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1 Introduction

The extent to which the holders of intellectual property rights (IPR) can freely exercise their market power in the global economy depends upon (i) the amount of protection available to them against potential imitators and (ii) the degree to which they can price discriminate across national markets. The objective of this paper is to understand the linkages between policies that determine these two facets of the market power possessed by IPR holders. To achieve this objective, the paper develops a stylized two-country model that is motivated by two simple observations. First, due to fundamental differences in the pattern of demand across countries, firms have an incentive to charge higher prices in developed countries relative to developing ones but they can engage in such international price discrimination only if policy restrictions in developed countries prevent *parallel imports*.¹ A country's stance toward parallel imports is determined by the nature of territorial exhaustion of IPR practised by it: parallel imports are permitted under *international exhaustion* (IE) whereas they are restricted under *national exhaustion* (NE). The second key observation motivating the model is that while holders of IPR enjoy fairly strong protection in developed countries, such is generally not the case in developing countries. In fact, up until the ratification of the Agreement on Trade Related Aspects of Intellectual Property (TRIPS) in 1995, IPR protection in most developing countries was quite weak or simply non-existent and the widespread imitation of foreign technologies and products by firms in developing countries was a major reason why developed countries pushed strongly for a multilateral agreement on IPR at the World Trade Organization (WTO).

Given these observations, we consider a North-South model where a firm that enjoys monopoly status in the North by virtue of an IPR (such as a patent or a trademark) has the incentive to price discriminate internationally because Northern consumers value its product more than Southern ones. The firm's market power fully extends to the South only if the South protects its technology from being copied by local imitators. Thus, while Northern policy regarding the territorial exhaustion of IPR determines whether the firm can price discriminate internationally and therefore exercise its market power *across* regions, Southern policy regarding the protection of IPR determines its monopoly

¹Following Maskus (2000), parallel trade is said to occur when a product (such as a patented medicine or software) offered for sale in one country by the holder of the relevant intellectual property right is re-sold in another country without the right holder's permission. As one might expect, such trade usually occurs when retailers attempt to arbitrage away international price differences.

power *within* the Southern market. In the model, policy interaction between the two regions occurs as follows. In the first stage, both regions choose their respective policies: the North chooses between NE and IE while the South decides whether or not to protect IPR. If the South does not protect IPR, a competitive Southern industry that produces an imitated (lower quality) version of the firm's product comes into existence. Next, the firm decides whether to incur the fixed (sunk) cost necessary to export to the South. Finally, the firm chooses its price(s) and consumption and trade occur. After deriving the subgame perfect equilibrium of the model, we ask how an exogenously imposed prohibition on Southern imitation, say due to the implementation of an international agreement such as TRIPS, affects equilibrium market outcomes and welfare.

By design, the model aims to capture those markets where the degree of IPR protection and the nature of exhaustion policies both have a significant effect on firm behavior. While IPR protection is relevant for many industries in which firms invest in innovation and in establishing brand names, exhaustion policies affect firm behavior primarily in those markets in which trading costs are low relative to the value of the product. This is because parallel trade is motivated by the existence of price differentials across markets and the margins earned by those engaging in parallel trade are likely to be small (at least relative to monopoly mark-ups). Parallel trade occurs most frequently between geographically proximate countries (such as US-Canada, member countries of the EU, Australia-Southeast Asia) in products such as footwear and leather goods, musical recordings, consumer electronics, domestic appliances, cosmetics, clothing, pharmaceuticals, soft drinks, and some other consumer products (NERA, 1999). Among these products, parallel trade is perhaps quantitatively most important in the market for pharmaceuticals. By some estimates, several billion dollars of such trade occurs annually within the EU and it currently accounts for roughly 10% of EU's total medicine trade.²

Interestingly enough, even with respect to IPR protection the pharmaceutical industry is of special relevance. It is widely recognized that the global pharmaceutical industry was a major proponent of the TRIPS agreement, largely because of the fact that costs

²See "European drug groups fear parallel trade" *Financial Times*, June 7, 2010. See also Kanavos et. al. (2004) for a detailed discussion of parallel trade in the EU's pharmaceutical market. They report that from 1997 to 2002, the share of parallel imports as a percentage of the total pharmaceutical market increased from under 2% to 10.1% in Sweden and from 1.7% to about 7% in Germany. On the export side, Greece's share of parallel exports increased from under 1% to 21.6% over the same time period. Of course, the volume of parallel trade is likely to understate the consequences of openness to parallel trade since the pricing behavior of firms is quite different when parallel imports are allowed relative to when they are not – a channel that lies at the heart of our model and its main results.

of imitation in this industry tend to be very low relative to the costs of innovation. This makes protection against infringement of IPR crucial for patent-holders in this industry. For example, a major reason the local pharmaceutical industry in India came into existence was that prior to 1995 Indian patent law only recognized process patents; virtually no protection was offered to product patents (Goldberg, 2010). As a result, local firms were free to imitate and reverse-engineer pharmaceuticals invented by foreign firms. As long as a local Indian firm could manufacture a patented drug via a production process that was not identical to the one used by a (foreign) patent holder, it could freely ignore the product patent and manufacture the drug in India. Thus, the two key policies analyzed in this paper – exhaustion policies and IPR protection – are both highly relevant for one major industry, i.e., the pharmaceutical industry. And since patents create substantial monopoly power in this industry (indeed that is their very purpose), a monopoly model with a partial equilibrium framework is the most natural set-up within which to analyze the joint interaction of these policies.³

In our model, the most attractive global policy environment from the firm's viewpoint is one where the North adopts NE and the South forbids imitation while the worst scenario is one where these policies are reversed. Given this, an interesting question arises. What does the firm value more: protection of intellectual property or the freedom to price discriminate internationally? It turns out that the firm values IPR protection relatively more if and only if the North-South quality gap (γ) falls below a certain threshold (γ^f) since a smaller quality gap implies stiffer price competition. Furthermore, the threshold quality gap γ^f is decreasing in the relative size of the Northern market (η) as well as in the degree to which Northern consumer tastes are skewed in favor of high quality (μ). Intuitively, an increase in either demand parameter (η or μ) makes the two markets more asymmetric thereby making international price discrimination more valuable to the firm while simultaneously reducing the relative importance of the Southern market in determining its global profit.

Conditional on the South protecting intellectual property, IE of IPR is preferred by the North so long as it does not eliminate its firm's incentive to export: provided the firm serves both markets, the threat of arbitrage induced parallel imports under IE forces the firm to set a uniform world price that is lower than the price it charges in the North

³While market power also exists in models of oligopoly or monopolistic competition, policy analysis is substantially more complicated in such models. Furthermore, as was noted above, existing estimates of the amount of parallel trade that occurs in the world suggest that such trade is not large enough in magnitude for exhaustion policies to have significant general equilibrium effects.

under NE. However, since the firm's Southern price is lower under NE, the North's choice of its exhaustion regime ignores the *international price externality* generated by its decision. The North finds NE of IPR optimal when circumstances are such that the firm exports *only if* it can price discriminate internationally: while uniform pricing is attractive to the North, it is less desirable than a scenario where the firm refrains from exporting in order to safeguard its profit at home.⁴ How does Southern IPR policy affect this trade-off? We show that the lack of Southern IPR protection not only shrinks the parameter range over which the North's exhaustion policy affects the firm's decision but it also makes it more likely that the North chooses NE since the adverse effect of imitation on the firm's export profit has to be offset by the freedom to price discriminate internationally in order to preserve its incentive to export.

Consider now the viewpoint of the South. Imitation is attractive to the South because it increases competition as well as variety by providing consumers access to a lower quality version of the Northern good. By lowering the profit of the Northern firm, Southern imitation inflicts a *negative rent externality* on the North. More interestingly, even though imitated goods cannot be sold in the North, the lack of IPR protection in the South also generates a *positive price externality* for Northern consumers when the Northern policy is IE and the firm sells in the South: since the firm sets a common international price under IE, competition from imitators in the Southern market is transmitted to the North in the form of a lower price.

We find that the South finds it optimal to voluntarily protect intellectual property only if such protection is necessary to induce the firm to sell in the South *and* the Northern good is sufficiently superior in quality than the local imitation. Furthermore, the minimum quality gap above which the South is willing to protect intellectual property is relatively lower under NE. This is because uniform pricing on the part of the firm raises the price of the high quality original in the South relative to price discrimination thereby making it less attractive for the South to protect intellectual property.

In the subgame perfect equilibrium of the model, each region's optimal policy takes into account the firm's pricing strategy, its incentive to export, and the other region's policy stance. If the firm exports to the South regardless of the global policy envi-

⁴Malueg and Schwartz (1994) were the first to show that when parallel trade is possible a monopolist may choose to not serve markets with higher elasticities of demand. Goldberg (2010) provides an extensive discussion of the empirical literature that shows how the practice of "global reference pricing" on the part of some rich countries and the possibility of parallel imports can induce pharmaceutical companies to not serve low income countries and/or raise their prices in such markets.

ronment, then each region implements its preferred policy: the North chooses IE while the South does not protect intellectual property. However, when the export decision of the firm is policy dependent, the two regions find themselves in a policy stand-off: each region takes into account whether or not the other would be willing to induce the firm to export by choosing to implement its less preferred policy. While the firm views NE and protection from imitation as *substitutes* in the sense that both policies increase its market power, the two governments view them quite differently since, holding the firm's export decision constant, NE lowers Northern welfare while protecting intellectual property harms the South.

The interdependence of the two regions' policy decisions implies that a change in one region's policy can induce a change in the other region's policy. As a result, the model can shed new light on the effects of the TRIPS agreement that required developing country members of the WTO to strengthen their protection of intellectual property while leaving the scope of exhaustion of IPR completely at the discretion of member countries. To be precise, TRIPS called for harmonization of IPR laws and regulations across countries but since such laws were generally weaker (or sometimes simply non-existent) in developing countries, its main practical effect was to strengthen IPR protection in the developing world without calling for any significant changes in the developed world. With regard to exhaustion of IPR, TRIPS essentially left member countries free to implement policies of their choice: Article 6 of TRIPS says that "nothing in this Agreement shall be used to address the issue of the exhaustion of intellectual property rights."

A major result of the paper is that the shutting down of Southern imitation increases global welfare if and only if it is necessary for *inducing* the firm to export to the South (Proposition 7). In other words, if the firm sells in the South despite the competition created by imitation or if it does not sell there even when such competition is absent (because the profit earned from such sales is too small relative to the fixed cost of exporting), TRIPS enforcement lowers world welfare. This is a strong result since it is independent of the magnitude of the North-South technology gap. An important practical implication of this welfare result is that the case for strengthening IPR protection in developing countries hinges critically on how such a change affects the *extensive margin* of exports from developed to developing countries – i.e. what matters is whether or not firms from developed countries are induced to sell new products in developing countries as a result of a strengthening of IPR protection on their part. In section 4 of the paper we discuss empirical evidence which shows that TRIPS induced reforms in developing

countries have already started to have a significant positive effect on developed country exports to their markets, particularly in sectors that are sensitive to IPR protection.

We also isolate conditions under which the TRIPS mandated change in Southern IPR policy leads to a reversal in the Northern policy from NE to IE. When this *policy reversal* occurs, Southern welfare takes an even harder hit due to TRIPS: variety is reduced since the low quality imitation is no longer produced and the price of the high quality good increases due to two separate reasons. First, shutting down imitation eliminates competition from the Southern industry. Second, the reversal in the North's policy causes the firm to switch to a single uniform price that exceeds its optimal discriminatory price for the South. However, on the flip side, the North gains on two separate counts: not only does the firm's total profit increase, Northern consumers also benefit since the firm's uniform price lies below its optimal discriminatory price for the North.

While the present paper is unique in its focus on the interaction between imitation and exhaustion policies, several papers have explored parallel import policies in a multi-country setting. Richardson (2002) considers a setting where all countries import a common good from a foreign monopolist and shows that, in equilibrium, all importing countries choose to permit parallel imports. Roy and Saggi (2012a, 2012b) explore how the presence of strategic competition in the product market affects incentives to export and the nature of equilibrium parallel import policies. Grossman and Lai (2008) consider a monopolistic competition model of endogenous innovation in which the South chooses its price control in response to the North's parallel import policy and show that, in contrast to conventional wisdom, the incentives for product innovation can be higher under IE since openness to parallel imports induces the South to loosen its price control in order to avoid its market from not being served by innovating Northern firms.⁵

The rest of the paper is organized as follows. Section 2 presents the model while section 3 describes North's optimal policy in the benchmark case where the South protects IPR. Section 4 describes how Southern imitation affects the North's optimal policy. Section 5 considers the South's decision regarding the protection of IPR. Section 6 presents the subgame perfect equilibrium of the model as well as the effects of TRIPS enforcement for the case where the firm values protection of IPR more than the freedom to price discriminate (i.e. when $\gamma \leq \gamma^f$) while section 7 contains the case where $\gamma > \gamma^f$. In Sec-

⁵Valletti and Szymanski (2006) endogenise product quality in a monopoly model where demand differs across countries and show that the monopolist has a stronger incentive to invest in quality improvement when parallel trade is possible. However, Valetti (2006) shows that this incentive is reversed when differential pricing arises due to cost differences across markets as opposed to demand differences.

tion 8, we comment on some of the assumptions underlying the model and also analyze an extension where Southern IPR policy variable is continuous in nature as opposed to being a discrete (0 or 1) choice. Section 9 offers some concluding remarks while Section 10, which constitutes the appendix, contains supporting calculations and proofs.

2 Model

We consider a world comprised of two regions: North (N) and South (S). There is a single firm that produces good x whose quality is denoted by $q \geq 1$ and whose marginal cost of production is normalized to zero. The firm enjoys monopoly status in the North by virtue of an IPR such as a patent or a trade-mark that is protected in the Northern market.

Each consumer buys at most one unit of good x . If a consumer in country i buys good x at price p , its utility is given by $U_i = \theta q - p$. Utility under no purchase is normalized to zero and $\theta \geq 0$ is a taste parameter that captures the willingness to pay for higher quality.

The two regions are asymmetric in two fundamental respects. First, the Northern market is larger: there are η_i consumers in region i where where $\eta_N = \eta \geq 1 = \eta_S$. Second, and more importantly, Northern consumers value quality relatively more than Southern ones in that the preference parameter θ is uniformly distributed over the interval $[0, \mu_i]$ in region $i = N, S$ where $\mu_N = \mu \geq \mu_S = 1$.⁶

The interaction between the two governments and the firm occurs as follows:

Stage 1: In the first stage, the South decides whether or not to protect the (Northern) firm's intellectual property while the North simultaneously chooses between NE and IE of IPR: parallel imports into the North are prohibited under the former regime whereas they are permitted under the latter.

If the South does not protect intellectual property, imitation occurs in the South leading to the emergence of a competitive Southern industry that produces a lower quality version of the Northern good. Post imitation, competition among Southern producers ensures that the equilibrium price of the low quality imitation equals its marginal cost (set to zero). Under such a scenario, the firm acts as a high quality producer facing competition from a low quality competitive industry in (only) the Southern market. If intellectual property is protected by the South, imitation does not occur and the firm

⁶Note that if there exists a numeraire good, the assumption that $\mu \geq 1$ can also be seen as the North having a lower marginal utility of income than the South.

acts a global monopolist.⁷

The global policy environment determined by each region's independent policy choice is denoted by the pair (X,Y) where $X = IE$ or NE and $Y = P$ or N where P denotes Southern policy decision to protect Northern intellectual property and N to not do so (i.e. to allow imitation).

Stage 2: After governments have chosen policies, the firm chooses whether or not to export to the Southern market. To be able to export, the firm must incur the fixed (sunk) cost $\varphi \geq 0$. If it exports to the South, the firm sells its product there via a competitive retail sector whose unit cost is normalized to zero. When the North chooses NE (i.e. prohibits parallel imports), Southern retailers can only sell locally. However, when the North chooses IE , Southern retailers have an incentive to engage in parallel trade if the Northern price exceeds the Southern one.

Stage 3: The firm chooses price(s) and consumption and trade occur.

We solve this game by backward induction. Before deriving the sub-game perfect equilibrium of this game, it is useful to quickly describe the market outcome under autarky (i.e. the complete absence of international trade).

Under autarky, the firm's optimal monopoly price p_N^d is found by solving

$$\max_p \eta p x(p) = \eta \frac{p}{\mu} \left(\mu - \frac{p}{q} \right) \Rightarrow p_N^d = \frac{\mu q}{2}$$

At the price p_N^d , all Northern consumers for whom $\theta > \theta^d \equiv p_N^d/q = \frac{\mu}{2}$ buy the good so that half the Northern market is covered under autarky. The firm's autarkic equilibrium profit equals $\pi_N^d = p_N^d x_N^d$ where $x_N^d = \frac{\eta}{\mu} (\mu - p_N^d/q)$. Consumer surplus in the North under autarky and aggregate Northern welfare equal

$$cs_N^d = \frac{\eta}{\mu} \int_{\frac{p_N^d}{q}}^{\mu} (q\theta - p_N^d) d\theta \text{ and } w_N^a = cs_N^d + \pi_N^d$$

As might be expected, the nature of the North's optimal policy with respect to the exhaustion of IPR depends upon the South's policy regarding the protection of IPR. We first derive North's optimal exhaustion policy for the case where the South protects

⁷This formulation of local imitation – i.e. it leads to the availability of a low quality version of the patented good – is quite in line with the approach taken by Chaudhuri et. al. (2006). In a counterfactual analysis based on a structural model of the antibiotic sub-segment of the pharmaceutical market in India, they showed that elimination of local brands (something that would have resulted if India's patent regime had enforced product patents) would have generated significant welfare losses for Indian consumers by reducing variety and increasing prices due to the elimination of competition from local brands.

intellectual property. This case is a natural benchmark since it has been extensively analyzed in the literature.

3 Optimal Northern policy in the benchmark case

Suppose that imitation is prohibited by the South and consider the firm's pricing strategy as a function of Northern exhaustion policy assuming the fixed cost (φ) of exporting has been incurred. Under IE, the firm sets a common price in both markets to avoid losing profit to arbitrage induced parallel imports and the resulting market outcome is referred to as *uniform pricing*. By contrast, under NE, the firm is free to price discriminate internationally (i.e. charge a lower price in the South) and the resulting market outcome is called *price discrimination*. Since the retail sector is assumed to be competitive with unit cost equal to zero, the final price in each market is effectively determined by the firm.

Under price discrimination the firm sets a separate price p_i for each region to solve

$$\text{Max}_{p_i} \frac{\eta_i}{\mu_i} p_i (\mu_i - \frac{p_i}{q}) \Rightarrow p_i^d = \frac{\mu_i q}{2} \quad (1)$$

Since $\mu_N = \mu$ and $\mu_S = 1$, the firm's aggregate profit under price discrimination equals

$$\pi^d = \sum_i \frac{\eta_i}{\mu_i} p_i^d (\mu_i - p_i^d) = \pi_N^d + \pi_S^d = \frac{\eta \mu q}{4} + \frac{q}{4} \quad (2)$$

Under uniform pricing the firm chooses a single price p for both markets to solve:

$$\text{Max}_p \sum_i \frac{\eta_i}{\mu_i} p (\mu_i - \frac{p}{q}) \quad (3)$$

Solving the above problem gives the optimal uniform price and the associated profits under uniform pricing:

$$p^u = \frac{q\mu(\eta + 1)}{2(\eta + \mu)} \text{ and } \pi^u = \frac{q\mu}{4} \frac{(\eta + 1)^2}{\eta + \mu} \quad (4)$$

The optimal uniform price p^u has intuitive properties: it is increasing in the quality level of the firm (q), the extent to which Northern consumers tastes are skewed in favor of quality (μ), and the size of the Northern market (η). Furthermore, as might be expected, the optimal uniform price is bound by the optimal discriminatory prices for

the two regions: $p_S^d \leq p^u \leq p_N^d$.⁸ In fact, we have

$$p^u = \omega p_N^d + (1 - \omega)p_S^d \text{ where } \omega = \frac{\eta}{\eta + \mu} \text{ and } 0 < \omega < 1$$

i.e. the firm's optimal price under uniform pricing is a weighted average of its optimal discriminatory prices where the weight (ω) on the Northern price (p_N^d) is increasing in the relative size of the Northern market (η).

We next note an important property of the model that follows from the assumption that θ is uniformly distributed over the interval $[0, \mu_i]$:

Lemma 1. *Total global sales of the firm under uniform pricing and price discrimination are equal: $\sum_i x_i^u = \sum_i x_i^d = (\eta + 1)/2$ where $i = N, S$.*

Lemma 1 is important because it implies that relative welfare under price discrimination and uniform pricing does not depend upon the total output produced under the two types of pricing. This makes uniform pricing more attractive from an aggregate welfare perspective (since it eliminates price differentials across markets) and provides an argument in favor of IE so long as the Northern firm exports. As we shall below, this feature of the model turns out to play an important role in determining the welfare implications of the TRIPS agreement (analyzed in section 6 below).⁹

Next, we determine the firm's optimal export decision under the policy pairs (IE,P) and (NE,P). Under (IE,P), the firm chooses to export to the South iff its global profit under uniform pricing exceeds its monopoly profit in the North:

$$\pi^u - \varphi \geq \pi_N^d \Leftrightarrow \varphi \leq \varphi^u = \frac{q\mu}{4} \frac{2\eta + 1 - \eta\mu}{\eta + \mu} \quad (5)$$

Since $\varphi^u \geq 0$ iff $\mu \leq \mu^d = 2 + 1/\eta$, a sufficient condition for the firm to *forego* the Southern market is $\mu > \mu^d$.¹⁰ Note also that $\frac{\partial \varphi^u}{\partial \mu} < 0$ and $\frac{\partial \varphi^u}{\partial \eta} > 0$ - i.e. as demand

⁸It is worth pointing out that there is positive demand in the South at the price p^u iff $\mu \leq \bar{\mu} = \frac{2n}{n-1}$. Observe that $\bar{\mu} \geq 2$ for all $n > 0$ and it approaches 2 when n approaches infinity. When $\mu > \bar{\mu}$, under IE the firm does not serve the South even if the fixed cost of exporting equals zero. Intuitively, if the two markets are highly asymmetric, under IE the firm is always better off serving only the Northern market at the optimal price p_N^d . Under such a scenario, Northern policy has no effect on the local price (and consumer surplus) since under both NE and IE, Northern price equals p_N^d . To rule out this uninteresting scenario, we assume that $\mu \leq \bar{\mu}$.

⁹Under alternative assumptions regarding the distribution of the taste parameter θ , it is possible for price discrimination to welfare dominate uniform pricing if it leads to an expansion in total output: see Schmalensee (1981) and Varian (1985). If so, some of the welfare implications of TRIPS that we discuss below would need to be modified. However, the equilibrium outcomes of our model would remain qualitatively unchanged if, all else constant, Northern welfare were to remain higher under uniform pricing by virtue of the fact that the price in its market is higher under discrimination (even though aggregate world output is also higher).

¹⁰Note that $\pi_N^d > \pi^u \Leftrightarrow \mu > \mu^d$. Thus, the firm's optimal pricing behavior (post entry) under the policy pair (IE,P) is to charge the price p^u if $\mu \leq \mu^d$ and p_N^d otherwise. Of course, when $\mu > \mu^d$, the firm would not incur the fixed cost of exporting under IE since Southern sales are zero at the price p_N^d .

asymmetry increases across the two markets, entry into the Southern market under uniform pricing becomes less attractive to the firm. As one might expect $\bar{\mu} \geq \mu^d$ i.e. it is optimal for the firm to drop the Southern market well before its Southern sales hit zero under uniform pricing.

Similarly, the firm exports under NE iff its Southern profit at the optimal discriminatory price p_S^d exceeds the fixed cost of exporting:

$$\pi_S^d \geq \varphi \Leftrightarrow \varphi \leq \varphi^d = \frac{q}{4} \quad (6)$$

Thus, given that the South does not permit imitation, the firm's net profits under alternative policy choices by the North are as follows:

$$\pi(\text{IE}, \text{P}) = \left\{ \begin{array}{l} \pi^u - \varphi \text{ if } \varphi \leq \varphi^u \\ \pi_N^d \text{ if } \varphi > \varphi^u \end{array} \right\} \text{ and } \pi(\text{NE}, \text{P}) = \left\{ \begin{array}{l} \pi^d - \varphi \text{ if } \varphi \leq \varphi^d \\ \pi_N^d \text{ if } \varphi > \varphi^d \end{array} \right\} \quad (7)$$

Note that $\varphi^d - \varphi^u = \pi^d - \pi^u \geq 0$: i.e., serving the Southern market is less attractive to the firm under IE since doing so requires it to lower price in the larger, more lucrative Northern market. We have:

Lemma 2. *In the absence of imitation, the firm is more likely to export under NE: $\varphi^d > \varphi^u$.*

Now the North's optimal policy in the benchmark case can be derived. Given that the South protects IPR, Northern welfare under IE and NE is given by

$$w_N(\text{IE}, \text{P}) = \left\{ \begin{array}{l} w_N^u \text{ if } \varphi \leq \varphi^u \\ w_N^a \text{ if } \varphi > \varphi^u \end{array} \right\} \text{ and } w_N(\text{NE}, \text{P}) = \left\{ \begin{array}{l} w_N^d \text{ if } \varphi \leq \varphi^d \\ w_N^a \text{ if } \varphi > \varphi^d \end{array} \right\}$$

where $w_N^u = cs_N^u + \pi^u - \varphi$; $w_N^a = cs_N^d + \pi_N^d$; and $w_N^d = cs_N^d + \pi^d - \varphi$.

Direct calculations (contained in the appendix) show that $w_N^u \geq w_N^d$ and $w_N^d \geq w_N^a$ with the inequality binding for $\varphi < \varphi^d$. These inequalities imply the following: for $\varphi \in [0, \varphi^u]$ we have $w_N(\text{IE}, \text{P}) \geq w_N(\text{NE}, \text{P})$; for $\varphi \in (\varphi^u, \varphi^d]$ we have $w_N(\text{IE}, \text{P}) \leq w_N(\text{NE}, \text{P})$; and for $\varphi > \varphi^d$ we have $w_N(\text{IE}, \text{P}) = w_N(\text{NE}, \text{P}) = w_N^a$. Our first major result can now be stated:

Proposition 1. *In the benchmark case of no imitation, for all $\varphi \in [0, \varphi^d]$, the optimal exhaustion policy of the North is such that its firm necessarily exports to the South. More specifically, the North's optimal policy varies with the fixed cost of exporting in the following manner:*

Exporting Cost	Optimal Policy
(i) $\varphi \in [0, \varphi^u]$	IE
(ii) $\varphi \in (\varphi^u, \varphi^d]$	NE
(iii) $\varphi > \varphi^d$	IE or NE

Part (i) of Proposition 1 informs us that when the North can implement IE without compromising its firm's incentive to export, it chooses to do so. However, part (ii) says that if the firm exports only when it can earn its optimal discriminatory profit, the North ends up implementing NE. Thus, an outcome where the firm does not sell in the Southern market is *not* in the interest of the North. It is worth emphasizing that under NE, the firm's incentive to export is perfectly aligned with Northern government's preferences: when there is no link between Northern and Southern prices, exporting increases Northern welfare iff it increases the firm's total profit. However, under IE, the firm's incentive to export is *weaker* than that of the welfare-maximizing Northern government since exporting lowers the firm's Northern profit by forcing it to charge a common price in both markets. From the viewpoint of aggregate Northern welfare, the benefit of this price reduction to local consumers is not taken into account by the firm when it is choosing whether or not to export.

Even though Northern policy is such that its firm always exports, it does not mean that Southern welfare is unaffected by the North's policy. In fact, conditional on the firm exporting, there is a direct clash between the preferences of the two regions: market coverage as well as welfare in the South are lower under uniform pricing relative to discrimination whereas the opposite is true in the North due to the fact that $p_S^d < p^u < p_N^d$. Thus, conditional on the firm exporting, we have $w_S(\text{NE,P}) \geq w_S(\text{IE,P})$.

We now consider the scenario where the South does not protect intellectual property.

4 Effects of Southern imitation

As noted before, imitation in the South results in the emergence of a competitive industry that produces a lower quality version of the Northern good. By assumption, the enforcement of IPR in the North prevents the imitated good from being sold there so that competition occurs only in the South. Let the quality level of Southern imitation be given by q_S where $q_S \leq q$ and let its marginal cost of production equal zero. Define $\gamma = q/q_S \geq 1$ as the North South quality gap.

Competition within the Southern industry ensures that the imitated good is sold at marginal cost (normalized to zero). As is well known, when both qualities are available for purchase at prices p (high quality) and 0 (low quality), Southern consumers can be partitioned into two groups: those in the range $[0, \theta_S)$ buy the low quality whereas those in $[\theta_S, 1]$ buy the high quality where $\theta_S = \frac{p}{q_S(\gamma-1)}$.

As before, Northern exhaustion policy determines the pricing behavior of the firm.

Under IE, the firm must charge the same price in both markets (if it serves both of them) and taking the price of the low quality imitation as zero it solves:

$$\underset{p}{Max} \pi(0, p) = \frac{\eta}{\mu} p \left(\mu - \frac{p}{q} \right) + p \left(1 - \frac{p - 0}{q_S(\gamma - 1)} \right)$$

which gives the optimal uniform price post imitation and the associated profit

$$p^{ui} = \frac{q\mu(\gamma - 1)(\eta + 1)}{2(\eta(\gamma - 1) + \gamma\mu)} \text{ and } \pi^{ui} = \frac{\eta}{\mu} p^{ui} \left(\mu - \frac{p^{ui}}{q} \right) + p^{ui} \left(1 - \frac{p^{ui}}{q_S(\gamma - 1)} \right)$$

As is obvious, we have $p^{ui} < p^u$ and $\pi^{ui} < \pi^u$ – i.e. competition from Southern imitation lowers the firm's optimal uniform price and reduces its global profit.

Consider now the firm's export decision under imitation. If the firm does not export to the South, it earns optimal monopoly profit π_N^d in the North since the imitated good cannot be sold in the North. Under IE, the firm does not export iff

$$\pi_N^d > \pi^{ui} - \varphi \Leftrightarrow \varphi > \varphi^{ui} = \frac{q\mu}{4} \frac{[(2\eta + 1)(\gamma - 1) - \gamma\eta\mu]}{\eta(\gamma - 1) + \gamma\mu}$$

If Northern policy is NE, the firm's optimal Southern price equals:

$$p_S^{di} = \frac{q_S(\gamma - 1)}{2}$$

which implies that under the policy regime (NE,N) the threshold level of fixed cost φ^{di} is given by:

$$\varphi^{di} = \pi_S^{di} = \frac{q_S(\gamma - 1)}{4}$$

We thus have:

$$\pi(\text{IE}, \text{N}) = \left\{ \begin{array}{l} \pi^{ui} - \varphi \text{ if } \varphi \leq \varphi^{ui} \\ \pi_N^d \text{ if } \varphi > \varphi^{ui} \end{array} \right\} \text{ and } \pi(\text{NE}, \text{N}) = \left\{ \begin{array}{l} \pi_N^d + \pi_S^{di} - \varphi \text{ if } \varphi \leq \varphi^{di} \\ \pi_N^d \text{ if } \varphi > \varphi^{di} \end{array} \right\}$$

The firm's incentive to export is summarized in the following lemma:

Lemma 3. *The following hold with respect to the firm's incentive to export: (i) $\varphi^{ui} < \max\{\varphi^u, \varphi^{di}\} < \varphi^d$; (ii) $\varphi^{di} \leq \varphi^u$ iff $\gamma \leq \gamma^f$ where $\frac{\partial \gamma^f}{\partial \mu} < 0$ and $\frac{\partial \gamma^f}{\partial \eta} < 0$; and (iii) $\varphi^{di} - \varphi^{ui} > \varphi^d - \varphi^u$.*

Part (i) of Lemma 3 ranks the firm's incentive to export under the different policy configurations and highlights some crucial mechanisms of the model. It informs us that the Southern market is most attractive to the firm when the North chooses NE and the South forbids imitation whereas it's the least attractive when the policies of the two regions are reversed. All else equal, the firm's incentive to export is stronger when the

North implements NE.¹¹ Similarly, the firm is more likely to export when the South forbids imitation.

Available evidence indicates that the mechanisms captured by Lemma 3 are very much empirically relevant. Consider first the impact of exhaustion policies on the decision of Northern firms to sell in the South. In a recent paper, Goldberg (2010) provides a detailed discussion of a variety of empirical studies, all of which find that the inability to price discriminate internationally either causes firms in the global pharmaceutical industry to drop developing country markets altogether or to introduce new products into such markets with significant delay (i.e. much after their initial launch in developed country markets).¹² For example, she notes that many antibiotic drugs were not introduced in India since foreign firms were concerned about the international repercussions of charging prices in India that were much lower than their prices in Europe and Canada. Of course, prior to the TRIPS induced patent reforms in India, high prices could not be sustained in India precisely because of competition from the local industry (that came into existence due to inadequate patent protection) and due to demand conditions in India viz-a-viz developed country markets, two factors that are at heart of our model. Goldberg (2010) also notes that prior to the implementation of TRIPS, the retail coverage of foreign firms in the Indian pharmaceutical industry tended to be quite low because of their thin marketing and distribution networks, a situation that reflects the relatively weak incentives that foreign firms have for establishing their products in markets with inadequate IPR protection.

Regarding the effect of imitation on exports, it is now a well established fact in the literature that IPR are ‘trade-related’ and that the lack of IPR protection can distort trade. Maskus and Penubarti (1995) showed that weak IPR protection in large developing countries was a significant barrier for manufacturing exports of OECD countries. Furthermore, they found that the pharmaceutical industry was particularly sensitive to

¹¹In this regard, note that any Northern policy that prevents the local firm from being able to price discriminate internationally would deter exporting on its part. In addition to exhaustion policies, the practice of *global reference pricing* by industrialized countries – under which the price a pharmaceutical company is allowed to charge in a particular market is determined, in part, on the basis of prices that it charges in other parts of the world – would also work very similarly to an open exhaustion regime.

¹²Lanjouw (2005) studied drug launches in 68 countries between 1982 and 2002 and found that firms usually launch new drugs in developed countries and that launch delay increasing with a decline in per capita income. As Goldberg (2010) notes, her findings are consistent with the argument that the presence of price regulations and global reference pricing in the industrialized world contribute to launch delay in developing countries. Danzon and Epstein (2008) found similar effects in their study of drug launches within the EU: their results show that the likelihood of a drug being launched in a low-price EU country decreases with the risk of spillover to higher price EU countries through global reference pricing.

the degree of patent protection in developing countries.¹³ They also found that trade in goods that were difficult to imitate – such as machinery – was less sensitive to variations in IPR protection across countries. In the context of our model, this implies that if the North-South technology gap is large, the effect of imitation on the Northern firm’s export decision is weaker.

More recently, Ivus (2010) has shown that the TRIPS induced increase in IPR protection in 18 developing countries increased the annual value of developed country exports by about \$25 million, an 8.6% increase in the imports of patent sensitive goods by developing countries in her sample. In a follow up paper, Ivus (2011) further investigates the effects of stronger IPR protection using highly detailed data (at the 10-digit Harmonized System level) on US exports to 64 developing countries. The data used allows her to assess the effects of stronger IPR protection in developing countries on quantities, prices, and the variety of U.S. exports. She finds that TRIPS induced changes in the IPR regimes of developing countries increased the annual value of U.S. exports in industries that rely heavily on patent protection (such as pharmaceuticals) by roughly 8% and that U.S. exports to a typical developing country increased by \$317 million (1990 US dollars). Equally important are her findings that about 75% of the increase in U.S. exports reflected an increase in product variety, something that is consistent with our result that stronger IPR protection can induce the firm to export to the South thereby introducing a high quality good to the local market.¹⁴ Finally, she also finds that IPR strengthening increased unit prices, a result that is also in line with our argument that imitation lowers prices by creating competition.

Part (ii) of Lemma 3 says that starting from the firm’s most preferred policy regime (NE,P), whether a reversal in Northern or Southern policy lowers its export incentive more depends upon the magnitude of the North-South quality gap: when this gap is small (i.e. $\gamma \leq \gamma^f$) the removal of IPR protection in the South hurts the firm’s export incentive more than a reversal in the exhaustion policy of the North. The quality gap threshold

¹³The results of Maskus and Penubarti (1995) were updated and confirmed by Smith (1999) using more disaggregated data for US manufacturing exports.

¹⁴Of course, exporting is not the only way in which firms introduce their products in developing countries. Foreign direct investment (FDI) is also a commonly used strategy for entering foreign markets. In this sense, exporting in our model should be viewed as a general proxy for the various modes via which the firm can sell to Southern consumers. Existing empirical evidence indicates that FDI responds positively to IPR protection in developing countries. For example, Branstetter, Fisman, Foley, and Saggi (2010) investigate the impact of IPR reform on multinational production by analyzing the responses of U.S. multinationals to IPR reforms by sixteen countries during the 1980s and 1990s. They find that U.S. based multinationals expanded their activities in reforming countries. Similar results were found by Mansfield (1994), Lee and Mansfield (1996), Nunnenkamp and Spatz (2004), and Javorcik (2004).

γ^f is decreasing in the size of Northern market (η) and the degree to which Northern tastes are skewed in favor of quality (μ) because the firm's incentive to export under uniform pricing relative to that under price discrimination (post imitation) decreases as the two markets become more asymmetric.

Part (iii) implies that *Southern imitation makes NE more attractive to the North*. Since imitation cuts into the firms export profits by creating competition in the South, it reduces the range of fixed costs over which the firm chooses to export.

The North's optimal policy under imitation can now be stated (proof is in the appendix):

Proposition 2. *Even when the South does not protect intellectual property, the optimal exhaustion policy of the North is such that its firm necessarily exports to the South. We have:*

<i>Exporting Cost</i>	<i>Optimal Policy</i>
(i) $\varphi \in [0, \varphi^{ui}]$	IE
(ii) $\varphi \in (\varphi^{ui}, \varphi^{di}]$	NE
(iii) $\varphi > \varphi^{di}$	IE or NE

The interpretation of Proposition 2 is analogous to that of Proposition 1. If the fixed cost of exporting is low, the North is able to keep its market open to parallel imports without compromising its firm's incentive to export; otherwise, it has to shut down parallel imports to induce the firm to export. From the North's viewpoint, while uniform pricing (which can arise only under IE) is attractive, it is not more desirable than autarky which is what obtains if its firm chooses to not export to the South in order to safeguard its profit at home. A comparison of Propositions 1 and 2 provides two insights. First, since $\varphi^{di} < \varphi^d$, Southern imitation shrinks the parameter range over which the North's exhaustion policy affects the firm's incentive to export: without imitation, the firm does not export when $\varphi > \varphi^d$ whereas with imitation it makes the same choice whenever $\varphi > \varphi^{di}$. Second, if Northern policy affects the firm's export decision both with and without imitation (i.e. $\varphi \leq \varphi^{di}$), the North is more prone to choosing NE when the South allows imitation relative to when it does not: over $(\varphi^{ui}, \varphi^u]$ imitation causes the North to switch its policy from IE to NE. Intuitively, to sustain the firm's export incentive, the reduction in market power (and profits) suffered by the firm because of imitation needs to be offset by providing it the ability to price discriminate across markets.

Proposition 2 suggests that due to the TRIPS induced enforcement of IPR in devel-

oping countries, one should expect developed countries to be less opposed to parallel imports.¹⁵ While widespread changes in exhaustion regimes among industrialized countries have not been observed since the ratification of TRIPS (at least not yet), it is worth noting that the EU's policy of community exhaustion – under which parallel imports flow freely within the EU but are forbidden from outside – is consistent with the basic message of Proposition 2 in the sense that IPR protection within the EU is stronger than developing countries from where parallel imports into the EU are likely to occur (if permitted). Similarly, at several points in time the US Congress has come close to opening its markets to pharmaceutical imports from Canada, a country where IPR protection is strong. By contrast, there is little support among US policy-makers for opening up the market to parallel imports from Mexico and other developing countries where IPR protection is much weaker. Our model suggests that the calculus underlying this policy stance of the EU and the US reflects the export incentives of their respective pharmaceutical industries.

5 South's decision: to protect or not?

Propositions 1 and 2 describe the best response of the North to alternative policy choices of the South. We now consider the South's policy decision regarding protection of intellectual property. First note that, regardless of Northern policy, if the firm does not export, the South's payoff from imitation equals the consumer surplus obtained when the high quality is unavailable locally and the low quality is sold at zero price:

$$w_S^{ai} = cs_S^{ai} = \int_0^1 (\theta q_S - 0) d\theta = \frac{q_S}{2}$$

The careful reader will note that the South is assumed to have the ability to imperfectly imitate the firm's technology even when it does not export to the South.¹⁶ This formulation is based on the idea that North-South technology transfer occurs through a variety of channels (exogenous to the model) and the only decision the South has to make is whether to allow imitation to occur or not; what is not at stake is the South's ability to imitate. Furthermore, this feature of the model makes it impossible for the firm to prevent imitation and helps focus the analysis on policy issues by resting the

¹⁵I thank an anonymous referee for pointing out that the recent opening up of its market to parallel imports in digital products by Australia is consistent with this result.

¹⁶I thank an anonymous referee for drawing attention to this aspect of the model.

entire control in the hands of the Southern government via its decision regarding the enforcement of IPR.¹⁷

Suppose the North chooses NE. The South's optimal IPR policy depends on the firm's export decision. If $\varphi \leq \varphi^{di}$, the firm exports regardless of the South's IPR policy. In such a situation, it is optimal for the South to not protect IPR. To see this, first note that if imitation occurs, Southern welfare equals the consumer surplus obtained when the high quality good is sold at $p_S^{di} = \frac{q_S(\gamma-1)}{2}$ and the low quality good at zero price. At these prices, consumers in the range $(0, \frac{p_S^{di}}{q_S(\gamma-1)}) = (0, \frac{1}{2}]$ buy the low quality good whereas those in the range $(\frac{1}{2}, 1]$ buy the high quality good. Therefore, we have:

$$w_S^{di} = cs_S^{di} = \int_0^{1/2} (\theta q_S - 0) d\theta + \int_{1/2}^1 (q\theta - p_S^{di}) d\theta = \frac{q_S(\gamma+3)}{8}$$

Note that w_S^{di} increases in γ : i.e. the larger the North-South quality gap, the stronger the Southern desire to permit imitation to help lower the price of the high quality good.

If the South forbids imitation, its welfare equals

$$w_S^d = cs_S^d = \int_{1/2}^1 (q\theta - p_S^d) d\theta = \frac{q}{8} = \frac{\gamma q_S}{8}$$

Clearly, $w_S^{di} > w_S^d$: if the firm necessarily exports to the South, local imitation is desirable for the South because it increases competition as well as variety (by making a lower quality version of the Northern good available to consumers). The increase in competition brings down the price of the high quality good from p_S^d to p_S^{di} and the increase in variety ensures that those consumers that do not wish to purchase the high quality good have access to the low quality imitation.

Now consider the range $(\varphi^{di}, \varphi^d]$. Over this range of fixed costs, the firm chooses to export to the South only if the South protects IPR. Thus, *now the South faces a trade-off between price and quality*: if it permits imitation, the low quality is available to local consumers at zero price where if it forbids it, the high quality is available at the (high) price p_S^d . Southern welfare in the absence of IPR protection equals $w_S^{ai} = \frac{q_S}{2}$ whereas that under IPR protection equals $w_S^d = \frac{\gamma q_S}{8}$. Thus, over $[\varphi^{di}, \varphi^d]$, it is optimal for the South to protect IPR iff $\frac{\gamma q_S}{8} \geq \frac{q_S}{2}$ or $\gamma \geq \gamma^d = 4$. Intuitively, when the North-South

¹⁷An alternative model would be one where exporting affects/increases the likelihood of imitation. Such a model should yield conclusions that are qualitatively similar to ours except that the firm would be more reluctant to export.

quality gap is large (i.e. $\gamma > \gamma^d$), it is optimal for the South to protect IPR in order to ensure that the high quality good is sold in its market. When such is not the case (i.e. $\gamma \leq \gamma^d$), the South is better off eschewing consumption of the high quality good and permitting imitation. An alternative way of understanding this result is that for the South to prefer a high quality (foreign) monopolist to a low quality competitive industry that sells the good at cost, the quality advantage of the monopolist over the competitive industry has to be sufficiently large.¹⁸

Finally, let $\varphi > \varphi^d$. Over this parameter range, the firm does not export to the South regardless of whether the South protects IPR or not. Given that, it is optimal for the South to not protect IPR in order to ensure that local consumers at least have access to the low quality which ensures a welfare level of w_S^{ai} .

We summarize this discussion below:

Proposition 3. *Suppose the North implements NE of IPR. Then, it is optimal for the South to protect intellectual property if and only if (i) such protection is necessary for inducing the firm to export to the South (i.e. $\varphi \in (\varphi^{di}, \varphi^d]$) and (ii) the North-South quality gap is sufficiently high (i.e. $\gamma > \gamma^d$).*

Following the above discussion, it is clear that under IE, if $\varphi \leq \varphi^{ui}$ or $\varphi > \varphi^u$ it is optimal for the South to not protect IPR – in the former case, the firm sells in the South even when imitation occurs whereas in the latter case, it does not even in the absence of imitation. Thus, for these two cases, the South is better off permitting imitation: when $\varphi \leq \varphi^{ui}$ imitation increases *competition as well as variety* whereas when $\varphi > \varphi^u$ imitation ensures that at least a low quality version of Northern good is available locally.

It remains to be verified under what conditions, if any, it is optimal for the South to protect IPR when $\varphi \in (\varphi^{ui}, \varphi^u]$. Over this range, protecting IPR is *necessary* to induce the firm to sell in the South. If the South protects IPR its welfare equals

$$w_S^u = cs_S^u = \int_{p^u/q}^1 (q\theta - p^u)d\theta = \frac{(q - p^u)^2}{2q}$$

where p^u is given in equation (4). If the South does not protect IPR, its welfare equals $w_S^{ai} = q_S/2$. Thus, over $\varphi \in (\varphi^{ui}, \varphi^u]$, protecting IPR is optimal for the South iff

$$w_S^u > w_S^{ai} \Leftrightarrow \gamma > \gamma^u = \frac{4(\eta + \mu)^2}{(2\eta + \mu - \eta\mu)^2}$$

¹⁸If the monopolist were domestic as opposed to foreign, the required quality threshold would be significantly lower (i.e. $\frac{3q}{8} \geq \frac{q_S}{2} \Leftrightarrow \gamma \geq 4/3$) since its profit would be part of domestic surplus.

i.e. over this range of fixed costs, IPR protection is optimal for the South only if the North-South quality gap lies above the minimum threshold γ^u . The minimum threshold γ^u is increasing in both η and μ : as the two markets become more asymmetric, Southern willingness to prevent local imitation declines because an increase in the number of Northern consumers (η) or in their willingness to pay for higher quality (μ) leads to a higher price of the high quality good in the South. In other words, the larger the degree of market asymmetry, the larger must be the North-South quality gap in order to compensate the South for the welfare loss it suffers under the policy regime (IE,P) relative to (IE,N) with the firm choosing not to export. By contrast, prices in the two markets under NE are independent and the North-South quality gap threshold γ^d that determines the Southern willingness to prevent imitation does not depend on parameters that capture demand asymmetry between the two regions (i.e. μ and η).

We can now state a result analogous to Proposition 3:

Proposition 4. *(i) If the North implements IE it is optimal for the South to protect intellectual property iff (i) such enforcement is necessary to induce the firm to serve the Southern market (i.e. $\varphi \in (\varphi^{ui}, \varphi^u]$) and (ii) the North-South quality gap exceeds the threshold γ^u . (ii) Furthermore, the minimum quality gap required for the South to voluntarily protect intellectual property is higher under IE relative to NE (i.e. $\gamma^u \geq \gamma^d$).*

The intuition for part (i) of Proposition 4 is clear – if the firm chooses to serve the South even when it is imitated or if the North-South quality gap is small, the South has no incentive to protect intellectual property. Part (ii) holds because Northern openness to parallel imports leads to a relatively higher price in the South that must be offset by a larger quality gap for Southern government to be willing to shut down local imitation.

Having described each region's best response to the policy choice of the other region, we are now ready to derive the equilibrium of the policy game and examine its welfare properties. Equilibrium outcomes depend upon whether or not the firm values protection from imitation more than the freedom to price discriminate internationally, i.e., whether or not $\gamma \leq \gamma^f \Leftrightarrow \varphi^{di} \leq \varphi^u$. Since exhaustion policies remain completely unconstrained by the WTO while IPR policies are subject to strict disciplines, it seems reasonable to deduce that during TRIPS negotiations, holders of IPR must have put more pressure (via their governments) on shutting down imitation than on implementing NE as a harmonized exhaustion policy of all WTO members. As a result, we take $\gamma \leq \gamma^f$ as the benchmark case and then briefly discuss the scenario where $\gamma > \gamma^f$.

6 Equilibrium and welfare when firm values IPR protection more

In what follows, assuming $\gamma \leq \gamma^f \Leftrightarrow \varphi^{di} \leq \varphi^u$ we first derive equilibrium policies, then compare them to first best policies, and finally draw out the implications of the TRIPS agreement.

6.1 Policy equilibrium and welfare

Putting together the best responses of the two regions summarized in Propositions 1-4 allows us to state:

Proposition 5. *Given that the firm values protection from imitation more than the freedom to price discriminate internationally (i.e. $\varphi^{di} \leq \varphi^u \Leftrightarrow \gamma \leq \gamma^f$), equilibrium policies of the two regions are as follows:¹⁹*

<i>Exporting Cost</i>	<i>Equilibrium policies</i>
(i) $\varphi \in [0, \varphi^{ui}]$	(IE,N)
(ii) $\varphi \in (\varphi^{ui}, \varphi^{di}]$	(NE,N)
(iii) $\varphi \in (\varphi^{di}, \varphi^u]$	(IE,P) if $\gamma > \gamma^u$ and (NE,N) or (IE,N) otherwise
(iv) $\varphi \in (\varphi^u, \varphi^d]$	(NE,P) if $\gamma > \gamma^d$ and (NE,N) or (IE,N) otherwise

Part (i) of Proposition 5 says that if the fixed costs of exporting are so small that the firm exports to the South regardless of the policies implemented by the two regions, then each region ends up implementing its preferred policy: the North chooses IE and the South does not protect intellectual property. In this policy equilibrium, the high quality Northern good is sold in both markets at a uniform price while the low quality Southern imitation is sold locally at a price equal to its marginal cost. Interestingly, since $p^{ui} < p^u$ Northern consumers benefit from Southern imitation even though the imitated good is *not* sold in the North: Northern openness to parallel imports ensures that the competition created by imitation in the Southern market is indirectly passed on to the North. Thus, even though the imitated good is not sold in the North, under IE Southern imitation generates a *positive price externality* for Northern consumers just as it imposes a *negative rent externality* on the firm.

From the firm's viewpoint, NE on the North's part and a prohibition of imitation on the South's part are *substitutes* in the sense that both policies give it greater room for exercising its monopoly power. However, the costs of implementing these two types

¹⁹If $\varphi^d \leq \varphi$, South does not protect intellectual property while North's policy is irrelevant since its firm chooses not to export.

of policies fall on different regions: conditional on the firm exporting, implementing NE of IPR imposes a welfare cost on the North while protecting intellectual property imposes a welfare cost on the South except when local imitation delivers a good that is much lower in quality than the Northern good. Except for the parameters referred to in part (i), the two regions find themselves in a policy stand-off: each region chooses its policy recognizing whether or not the other region is willing to bear the welfare cost of inducing the firm's entry into the Southern market. For example, over $(\varphi^{ui}, \varphi^{di}]$ recognizing that the North has an incentive to implement NE to induce the firm to export even if imitation occurs, the South chooses to not protect intellectual property. Over this range, not protecting IPR results in more competition as well as greater variety in the Southern market because two quality levels are sold in the South as opposed to one. The North's equilibrium policy of NE recognizes that since the South has no incentive to protect intellectual property, it must allow the firm to price discriminate internationally to induce it to export.

If $\varphi \in (\varphi^{di}, \varphi^u]$ and $\gamma > \gamma^u$, the South chooses to not permit local imitation since the quality gap between the imitation and Northern original is large and the North ends up choosing IE knowing that the Southern protection is sufficient to induce the firm to export. However, when the North-South quality gap lies below γ^u the South has no incentive to offer IPR protection and the lack of such protection eliminates the firm's incentive to export, making Northern exhaustion policy irrelevant. Over the range $(\varphi^u, \varphi^d]$, Northern exhaustion policy matters only if the South protects intellectual property since the firm does not export if imitation occurs (regardless of the North's exhaustion policy). The Southern decision, in turn, is determined once again by the North-South quality gap. When this gap is not too large (i.e. $\gamma \leq \gamma^d$), the South permits imitation and the firm refrains from exporting rendering Northern policy irrelevant. However, when $\gamma > \gamma^d$, the South protects intellectual property and it is optimal for the North to implement NE to ensure that its firm exports.

6.2 Global welfare

In this section, we discuss global welfare and provide a comparison of equilibrium outcomes with the first-best. Next, we draw out the implications of requiring the South to prohibit imitation. The goal of this exercise is to shed light on the effects of a strengthening of IPR protection in developing countries that was mandated by the WTO's TRIPS agreement.

Global welfare is defined as the sum of each country's welfare:

$$ww^r = w_N^r + w_S^r \text{ where } r = a, ai, d, di, u, \text{ or } ui.$$

We begin with two preliminary but important observations regarding welfare. First, since imitation creates competition in the South while also increasing variety, *holding constant the firm's export decision*, imitation necessarily increases global welfare: $ww^{ri} > ww^r$ for $r = a, d, \text{ or } u$. Thus, the only scenario where imitation can lower global welfare is when it causes the Northern firm to not sell in the South. Second, as was noted earlier, in the absence of imitation uniform pricing is preferable to price discrimination since aggregate output under both regimes is the same but the latter regime leads to unexploited price differentials across countries. Furthermore, both regimes necessarily dominate autarky under which the Southern market goes totally unserved. Therefore we have: $ww^u > ww^d > ww^a$. For analogous reasons, this welfare ranking continues to hold under imitation: $ww^{ui} > ww^{di} > ww^{ai}$.

Given that the firm exports, which outcome is preferable for the world: uniform pricing without imitation or price discrimination with imitation? We can show the following:

Proposition 6. *From a global welfare perspective, price discrimination coupled with imitation is preferable to uniform pricing in the absence of imitation iff the North-South quality gap falls below the threshold γ^f : $ww^{di} \geq ww^u$ iff $\gamma \leq \gamma^f$.*²⁰

A secondary question is whether price discrimination in the absence of imitation is preferable than autarky coupled with imitation. In this regard we can show that $ww^d \geq ww^{ai}$ iff $\gamma \geq \gamma^w$ where $\gamma^w = 4/3$. In other words, so long as the Northern good is even mildly superior in quality than its Southern imitation, price discrimination is preferable from a social welfare perspective. For the remainder of the paper, we assume that this is the case (i.e. $\gamma \geq \gamma^w$). This assumption just says that the North-South technology gap is not so small that autarky (coupled with imitation) is preferable to trade under price discrimination.

We are now in a position to compare equilibrium policy outcomes reported in Proposition 5 (which assumes $\varphi^{di} \leq \varphi^u \Leftrightarrow \gamma \leq \gamma^f$) with the first-best outcome reported in

²⁰Together with Lemma 3, this result implies that the firm values protection from imitation more than the freedom to price discriminate precisely when world welfare considerations argue in the opposite direction, i.e., when $\gamma \leq \gamma^f$. Note also that if total output under discrimination were to exceed that under uniform pricing (as it could if θ were not distributed uniformly) then imitation would make discrimination even more desirable by increasing output as well as variety in the South while having no effect on Northern consumers.

Proposition 6.

Figure 1 illustrates equilibrium policies when $\gamma \leq \gamma^f$.

– Figure 1 here –

When fixed costs of exporting are so small (i.e. $\varphi \leq \varphi^{ui}$) that the firm exports even under its least preferred policy environment, i.e., (IE,P), the equilibrium policy outcome is (IE,P) and it is first-best. As noted before, in such a policy equilibrium, the benefits of imitation induced competition also accrue to Northern consumers due to the North's openness to parallel imports. Similarly, the policy equilibrium (NE,N) is efficient over $(\varphi^{ui}, \varphi^{di}]$ since $\gamma \leq \gamma^f$: since the firm exports under both (NE,N) and (IE,P) over this range, from Proposition 6 we know that it is better to induce exporting by allowing price discrimination as opposed to forbidding imitation because the competition induced by imitation is intense when the quality gap is below γ^f .

Once fixed costs increase further, the harmony between equilibrium policies and global welfare is no longer guaranteed. Consider the range $(\varphi^{di}, \varphi^u]$. Figure 1 shows that over $(\varphi^{di}, \varphi^u]$, the policy pair (IE,P) is globally optimal but it emerges as an equilibrium iff $\gamma \geq \gamma^u$; when $\gamma < \gamma^u$, the lack of Southern IPR protection ensures that the firm does not export so that Northern exhaustion policy is inconsequential and both (NE,N) and (IE,N) are equilibria. Finally, over the range $(\varphi^u, \varphi^d]$ the policy pair (NE,P) is socially optimal but it emerges as an equilibrium only if $\gamma \geq \gamma^d$; when $\gamma < \gamma^d$ the South chooses not to protect IPR and the firm refrains from exporting, making the North indifferent between its policy options.

It is worth noting from Figure 1 that if the South could reduce the fixed cost φ through some policy actions, it has an incentive to do so.²¹ First, all else equal, a lower fixed cost is more likely to induce the firm to export. Second, as Figure 1 shows, if the fixed cost is low the South can get away with no IPR enforcement while still ensuring that the Northern firm sells in its market. However, a slight subtlety is worth noting: the South would not want to lower the fixed cost so much so that it falls below φ^{ui} . This is because when $\varphi \leq \varphi^{ui}$ the equilibrium is (IE,N) whereas over the range $(\varphi^{ui}, \varphi^{di}]$ it is (NE,N) which is not only the South's most preferred policy combination but also the globally efficient outcome over this parameter range.

²¹This issue is interesting since part of the fixed cost of exporting might reflect policy restrictions, bureaucratic hurdles, and red tape etc. As a result, a reduction in φ could partly be thought of as economic reforms in the South that improve market access for foreign firms.

We can now use the model to evaluate the effects of the TRIPS agreement which required developing country members of the WTO to strengthen their protection of intellectual property but imposed no restrictions on national policies pertaining to the exhaustion of IPR.

6.3 Effects of TRIPS

Suppose the South no longer has the option of permitting imitation while the North is free to pick its preferred exhaustion regime. From Proposition 5 we know that if the South protects intellectual property, the North chooses IE iff $\varphi \leq \varphi^u$; otherwise it opts for NE. Thus, in a TRIPS constrained world, the equilibrium policy vector is (IE,P) when $\varphi \leq \varphi^u$ with uniform pricing as the market outcome and (NE,P) otherwise, with price discrimination as the market outcome.

The effects of shutting down Southern imitation when $\gamma \leq \gamma^f$ are as follows.

Suppose $\varphi > \varphi^d$ so that the firm does not export to the South under any policy configuration. If so, enforcement of Northern IPR in the South confers a pure welfare loss on the South while having no effect on the Northern economy.²² This is because Southern imitation ensures that at least a lower quality version of the Northern good is locally available and since the fixed costs of exporting are so large that the firm does not export to the South even if imitation is prohibited, shutting down imitation has no effect on its global profit.

Now suppose $\varphi \in (\varphi^u, \varphi^d]$. Over this range, whether or not a prohibition on Southern imitation has any consequences depends upon the North-South quality gap. We know that when $\gamma > \gamma^d$, the South finds it optimal to shut down imitation voluntarily in order to ensure that the high quality Northern good is sold locally and the North chooses NE. Thus, the policy outcome under TRIPS is the same as that without it implying that TRIPS has no effects on the world economy when $\gamma > \gamma^d$. However, when $\gamma \leq \gamma^d$, in the absence of TRIPS, the South permits imitation while the North is indifferent between its policy options since its firm does not export. Thus, when $\gamma \leq \gamma^d$, by forcing the South to prohibit imitation, TRIPS makes NE the preferred policy for the North since its firm exports under this policy but not under IE. These policy changes reduce Southern welfare because the Northern good is not sufficiently superior in quality relative to its

²²One could alternatively interpret this result as saying that if the Southern market is so small that the Northern firm does not sell there even if its intellectual property is protected by the South then it is welfare reducing to offer such protection to the firm. This result is in line with the argument made by TRIPS opponents that enforcing IPR protection in poor developing countries reduces their welfare without generating any compensating benefits.

Southern imitation to justify its higher price; have no effect on Northern consumers since the price remains at p_N^d in the North; increase the firm's profit; and also increase global welfare because the rent externality generated by the Southern decision to permit imitation (in the absence of TRIPS) is eliminated. Thus, when $\varphi \in (\varphi^u, \varphi^d]$, TRIPS enforcement (weakly) increases global welfare: when $\gamma < \gamma^d$ it has no effect whereas when $\gamma > \gamma^d$ it strictly increases welfare. TRIPS is welfare enhancing over this range since prohibiting imitation induces the firm to export and the North-South quality gap is not high enough for the South to want to do so voluntarily.

Consider now the effect on Northern consumers of TRIPS over $\varphi \in (\varphi^{di}, \varphi^u]$. As Figure 1 notes, over this range TRIPS enforcement has no effect on world welfare when $\gamma > \gamma^u$ since the policy equilibrium remains unchanged at (IE,P). However, when $\gamma \leq \gamma^u$, firm does not export in the absence of TRIPS so that both (IE,N) to (NE,N) are equilibria. In such a situation, TRIPS increases world welfare by delivering the globally efficient outcome (IE,P). The South loses because TRIPS enforcement replaces the cheap low quality good by the expensive high quality good but the price-quality ratio is not favorable since the quality gap is small (i.e. $\gamma \leq \gamma^u$). But since the Southern decision to allow imitation imposes a rent externality on the North (which the South ignores), TRIPS enforcement (weakly) increases global welfare over $(\varphi^{di}, \varphi^u]$.

TRIPS enforcement causes the sharpest change in the global policy environment when $\varphi \in (\varphi^{ui}, \varphi^{di}]$: over this range, the policy equilibrium completely reverses due to TRIPS – it changes from (NE,N) to (IE,P). Recognizing that the TRIPS mandated change in Southern IPR policy (from N to P) is sufficient to sustain the firm's incentive to export, the North reverses its policy regarding the exhaustion of IPR from NE to IE. Southern welfare takes a sharp hit because of these policy changes: variety is reduced since the low quality imitated good is no longer sold and the price of the high quality good increases from p_S^{di} to p^u . The overall increase in the price of the high quality good (Δp^T) suffered by the South due to TRIPS enforcement can be broken down into two components (Δp_S^N and Δp_S^{IE}):

$$\Delta p^T = \Delta p_S^N + \Delta p_S^{IE} \text{ where } \Delta p_S^N = p_S^d - p_S^{di} \text{ and } \Delta p_S^{IE} = p^u - p_S^d$$

Holding Northern policy constant at NE, the first component (Δp_S^N) measures the price increase that results from the elimination of competition from Southern industry that is shut down due to the enforcement of TRIPS. The second component (Δp_S^{IE}) captures the price externality generated by the reversal in the North's policy from NE to IE holding

Southern policy constant at P: Northern openness to parallel imports induces the firm to raise its price in the South from p_S^d to p^u and the negative effect of this price increase on Southern consumers is ignored by the North.

When $\varphi \in (\varphi^{ui}, \varphi^{di}]$, the overall effect of the TRIPS induced policy reversal on the firm's profit can also be broken down into two components:

$$\Delta\pi^T \equiv \pi^u - \pi^{di} = \Delta\pi^N + \Delta\pi^{IE} \text{ where } \Delta\pi^N = \pi_S^d - \pi_S^{di} > 0 \text{ and } \Delta\pi^{IE} = \pi^u - \pi^d < 0$$

i.e. while shutting down imitation makes the firm better off, the reversal in the Northern policy makes it worse off since it loses the ability to price discriminate internationally. Since $\Delta\pi^T \geq 0$ iff $\gamma \leq \gamma^f$, the firm benefits from the TRIPS induced global policy reversal over the parameter range being considered. Further note that Northern consumer welfare is also strictly higher under (IE,P) relative to (NE,N) – indeed this is the primary reason as to why the North reverses its policy. Thus, the TRIPS induced policy reversal makes the North better off on both counts: it increases the firm's profits while also lowers price in the North. However, from Proposition 6 we know that, given that the firm exports, (NE,N) welfare dominates (IE,P) when $\gamma \leq \gamma^f$, TRIPS enforcement reduces aggregate global welfare when $\varphi \in (\varphi^{ui}, \varphi^{di}]$ even as it benefits the North.

Finally, consider the scenario where the fixed costs of exporting are so small that the firm exports regardless of the policy environment: i.e. $\varphi \leq \varphi^{ui}$. Here, TRIPS enforcement increases prices worldwide and therefore hurts consumers in both regions. The firm's aggregate profit increases while Southern welfare declines, as does global welfare since the mark-up of the firm increases globally.

The key conclusion regarding TRIPS can now be stated:

Proposition 7. *A prohibition on Southern imitation increases global welfare if and only if it is necessary for inducing the firm to export.*²³

The most important practical implication of this result is that for TRIPS enforcement to increase global welfare, it is imperative that Northern firms respond to such enforcement by selling more products in the South, i.e., the *extensive margin* of Northern exports to the South needs to increase due to TRIPS. This result fits quite well with the existing empirical literature on this issue: as was discussed in Section 4, this literature finds that Northern exports to the South generally do respond in a manner that is consistent with increased IPR enforcement in the South being welfare improving in the aggregate.

²³While the analysis in this section assumes $\gamma \leq \gamma^f$, we show below that this result holds even when $\gamma > \gamma^f$.

7 When firm values price discrimination more

When $\gamma \geq \gamma^f \Leftrightarrow \varphi^{di} \geq \varphi^u$, the equilibrium outcome is as follows:

Proposition 8. *Given that the firm values the freedom to price discriminate internationally more than protection from imitation (i.e. $\gamma > \gamma^f \Leftrightarrow \varphi^{di} > \varphi^u$), equilibrium policies of the two regions are as follows:*

<i>Exporting Cost</i>	<i>Equilibrium Policies</i>
(i) $\varphi \in [0, \varphi^{ui}]$	(IE,N)
(ii) $\varphi \in (\varphi^{ui}, \varphi^u]$	(IE,P) if $\gamma > \gamma^u$ and (NE,N) otherwise
(iii) $\varphi \in (\varphi^u, \varphi^{di}]$	(NE,N)
(iv) $\varphi \in (\varphi^{di}, \varphi^d]$	(NE,P) if $\gamma > \gamma^d$ and (IE,N) or (NE,N) otherwise

The interpretation of Proposition 6 is completely analogous to that of Proposition 5 and we skip a detailed discussion of this result to avoid redundancy.

Figure 2 illustrates Proposition 8 as well as the welfare effects of TRIPS for the case $\gamma > \gamma^f$.

– Figure 2 here –

As before, when $\varphi \leq \varphi^{ui}$, TRIPS induced protection of intellectual property lowers world welfare by altering the policy environment from (IE,N) to (IE,P). When $\varphi \in (\varphi^{ui}, \varphi^u]$, TRIPS enforcement causes a reversal in the global policy environment from (NE,N) to (IE,P) when $\gamma < \gamma^u$ whereas it has no effect when $\gamma > \gamma^u$. From Proposition 6 we know that that such a policy reversal increases world welfare when $\gamma > \gamma^f$. Over $(\varphi^u, \varphi^{di}]$, TRIPS lowers world welfare by changing the policy environment from (NE,N) to (IE,P) and raising mark-ups in the South. Finally, over $(\varphi^{di}, \varphi^d]$, TRIPS increases world welfare when $\gamma \leq \gamma^d$ because it induces the firm to export whereas for $\gamma > \gamma^d$ it has no effect on welfare since the policy outcome remains unchanged at (NE,P) – the South protects IPR anyway and the North retains its policy of NE to ensure that its firm exports to the South.

8 Discussion of model and robustness of results

In what follows, we discuss three important aspects of the model and its results. First, we ask how our results would change if parallel importers incurred fixed costs and discuss why it is reasonable to assume that they do not. Second, we provide an extension of

the model where Southern IPR enforcement is modeled as a continuous policy variable and show that our main results continue to hold under this more general formulation. Third, we provide some justification for the model's assumption that IPR are perfectly enforced in the North.

8.1 Costly parallel imports

The model assumes that parallel imports flow costlessly from the South to the North whenever prices in the two markets differ. This commonly used assumption obviously makes the analysis more tractable. In the real world, parallel imports are likely to be hampered by several types of frictions such as transportation costs and other costs of accessing foreign markets.²⁴ However, the assumptions of the model are reasonable in one important sense: while parallel imports are likely to be costly, they are unlikely to involve all of the costs that are incurred by firms when they export their product to foreign markets for the first time. In our model, the Northern firm must incur the fixed cost φ prior to being able to export to the South. This fixed cost should be interpreted to include all the expenditures that a firm has to incur prior to selling its product in a foreign market such as expenditures on establishing a retail presence, advertising, and other promotional efforts. By contrast, from the viewpoint of parallel traders, the local consumers in a firm's home market are likely to be well aware of its product. Indeed, in the model the firm's entry into its home market (i.e. the North) is assumed to have already occurred and any associated costs with that already incurred. Since the firm's product is well established in the Northern market, any fixed costs that parallel importers would need to incur prior to selling to local consumers are likely to be much smaller than the fixed cost of exporting incurred by the firm.²⁵

Nevertheless, it is useful to ask how our policy analysis is affected if parallel importers have to incur a fixed cost like the one incurred by the firm prior to exporting. The main implication of incorporating such a fixed cost is that when the North's policy is IE , parallel imports would flow to the North only if the North-South price differential is sufficiently high. In turn, this implies that there would be scenarios where the North would be indifferent between its policy choices: if the North-South price differential is small relative to the fixed cost of parallel importing, Northern exhaustion policy would

²⁴For example, parallel importers might need to obtain a license as is the case for parallel trade in pharmaceuticals in some European countries.

²⁵Of course, as was noted earlier, the margins available to parallel importers are likely to be smaller since these are derived from international price differentials as opposed to market power enjoyed by patent holders.

be inconsequential since there would be no incentive for parallel trading. This implies that the likelihood of a TRIPS induced policy reversal would be lower in the presence of such a fixed cost. The intuition becomes transparent if engaging in parallel importing becomes prohibitively costly: in such a situation, Northern exhaustion policy would be totally irrelevant and therefore unresponsive to Southern IPR protection. Furthermore, it is also clear that even if parallel imports were subject to only variable costs, the firm would have greater freedom to engage in international price discrimination and Northern exhaustion policy would be once again less potent and therefore less responsive to changes in Southern IPR protection.

8.2 A continuous formulation of Southern IPR protection

In the model, the Southern policy decision is a binary choice: to protect or not protect IPR. This assumption is made for convenience and because it adds a degree of symmetry to the model in the sense that the policy choice of each region is discrete in nature. A more general formulation of the South's policy decision would be to treat it as the degree of IPR enforcement that determines the probability with which local imitation is detected and shut down. Below, it is shown that the results of the basic model extend quite naturally to such a setting.

Consider the following game. In the first stage, North determines its exhaustion policy while the South chooses the degree of IPR enforcement that determines the probability (x) that local imitation is detected and shut down by local authorities. Next, knowing the degree of IPR enforcement x and the exhaustion policy of the North, the Northern firm decides whether to incur the fixed cost (φ) of exporting. The final stage involves pricing, trade, and consumption.

Suppose the North chooses NE and consider the firm's export decision. If it decides to export, its expected profit in the Southern market equals

$$\pi_S^d(x) = x\pi_S^d + (1-x)\pi_S^{di}$$

This implies that the firm chooses to export iff

$$\pi_S^d(x) - \varphi \geq 0 \Leftrightarrow \varphi \leq \varphi^d(x) = \pi_S^d(x)$$

Note that $\varphi^d(0) = \varphi^{di}$; $\varphi^d(1) = \varphi^d$; and $\frac{\partial \varphi^d(x)}{\partial x} = \pi_S^d > 0$. Thus, this formulation naturally extends the basic model to a setting where the South's IPR policy is a continuous choice variable.

Consider the South's optimal IPR policy given that the North chooses NE. First observe that when $\varphi \leq \varphi^d(0) = \varphi^{di}$, the firm exports to the South even when $x = 0$ (i.e. the South offers no IPR protection). This in turn makes it optimal for the South to set $x = 0$ when $\varphi \in (0, \varphi^{di}]$ since allowing imitation creates competition and expands consumer choice. Similarly, when $\varphi \geq \varphi^d(1) = \varphi^d$, the firm does not export even if the South offers complete IPR protection (i.e. sets $x = 1$). This implies that for $\varphi \geq \varphi^d$, it is once again optimal for the South to choose $x = 0$: allowing imitation ensures that at least a low quality version of the Northern good is available locally.

Over the range $(\varphi^{di}, \varphi^d)$ if the North-South quality gap is sufficiently high (i.e. $\gamma > \gamma^d$) it is optimal for the South to choose a level of IPR protection that is just sufficient to induce the firm to export and this is found by solving the following equation for x :

$$\varphi = x\pi_S^d + (1-x)\pi_S^{di}$$

which gives

$$x^d = \frac{\varphi - \pi_S^{di}}{\pi_S^d - \pi_S^{di}}$$

Observe that x^d is defined only when $\varphi \in (\varphi^{di}, \varphi^d)$ and over this range we have $0 < x^d < 1$. This implies that the South's optimal IPR policy when the North's exhaustion policy is NE is given by

$$x^*(\text{NE}) = \begin{cases} 0 & \text{if } \varphi \in (0, \varphi^{di}] \\ x^d & \text{if } \varphi \in (\varphi^{di}, \varphi^d) \text{ and } \gamma > \gamma^d \\ 0 & \text{if } \varphi \geq \varphi^d \end{cases}$$

In Figure 3, the thick dark line plots the South's optimal IPR policy $x^*(\text{NE})$ under NE given that $\gamma > \gamma^d$.

– Figure 3 here –

Outside of $\varphi^{di} < \varphi < \varphi^d$, we have $x^*(\text{NE}) = 0$ – exactly what we obtained in the core model. The key difference arises over the range $\varphi^{di} < \varphi < \varphi^d$. Here, given that $\gamma > \gamma^d$, optimal IPR protection in the South $x^*(\text{NE})$ increases with the fixed cost φ in order to ensure that the firm continues to make sufficient profits to cover this cost.²⁶ By contrast,

²⁶It is straightforward to show that x^d decreases with the quality gap γ . Intuitively, as the firm's quality advantage over imitators increases, a weaker level of IPR protection is needed to ensure that it makes enough profit to cover its fixed cost φ .

when the South's decision is discrete (i.e. $x = 0$ or 1), the level of IPR protection over this range of fixed costs is set at the maximum level (i.e. $x^* = 1$). This is shown by the thick dashed line in Figure 3. Intuitively, when the South picks only between two discrete policies (zero or full protection), it ends up offering too much protection to the Northern firm (i.e. $x^* = 1 > x^d$ when $\gamma > \gamma^d$). By contrast, under the more general model, the South can fine tune its IPR policy and offer 'just enough' protection to induce the Northern firm to sell locally.

Using corresponding logic, we can state the optimal Southern policy when the North picks IE:

$$x^*(\text{IE}) = \left\{ \begin{array}{l} 0 \text{ if } \varphi \in (0, \varphi^{ui}] \\ x^u \text{ if } \varphi \in (\varphi^{ui}, \varphi^u] \text{ and } \gamma > \gamma^u \\ 0 \text{ if } \varphi \geq \varphi^u \end{array} \right\} \text{ where } x^u = \frac{\varphi - \pi^{ui} + \pi_N^d}{\pi^u - \pi^{ui}}$$

Indeed, under this continuous formulation of Southern IPR protection, Propositions 3 and 4 need to be modified only slightly. The two statements of Proposition 3 remain intact. In addition, we need to add a third statement that specifies the level of IPR protection offered by the South to be $x^*(\text{NE})$. Similarly, Proposition 4 needs to be expanded by specifying the level of Southern IPR protection under IE to be $x^*(\text{IE})$. Finally, the key equilibrium result reported in Proposition 5 also needs a minor modification. We can state:

Proposition 5B: *Suppose the level of Southern IPR protection (x) is endogenously chosen. Then, given that $\gamma \leq \gamma^f \Leftrightarrow \varphi^{di} \leq \varphi^u$, equilibrium policies of the two regions are as follows:*

<i>Exporting Cost</i>	<i>Equilibrium policies (X,Y)</i>
(i) $\varphi \in [0, \varphi^{ui}]$	(IE, $x^* = 0$)
(ii) $\varphi \in (\varphi^{ui}, \varphi^{di}]$	(NE, $x^* = 0$)
(iii) $\varphi \in (\varphi^{di}, \varphi^u]$	(IE, $x^* = x^u$) if $\gamma > \gamma^u$ and (IE, $x^* = 0$) or (NE, $x^* = 0$) otherwise
(iv) $\varphi \in (\varphi^u, \varphi^d]$	(NE, $x^* = x^d$) if $\gamma > \gamma^d$ and (IE, $x^* = 0$) or (NE, $x^* = 0$) otherwise

Given this result, it is clear that this alternative formulation of Southern IPR protection yields conclusions regarding the effects of TRIPS on equilibrium outcomes and welfare that are very similar to those yielded by the basic model.

8.3 Role of Northern IPR protection

The model assumes that the North offers complete IPR protection to its firm, which allows the firm to act as a monopolist in the Northern market. In other words, why

the North offers IPR protection is exogenous to the model. This is a reasonable way to proceed due to several reasons. First, the objective of the paper is to understand the North's choice between alternative exhaustion regimes and the relationship of that choice to the South's decision regarding IPR protection. Abstracting from Northern IPR protection allows us to focus on this interaction. Furthermore, when TRIPS came into existence, the industrialized countries already offered strong IPR protection so there was no real change in the Northern IPR protection as a result of TRIPS.

At a more general level, the decision to protect IPR is a deeper, more fundamental decision than the choice of an exhaustion regime. One reflection of this difference between the two policy decisions is the fact that exhaustion regimes can be changed relatively quickly and can actually even be fine tuned at the level of the industry as well as to the nature of the IPR in question (i.e. exhaustion policies for patents, copyrights, and trademarks can be different). Indeed, one of the key motivating facts of this paper is that TRIPS left WTO member countries completely free to implement exhaustion regimes of their choice while requiring complete harmonization of virtually all other aspects of IPR. This stance implies that it is possible for two countries to implement the exhaustion regimes of their choice even if they have to offer the same level of protection to IPR holders. Indeed, exhaustion policies vary widely across member countries of the WTO. Even countries that offer strong IPR protection do not necessarily follow the same types of exhaustion policies. For example, the US practises NE with respect to patented goods, Japan follows IE, while the EU's chosen regime is community exhaustion under which parallel imports can flow freely within the community but are prohibited from the rest of the world. Thus, it is reasonable to focus on the interaction between exhaustion policies and protection of IPR in the South while abstracting from the North's decision to protect IPR.

9 Conclusion

Issues related to intellectual property have always been contentious in the context of North-South trade. This paper provides a North-South model that focuses on the linkages between Northern policy regarding the exhaustion of IPR and Southern policy regarding the protection of intellectual property.

The model is built on the insight that while Southern IPR protection determines the firm's market power within the Southern market, Northern policy regarding the exhaustion of IPR determines its market power across regions. Which of these aspects

of market power is more valuable to the firm depends upon the intensity of competition generated by imitation and the degree of asymmetry between markets. If the quality gap between the Northern original and the Southern imitation is quite small, IPR protection is more valuable to the firm since it helps avoid vigorous market competition. On the other hand, the larger the Northern market and more skewed Northern consumer tastes are in favor of quality, the higher the premium the firm puts on the ability to price discriminate internationally. As a result, the threshold quality gap below which the firm values IPR protection relatively more than the ability to price discriminate internationally is decreasing in parameters that determine the degree of asymmetry across markets.

In the model, while choosing its policy each region takes into account not only the other region's policy but also the firm's decisions regarding pricing and exporting under alternative policy configurations. In this regard, we find that the North has a stronger incentive to adopt IE when the South protects IPR relative to when it does not. On the other side, the South is less likely to protect IPR if the North chooses IE. The nature of this interaction implies that, in equilibrium, the two regions can find themselves in a policy-standoff wherein each region takes into account whether or not the other would be willing to implement its less preferred policy in order to induce the firm to export. While from the firm's viewpoint, protection from imitation and the freedom to price discriminate internationally both serve to enhance its monopoly power on world markets, the two policies differ substantially with respect to their distributional burden. Conditional on the firm exporting, the North is better off under IE while the South is better off not protecting IPR, policies that are beggar-thy-neighbor in nature.

The interdependence of policy decisions implies that a change in one region's policy can induce a change in the other region's policy. For example, if the South is forced to shut down local imitation – say due to the enforcement of an international trade agreement such as TRIPS – there are circumstances where the North responds to the change in Southern policy by reversing its policy from NE to IE. When such a TRIPS induced policy reversal occurs, Southern welfare suffers multiply. First, variety is reduced since the low quality imitation is no longer sold locally. Second, price of the high quality increases due to the elimination of Southern competition. Third, the reversal in the Northern policy induces the firm to switch to a uniform price that exceeds its Southern price under price discrimination. However, on the flip side, Northern consumers benefit from these changes, as does the Northern firm.

It is worth noting that since the model abstracts from innovation, its conclusions

regarding the effects of increased IPR enforcement in the South on global welfare do not account for dynamic benefits that might accrue to the global economy from such a policy change. Ignoring these dynamic effects is quite reasonable insofar as increased IPR enforcement in small developing countries is concerned but less so when evaluating the consequences of IPR reforms in large countries such as Brazil, China and India. In the model's defense, however, it should be noted that the entry of the Northern firm into the South affects Southern welfare much like innovation: it introduces a new good to the local economy that is higher in quality than the one that is produced locally. Similarly, the result that TRIPS enforcement increases global welfare iff it induces the firm to export is quite analogous to the idea that a sufficiently large innovation response by the North can make TRIPS enforcement by the South to be in its interest. What is not captured by the model, however, is that innovation can expand the set of products in the North or increase their quality (or both). If the model were extended to include such types of innovation, one would expect the case for enforcement of IPR in the South to be stronger. While exporting by Northern firms would continue to play a crucial role in terms of how Southern IPR enforcement affects local welfare, its role with respect to global welfare would be weaker, particularly if innovation were to be sufficiently elastic with respect to Southern IPR enforcement. Under such a situation, Northern welfare (and perhaps even global welfare) could increase with TRIPS enforcement even if the export response of Northern firms to Southern IPR reforms were not particularly strong.

10 Appendix

Lemma 1

We have

$$\sum_i x_i^u = x_N^u + x_S^u = \frac{\eta(\eta + 2\mu - 1)}{2(\eta + \mu)} + \frac{2\eta - \mu(\eta - 1)}{2(\eta + \mu)} = \frac{\eta + 1}{2}$$

and

$$\sum_i x_i^d = x_N^d + x_S^d = \frac{\eta}{2} + \frac{1}{2} = \sum_i x_i^u$$

Lemma 3

Since imitation lowers the firm's profit, we have $\varphi^u - \varphi^{ui} = \pi^u - \pi^{ui} > 0$. Also,

$$\varphi^{di} - \varphi^{ui} = \pi_N^d + \pi_S^{di} - \pi^{ui} = \frac{\eta q_S (\gamma(\mu - 1) + 1)^2}{4 (\eta(\gamma - 1) + \gamma\mu)} > 0$$

i.e. imitation hurts the firm less under price discrimination since prices in the two markets are not linked.

Let

$$\Delta\varphi = \varphi^{di} - \varphi^u = \pi_N^d + \pi_S^{di} - \pi^u = \frac{1}{4} \frac{q_S [\gamma\eta(\mu - 1)^2 - (\eta + \mu)]}{\eta + \mu}$$

Simple differentiation shows that $\Delta\varphi$ is increasing in γ and that

$$\Delta\varphi \geq 0 \Leftrightarrow \varphi^{di} \geq \varphi^u \text{ iff } \gamma \geq \gamma^f = \frac{\eta + \mu}{\eta(\mu - 1)^2}$$

where

$$\frac{1}{\gamma^f} \frac{\partial \gamma^f}{\partial \eta} = -\frac{\mu}{\eta(\eta + \mu)} < 0 \text{ and } \frac{1}{\gamma^f} \frac{\partial \gamma^f}{\partial \mu} = -\frac{\mu + 1 + 2\eta}{(\eta + \mu)(\mu - 1)} < 0$$

Next, we have

$$\begin{aligned} \varphi^{di} - \varphi^{ui} - (\varphi^d - \varphi^u) &= \pi_S^{di} - (\pi^{ui} - \pi_N^d) - (\pi_S^d - \pi^u + \pi_N^d) \\ &= \pi_S^{di} - \pi^{ui} - \pi_S^d + \pi^u \\ &= (\pi^u - \pi^{ui}) - (\pi_S^d - \pi_S^{di}) \\ &= \frac{\eta q_S [2\gamma\mu(\mu - 1) + \gamma\eta(\mu^2 - 1) + (\eta + \mu)]}{4 (\eta + \mu) (\eta(\gamma - 1) + \gamma\mu)} > 0 \end{aligned}$$

Proposition 1

Given price p and quality $q = \gamma q_S$, Northern consumer surplus equals

$$cs_N = \frac{\eta}{\mu} \int_{p/q}^{\mu} (q\theta - p) d\theta = \frac{\eta (q\mu - p)^2}{2 q\mu}$$

which implies that Northern consumer surplus under uniform pricing and international price discrimination is given by

$$cs_N^u = \frac{\eta (q\mu - p^u)^2}{2 q\mu} \text{ and } cs_N^d = cs_N^a = \frac{\eta (q\mu - p_N^d)^2}{2 q\mu} \quad (8)$$

respectively. Utilizing the above expressions and those for the firm's prices and profits reported in the text, we directly calculate

$$w_N^u - w_N^d = cs_N^u + \pi^u - cs_N^d - \pi^d = \frac{\eta q (\mu - 1) 2\eta + \mu + \mu^2}{8 (\eta + \mu)^2} \geq 0$$

Proposition 2

To determine Northern policy in a world where imitation occurs in the South, we first calculate consumer surplus under alternative policies. When the North is open to parallel imports, post imitation, if the firm serves both markets (which happens when $\varphi \leq \varphi^{ui}$) Northern welfare equals

$$w_N^{ui} = cs_N^{ui} + \pi^{ui} - \varphi$$

But when $\varphi > \varphi^{ui}$, if the North chooses IE, it gets autarkic welfare w_N^a since its firm decides not to export. Thus, given that the South does not protect IPR, Northern welfare under IE can be written as

$$w_N(\text{IE}, \text{N}) = \begin{cases} w_N^{ui} & \text{if } \varphi \leq \varphi^{ui} \\ w_N^a & \text{if } \varphi > \varphi^{ui} \end{cases}$$

Similarly, given that the South does not protect IPR, Northern welfare under NE equals

$$w_N(\text{NE}, \text{N}) = \begin{cases} w_N^{di} & \text{if } \varphi \leq \varphi^{di} \\ w_N^a & \text{if } \varphi > \varphi^{di} \end{cases}$$

where $w_N^{di} = cs_N^d + \pi_N^d + \pi_S^{di} - \varphi$. From where it immediately follows that when $\varphi^{ui} < \varphi \leq \varphi^{di}$, $w_N(\text{NE}, \text{N}) - w_N(\text{IE}, \text{N}) = w_N^{di} - w_N^a = \pi_S^{di} - \varphi^{di} \geq 0$ since $\varphi \leq \varphi^{di}$. However, when $\varphi > \varphi^{di}$, since the firm does not export, we have $w_N(\text{NE}, \text{N}) = w_N(\text{IE}, \text{N}) = w_N^a$ when $\varphi > \varphi^{di}$.

Now suppose $\varphi \leq \varphi^{ui}$. Over this range, direct calculations give:

$$\begin{aligned} w_N(\text{IE}, \text{N}) - w_N(\text{NE}, \text{N}) &= (cs_N^{ui} + \pi^{ui} - \varphi) - (cs_N^d + \pi_N^d + \pi_S^{di} - \varphi) \\ &= \frac{\eta q_S ((\mu - 1)\gamma + 1) 2\eta(\gamma - 1)^2 + \gamma\mu(\gamma(\mu + 1) - 1)}{8 (\gamma\mu + \eta(\gamma - 1))^2} > 0 \end{aligned}$$

Proposition 4

We have

$$\begin{aligned}\gamma^u/\gamma^d &= \frac{(\eta + \mu)^2}{(2\eta + \mu - \eta\mu)^2} \geq 1 \\ \Leftrightarrow \eta + \mu &> 2\eta + \mu - \eta\mu \\ \Leftrightarrow \eta\mu &\geq \eta \Leftrightarrow \mu \geq 1\end{aligned}$$

Proposition 6

World welfare under uniform pricing equals

$$ww^u = cs_N^u + \pi^u + cs_S^u$$

where cs_N^u is given in equation (8) and π^u in equation (4) and $cs_S^u = cs_N^u|_{\eta=\mu=1}$.

$$ww^{di} = cs_N^d + \pi^{di} + cs_S^{di} = \frac{3\eta\mu q}{8} + \frac{q_S(\gamma - 1)}{4} + \frac{q_S(\gamma + 3)}{8}$$

Direct calculations yield

$$\Delta ww = ww^u - ww^{di} = \frac{1}{8} \frac{q_S(\eta\gamma(\mu - 1)^2 - (\eta + \mu))}{\eta + \mu}$$

Simple differentiation shows that Δww is increasing in q and $\Delta ww = 0$ at

$$\gamma = \gamma^f = \frac{\eta + \mu}{\eta(\mu - 1)^2}$$

Under international price discrimination, world welfare equals

$$ww^d = cs_N^d + \pi^d + cs_S^d = \frac{3q(\eta\mu + 1)}{8}$$

which implies

$$ww^u - ww^d = \frac{\eta q}{8} \frac{(\mu - 1)^2}{\eta + \mu} \geq 0$$

Next, we have

$$ww^{ai} = \frac{3\eta\mu q}{8} + \frac{q_S}{2}$$

Using which we calculate

$$ww^d - ww^{ai} = \frac{1}{8} (3q - 4q_S) \geq 0 \text{ iff } \gamma \geq \gamma_w = \frac{4}{3}$$

References

- [1] Branstetter, L., Fisman, R., Foley F., Saggi K. (2010). ‘Does intellectual property rights reform spur industrial development?’ *Journal of International Economics* 83, 27-36, 2011.
- [2] Chaudhuri, S., Goldberg, P. and Jia, P. (2006). ‘Estimating the effects of global patent protection in pharmaceuticals: a case study of quinolones in India’, *American Economic Review*, vol. 96(5), pp. 1477-1514.
- [3] Goldberg, P. K. (2010). ‘Intellectual property rights protection in developing countries: the case of pharmaceuticals.’ *Journal of the European Economic Association* 8, pp. 326-353.
- [4] Danzon, P., Wang, Y. R., Wang, L. (2005). ‘The impact of price regulation on the launch delay of new drugs.’ *Journal of Health Economics* 14, pp. 269-92.
- [5] Grossman, G.M., Lai, E. (2008). ‘Parallel imports and price controls.’ *Rand Journal of Economics* 39, pp. 378-402.
- [6] Ivus, O. (2010). ‘Do stronger patent rights raise high-tech exports to the developing world?’ *Journal of International Economics* 81, pp. 38-47.
- [7] Ivus, O. (2011). ‘The quantity, price, and variety response of U.S. exports to stronger IPR protection.’ Mimeo, Queen’s University.
- [8] Javorcik, B. (2004). ‘The composition of foreign direct investment and protection of intellectual property rights in transition economies’, *European Economic Review*, vol. 48(1), pp. 39-62.
- [9] Kanavos, P., Costa-i-Font, J., Merkur, S., Gemmill, M. (2004). ‘The economic impact of pharmaceutical parallel trade in European member states: a stakeholder analysis.’ Special Research Paper, LSE Health and Social Care, London School of Economics and Political Science.
- [10] Lanjouw, J. O. (2005). ‘Patents, price controls and access to new drugs: how policy affects global market entry.’ National Bureau of Economic Research Working Paper No. 11321.

- [11] Lee, J-Y. and Mansfield, E. (1996). 'Intellectual property protection and U.S. foreign direct investment', *Review of Economics and Statistics*, vol. 78(2), pp. 181-186.
- [12] Malueg, D.A., Schwartz, M. (1994). 'Parallel imports, demand dispersion, and international price discrimination.' *Journal of International Economics* 37, pp. 167-195.
- [13] Mansfield, E. (1994). 'Intellectual property protection, foreign direct investment, and technology transfer', Discussion Paper 19, International Finance Corporation, Washington DC.
- [14] Maskus, K.E., (2000). 'Parallel imports.' *World Economy* 23, pp. 1269-1284.
- [15] Maskus, K. E., Penubarti, M. (1995). 'How trade-related are intellectual property rights?' *Journal of International Economics* 39, pp. 227-248.
- [16] National Economic Research Associates (NERA), 1999. The economic consequences of the choice of regime of exhaustion in the area of trademarks. Final Report for DG XV of the European Commission.
- [17] Nunnenkamp, P. and Spatz, J. (2004). 'Intellectual property rights and foreign direct investment: a disaggregated analysis', *Weltwirtschaftliches Archiv (Review of World Economics)*, vol. 140(3), pp. 393-414.
- [18] Richardson, M. (2002). 'An elementary proposition concerning parallel imports.' *Journal of International Economics* 56, pp. 233-245.
- [19] Roy, S., Saggi, K. (2012a). 'Equilibrium parallel import policies and international market structure.' *Journal of International Economics*, forthcoming.
- [20] Roy, S., Saggi, K. (2012b). 'Strategic competition and optimal parallel import policy.' *Canadian Journal of Economics*, forthcoming.
- [21] Schmalensee, R. (1981). 'Output and welfare implications of monopolistic third-degree price discrimination.' *American Economic Review* 71, pp. 242-247.
- [22] Smith, P. (1999). 'Are weak patent rights a barrier to US exports?' *Journal of International Economics* 48, pp. 151-177.
- [23] Valletti, T.M. (2006). 'Differential pricing, parallel trade, and the incentive to invest.' *Journal of International Economics* 70, pp. 314-324.

- [24] Valletti, T.M., Szymanski, S. (2006). 'Parallel trade, international exhaustion and intellectual property rights: a welfare analysis.' *Journal of Industrial Economics* 54, 499-526.
- [25] Varian, H., (1985). 'Price discrimination and social welfare.' *American Economic Review* 75, pp. 870-875.

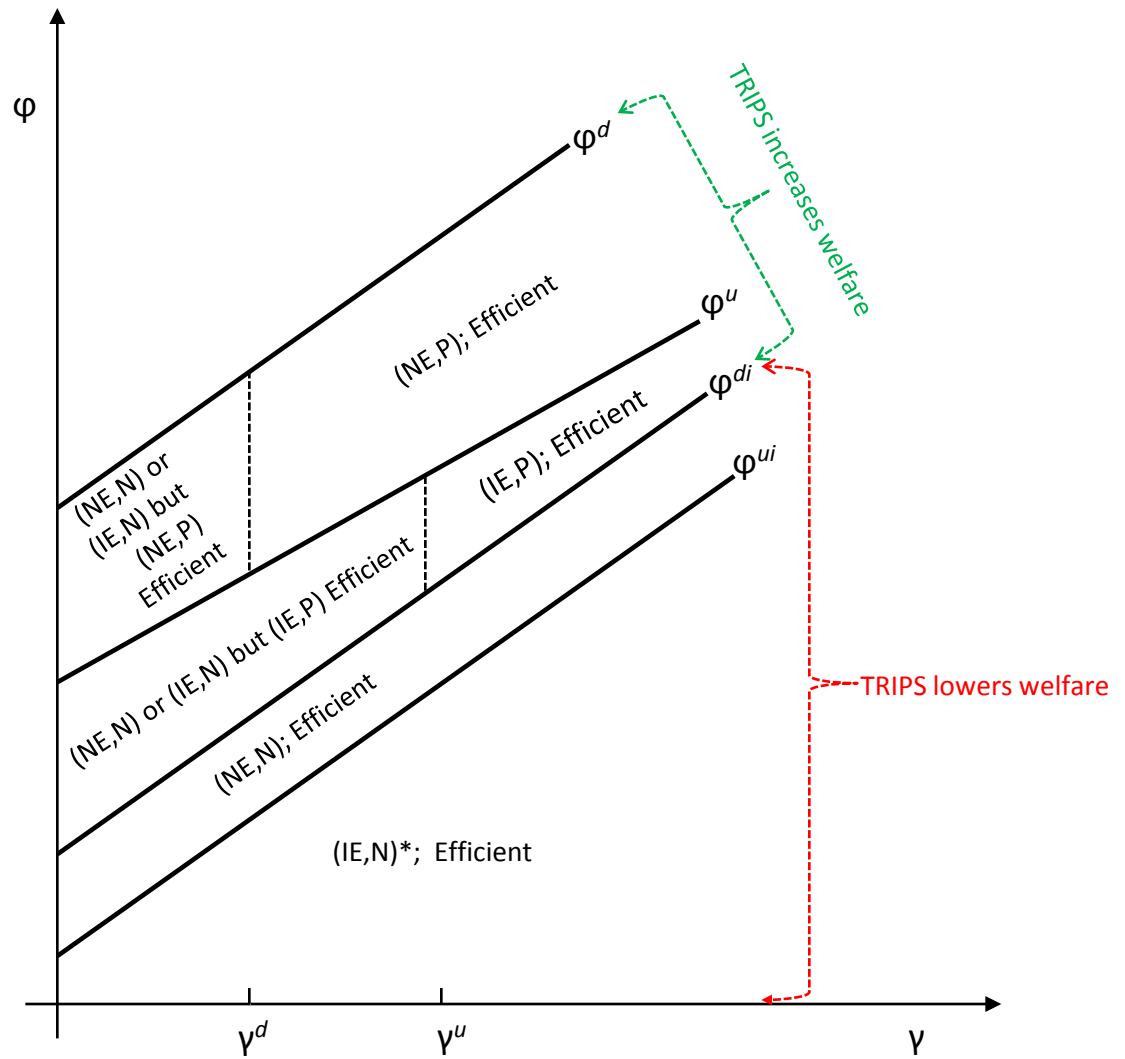


Figure 1: Policy Equilibrium and Welfare Effects of TRIPS ($\gamma \leq \gamma^f$)

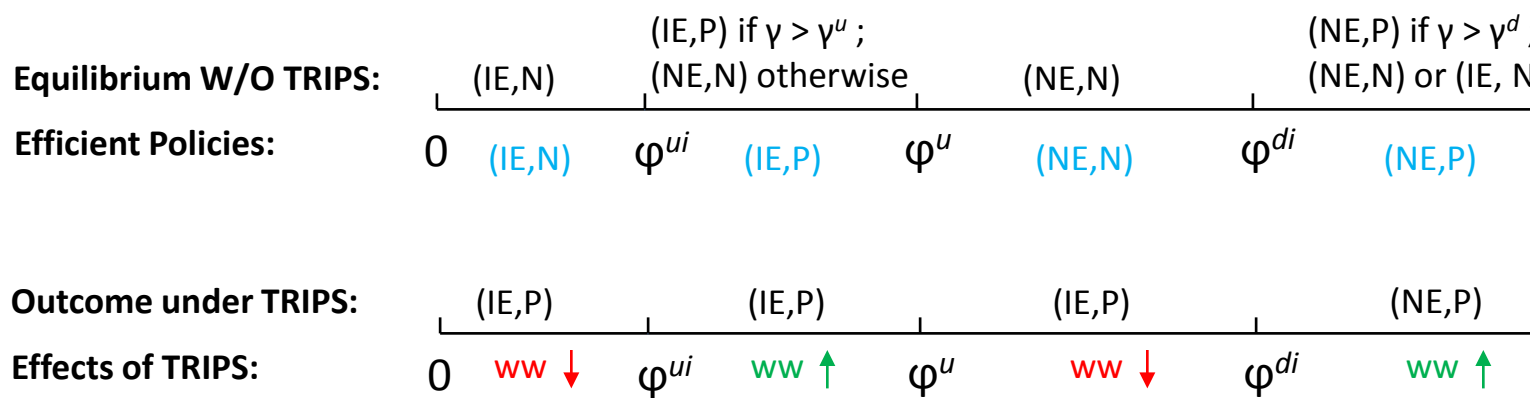


Figure 2: Policy Equilibrium and Effects of TRIPS ($\gamma > \gamma^d$)

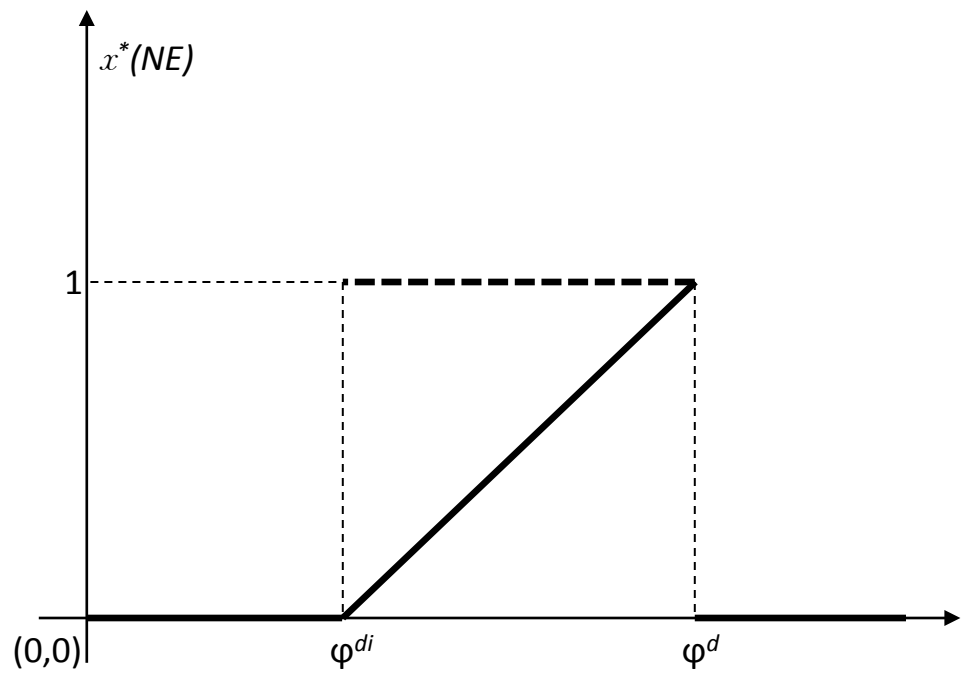


Figure 3: Optimal IPR policy of the South under *NE*