MARKET POWER IN THE GLOBAL ECONOMY: THE EXHAUSTION AND PROTECTION OF INTELLECTUAL PROPERTY

by

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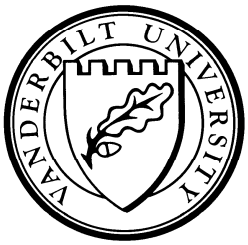

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Market power in the global economy: the exhaustion and protection of intellectual property

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Abstract

This paper analyzes economic linkages between the exhaustion and protection of intellectual property. We consider a North-South model, where a firm that enjoys monopoly status in the North by virtue of an intellectual property right (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 key intuition underlying the model is that while Northern policy regarding the territorial exhaustion of IPRs determines whether the firm can price discriminate internationally and therefore exercise market power *across* regions, Southern policy regarding the protection of IPRs determines the firm's monopoly power *within* the South. In equilibrium, each region's policy takes into account the firm's pricing behavior, its incentive to export, and the other region's policy stance. Major results are: (a) the North is more likely to prefer national exhaustion when the South does *not* protect IPRs whereas the South is more willing to protect intellectual property if the North chooses national exhaustion; (b) the firm values protection of intellectual property relatively more than the freedom to price discriminate internationally that exists under national exhaustion if and only if the quality gap between it and Southern imitators lies below a certain threshold; (c) except for the situation where the firm sells in the South regardless of the global policy environment, the two regions find themselves in a policy stand-off wherein each region takes into account whether or not the other would be willing to implement its less preferred policy to induce the firm to export and (d) requiring the South to protect IPRs increases global welfare iff (i) it induces the North to reverse its policy stance from national to international exhaustion and (ii) the quality gap between the Northern original and the Southern imitation exceeds a certain minimum threshold.

Keywords: Exhaustion of IPRs, Imitation, Market power, TRIPS, Welfare. *JEL Classifications*: F13, F10, F15.

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1 Introduction

It is well understood that the extent to which the holders of intellectual property rights (IPRs) can freely exercise their rights depends on (*i*) the degree of protection available to them against potential imitators and (*ii*) the scope of exhaustion of IPRs implemented by countries in which they sell their products. However, virtually nothing is known about the relationship between the *exhaustion* and *protection* of intellectual property in the global economy. The objective of this paper is to analyze economic linkages between these two salient aspects of intellectual property law.

The paper develops a stylized two-country model that is based on two simple observations. First, due to fundamental differences in the pattern of demand across countries, firms with market power have an incentive to charge higher prices in developed countries relative to developing ones. However, attempts to engage in such international price discrimination can be undone by arbitrage unless policy restrictions in developed countries prevent *parallel trade*.[1] Whether or not such restrictions exist in a particular country depends on the nature of territorial exhaustion of IPRs practised by it. A country that adheres to the principle of *national exhaustion* effectively bans parallel trade since under this principle a right holder's rights over a product expire only in the country of first sale, making it possible for the right holder to prevent its resale in other markets by retailers or other parties. On the other hand, under the doctrine of *international exhaustion* rights are deemed to expire globally with the first sale of a product anywhere so that a right holder is unable to block parallel trade.

The second key observation motivating the model is that while developed countries offer fairly strong protection against infringement of IPRs, such is generally not the case in developing countries. It is well known that up until the ratification of the Agreement on Trade Related Aspects of Intellectual Property (TRIPS) by the World Trade Organization (WTO), IPR protection in most developing countries was quite weak or simply non-existent. Indeed, the widespread imitation of foreign technologies by firms in developing countries was a major reason why developed countries pushed for TRIPS at the WTO.

Given these observations, we consider a North-South scenario 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 (Northern) firm's market power 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 IPRs determines whether the firm can price discriminate internationally and therefore exercise its market power *across* regions, Southern policy regarding the protection of IPRs determines its monopoly power *within* the Southern market.

[1] Following Maskus (2000), parallel trade is said to occur when a product protected by some form of IPR offered for sale by the right holder in one country 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.

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 national and international exhaustion while the South decides whether or not to protect IPRs. If the South chooses not to protect IPRs, 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.

In equilibrium, each region's optimal policy takes into account the firm's pricing behavior, its incentive to export, and the other region's policy stance. Conditional on the South protecting intellectual property, international exhaustion of IPRs is preferred by the North so long as it does not eliminate its firm's incentive to export. Provided the firm serves both markets, international exhaustion forces the firm to set a uniform world price that is lower than the price it charges in the North under national exhaustion. This is because arbitrage-induced parallel imports are not permitted under national exhaustion and the firm is free to price discriminate internationally. However, the North finds national exhaustion of IPRs 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.[2] How does Southern IPR policy affect this trade-off? We show that the lack of Southern IPR protection makes it more likely that the North prefers national exhaustion since the adverse effect of Southern imitation on the firm's incentive to export is partially offset by the freedom to price discriminate internationally.

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. As a result, it is optimal for the South to 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 Southern imitation. Furthermore, the minimum quality gap above which the South is willing to protect intellectual property is relatively lower under national exhaustion. Thus, the South's willingness to protect Northern intellectual property is weaker under international exhaustion. This is because Northern openness to parallel imports raises the price of the high quality original in the South thereby making it less attractive for the South to protect intellectual property in order to induce the firm to sell locally.

It is clear that from the firm's perspective, the most attractive global policy environ-

[2] Malueg 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.

ment is one where the North adopts national exhaustion 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 national exhaustion? It turns out that the firm values IPR protection relatively more if and only if the North-South quality gap falls below a certain threshold (q^e). This is because a smaller quality gap implies stiffer price competition post imitation. Furthermore, the threshold quality gap q^e 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 parameter (η or μ) makes the two markets more asymmetric thereby increasing the value of international price discrimination to the firm while simultaneously reducing the relative importance of the Southern market in determining its global profit.

It turns out that the welfare effects of equilibrium policies also depend upon their relative ranking from the firm's viewpoint. Suppose the firm values the ability to price discriminate relatively more than protection from imitation (i.e. $q > q^e$). Given that, the nature of equilibrium policies is as follows. If the firm exports to the South regardless of the global policy environment, then each region implements its preferred policy: the North chooses international exhaustion 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 national exhaustion and protection from imitation as *partial substitutes*, the two governments view them quite differently since, conditional on entry, national exhaustion 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 IPRs completely at the discretion of member countries.[3]

We show that if the firm finds it optimal to not export to the South under any policy configuration, Southern enforcement of Northern IPRs confers a pure welfare loss on the world economy by eliminating Southern access to a lower quality version of the Northern good. However, effects of the TRIPS mandated change in Southern IPR policy turn out to be rather subtle when it ends up *inducing* the firm to sell in the South. Under such a scenario, the North responds to the shut down of imitation in the South by reversing

[3]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 IPRs, TRIPS essentially left member countries free to implement policies of their choice. Article 5 of TRIPS says that "nothing in this Agreement shall be used to address the issue of the exhaustion of intellectual property rights."

its policy from national to international exhaustion. 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, price of the high quality good increases in the South because competition from the Southern industry is eliminated. 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, Northern consumers benefit from this change in the firm's pricing behavior and aggregate Northern welfare increases due to the TRIPS induced policy reversal as does world welfare provided the North-South quality gap exceeds the threshold q^e.

While the present paper is unique in its focus on the interaction between Southern imitation and Northern policy regarding the exhaustion of IPRs, 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 (2010a, 2010b) 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 international exhaustion 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.[4]

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

$$U_i = \theta q - p \tag{1}$$

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 $\eta_N = \eta \geq 1 = \eta_S$.

[4] Valletti 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.

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 $\mu_N = \mu \geq \mu_S = 1$.[5]

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 national and international exhaustion of IPRs: 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 acts a global monopolist.

The global policy environment determined by each region's independent policy choice is denoted by the pair (X,Y) where X = IE or NE, IE stands for international exhaustion and NE for national exhaustion; 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 acts as a monopolist in the Northern market and chooses its price p to maximize profit:

$$\max_p \eta p x(p) = \eta \frac{p}{\mu}(\mu - \frac{p}{q})$$

[5]Note 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.

which gives the optimal price in the North as

$$p_N^d = \frac{\mu q}{2} \tag{2}$$

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, i.e., $x_N^d = \frac{\eta}{\mu}(\mu - p_N^d/q) = \frac{\eta}{2}$. The firm's autarkic equilibrium profit equals

$$\pi_N^d = p_N^d x_N^d = \frac{\eta\mu q}{4}$$

while consumer surplus in the North equals

$$cs_N^d = \frac{\eta}{\mu}\int_{\frac{p_N^d}{q}}^{\mu}(q\theta - p_N^d)d\theta = \frac{\eta\mu q}{8}$$

Aggregate Northern welfare under autarky is given by

$$w_N^a = cs_N^d + \pi_N^d$$

3 Optimal Northern policy

As might be expected, the nature of the North's optimal policy with respect to the exhaustion of IPRs depends upon the South's policy regarding the protection of IPRs. We first derive North's optimal policy regarding exhaustion when the South chooses to protect intellectual property.

3.1 When the South protects intellectual property

Given that imitation is prohibited by the South, consider the firm's pricing behavior as a function of Northern parallel import policy assuming it has incurred the fixed cost of exporting φ. Under international exhaustion, 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 national exhaustion, 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.

3.1.1 Prices and sales

Under national exhaustion, in region i the firm choose p_i to solve

$$\underset{p_i}{Max}\ \pi_i(p_i) = p_i\eta_i x_i(p_i) = \frac{\eta_i}{\mu_i}p_i(\mu_i - \frac{p_i}{q}) \tag{3}$$

which gives the optimal discriminatory prices for the two regions as

$$p_N^d = \frac{\mu q}{2} \text{ and } p_S^d = \frac{q}{2}$$

The firm's aggregate profit under price discrimination equals

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

Under international exhaustion, if the firm sells in both markets, it chooses the common price p to solve:

$$\underset{p}{Max} \sum_i \pi_i(p) = \sum_i p x_i(p) = \sum_i \frac{\eta_i}{\mu_i} p(\mu_i - \frac{p}{q}) \tag{5}$$

Solving the above problem gives the optimal uniform price:

$$p^u = \frac{q\mu(\eta+1)}{2(\eta+\mu)} \tag{6}$$

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: $p_S^d \leq p^u \leq p_N^d$.[6] In fact, we have

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

i.e. the firm's optimal price under uniform pricing is a weighted average of its optimal discriminatory prices where the weight (γ) 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:* $\Sigma_i x_i^u = \Sigma_i x_i^d = (\eta+1)/2$ *where* $i = N, S$.

The firm's aggregate profits π^u (gross of entry cost) under uniform pricing equal

$$\pi^u = \pi_N^u + \pi_S^u = \frac{\eta}{\mu} p^u(\mu - \frac{p^u}{q}) + p^u(1 - \frac{p^u}{q}) = \frac{q\mu}{4} \frac{(\eta+1)^2}{\eta+\mu} \tag{7}$$

Next, we determine the firm's optimal export decision under the policy pairs (IE,P) and (NE,P).

[6] It is worth pointing out that there is positive demand in the South at the price p^u iff $\mu \leq \overline{\mu} = \frac{2\eta}{\eta-1}$. Observe that $\overline{\mu} \geq 2$ for all $\eta > 0$ and it approaches 2 when η approaches infinity. When $\mu > \overline{\mu}$, under international exhaustion 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 international exhaustion the firm is always better off serving only the Northern market at the optimal price p_N^*. Under such a scenario, Northern policy has no effect on the local price (and consumer surplus) since under both national and international exhaustion, Northern price equals p_N^*. To rule out this uninteresting scenario, we assume that $\mu \leq \overline{\mu}$.

3.1.2 Export decision

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:

$$\pi^u - \varphi \geq \pi_N^d \Leftrightarrow \varphi \geq \varphi^u = \pi^u - \pi_N^d = \frac{q\mu}{4}\frac{2\eta + 1 - \eta\mu}{\eta + \mu} \tag{8}$$

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 $\mu > \mu^d$.[7] Note also that $\frac{\partial \varphi^u}{\partial \mu} < 0$ and $\frac{\partial \varphi^u}{\partial \eta}$ – i.e. as demand asymmetry increases across the two markets, entry into the Southern market under uniform pricing becomes less attractive to the firm.[8]

Thus, under the policy pair (IE,P), the firm's net profit, taking its entry decision into account, are as follows:

$$\pi(\text{IE}, \text{P}) = \begin{cases} \pi^u - \varphi \text{ if } \varphi \leq \varphi^u \\ \pi_N^d \text{ if } \varphi > \varphi^u \end{cases} \tag{9}$$

Under national exhaustion, the firm exports iff its Southern profit at the optimal discriminatory price p_S^d exceeds the fixed cost of exporting:

$$\pi_S^d \geq \varphi \Leftrightarrow \varphi \leq \varphi^d = \pi_S^d = \frac{q}{4} \tag{10}$$

which implies

$$\pi(\text{NE}, \text{P}) = \begin{cases} \pi^d - \varphi \text{ if } \varphi \leq \varphi^d \\ \pi_N^d \text{ if } \varphi > \varphi^d \end{cases}$$

Note that $\varphi^d - \varphi^u = \pi_S^d - (\pi^u - \pi_N^d) = \pi^d - \pi^u \geq 0$. In other words, serving the Southern market is less attractive to the firm under international exhaustion since doing so requires it to lower price in the larger, more lucrative Northern market.

Lemma 2. *Given that the South protects intellectual property, the firm is more likely to export under national exhaustion:* $\varphi^d > \varphi^u$.

Now we are ready to derive the North's optimal policy when the South protects IPRs.

3.1.3 Optimal Northern policy given the South protects

Given that the South protects IPRs, Northern welfare under international exhaustion is given by

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

[7] Note 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 .

[8] Furthermore $\overline{\mu} \geq \mu^d$ i.e. it is optimal for the firm to drop the Southern market well before its Southern sales hit zero under uniform pricing.

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

Under national exhaustion, Northern welfare is given by

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

where $w_N^d = cs_N^d + \pi^d - \varphi$. Note that $w_N^d \geq w_N^a$ with the inequality binding for $\varphi < \varphi^d$

Direct calculations (see appendix) show that $w_N^u \geq w_N^d$. This implies the following:

Proposition 1. *Suppose the South protects Northern intellectual property. Then, the following hold:*

(a) If $\varphi \leq \varphi^u$ *then* $w_N(\text{IE,P}) \geq w_N(\text{NE,P})$.

(b) If $\varphi^u < \varphi \leq \varphi^d$ *then* $w_N(\text{IE,P}) \leq w_N(\text{NE,P})$.

(c) If $\varphi \geq \varphi^d$ *then* $w_N(\text{IE,P}) = w_N(\text{NE,P}) = w_N^a$.

Parts (a) of Proposition 1 informs us that when the North can implement international exhaustion without compromising its firm's incentive to export, it chooses to do so. However, part (b) says that if the firm exports only when it can earn its optimal discriminatory profit, the North ends up implementing international exhaustion. Together, these results imply that an outcome where the firm does not serve the Southern market is *not* in the interest of the North and Northern policy ensures that this does not happen.

It is worth emphasizing that under national exhaustion, 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 international exhaustion, the firm's incentive to export is *weaker* than what is optimal for the North since exporting to the South lowers the firm's profit in Northern market by forcing it to charge a common price in both markets. From the viewpoint of Northern welfare, however, this price reduction in the North benefits consumers, something that the firm does not take into account.

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 $w_S(\text{IE,P}) \geq w_S(\text{NE,P})$.

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

3.2 When the South permits 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 IPRs in the North prevents the imitated good from being sold there so that competition occurs only in the South.

For expositional ease, we normalize the quality level of Southern imitation to one and its marginal cost of production to zero. Given this normalization of the quality of the Southern imitation, the parameter q now measures the relative quality level of the firm or the North-South *quality gap*.

3.2.1 Pricing post imitation

Competition within the Southern industry ensures that the price of the imitated good equals 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 $\theta_S = \frac{p}{q-1}$. The demand function facing the (high quality) firm is given by

$$x(0,p) = 1 - \theta_S = 1 - \frac{p}{q-1} \tag{11}$$

As before, Northern policy determines the pricing behavior of the firm. Under international exhaustion, the firm must charge the same price in both markets (if it serves both of them) and taking the price of the low quality good as zero it solves:

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

which gives the optimal uniform price post imitation

$$p^{ui} = \frac{q\mu(q-1)(\eta+1)}{2(\eta(q-1)+q\mu)}$$

while aggregate profits equals

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

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.

3.2.2 Export decision in the absence of IPR protection

If the firm does not export to the South, it earns optimal monopoly profit π_N^d in the North since the imitated good can be sold only in the South. Under international exhaustion, the firm does not export iff

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

Thus, we have

$$\pi(\text{IE}, \text{N}) = \begin{cases} \pi^{ui} - \varphi \text{ if } \varphi \leq \varphi^{ui} \\ \pi_N^d \text{ if } \varphi > \varphi^{ui} \end{cases}$$

If Northern policy is national exhaustion, the firm makes its optimal monopoly profit π_N^d at home whereas in the South it solves

$$\underset{p}{Max}\ p\left(1 - \frac{p}{q-1}\right)$$

which gives its optimal Southern price and aggregate profit as follows

$$p_S^{di} = \frac{q-1}{2} \text{ and } \pi_S^{di} = \frac{1}{4}(q-1)$$

which implies that the firm's global profit is

$$\pi^{di} = \pi_N^d + \pi_S^{di} = \frac{\eta\mu q}{4} + \frac{1}{4}(q-1)$$

The threshold level of fixed cost φ^{di} below which the firm finds it profitable to serve the South under the policy regime (NE,N) therefore equals:

$$\varphi^{di} = \pi^{di} = \frac{1}{4}(q-1)$$

We thus have:

$$\pi(\text{NE}, \text{N}) = \begin{cases} \pi^{di} - \varphi \text{ if } \varphi \leq \varphi^{di} \\ \pi_N^d \text{ if } \varphi > \varphi^{di} \end{cases}$$

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) $\varphi^{di} \geq \varphi^u$ *iff* $q \geq q^e$ *where* $\frac{\partial q^e}{\partial \mu} < 0$ *and* $\frac{\partial q^e}{\partial \eta} < 0$.

(iii) $\varphi^{di} - \varphi^{ui} > \varphi^d - \varphi^u$.

Part (i) of Lemma 3 simply ranks the firm's incentive to export under the different policy configurations. It informs us that the Southern market is most attractive to the firm when the North chooses national exhaustion and the South forbids imitation whereas its the least attractive when the policies of the two regions are reversed.[9] Part (ii) 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

[9] Maskus and Penubarti (1995) were the first to show that global trade flows are influenced strongly by the pattern of IPR protection in the global economy. More recently, Olena (2010 and 2011) has shown that stronger IPRs in developing countries encourage developed country firms in a wider range of industries to start exporting to their markets.

the magnitude of the North-South quality gap: when this gap is large (i.e. exceeds q^e) the removal of IPR protection in the South hurts the firm's export incentive less than a reversal in the exhaustion policy of the North. The quality gap threshold q^e 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) falls as the two markets become more asymmetric.

Part (*ii*) implies that *Southern imitation makes national exhaustion more attractive to the North.* Imitation makes the South a less attractive market to the firm by creating competition from a low quality version of its good. As a result, the range of fixed costs over which the firm chooses not to export expands.

3.2.3 Northern policy under imitation

The following result is proved in the appendix:

Proposition 2. *Suppose the South does not protect Northern intellectual property. Then the following hold:*

(a) If $\varphi \leq \varphi^{ui}$ *then* $w_N(\text{IE,N}) > w_N(\text{NE,N})$.

(b) If $\varphi^{ui} \leq \varphi < \varphi^{di}$ *then* $w_N(\text{IE,N}) < w_N(\text{NE,N})$.

(c) If $\varphi^{di} \leq \varphi$ *then* $w_N(\text{IE,N}) = w_N(\text{NE,N}) = w_N^a$.

Parts (a) through (c) of the above Proposition are analogous to Proposition 1 and they inform us that the optimal Northern policy ensures that its firm has an incentive to export to the South. If fixed costs of exporting are 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 its firm to export.

From Northern government's viewpoint, while uniform pricing (which can arise only under international exhaustion) 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. Therefore, Northern government is *more* prone to choose national exhaustion when the South does not protect Northern intellectual property relative to when it does.

4 Southern protection of intellectual property

Lemmas 3 and 4 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:

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

Second, the nature of the optimal Southern IPR policy depends on whether or not its policy affects the firm's decision to export to the South. Recall from part (*ii*) of Proposition 1 that the firm's incentive to export is strongest under the policy pair (NE,P) whereas it is weakest under (IE,N).

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

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

On the other hand, if the South were to not permit imitation, its welfare would equal

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

Clearly, $w_S^d < w_S^{di}$: if the firm necessarily exports to the South, local imitation is desirable because it increases competition as well as the degree of product differentiation in the market. The increase in competition brings down the price of the high quality Northern good from p_S^d to p_S^0. And increased choice ensures that those consumers that do not wish to purchase the high quality good have access to the low quality Southern good.

Note also that $w_S^{di} > w_S^{ai}$– i.e. the firm's entry increases the benefit of imitation under national exhaustion since prices are lower in the South relative to that under international exhaustion. Also, further note that w_S^{di} increases in q – 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.

Now consider $\varphi^{di} < \varphi \leq \varphi^d$. Over this range of fixed costs, the firm chooses to export to the South *only if* the South protects IPRs. 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 $p_S^d > 0$. Southern welfare in the absence of IPR protection equals $w_S^{ai} = \frac{1}{2}$ whereas that under IPR protection equals $w_S^d = \frac{q}{8}$. Thus, over the range $\varphi^{di} < \varphi \leq \varphi^d$, it is optimal for the South to protect IPRs iff $\frac{q}{8} > \frac{1}{2}$ or $q > q^d = 4$. Intuitively, when the North-South quality gap is large, it is optimal for the South to protect IPRs in order to ensure that the high quality good in its market. When such is not the case (i.e. $q < q^d$), the South is better off eschewing consumption of the high quality and permitting imitation.

Finally, let $\varphi > \varphi^d$. Over this parameter range, the firm does not export to the South regardless of whether the South protects IPRs or not. Given that, it is optimal for the South to not protect IPRs in order to ensure that local consumers at least have access to the low quality which ensures a welfare level of $w_S^{ai} = \frac{1}{2}$.

We summarize this discussion below:

Proposition 3. *Suppose the North implements national exhaustion of IPRs. Then, it is optimal for the South to protect intellectual property i.e.* $w_S(\text{NE,P}) > w_S(\text{NE,N})$ *if and only if*

(i) such protection is necessary to induce the firm to serve the Southern market (i.e. $\varphi^{di} < \varphi \leq \varphi^d$*) and*

(ii) the North-South quality gap is sufficiently high (i.e. $q > q^d$*).*

Following the above discussion, it is clear that under international exhaustion, if $\varphi \leq \varphi^{ui}$ or $\varphi > \varphi^u$ it is optimal for the South to not protect IPRs – 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.

The only issue is whether it is optimal for the South to protect IPRs when $\varphi^{ui} < \varphi \leq \varphi^u$. Over this range, protecting IPRs is *necessary* to induce the firm to enter the South. If the South protects IPRs its welfare equals

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

whereas if it does not protect IPRs, local welfare equals $w_S^{ai} = \frac{1}{2}$. Thus, over $\varphi^{ui} < \varphi \leq \varphi^u$, protecting IPRs is optimal for the South iff

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

i.e. over this range of fixed costs, IPR protection is optimal for the South only if the North-South quality gap exceeds the minimum threshold q^u. The minimum threshold

q^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 when the policy regime is (IE,N) and the firm refrains from exporting. By contrast, under national exhaustion, prices in the two markets are independent and Southern willingness to prevent imitation does not depend on parameters that capture demand asymmetry between the two regions (i.e. μ and η) and is determined solely by the magnitude of the North-South quality gap q.

We can now state a result analogous to Proposition 3:

Proposition 4. *(a) If the North implements international exhaustion, it is optimal for the South to protect intellectual property i.e.* $w_S(\text{IE}, \text{P}) > w_N(\text{IE,N})$ *iff (i) such enforcement is necessary to induce the firm to serve the Southern market (i.e.* $\varphi^{ui} < \varphi \leq \varphi^u$*) and (ii) the North-South quality gap exceeds the threshold* q^u*.*

(b) Furthermore, the minimum quality gap required for the South to be willing to protect intellectual property is higher under international exhaustion relative to national exhaustion (i.e. $q^u \geq q^d$*).*

The intuition for part (a) of Proposition 4 is clear – if the firm chooses to serve the South even when if it is imitated or if the North-South quality gap is small, the South has no incentive to protect intellectual property. Part (b) 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.

5 Equilibrium policies and welfare

The analysis in this section proceeds as follows. We first characterize equilibrium policy outcomes. Next, we discuss global welfare. This is followed by a comparison of equilibrium outcomes with the first-best. Finally, we draw out the implications of requiring the South to shut down imitation. The goal of this exercise is to shed light on the effects of a strengthening of IPR protection in developing countries that was called for by the WTO's TRIPS agreement.

5.1 Policy equilibrium

Putting together the best responses of each region yields the sub-game perfect policy equilibrium of the game:

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

(a) If $\varphi \leq \varphi^{ui}$ *the policy equilibrium is* (IE,N).

(b) Suppose $\varphi^{ui} < \varphi \leq \varphi^{u}$*. The policy equilibrium is* (NE,N) *when* $q \leq q^{u}$ *whereas it is* (IE,P) *otherwise.*

(c) If $\varphi^{u} < \varphi \leq \varphi^{di}$*, the policy pair* (NE,N) *obtains.*

(d) If $\varphi^{di} < \varphi \leq \varphi^{d}$*, both* (IE,N) *and* (NE,N) *are policy equilibria when* $q < q^{d}$ *– i.e. the North is indifferent between its policy options while the South does not protect if* $q < q^{d}$*; otherwise, the outcome is* (NE,P).[10]

Part (a) of Proposition 5 says that if the fixed costs of exporting are quite small (i.e. $\varphi \leq \varphi^{ui}$) in the sense 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 international exhaustion 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 sold only in the South: Northern openness to parallel imports ensures that competition that occurs in the Southern market as a result of imitation is also passed on to the North.

Except for the parameters referred to in part (a), 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 by choosing to not implement its preferred policy. From the firm's viewpoint, national exhaustion on the North's part and a prohibition of imitation on the South's part are partial *policy substitutes* in the sense that both policies give it greater room for exercising the monopoly power conferred by its intellectual property. However, the costs of implementing these two types of policies fall on different regions: conditional on the firm exporting, implementing national exhaustion of IPRs 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 good produced by the firm. For example, if $\varphi^{ui} < \varphi \leq \varphi^{u}$ and $q \leq q^{u}$, the South chooses to permit local imitation since the quality gap between the imitation and Northern

[10] If $\phi^{d} \leq \phi$, South does not protect intellectual property while North's policy is irrelevant since its firm chooses not to export.

original is not large and the North ends up choosing national exhaustion to ensure that its firm sells in the South. In this situation, the North's equilibrium policy recognizes that the South has no incentive to protect intellectual property since imitation does not suffer from a large quality gap (i.e. $q \leq q^u$). Furthermore, since $\varphi^{ui} < \varphi \leq \varphi^u$, under international exhaustion the firm drops the Southern market in order to charge a high price in the more lucrative the Northern market, an outcome that is detrimental for overall Northern welfare. Thus, for this range of parameters, not protecting IPRs results in more competition as well as greater variety in the Southern market because, in equilibrium, two quality levels are sold in the South as opposed to one. However, when the North-South quality gap exceeds q^u the North recognizes that the South has an incentive to protect IPRs to induce the firm to sell its high quality good. As a result, the North chooses international exhaustion to induce uniform pricing by its firm, thereby securing higher aggregate welfare for itself.

If $\varphi^u < \varphi \leq \varphi^{di}$, international exhaustion is no longer a viable option for the North since this policy leads its firm to not export regardless of what the South does. Recognizing the fact that the North has an incentive to implement national exhaustion to induce the firm to export, the South chooses not to protect intellectual property.

Finally, over the range $\varphi^{di} < \varphi \leq \varphi^d$, Northern policy matters only if the South protects intellectual property. The Southern decision in turn is determined by the North-South quality gap. When this gap is not too large (i.e. $q < q^d$), the South permits imitation and the firm refrains from exporting. However, when $q > q^d$, the North ends up choosing national exhaustion and the South protects intellectual property: when the fixed cost of exporting and the North-South quality gap are both large, both policies end up being favorable to the firm.

5.2 Global welfare

As might be expected, each region's policy has a bearing on aggregate global welfare which is defined as the sum of each country's welfare under the alternative regimes that can arise:

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

We have:

Proposition 6. *(i) Holding constant the firm's export decision, imitation increases aggregate global welfare under all possible regimes:* $ww^{ri} > ww^r$ *for* $r = a, d,$ *or* u.

(ii) Holding Southern IPR policy fixed, uniform pricing is the most desirable regime from a welfare perspective while autarky is the least desirable: $ww^u > ww^d > ww^a$ *and* $ww^{ui} > ww^{di} > ww^{ai}$.

(iii) Price discrimination coupled with Southern imitation is preferable to uniform pricing in the absence of imitation iff the North-South quality gap falls below the threshold q^e: $ww^{di} > ww^u$ *iff* $q < q_e$.

(iv) Price discrimination in the absence of Southern imitation is preferable than autarky coupled with imitation iff the quality gap exceeds the threshold q'_w where $q'_w = 4/3$: $ww^d > ww^{ai}$ *iff* $q > q'_w$.

Parts (i) of Proposition 6 can be understood as follows. If the firm does not export, imitation increases Southern welfare by ensuring that at least a low quality version of Northern good is supplied locally. On the other hand, given that the firm exports, imitation makes the South better off by lowering price and increasing variety – those consumers that value quality relatively less obtain access to the cheaper and imitated good. Of course, the effect of imitation on the North is always negative since it lowers the firm's export profit. Finally, holding the firm's export constant, aggregate global welfare increases due to imitation: if the firm sells in the South, imitation moves price closer to marginal cost whereas when it does not, imitation has no effect on the North while it strictly increases Southern welfare by ensuring that local consumers at least have access to a lower quality version of the firm's good.

Since global sales of the firm under price discrimination and uniform pricing are the same (Lemma 1), the welfare comparison of the two regimes depends only on the allocation of sales across the two markets. The second statement of Proposition 6 holds because, by equalizing prices internationally, uniform pricing ensures an efficient allocation of global sales.[11] By contrast, under price discrimination, the existence of an international price differential creates an inefficiency in that aggregate welfare can be increased by shifting some sales from the South to the North till prices in the two regions are equalized, as they are under uniform pricing. The logic for the second set of inequalities reported in part (ii) of the Proposition (i.e. $ww^{ui} > ww^{di} > ww^{ai}$) is the same since Lemma 1 continues to hold post imitation.

Part (iii) of Proposition 6 is quite intuitive: it says that, from an aggregate welfare perspective, price discrimination post imitation is preferable to uniform pricing in the absence of imitation (i.e. $ww^{di} > ww^u$) when the North-South quality gap falls below the threshold q^e.

Recall from Lemma 3 that this quality threshold q^e is decreasing in degree of asymmetry between the two markets (as captured by the parameter η and μ). Intuitively, the efficiency gain achieved by eliminating the price wedge between the two regions increases when markets become more asymmetric, making uniform pricing more attractive.

Finally, consider part (iv) of Proposition 6 which compares world welfare under a regime where imitation occurs in the South and the firm refrains from exporting with international price discrimination in the absence of imitation. The latter regime is preferable from a global welfare perspective so long as the North-South quality gap is not smaller than $q'_w = 4/3$.

[11] Of course, the South is better off under discrimination but aggregate world welfare is higher under uniform pricing.

5.3 Welfare properties of equilibrium outcomes

We are now in a position to compare equilibrium policy outcomes reported in Proposition 5 (which assumes $\varphi^{di} \geq \varphi^u \Leftrightarrow q \geq q^e$) with the first-best outcome reported in Proposition 6. First, when fixed costs of exporting are so small that the exporting decision of the firm is policy invariant, equilibrium policies are first-best: the North chooses international exhaustion and the South does not protect intellectual property. As noted before, in such a policy equilibrium, the benefits of imitation induced competition also accrue to the North due to its openness to parallel imports.

Once fixed costs start to matter, this harmony between equilibrium policies and global welfare is no longer guaranteed. Consider the range $\varphi^{ui} < \varphi \leq \varphi^u$. Propositions 1 and 2 indicate that over this range, equilibrium policies are globally optimal iff $q^u = q^w$, a relationship that yields a downward sloping zero contour in the (η, μ) space. Above this contour, i.e. for most of the relevant parameter space it turns out that $q^u > q^w$. Under such a scenario, over the range $(1, q^w]$ the equilibrium policy vector is (NE,N) and that is socially optimal. When $(q^w,\ q^u]$, the policy outcome is the same but it is no longer socially optimal; instead social optimality calls for the policy vector (IE,P). Finally, when $q > q^u$, the policy outcome is (IE,P) and it also socially optimal.

Over the range $\varphi^u < \varphi \leq \varphi^{di}$ the equilibrium policy vector (NE,N) is socially optimal whereas such is not necessarily the case when $\varphi^{di} < \varphi \leq \varphi^d$: over this range the equilibrium outcome (NE,N) is socially optimal only if $q > q^d$ since social optimality calls for (NE,P) when the North-South quality gap exceeds q^d.

Note that under both (NE,N) and (NE,P), consumer surplus in the North is the same since the firm charges the price p_N^d in either case. Thus, relative global welfare under the two regimes depends upon a comparison of the joint welfare of the firm and Southern consumers. But since Southern policy ignores the firm's profits, it is clear that its choice regarding protection of intellectual property is sub-optimal. Indeed, from part (iv) of Proposition 5 we know that Southern choice aligns with the globally optimal policy only when $q > q^d = 4$. Thus, over the interval (q'_w, q^d), it is globally optimal for the South to protect the firm's intellectual property but the South chooses not to do so in equilibrium.

5.4 Effects of TRIPS: shutting down Southern imitation

In this section, we 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 IPRs.

Suppose the South no longer has the option of permitting imitation while the North is free to pick its preferred IPR regime between national and international exhaustion. From Proposition 5 we know that if the South protects intellectual property, then the North chooses international exhaustion iff $\varphi \leq \varphi^u$; otherwise it opts for national exhaustion. 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 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 IPRs in the South confers a pure welfare loss on the South while having no effect on the Northern economy.[12] 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 $\varphi^{di} < \varphi \leq \varphi^d$. 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 $q > q^d$, 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 international exhaustion. Thus, the policy vector under TRIPS is the same as that without it when $q > q^d$ implying that TRIPS has no effects on the world economy. However, when $q \leq q^d$, TRIPS enforcement alters the policy vector from (NE,N) to (NE,P). This policy change reduces Southern welfare by making the high quality good more expensive (its price in the South increases from p_S^{di} to p_S^d); has no effect on Northern consumers since the price remains at p_N^d in the North; increases the firm's profit but reduces global welfare due to the increase in the firm's mark-up in the South. The same conclusions hold over the parameter range $\varphi^u < \varphi \leq \varphi^{di}$ since here too TRIPS enforcement alters the policy equilibrium from (NE,N) to (NE,P).

TRIPS enforcement causes the sharpest change in the global policy environment when $\varphi^{ui} < \varphi \leq \varphi^u$: over the 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 induce its firm to export, the North reverses its policy regarding the exhaustion of IPRs. 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}):

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

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

[12] One 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.

the price impact of the reversal in the North's policy from national to international exhaustion 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, its common price in both markets under international exhaustion.

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

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

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. What is the net effect on the firm? It is straightforward to show that

$$\Delta\pi^T > 0 \text{ iff } q < q^e$$

In other words, for the firm to benefit from the TRIPS induced global policy reversal, the North-South quality gap needs to fall below the threshold q^e. Intuitively, the freedom to price discriminate internationally is more precious to the firm than protection from imitation when the imitated good suffers from a large quality disadvantage. Furthermore, since q^e is decreasing in both η and μ, the higher the degree of asymmetry between markets, the *less* likely it is that the TRIPS induced policy reversal benefits the firm.

Consider now the effect on Northern consumers of the TRIPS induced policy reversal. Since the imitated good cannot be sold in the North, the effect on Northern consumers is simply that the price facing them drops from p_S^d to p^u. Furthermore, it is straightforward to show that aggregate Northern welfare increases due to the TRIPS induced policy reversal. Recall from part (*iii*) of Proposition 6 that the TRIPS induced policy reversal from (NE,N) to (IE,P) increases world welfare iff $q > q^e$. This, together with the result that $\Delta\pi^T > 0$ iff $q < q^e$ implies that the firm loses from TRIPS induced policy reversal precisely when aggregate world welfare increases because of it.

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. Finally, part (*i*) of Proposition 6 informs us that global welfare declines as well since the mark-up of the firm increases globally.

We collect the key conclusions into the following proposition:

Proposition 7. *Suppose $q > q^e$. Then a prohibition on Southern imitation increases global welfare if and only if it causes a reversal in the global policy environment from* (NE,N) *to* (IE,P).

It is worth emphasizing once again that, in this model, the reversal in Northern policy from national to international exhaustion is the fundamental reason that the TRIPS mandated shut-down of the Southern industry increases global welfare.

What are the implications of TRIPS when $\varphi^{di} < \varphi^u \Leftrightarrow q < q^e$ – i.e. when the firm values protection from imitation more than the freedom to price discriminate? To answer this question, we first need to describe equilibrium policy outcomes under this scenario. In this regard, we can state:

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

(a) If $\varphi \leq \varphi^{ui}$ the policy equilibrium is (IE,N).

(b) If $\varphi^{ui} < \varphi \leq \varphi^{di}$ the policy equilibrium is (NE,N).

(c) If $\varphi^{di} < \varphi \leq \varphi^u$, the policy equilibrium is (IE,P) *when $q \leq q^u$ whereas both* (IE,N) *and* (NE,N) *are policy equilibria when $q > q^u$.*

(d) If $\varphi^u < \varphi \leq \varphi^d$, the policy equilibrium is (NE,N) *when $q < q^d$; whereas it is* (NE,P) *when $q > q^d$.*

Now consider the effects of TRIPS when $q \leq q^e$. Since the analysis follows the case of $q > q^e$, we provide a brief discussion as opposed to a comprehensive one. 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). Over the range $\varphi^{ui} < \varphi \leq \varphi^{di}$, TRIPS enforcement causes a reversal in the global policy environment from (NE,N) to (IE,P). However, we know from Proposition 6 that such a policy reversal lowers world welfare when $q \leq q^e$. In other words, the policy reversal lowers world welfare precisely when the firm values protection from imitation more than the freedom to price discriminate. Over $\varphi^{di} < \varphi \leq \varphi^u$, TRIPS has no effects when $q \leq q^u$ whereas it can cause a policy reversal when $q > q^u$, again with the same effects. Finally, over $\varphi^u < \varphi \leq \varphi^d$, TRIPS lowers world when $q < q^d$ by causing the same type of policy reversal whereas for $q > q^d$ it has no effect on world welfare since the policy vector remains unchanged at (NE,P) – the South protects IPRs anyway and the North retains its policy of national exhaustion to ensure that its firm exports to the South.

6 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 IPRs and Southern policy regarding the protection of (Northern) 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 IPRs 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 decision making regarding pricing and exporting under alternative policy configurations. In this regard, we find that the North has a stronger incentive to adopt national exhaustion when the South does not protect IPRs relative to when it does. On the other side, the South is less likely to protect IPRs when the North adopts international exhaustion. 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 international exhaustion while the South is better off not protecting Northern intellectual property, 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 national to international exhaustion. 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 and aggregate Northern welfare increases as does world welfare provided the quality gap between Northern original and the Southern imitation exceeds a certain threshold. But if the shut down of Southern imitation does not lead to a reversal in Northern policy, world welfare necessarily declines due to TRIPS enforcement.

7 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,

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

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

Let

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

Simple differentiation shows that $\Delta\varphi$ is increasing in q and is zero at $q = q^e$ so that

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

where

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

Next, we have

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

Proposition 1

Given price p, Northern consumer surplus equals

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

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

$$cs_N^u = \frac{\eta}{2}\frac{(q\mu - p^u)^2}{q\mu} \text{ and } cs_N^d = cs_N^a = \frac{\eta}{2}\frac{\left(q\mu - p_N^d\right)^2}{q\mu} \tag{12}$$

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

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

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 IPRs, 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 IPRs, 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 $\varphi^{ui} < \varphi \leq \varphi^{di}$, national exhaustion is preferable for the North: $w_N(\text{NE},\text{N}) - w_N(\text{IE},\text{N}) = w_N^{di} - w_N^a = \pi_S^{di} - \varphi^{di} \geq 0$ since $\varphi \leq \varphi^{di}$. However, when $\varphi > \varphi^{di}$, the North is indifferent between its policy options since its firm does not export regardless of the nature of its policy: $w_N(\text{NE},\text{N}) = w_N(\text{IE},\text{N}) = w_N^a$ when $\varphi > \varphi^{di}$.

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

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

Proposition 4

We have

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

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 (12) and π^u in equation (7) and $cs_S^u = cs_N^u|_{\eta=\mu=1}$. Similarly, we have

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

Direct calculations yield

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

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

$$q = q^e = \frac{\eta+\mu}{\eta(\mu-1)^2}$$

Under international price discrimination, world welfare equals

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

which implies

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

Next, we have

$$ww^{ai} = \frac{\eta\mu q}{4} + \frac{\eta\mu q}{8} + \frac{1}{2}$$

Using which we calculate

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

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