(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}) > W_2^D(\gamma_{T1}^D) = n_R\,(y_{R1} + y_{R2})\,s$, hence, if the Rich country can induce a higher than the minimum subsidy, it will prefer that to not subsidizing.

## 3.2 Rich country's subsidy and PI policies

In what follows, we continue to assume that $(n_R + n_T)\,y_{R1} > n_R y_{R2}$ and only consider the case where the rich can actually push up subsidy to its maximum level. The following Lemma 3 that summarizes the second-stage choice of the Poor country as discussed in the above two sub-sections will be helpful in finding out the the first-stage choice of the Rich country, and consequently the sub-game perfect equilibrium.

**Lemma 3:** *For all* $y_{R2} \in \left\{y_{R1}, \min\left(2y_{R1}, \dfrac{n_R + n_T}{n_R} y_{R1}\right)\right\}$*, the Poor country provides subsidy to its poorer buyers regardless of whether the Rich country provides a subsidy or not under PI as long as* $y_{R1} < y^*$*. For a larger within-country income disparity (*$y_{R1} > y^*$*), when the Rich does not subsidize, there is no scope for the Poor to allow PI from the Rich, but when the Rich subsidizes, it is feasible as well as optimal for the Poor to allow PI from the Rich instead of subsidizing. On the other hand, when the Rich does not allow PI, the Poor provides subsidy regardless of whether the Rich subsidizes or not and how large is the within-country income disparity.*

**Proof:** See appendix**.**

Comparing Lemma 3 with Lemma 1, it is immediate that the ability of the Poor country to allow PI from the Rich country substantially changes its second-stage choice. Since the Poor country can now gain from PI whenever the price of the drug is lower in the Rich country due to subsidy given there, the Poor country does not always respond to a Rich-country subsidy by providing a subsidy as well.

We now proceed to find out the first-stage choice of the Rich country. Consider first the case where the within-country income disparity is small in the sense that $y_{R1} < y^*$. As is immediate from Lemma 3, to make a choice the relevant welfare levels for the Rich are: $W_2^{ND}(\gamma_{T1}^{ND})$, $W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max})$, $W_2^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right)$ and $W_2^D(\gamma_{T1}^D)$. Referring back to Table A3, it is easy to check that

$$
\begin{aligned}
W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) &= n_R y_{R2} s + 2\,(n_R + n_T)\,y_T s > \qquad (53)\\
W_2^{ND}(\gamma_{T1}^{ND}) &= n_R y_{R2} s + \frac{2n_R y_{R1} s\,(n_T + n_R)}{2n_R + n_T} \text{ if } y_{R1} < y^*.
\end{aligned}
$$

On the other hand, it is immediate from Table A4 that $W_2^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right) > W_2^D(\gamma_{T1}^D)$.

Finally, it is straightforward to check that,

$$W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) > W_2^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right) \text{ if } y_{R1} > 2y_T. \tag{54}$$

The condition stated in (54) is consistent with our earlier assumption that $y_{R1} > \dfrac{(n_T + n_R)}{n_R} y_T$ as long as $n_T \geq n_R$. More precisely, $\dfrac{(n_T + n_R)}{n_R} y_T \geq 2y_T$ $\forall\, n_T \geq n_R$. For $n_T < n_R$, since $\dfrac{(n_T + n_R)}{n_R} y_T < 2y_T$ so $W_2^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right)$ is larger than $W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max})$ $\forall\, y_{R1} \in \left(\dfrac{(n_T + n_R)}{n_R} y_T,\, 2y_T\right)$.

It appears then that the SPNE will depend on the size of the income classes. For $n_T \geq n_R$, the SPNE in this sub-case $\left(y_{R1} < y^* = \dfrac{(n_T + 2n_R)}{n_R} y_T\right)$ is $\{(PI\ \&S) \longrightarrow S\}$. But, for $n_T < n_R$, the SPNE is $\{S \longrightarrow S\}$ $\forall$ $y_{R1} \in \left(\dfrac{(n_T + n_R)}{n_R} y_T,\, 2y_T\right)$, and $\{(PI\ \&S) \longrightarrow S\}$ $\forall\, y_{R1} > 2y_T$.

Now consider the case of larger within country income disparity: $y_{R1} > y^*$. In this case, by Lemma 3, the relevant welfare levels for the Rich country making a choice are: $W_2^{ND}$, $W_2^{ND}(\gamma_{T2}^{ND})$ and $W_2^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right)$. But $W_2^{ND}(\gamma_{T2}^{ND}) = n_R y_{R2} s + n_T y_T s + \dfrac{2n_R y_{R1} s}{2n_R + n_T} n_R < W_2^{ND} = n_R s\,(y_{R2} + y_{R1})$ when $y_{R1} > y^*$ and hence the relevant comparison is between $W_2^{ND}$ and $W_2^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right)$. Referring back to Tables A3 and A4, it is easy to check that:

$$W_2^{ND} = n_R s\,(y_{R2} + y_{R1}) < W_2^D(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}) = n_R y_{R2} s + n_R y_{R1} s + 2n_T y_T s. \tag{55}$$

Hence, in this case MBD and subsidy will be preferred by the rich with will induce a subsidy by the poor. That is , the SPNE is $\{S \longrightarrow S\}$. The following proposition summarizes our results.

**Proposition 2**: *As long as* $y_{R2} \in \left\{y_{R1}, \min\left(2y_{R1}, \dfrac{n_R + n_T}{n_R} y_{R1}\right)\right\}$, *the Rich not allowing PI and providing subsidy to its poorer buyers and the Poor providing subsidy to its poorer buyers (but not allowing PI),* $\{S \rightarrow S\}$, *are the SPNE strategy choices when* $y_{R1} > y^*$. *When* $y_{R1} < y^*$, *the Rich allowing PI and providing subsidy to its poorer buyers and the Poor providing subsidy to its poorer buyers (PI),* $\{(PI\ \&S) \longrightarrow S\}$, *becomes the SPNE as long as* $n_T \geq n_R$.

An interesting implication we have here is that the Poor's ability to PI may actually induce the Rich to giving up on PI so as to induce subsidy rather than allowing PI by the Poor. However, this is only likely to happen if the Poor country is *not too poor* $(y_{R1} > y^*)$. In addition, note that our results focus on the case where the relative difference in the income ranges between Poor and Rich is not too high $y_{R2} \in \left\{y_{R1}, \min\left(2y_{R1}, \dfrac{n_R + n_T}{n_R} y_{R1}\right)\right\}$. On this range, first, the income distribution parameter is such that without a subsidy being given (or parallel imports being allowed), the MNC does not cater to the poor in either country (see equation (5)), second, it is still profitable for the MNC to serve both the Rich and Poor countries when the Rich allows PI.

A simple comparison shows that aggregate welfare levels across all possible SPNE are the same. Hence, a move across SPNE implies a redistribution in welfare across countries. In relation to this, we state the two following lemmas:

**Lemma 4:** *When the Poor country can PI , the welfare of the Poor country rises whereas that of the Rich country falls relative to what they could achieve through similar policy choices when the Poor could not PI and the Rich allows PI as part of the SPNE. Otherwise, welfare levels remain the same.*

A simple comparison of welfare levels shows that in any of the two possible SPNE when the Poor can allow PI its welfare either remains the same (if Rich does not allow PI) or goes up (if Rich allows PI) relative to the unique SPNE welfare levels under PI not being possible for the Poor. The opposite result applies to the Rich.

The only chance for the Poor to get a strictly positive level of welfare arises in the case where they have the ability to PI. The ability to allow PI by the Poor, even if it does not do it in the end may change the SPNE and indeed the PI policy of the Rich. Interestingly, it is when the Rich allows PI and provides a subsidy to induce a price subsidy being given by the Poor country to its poorest consumers that the welfare of the Poor may become strictly positive, with it being zero in all other possible SPNE. However, for this to be the SPNE, it must the case that the poor has the ability to PI and also that the income of the richest group within the Poor country is below the $y^*$ threshold (with $n_T \geq n_R$).

**Lemma 5:** *Persuading the Poor country to enter into an agreement in which both countries commit to not allowing PI will imply a strict increase in the Rich country's welfare iff the SPNE that arises in the case where the Poor can PI is the one where the Rich country is better off committing to not PI.*

**Proof:** See appendix.

Note however that such agreement would not be a SPNE if the Rich country forced the poor to commit to not PI as it would be then in the Rich country's best interest to PI. Also note that the Rich country committing to not PI as part of it SPNE strategy when Poor can PI will only happen if $y_{R1} > y^*$ hence, income distributions between the two countries being closer in terms of the rich group's income within each country.

# 4 Conclusions

The model presented in this paper aims to capture some interesting features of government policy in international health markets. We have focused on two policies which have been discussed as possible means to increase access to medicines to poorer members of society: parallel imports and price subsidies to poorer consumers. We have presented a policy game that captures the asymmetric nature of power in policy setting between richer and poorer countries by first, allowing the Rich country a higher capacity to commit to pharmaceutical market policies and secondly by considering the scenario in which the poor country might, or might not be able to allow PI. An interesting feature of our model is that, even though there is an ex ante richer and poorer country, changes in purchasing power due to the income related price subsidy within each country allows for the possibility that it might be in the interest of the poorer country to allow PI from the rich.

When the Poor country cannot allow PI, and has only the choice regarding whether to provide a subsidy or not to its poorer buyers, the Rich allowing PI and providing subsidy to its poorer buyers and the Poor providing subsidy to its poorer buyers are the subgame perfect strategy choices for the governments. The ability of the poorer country to allow PI might increase welfare in this country even if price difference in equilibrium is such that PI is never implemented. Our analysis shows that the equilibrium arising in the case when the Poor country can allow PI will depend on the income distribution within the Poor country. Interestingly, the poorer country may only achieve an increase in its welfare by being able to allow PI if they are poor enough. We also prove that if the Poor country's highest income is high enough it will not be in their best interest to sign an agreement with the Rich to commit to not allowing PI. This is a relevant policy issue that relates to the *TRIPS-Plus provisions* increasingly included in bilateral FTA negotiations between developed and developing countries that require developing countries to commit to not allow parallel imports.

We make here an ex post analysis in the sense that a drug is already innovated and thus its quality is exogenously given. The policy choices influencing the innovation decision and the quality of the drug is analyzed elsewhere [Acharyya and García-Alonso (2009)].

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# 5 Appendix

**I. Welfare Maximizing subsidy by the Rich**

Now, when the Poor country subsidizes, setting the minimum subsidy $\gamma_{T2}^{ND} = \frac{n_R}{n_R+n_T} y_{R1}s - y_T s$ that ensures full market coverage may not be optimal for the Rich country because its welfare is increasing in its own subsidy, everything else remaining the same:

$$W_2^{ND}(\gamma_{T1}^{ND}, \gamma_{T2}^{ND}) = n_R y_{R2} s + n_T y_T s + (n_R + n_T)\left(\gamma_{T1}(\gamma_{T2}) + y_T s\right).$$

Note that, in order to induce full market coverage, the Poor must provide a subsidy $\gamma_{T1}$ such that

$$2(n_R + n_T)(y_T s + \gamma_{T1}) = (n_R + n_T)(y_T s + \gamma_{T2}) + n_R y_{R1} s > 2 n_R y_{R1} s,$$

Hence,

$$\gamma_{T1} = \frac{(n_R + n_T)(y_T s + \gamma_{T2}) + n_R y_{R1} s}{2(n_R + n_T)} - y_T s.$$

It is immediate that the above subsidy is increasing in the subsidy given in the Rich country:

$$\frac{\partial \gamma_{T1}(\gamma_{T2})}{\partial \gamma_{T2}} = \frac{n_R + n_T}{2(n_R + n_T)} > 0$$

and so is the Rich country's welfare.

$$W_1^{ND}(\gamma_{T1}^{ND}, \gamma_{T2}^{ND}) = n_R(y_{R1}s - (\gamma_{T1} + y_T s)) - n_T \gamma_{T1}^{ND\max} = 0 \Leftrightarrow \gamma_{T1}^{ND\max} = \frac{n_R s\,(y_{R1} - y_T)}{n_R + n_T}.$$

To achieve this, $\gamma_{T2}$ should be such that

$$\frac{n_R s\,(y_{R1} - y_T)}{n_R + n_T} = \frac{(n_R + n_T)(y_T s + \gamma_{T2}^{ND\max}) + n_R y_{R1} s}{2(n_R + n_T)} - y_T s$$

$$\Longrightarrow \gamma_{T2}^{ND\max} = \frac{n_R\,(y_{R1} - y_T) + n_T y_T}{n_R + n_T} s.$$

As expected

$$\gamma_{T1}^{ND} = \frac{n_R}{n_R + n_T} y_{R1} s - y_T s = \frac{n_R s\,(y_{R1} - y_T) - n_T y_T s}{n_R + n_T} < \gamma_{T1}^{ND\max} < \gamma_{T2}^{ND\max}.$$

**II. Welfare Levels when the Poor country cannot allow PI**

The Tables presented in this Appendix below summarize the relevant welfare levels for each of the four cases considered. Note that we are only representing the most relevant subsidy choices from amongst all the possible subsidy levels so as to simplify the way in which we present the policy options. We are there presenting the welfare levels under four possible policy combinations (with providing or not subsidy by each country) whereby in each of them the strictly positive subsidy choice of each party is optimized.

Table A1: Rich allows PI (Poor cannot PI)

| *2/1* | *S* | *NS* |
|---|---|---|
| *S* | $W_2^{ND}\left(\gamma_{T1}^{ND\max},\gamma_{T2}^{ND\max}\right)=n_Ry_{R2}s+n_Ry_{R1}s+2n_Ty_Ts$ <br> $W_1^{ND}\left(\gamma_{T1}^{ND\max},\gamma_{T2}^{ND\max}\right)=0$ | $W_2^{ND}(\gamma_{T2}^{ND})=n_Ty_Ts+n_Ry_{R2}s,$ <br> $W_1^{ND}(\gamma_{T2}^{ND})=0$ |
| *NS* | $W_2^{ND}(\gamma_{T1}^{ND})=n_Ry_{R2}s+\frac{2n_Ry_{R1}(n_T+n_R)}{2n_R+n_T}s$ <br> $W_1^{ND}(\gamma_{T1}^{ND})=n_T\left(y_T-\frac{n_R}{2n_R+n_T}y_{R1}\right)s$ | $W_2^{ND}=n_R\left(y_{R2}+y_{R1}\right)s$ <br> $W_1^{ND}=0$ |

Table A2: Rich does not allow PI (Poor cannot PI)

| *2/1* | *S* | *NS* |
|---|---|---|
| *S* | $W_2^{D}(\gamma_{T1}^{D},\gamma_{T2}^{D})=n_Ty_Ts+n_R(y_{R1}+y_{R2})s$ <br> $W_1^{D}(\gamma_{T1}^{D},\gamma_{T2}^{D})=n_Ty_Ts$ | $W_2^{D}(\gamma_{T2}^{D})=n_Ty_Ts+n_R(y_{R1}+y_{R2})s$ <br> $W_1^{D}(\gamma_{T2}^{D})=0$ |
| *NS* | $W_2^{D}(\gamma_{T1}^{D})=n_R\left(y_{R1}+y_{R2}\right)s$ <br> $W_1^{D}(\gamma_{T1}^{D})=n_Ty_Ts$ | $W_2^{D}=n_Rs\left(y_{R1}+y_{R2}\right)$ <br> $W_1^{D}=0$ |

**III. Proof of Lemma 2**

**Proof**: First, consider the case $y_{R1}<\dfrac{2n_R+n_T}{n_R}\equiv y^*$. By Lemma 1, in the second stage the Poor country provides subsidy whatever strategy does the Rich country choose. Hence, given the welfare ranking in (27) and (28), the Rich country chooses (PI & S). Next, consider $y_{R1}>\dfrac{2n_R+n_T}{n_R}\equiv y^*$. Once again referring back to Lemma 1, regardless of whether the Rich country subsidizes or not, under market segmentation the Poor country subsidizes its poorer buyers. But when the Rich allows PI, the Poor subsidizes only when the Rich subsidizes as well. Given these second-stage strategy choices of the Poor country, using backwards induction, the relevant welfare levels for the Rich country to make a choice are: $W_2^{ND}$, $W_2^{D}(\gamma_{T1}^{D},\gamma_{T2}^{D})$, $W_2^{ND}\left(\gamma_{T1}^{ND\max},\gamma_{T2}^{ND\max}\right)$. It is immediate that,

$$W_2^{ND}\left(\gamma_{T1}^{ND\max},\gamma_{T2}^{ND\max}\right) > W_2^D(\gamma_{T1}^D,\gamma_{T2}^D) > W_2^{ND}.$$

Thus, the Rich chooses (PI & S) in this case as well. Hence, the claim. □

**IV. Welfare Levels when the Poor can allow PI**

Table A3: Rich allows PI (Poor can PI)

| *2/1* | *S* | *NS* |
|---|---|---|
| *S* | $W_2^{ND}(\gamma_{T1}^{ND\max},\gamma_{T2}^{ND\max}) = n_R y_{R2} s + 2\left(n_R+n_T\right) y_T s$<br><br>$W_1^{ND}\left(\gamma_{T1}^{ND\max},\gamma_{T2}^{ND\max}\right) = n_R(y_{R1}s - 2y_T s)$ | $W_2^{ND}(\gamma_{T2}^{ND}) = n_R y_{R2} s + n_T y_T s +$<br>$+\dfrac{2n_R y_{R1} s}{2n_R+n_T} n_R$<br><br>$W_1^{ND}(\gamma_{T2}^{ND}) = \dfrac{n_R n_T y_{R1} s}{2n_R+n_T}$ |
| *NS* | $W_2^{ND}(\gamma_{T1}^{ND}) = n_R y_{R2} s + \dfrac{2n_R y_{R1}\left(n_T+n_R\right)}{2n_R+n_T} s$<br><br>$W_1^{ND}(\gamma_{T1}^{ND}) = n_T\left(y_T - \dfrac{n_R}{2n_R+n_T} y_{R1}\right) s$ | $W_2^{ND} = n_R s\left(y_{R2}+y_{R1}\right)$<br><br>$W_1^{ND} = 0$ |

**V. Maximum Subsidy when the Poor can allow PI**

That a strategy for the Rich of inducing the Poor to proivide a higher subsidy by giving a higher subsidy itself is relevant for the Rich country is evident from the fact that its own welfare

$$W_2^D(\gamma_{T1}^D,\gamma_{T2}^D) = n_R y_{R2} s + n_T y_T s + \left(n_R+n_T\right)\left(\gamma_{T1}(\gamma_{T2}) + y_T s\right) \tag{56}$$

is increasing in $\gamma_{T2}$ since $\dfrac{\partial \gamma_{T1}(\gamma_{T2})}{\partial \gamma_{T2}} = \dfrac{n_R}{n_R+n_T} > 0$. Also note that for all subsidy levels

$$W_1^D\left(\gamma_{T1}^D,\gamma_{T2}^D\right) > W_1^D\left(\gamma_{T2}^D\right) = n_R s y_{R1} - n_R(y_T s + \gamma_{T2}^D).$$

Hence, while setting the maximum subsidy the only thing the Rich needs to ensure is that the Poor achieves a non-negative welfare level. That is, the maximum subsidy that the Rich country must set is,

$$W_1^D\left(\gamma_{T1}^D,\gamma_{T2}^D\right) = n_R s y_{R1} + n_T y_T s - n_R(y_T s + \gamma_{T2}^D) = 0 \Longleftrightarrow \gamma_{T2}^{D\max} = \frac{n_R s y_{R1} + y_T s\left(n_T - n_R\right)}{n_R}$$

**VI. Welfare levels**

Table A4: Rich does not allow PI but the Poor can PI

| 2/1 | $S$ | $NS$ |
|---|---|---|
| $S$ | $W_2^D(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}) = n_R y_{R2} s + n_R y_{R1} s + 2n_T y_T s$<br>$W_1^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right) = 0$ | $W_2^D(\gamma_{T2}^{D\max}) = n_T y_T s + n_R y_{R2} s +$<br>$+n_R \frac{n_R s\,(y_{R1} + y_{R2})}{(2n_R + n_T)}$<br>$W_1^D\left(\gamma_{T2}^{D\max}\right) = 0$ |
| $NS$ | $W_2^D(\gamma_{T1}^D) = n_R\,(y_{R1} + y_{R2})\,s$<br>$W_1^D(\gamma_{T1}^D) = n_T y_T s$ | $W_2^D = n_R s\,(y_{R2} + y_{R1})$<br>$W_1^D = 0$ |

**VII. Proof of Lemma 3**

For $y_{R1} < y^*$, since $W_1^{ND} = 0$ and $W_1^{ND}(\gamma_{T1}^{ND}) > 0$, the Poor provides subsidy to its poorer buyers but does not allow PI when the Rich allows only PI from the Poor. For larger within-country income disparity, a larger subsidy is required to ensure full market coverage for reasons spelled out earlier but that does not ensure a non-negative net welfare for the Poor. On the other hand, without the Rich providing any subsidy, there is no scope for the Poor to allow PI from the Rich country as well. When the Rich provides a subsidy along with allowing PI, by (37), it is optimal for the Poor to provide a subsidy as long as $y_{R1} < y^*$. But for larger within-country income disparity, it is optimal for the Poor to allow PI from the Rich.

For the second part (the Rich not allowing PI) when the Rich provides a (maximum) subsidy, it is immediate from Table A4 that $W_1^D\left(\gamma_{T1}^{D\max}, \gamma_{T2}^{D\max}\right) = 0 = W_1^D\left(\gamma_{T2}^{D\max}\right)$. By the tie-breaking rule mentioned above, the Poor provides the corresponding maximum subsidy. Finally, if the Rich does not provide a subsidy under market segmentation, there is again no scope for the Poor to allow PI, and the only way it can benefit is by subsidizing its poorer buyers and thus ensuring their market access, which lowers the price paid by their richer buyers: $W_1^D(\gamma_{T1}^D) = n_T y_T s > 0 = W_1^D$. Hence the claim$\square$

**VIII. Proof of Lemma 5**

We compare welfare under both countries giving subsidy and not allowing PI (see lemma 1: $W_2^D(\gamma_{T1}^D, \gamma_{T2}^D) = n_T y_T s + n_R(y_{R1} + y_{R2})s$, $W_1^D(\gamma_{T1}^D, \gamma_{T2}^D) = n_T y_T s$) and the welfare levels when both PI and both give subsidy in the robustness section ($W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) = n_R y_{R2} s + 2\,(n_R + n_T)\,y_T s$, $W_1^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) = n_R(y_{R1} s - 2y_T s)$). We then have that:

$W_2^D(\gamma_{T1}^D, \gamma_{T2}^D) = n_T y_T s + n_R(y_{R1} + y_{R2})s > W_2^{ND}(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}) = n_R y_{R2} s + 2\,(n_R + n_T)\,y_T s \Leftrightarrow y_{R1} > y^*$, which is as well the condition for the SPNE where the rich commits to not PI to arise. Similarly,

$W_1^D(\gamma_{T1}^D, \gamma_{T2}^D) = n_T y_T s < W_1^{ND}\left(\gamma_{T1}^{ND\max}, \gamma_{T2}^{ND\max}\right) = n_R(y_{R1} s - 2y_T s) \Leftrightarrow y_{R1} > y^*$.$\square$