Trade Policy, Market Leaders and Endogenous Competition Intensity

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Abstract

It is well known that tariff policy can alleviate the negative consequences of breaching intellectual property rights by foreign firms. Yet, the positive effect of tariff protection is thought to benefit firms at the expense of consumers (at least in the short run). Using a setup in which the intensity of market competition is endogenous we argue that consumers can benefit from tariffs even in the short run. A high level of tariff protection alters the firms' cost efficiency distribution and induces tougher market competition. Consumers benefit from tariff policy and governments that assign a high enough weight to the consumer surplus set positive tariff levels. Under protection the innovation level remains the same as under free trade but the average industry efficiency increases.

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1. INTRODUCTION

It has been shown that in imperfectly competitive markets tariff policy can alleviate the negative consequences of breaching the intellectual property rights by Southern firms on a Northern country's social welfare. Yet, the overall positive effect of tariff protection is achieved at the consumers' expense (see for instance Brander and Spencer 1984, Dixit 1984 and 1988, Helpman and Krugman 1989, or Brander's 1995 survey).[2]

These results have been derived in setups that model the imperfect competition using either Bertrand or Cournot type of competition (see Brander 1995, for an extensive survey of these literature), or, to much lesser extent, Stackelberg leadership (see, for instance, Hwang and Schulman, 1992). In addition, the initial asymmetries between the Northern and Southern firms in these models have no impact on the nature of market conduct (or, in jargon, the "toughness of competition" is given exogenously). However, there is convincing evidence that the presence of firm asymmetries might affect the market conduct in two ways. First of all, the nature or toughness of market competition might be endogenously induced by the level of cost, capacity or capital asymmetry that exists among firms (see Boone 2002 and 2004, Rothschild 1999, Compte, Jenny and Rey 2002, and Vasconcelos 2002). Secondly, firm differences may induce a firm or a group of firms to assume the role of the leader in the market. Among others, Rotemberg and Saloner (1990) and Deneckere, Kovenock and Lee (1992), have shown that, respectively, with asymmetric information the better informed firm can become leader, and with switching costs the firm with the biggest share of loyal consumers can become leader. In addition, van Damme and Hurkens (1999) have shown that in the presence of cost asymmetries the most cost efficient firms have incentives to assume a leadership role in the market.

When firm asymmetries determine the market conduct and market leadership, positive tariffs (as well as some other non-tariff barriers like imposing standards, regulations, etc. that confer a better position to domestic firms and have similar effects on foreign firms) may play additional roles than in traditional models of imperfect competition. and therefore their impact on consumers, firms and social welfare might be different than in those models. We show that this is indeed the case using a setup in which a group of firms play a role of leaders and firm asymmetries determine the strength of market competition. Our results suggest that tariffs (or non-tariff barriers) set to protect domestic firms may depress the market price and increase

[2] These results hold at least in the short run. However, if the tariff policy enhances domestic firms' incentives to innovate, consumers may benefit in the long run.

consumer surplus.

We introduce asymmetries as differences between firms' efficiency levels. We model a situation in which both domestic and foreign firms supply a domestic market. Domestic (Northern) firms are more cost efficient due to their ability to innovate. Foreign (Southern) firms do not have such ability but they copy, although imperfectly, the results of Northern R&D. To protect domestic producers against the negative externality the Northern government might introduce tariff duties.

The government's decision is based on a social welfare function that generally assigns different weights to its three components (domestic firms' profits, consumer surplus, and government revenue). A very frequent implicit assumption in the trade literature is that all three weights are equal. However, recent EU experts' discussion on competition policy (see the European Commission report by Rey, et al. 2005) stresses the importance of consumer welfare. Therefore, we allow for the weight attached to consumer surplus to be higher than the corresponding weights of domestic firms' profits and tariff revenue (when trade policy appears in the form of tariff). The situation in which all of the components of social welfare have equal weights is a special case of our specification.

Domestic prices are determined in a supergame where domestic firms are leaders[3] and the degree of firm cost asymmetries determines the intensity and the nature of competition. We assume that domestic firms collude (implicitly) and coordinate on the price charged in the market out of all incentive compatible prices. It is then also incentive compatible for foreign firms (if they are active at all in the market) to follow this price. If they do not, the domestic firms retaliate and switch to the non-cooperative Nash equilibrium outcome from then onwards.

When firms are asymmetric it is more difficult to sustain a fully collusive outcome in supergames (Schmalensee, 1987). Yet, when a collusive outcome exists the Folk theorem predicts that there are a multitude of potential equilibria. Out of the pool of feasible equilibria Boone (2004) argues that casual observation and theoretical and empirical evidence suggests that when there are significant differences in efficiency levels among players, the most efficient players act aggressively and impose an outcome that is more beneficial for them. Therefore he proposes an equilibrium refinement that focuses on outcomes Preferred by

[3] Two characteristics of the market we study justify this assumption. First, domestic firms innovate and as a result they have lower unit costs of production than the foreign firms (van Damme and Hurkens, 1999). Second, the mere fact that domestic firms are more familiar with the local context might provide them with enough incentives to assume the leadership role in the market (Kirman and Schueller, 1990).

Efficient Players (PEP).[4] The strategies associated with the PEP refinement distinguish between two types of deviations: on the one hand, a firm that in secret slightly undercuts the current price to gain the whole market at the expense of its opponents; on the other hand, a firm that reduces the price to one where all the remaining firms are actually better off. In the former case the firms revert to playing Bertrand-Nash from then on, in the latter case the remaining firms reduce their price to the one charged by the deviator (leader).

When the collusive outcome is modelled using the PEP refinement, the toughness of market competition is driven endogenously by the level of heterogeneity that exist among firms (more precisely, by the distribution of firms' unit costs). If firms have similar levels of cost efficiency, there is a "balance of power" inducing firms to behave "softly" towards their rivals and charge high prices. In this situation any price undercut is perceived as the first type of deviation and thus leads to the Bertrand Nash outcome. On the contrary, if some firms are much more efficient than their competitors, it could pay off to price aggressively and drive the less efficient firms out of the market. The price undercut is then perceived as a second type of deviation and is not met by retaliation from the surviving firms (the firms that cannot survive at the new lower price cannot retaliate either). By enacting a tariff, or by introducing new standards and regulations, in this context the government can change the balance of power in the market and induce either a softer or a more aggressive pricing strategy.

We show that when prices are determined in the supergame described above, the protection may preserve or raises consumer's welfare relative to free trade. Due to the trade policy, the unit cost differential between domestic and foreign firms increases, triggering a more aggressive pricing strategy. Put into the international trade jargon, there is a tremendous improvement in terms of trade so that even domestic consumers benefit from protection. Since trade protection has a positive effect on consumers, the government is more likely to protect its markets when it assigns a higher weight to consumer surplus (this result is stronger for non-tariff barriers where the concern for tariff rent extraction is not an issue[5]). This is in contrast with perfectly competitive environments or in imperfectly competitive ones in which firms compete *à la* Cournot or Bertrand where the higher is the importance the government assigns to the consumer surplus, the less likely it is to enact tariff protection.

Under a designed policy in our model, domestic producers invest in innovation as much as under free trade and get the same level of profit as in the case of free trade. The gain

[4] For examples and arguments on the plausibility of this refinement see Boone (2004).

[5] The results pertaining to the instances in which the government uses non-tariff barriers are inferred from the case of tariff protection in which the weight for tariff revenue is set to zero

in market share of the domestic firms associated with entry deterrence exactly offsets the negative effect that a lower price (compared with the collusive, monopoly price) has on domestic firms' price mark-up, and through it, on profits. Since only the low cost firms end up producing in the market, average efficiency in the industry increases. Thus, the trade protection is set in order to induce the most competitive (but still collusive) market outcome. It does so, by increasing the perceived cost inefficiency of the foreign rivals, offering therefore incentives to domestic producers to price aggressively and deter foreign entry. Consequently, the policy induced equilibrium is in line with Sutton's (1991) notion of "toughness of price competition". Namely, the higher market concentration implies tougher price competition compared with the lower market concentration and softer intensity of competition when all (domestic and less efficient foreign) firms are active in equilibrium. This is because the threat that the remaining firms will enter the market presses the domestic firms to keep prices low. Much like in Etro (2006) faced with the threat of entry, firms that act as leaders in the market behave aggressively and undertake actions (such as pricing aggressively in our model or overinvestment in strategic variable in the case of Etro) that lead them to charge lower prices than their followers.

1.1. Related literature

Related results using supergames were previously obtained by Davidson (1984), and Rotemberg and Saloner (1989). They show that when deviators are not effectively punished, the government through its policy can destroy the cartel leading to a more competitive market outcome characterized by lower prices and enhanced consumer welfare. Thus Davidson (1984) analyzes the impact of a tariff on a market with no leaders, where collusion leads always to monopoly prices, and deviations from collusion only trigger Cournot competition. In this context, tariffs shrink the size of the pay offs that collusive firms share, increasing meanwhile domestic profits under Cournot competition. Therefore when the tariff is high, collusion cannot be sustained anymore. Using maximal punishment strategies, Rotemberg and Saloner (1989) show that after the introduction of a quota, the price in the protecting country may decrease. Under a quota, punishment becomes less effective as cheating rivals earn positive profits, making collusion less likely. However, this result does not extend to tariff protection where cheating is effectively punished bringing zero future profits. Unlike Davidson (1984) and Rotemberg and Saloner (1989) in our setup deviators are effectively punished. Yet higher tariffs result in lower prices and higher consumer surplus by inducing the most competitive *collusive* outcome.

Also related results were obtained in setups other than supergames. Kabiraj and Marjit (2003) study a North-South trade situation in which IPR is not an issue and moreover, the target market is located in the Southern country. They show that tariff protection has a positive impact on prices and the consumer surplus providing that it induces foreign firms to transfer its superior technology to its domestic rival. On the contrary, in our model tariff protection is a policy that in the end prevents technological transfer. Venables (1985) also finds that in a two country setup, with no spillovers and no R&D investment, the unilateral introduction of a tariff protection leads to a price reduction and to a higher social welfare. Much like in our model, this is due to the fact that in the country that sets the tariff only those firms that can produce at the lowest costs for the economy – the domestic firms – will supply the market. However, unlike in our model, after the tariff protection is introduced, the number of active domestic firms increases (this result in fact holds only when there is free entry and exit).

The paper is organized in the following way. First we introduce the core model and discuss the role of government intervention. Next, we describe the pricing game and its equilibrium. In Section 2.2 we describe the market equilibrium under free trade. The case of tariff protection and the corresponding market outcome is discussed in Section 2.3. Main findings and conclusions are presented in Section 3.

2. THE SET-UP

We focus on the interaction between domestic and foreign firms that takes place in the domestic (Northern) market. Consider an industry in which N (≥ 2) "domestic" firms located in the North and n "foreign" firms located in the South produce a homogenous good. Domestic firms posses enough knowledge and resources to conduct process R&D activities. Innovation has an impact on the production efficiency rather than on the type or on the quality of the provided goods.[6] We assume that there is no "leakage" of information between domestic firms or, alternatively, the IPR are perfectly enforced in the domestic country. Also, we assume that all domestic firms have the same knowledge and capabilities to innovate. Domestic firms have constant marginal costs equal to $C(x)$ if an amount x is invested in R&D (where $C() > 0$, $C'() < 0$, $C''() \geq 0$). Foreign firms have no capabilities to innovate on their own. Yet, they can imitate the innovation of domestic firms and adapt it to their production process. Therefore they have constant marginal costs equal to c(x), where x is the R&D investment by domestic firms (c() > 0, c'() < 0, c''() ≥ 0). We focus on the case in which spillovers are imperfect so that C'(x) < c'(x) for each x > 0. Finally, we assume that in equilibrium domestic firms are at least as efficient as foreign firms. Because spillovers are imperfect, a sufficient condition for this is C(0) ≤ c(0).

First to act in the market are the Northern firms which invest in cost reducing innovation. After the innovation is in place, in the second stage, the domestic government decides whether to introduce a tariff policy or to allow for free trade. Government's decision is based on a welfare function that assigns different weights to its components, with the highest one being attached to the consumer surplus (however, we do not exclude the case when the weights are all equal). We work with a more general social welfare function than is usually the case in order to contrast our results with the existing ones in the literature. More precisely, we want to show that enhancing consumer surplus can be the main rationale for introducing strategic trade policies.

When the government sets a tariff $t \geq 0$ for foreign goods, the marginal costs of the foreign firms becomes c(x) + t (note that in the case of non-tariff barriers, the symbol "t" stands for the increase in foreign unit costs due to imposed domestic standards regulations, etc). Once there is a decision on the tariff policy, as long as the market exists, firms repeatedly meet in the market. Each period there is a probability δ > 0 that the market will exist in the next period (in other words, the expected lifetime of the product produced by these firms equals 1/(1-δ)). We assume that the size of the Southern market is negligible compared with the size of the Northern market and that the two markets are segmented. Consequently, firms' decisions are mostly based on the interactions that take place in the domestic market.[7]

Prices and quantities in the market are determined in a supergame where domestic firms act as market leaders. We assume that domestic firms collude implicitly and coordinate on the price charged in the market.[8] Foreign firms either follow this price or do not enter the market. The active participants in the market equally share the total demand. To chose among the many possible equilibria we use the refinement proposed by Boone (2004) and therefore

[6] Spence (1984) has noticed that, "if one thinks of the product as the services it delivers to the customer (in the way that Lancaster pioneered), then product development often is just cost reduction" (p.101).

[7] Much like Loury (1979), we assume that before starting to innovate, firms have to sink upfront their R&D investment. In our context we could think at a situation where domestic firms have to make an irreversible investment in a research lab that allows them to first increase their cost efficiency and then to maintain this efficiency level over many periods.

[8] The collusion could also be explicit. However, explicit collusion is prohibited by law. In addition, with explicit collusion the best outcome for firms is to charge the monopoly price and then share the monopoly profit by using adequate transfer schemes.

we assume that the domestic firms coordinate on the price that maximizes their own profits. In our model this leads to two possible outcomes – one in which all firms in the market charge the monopoly price and one where domestic firms charge the highest price that still keeps the foreign firms out of the market. Domestic demand for the homogenous good is given by D(*p*) where D() is continuous and twice differentiable function, with $D'(p) < 0$, $D'(p)(p\text{-}C) + D(p) > 0$ for any p in $(0, p^m)$ and $D''(p) < -2D'(p)/p$ for any $p > 0$ (these assumptions ensure that the profit function is concave for any constant marginal cost).

As noted above, we assume that the government's decision on the tariff policy follows domestic firms' R&D investment, but precedes the pricing game. This seems a reasonable timing assumption in this context due to the fact that, in general, the governments and firms are likely to differ in their ability to commit to future action (see Neary and Leahy 2000). In particular, in our setup, the firms will be able to lobby for tariffs if they can show their R&D efforts have been illegally appropriated by foreign firms. Moreover, trade policy is by its nature of second (or even third-best) character, and it is plagued with the time consistency problem (see, for instance, Staiger and Tabellini 1987, 1989, and 1999). The above timing takes into account these phenomena and the tariff that we calculate below is, in fact, a time consistent tariff (more specifically, we calculate the subgame perfect tariff since subgame perfection implies time consistency but not necessarily, vice versa, see Fersthman 1989).

2.1. The pricing game

Using backward induction, we start by considering the market outcome when domestic and foreign firms compete in prices. At this stage domestic firms take the investments, *x*, and the tariff, *t*, as given. Hence, costs equal C and (c + *t*) for domestic and foreign firms, respectively. If domestic firms set a price *p* (not exceeding the monopoly price of domestic firms, $p^m = \text{argmax}_p\, D(p)(p - C)$, such that both domestic and foreign producers can enter, then incentive compatibility (IC) requires

$$D(p)(p - C)/(N+n) \geq (1\text{-}\delta)\, D(p)(p - C) + \delta * 0$$

$$D(p)(p - c\text{-}t)/(N+n) \geq (1\text{-}\delta)\, D(p)(p - c\text{-}t) + \delta * 0$$

If a domestic or a foreign firm deviates by slightly undercutting its opponents at the current price *p*, it gains the whole market. This leads to profits $D(p)(p - C)$ if the undercutting is done by a domestic firm, and to $D(p)(p - c\text{-}t)$ if the undercutting is done by a foreign firm.

This profit is only made one period, because after that all other firms retaliate and charge the Bertrand-Nash price (p = C) which leads to zero profits. If the firm cooperates its demand has to be shared with all the other firms. Hence a firm's output equals D(p)/(N+n). We assume that δ is close enough to 1 that this type of collusion can be sustained. Thus we assume that $\delta \geq 1 - 1/(N+n)$. As shown below, when the government assigns a high enough weight to the consumer benefit, this type of collusion is not optimal for domestic firms.

For $\delta \geq 1 - 1/(N+n)$ any price is sustainable. Hence, if domestic firms decide to set a price such that foreign firms sell on the domestic market as well, they will set a price equal to their monopoly price, p^m. As long as the market is shared with N+n firms, any higher or lower price reduces their profits. In this sense, the monopoly price stands out and even without explicit collusion the firms may be able to coordinate on this price.

Alternatively, the domestic firms may decide to set a price p that is lower or equal with the limit price to keep the foreign firms out. Since we assume that the foreign firms have no specific sunk costs to enter the domestic market, the limit price equals $p^p = c+t$.[9] The limit price is IC for the domestic firms if

$$D(c+t)(c+t - C)/N \geq (1-\delta)\ D(c+t)(c+t - C) + \delta*0$$

which boils down to $\delta \geq 1 - 1/N$. This requirement is satisfied if the earlier condition on δ holds. As before, given that the domestic firms want to keep the foreign firms out, the most profitable price at which they can deter foreign entry is $p^p = c+t$. For a lower price also keeps the foreign entrants out but leads to lower profits if $c+t < p^m$, which we assume to be the case.[10]

Hence domestic firms can choose between two relevant prices: the monopoly price p^m and the limit price $p^p = c+t$. We assume that they can coordinate on the one of these two prices that gives the highest profits. This can be because in this context the two choices stand out, firms can figure out themselves which of these prices maximizes their expected discounted profits. Thus, in our context, even implicit collusion may be enough to end up

[9] We make this assumption to keep notation simple. However, it is easy to incorporate a sunk entry cost $f > 0$ for foreign firms. Suppose at a price p the foreign firms are supposed to stay out of the market. Now one firm deviates and enters. In the period in which it enters, it slightly undercuts the domestic firms and gains the whole market. From the next period onward, all domestic firms will play Betrand-Nash to punish the deviation of entering the market. Hence a price p makes entry unprofitable if $D(p)(p - c\text{-}t) - f = 0$. This implicitly defines the limit price in case of a sunk entry cost.

coordinating on one of the two prices.

This discussion leads to the following result.

Lemma: *Domestic firms set a price equal to the limit price* $p^p = c+t$ *if and only if*

$$D(c+t)(c+t-C)/N \geq D(p^m)(p^m - C)/(N+n)$$

Otherwise, they set the monopoly price p^m.

Several things follow from this lemma. First, through the tariff policy the government can induce domestic firms to coordinate either on the monopoly or on the limit price. As long as $c+t$ is kept below p^m, an increase in the level of tariff protection raises the individual profit domestic firms earn when deterring foreign entry. An increase in the level of tariff weakens the competitive position of the foreign firms, destroying the balance of power in the market, and therefore making the aggressive pricing strategy more profitable. When the tariff is high enough, domestic firms charge the limit price and deter foreign entry. Second, the level of spillovers also influences the outcome of the pricing stage. Spillovers work towards reducing unit cost heterogeneity and thus induce less aggressive pricing as they increase.

2.2. Free trade – outcome

We first consider the case where the government can commit to free trade, i.e. $t=0$. After firms have invested x in R&D, depending on the level of technological spillovers two things can happen. First, knowledge spillovers are small enough, and thus, the difference $c(x)$-$C(x)$ is big enough that domestic firms set the limit price $p^p = c(x)$ to keep foreign firms out of the market. Second, spillovers are big, the cost difference is therefore small, and firms accommodate entry by setting the monopoly price p^m. If

$$max_x \{D(c(x))(c(x) - C(x))/[N(1\text{-}\delta)] - x\} \geq max_x \{D(p^m(x))(p^m(x) - C(x))/[(N+n)(1\text{-}\delta)] - x\}$$

domestic firms will deter foreign entry; otherwise foreign entry is accommodated.

We are interested in the situations in which IPR violation is the main rationale for introducing tariff protection. Therefore we focus on the case where in the absence of spillovers ($c=c(0)$ irrespective of the level of x chosen by domestic firms) under free trade

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[10] This assumption is without loss in generality. The government will never set a tariff so high that $c+t \geq p^m$ (in fact, the government uses the tariff to get a lower price than the monopoly price). Further, the case where $c > p^m$ is not particularly interesting since then the foreign competition is not relevant anyway.

domestic firms deter foreign entry

$$max_x \{D(c(0))(c(0) - C(x))/[N(1\text{-}\delta)] - x\} \ \geq \ max_x \{D(p^m(x))(p^m(x) - C(x))/[(N+n)(1\text{-}\delta)] - x\}$$

If this is the case, then as the protection of intellectual property rights deteriorates, at some point it becomes optimal for domestic firms to charge the monopoly price and accommodate foreign entry. For when IPR deteriorate, the left hand side of the inequality decreases. At the extreme, when the IPR are entirely breached, no matter how much domestic firms invest in R&D, they cannot create any difference between their costs and the costs of the foreign firms. In that case, domestic firms charge the monopoly price and accommodate foreign entry. Thus for perfect imitation, the above inequality holds with different sign. By continuity then, for small levels of spillover domestic firms deter foreign entry while for high levels of spillover domestic firms accommodate foreign entry.

To formalize this, it is convenient to think of the function $c(x)$ as $c(x) = \varphi c + (1\text{-}\varphi)C(x)$ where $c=c(0)=C(0)$ and $\varphi \in [0,1]$.[11] The parameter φ captures how well intellectual property is protected: $\varphi = 1$ implies full protection while $\varphi = 0$ implies no protection at all. The above discussion leads to the following result (proofs are delegated to the appendix)

Proposition 1. There exists a critical value φ^*, where $1 > \varphi^* > 0$ such that for $\varphi < \varphi^*$ domestic firms accommodate foreign entry and for $\varphi^* < \varphi$ domestic firms deter foreign entry.

The level of φ^* is implicitly defined by

$$max_x \{D(c(x))(c(x)\text{-}C(x))/(N(1\text{-}\delta)) - x\} \ = \ max_x \{D(p^m(x))(p^m(x) - C(x))/[(N+n)(1\text{-}\delta)] - x\}$$

2.3. The tariff policy – outcome

We now return to the more plausible case in which the government lacks ability to precommit to either free trade or to *ex ante* tariff and intervenes only *ex post* (that is, when R&D is already in place) by setting an optimal, time consistent tariff. In principle foreign firms might avoid paying tariff duties by establishing a plant in the domestic country (Motta, 1992). However, since in the Northern country IPRs are perfectly enforced, besides paying set-up costs associated with direct investment and, quite likely, higher wages, foreign firms that establish subsidiaries in the domestic country have to forgo the benefits associated with spillover. Given that, when there is no imitation, it is optimal for domestic firms to deter foreign entry even when the setup costs are zero and the wages are the same in the North as in the South. Thus, the foreign firms have no incentive to avoid tariff duties by establishing a local affiliate.[12]

The Northern government chooses the tariff, t, based on the following objective function:

$$W(p, t) = \alpha \, CS(p) + \beta \, N \, \pi(p) + \gamma \, n \, q^f(p) \, t$$

where CS(p) is consumer surplus as a function of price p with $CS'(p) < 0$, α is the weight the government attaches to consumer surplus, $\pi(p)$ is the profit made by a domestic firm at price p and β is the weight the government attaches to domestic profits. Finally, $q^f(p)$ is the output level of a foreign firm. Hence $n \, q^f(p) \, t$ equals total tariff revenue of the government and γ is the weight associated with tariff revenue in the social welfare function. We assume $\alpha \geq \beta$: that is, the government attaches higher weight to consumers than producers. For instance, in a recent report for the European Commission, Gual et. al. (2005) argue that consumer welfare should be the standard in competition policy implying that $\beta = \gamma = 0$. With this fairly general welfare function we also capture the case when the government sets non-tariff barriers by setting $\gamma = 0$.

We want to show that tariffs can be optimal even if α is "high" compared to β and γ. We know already from the literature that in a given setup positive tariffs are generally optimal if β and γ are not "very different" than α. In this case, the rationale for tariff protection is to protect domestic firms against IPR violation and thus to restore incentives for investment in R&D (see Zigic, 2000 and Qiu and Lai, 2004), as well as to capture foreign rents through profit shifting and tariff revenue. This is usually achieved at the consumers' expense. We argue that the tariff can be positive even if $\beta = \gamma = 0$, thus even when tariff revenue and, more importantly, domestic profits are not part of the government's objective function.

Since only two prices are relevant, the monopoly price and the limit price, the government compares social welfare when the tariff is "high", and welfare is given by

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[11] All our results hold for general cost functions, c(x).

[12] According to stylized facts, less than 5% of the developed countries inward foreign direct investment stocks originate in developing countries (own calculations based on reports from OECD, UNCTAD, the U.S. Bureau of Economic Analysis, and South African Reserve Bank).

$$W(c+t^h, t^h) = \alpha\, CS(c+t^h) + \beta\, D(c+t^h)(c+t^h - C)$$

with the case where the tariff is "low" and welfare is given by

$$W(p^m, t^l) = \alpha\, CS(p^m) + \beta\, D(p^m)(p^m - C)\, N/(N+n) + \gamma\, n/(N+n)\, D(p^m)\, t^l$$

In selecting the optimal tariff, the government takes into account that the tariff level, t, affects the subsequent choice of the domestic firm's pricing strategy (p^m vs. $c+t$).[13]

Since $CS(p)$ is decreasing in prices, we get the following result.

Proposition 2: *There exists $\gamma^* > 0$ such that for $\gamma < \gamma^*$ the optimal level of tariff protection is (slightly above) t^p, where t^p is defined by*

$$D(c+t^p)(c+t^p - C)/N = D(p^m)(p^m - C)/(N+n)$$

Domestic firms set the limit price $p^p = c+t^p$ to deter foreign firms from the domestic market.

Hence the government induces firms to limit price if it does not value revenues from import tariffs too much. If, however, the government assigns a high weight to tariff revenues ($\gamma > \gamma^*$), it sets a tariff below t^p so that all domestic and foreign firms sell on the market at the monopoly price. Although the high price reduces consumer surplus, it generates relatively more valuable tariff rents for the government.

Finally, it is important to note that regardless of whether limit pricing or monopoly pricing prevails in the equilibrium, being protected by a tariff level t^p each domestic firm invests $x^* = \text{argmax}_x \{D(p^m(x))(p^m - C)/(N+n)\}$ in innovation.

According to Proposition 2, when spillovers are high it may happen that a government which puts a high weight on the consumer surplus will threaten to subsidize foreign imports ($t^p < 0$) to force domestic firms to set a lower price. This case does not seem very realistic and hence we focus on tariffs $t^p \geq 0$.[14] Moving back to the degree of IPR protection φ, then we can summarize our main result as follows.

[13] Note that for any tariff such that $t > p^m - c$ the outcome in the market is the same as for a tariff protection $t^m = p^m - c$: domestic firms charge the monopoly price and foreign firms cannot enter. Social welfare is then given by $W(c+t^m, t^m)$.

[14] Rarely governments use import subsidies to enhance consumer welfare, since there are more efficient ways to do it (e.g. give an output or an R&D subsidy to domestic producers; then both domestic producers and consumers benefit from the policy). In addition, the fact that we would like to capture with this setup the impact of other policies instruments, such as standards and regulations, gives us one more reason not to focus on negative tariffs.

Proposition 3

1. *For φ > φ*, the optimal level of tariff protection is* 0*. Under free trade domestic firms deter foreign entry.*
2. *For φ < φ* and γ < γ*, the optimal level of tariff protection is(slightly above)* t^p*, where* t^p *is defined by*

$$D(c+t^p)(c+t^p - C)/N = D(p^m)(p^m - C)/(N+n)$$

and domestic firms set the limit price p = $c+t^p$*. If γ > γ* the optimal tariff is (slightly below)* t^p*, foreign entry is accommodated and the market price equals* p^m*.*

Fig 1 illustrates graphically the result of Proposition 3 [15]

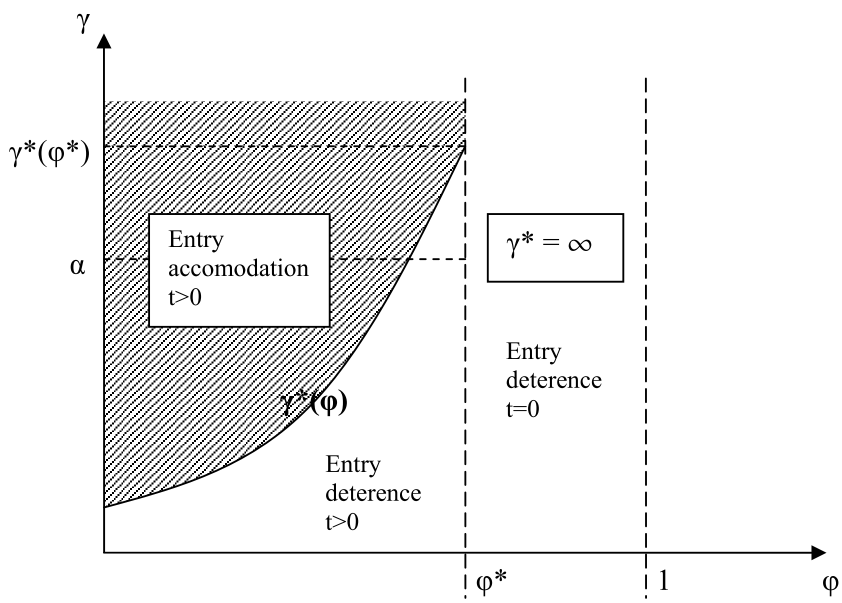

Fig 1. Tariff regimes and pricing strategies corresponding to different levels of γ and φ

If IPR protection is strong enough, there is no need for the government to intervene. Domestic firms invest in R&D to exclude foreign rivals from the market. If the knowledge spillovers are big and the government does not value import tariffs very much (compared to consumer surplus), the government sets t^p to induce domestic firms to exclude foreign rivals.

[15] The critical value γ* is given by $\gamma^* = \alpha \frac{(N+n)\int_{c+t^p}^{p^m} D(z)dz}{nD(p^m)t^p}$, and it decreases with spillovers: when the government sets a positive level of tariff protection, the optimal level of R&D is $x^* = argmax_x$ $\{D(p^m(x))(p^m - C)/(N+n)\}$ which does not vary with spillovers. Then the limit price $c+t^p$, which is implicitly defined as $D(c+t^p)(c+t^p - C)/N = D(p^m)(p^m - C)/(N+n)$, is constant and does not vary with φ. This means that when c decreases due to higher spillovers, t^p has to increase to completely offset this decrease. Therefore γ* increases with φ.

If, however, the government does value import tariffs as a revenue source, it induces domestic firms to accommodate entry by setting the monopoly price. These results summarize our main point: if IPR protection is weak and the government does not value tariff revenues, it is optimal to set a strictly positive tariff. This tariff enables domestic firms to price aggressively and to exclude foreign firms from the market, thereby indirectly protecting their IPR. Having to pay lower prices, domestic consumers benefit from tariff protection.

As is clear from the Fig 1, even if the government highly values tariff revenue (that is, $\gamma > \alpha$) the exclusionary tariff, t^p, might be optimal if the actual spillovers level is "close" to the critical level φ^*. Consequently, it is feasible that t^p appears as the optimal tariff in the standard situation where $\alpha = \beta = \gamma$ (as it could be shown to hold, for instance, for the linear demand function in our setup)[16]. The intuition is that in the "close" left neighborhood of the critical spillover level, φ^*, the domestic firms need just a "small" help in terms of tariff protection to be better off with limit pricing and that in turn has tremendous impact on consumer surplus by preventing monopoly pricing. On the other hand, the tariff revenue is small because the tariff itself is small. Thus, even if the government attaches relatively high weight to tariff revenue in this spillovers range, the exclusionary tariff might be preferred due to large relative gain in consumer surplus. This also explains why γ^* increases in φ when φ approaches φ^*.

Contrary to our findings, prior results obtained using Cournot competition show that in most of the cases tariff protection induces higher prices and therefore hurts consumers. The immediate consequence is that a government that assigns a high weight to consumers' welfare does not set a tariff protection.

3. CONCLUSIONS

In this paper we consider a North-South trade set-up in which firms from a developed, Northern, country compete with firms from a less developed, Southern, country. Competition takes place in the Northern market. In this market prices are determined in a supergame where domestic firms are leaders and the competition level is endogenously determined by firms' cost efficiency distribution. We assume that domestic firms collude (implicitly) and coordinate on the price charged in the market out of all the incentive compatible prices. It is then also incentive compatible for foreign firms (if they are active at all in the market) to

[16] The case of linear demand is discussed in Ionaşcu and Žigić (2004).

follow this price. If they do not, the domestic firms retaliate and switch to the standard, non-cooperative Nash equilibrium from then onwards.

Domestic firms' leadership stems from their innovative efforts that result in lower unit costs of production. There is no technological leakage among firms from the North as the IPR rights are perfectly enforced in this country. Firms from the South do not have the capacity to conduct R&D. However, due to lax IPR protection in their home country, they can imperfectly imitate the new technology developed by firms from the North. Given this problem of R&D appropriability that emerges in this situation, the government from the North might want to introduce a tariff protection in order to prevent technological spillovers. Note that in our setup IPR violation has (besides its likely adverse effect on incentive to invest in R&D) a detrimental impact on consumer welfare since increase in IPR violation tips towards monopoly pricing. The optimal tariff offsets this adverse effect by changing the distribution of firms' cost efficiency in the market and thereby changing the intensity of competition. In this context, we analysed the role of tariff in preventing the technological leakages and its impact on domestic profits, innovation, consumer surplus, and social welfare.

In contrast to previous results that were obtained under different pricing strategies, we show that a government that assigns a high weight to consumer surplus sets a tariff whenever the level of spillovers is high. Under the tariff regime, both consumer surplus and social welfare are higher relative to a regime in which the government commits in advance to free trade. The intuition for this result lies in the relation between cost distribution and prices. If domestic and foreign firms have similar cost levels, entry deterrence is too costly. As a result the competition in the market is soft and the price high. Due to tariffs, the cost differential between domestic and foreign firms increases, triggering a more aggressive domestic pricing strategy that drives foreign firms out of the market. In this sense R&D becomes appropriable. What is more, tariff protection leads to more intense competition and lower prices. Consequently, consumers benefit from tariff protection. Since only the low cost firms end up producing in the market, the total efficiency in the industry increases.

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APPENDIX

Proof of Proposition 1

We denote profits at the monopoly price by π^{*m} = $\max_x$ {D($p^m(x)$)($p^m(x)$ – C(x))/[(N+n)(1-δ)] – x}. Profits under entry deterrence are denoted π^{*ed} = D(c(x^*))(c(x^*) – C(x^*))/[N(1-δ)] – x^*}, where x^* = argmax_x {D(c(x))(c(x) – C(x))/[N(1-δ)] – x}.

Using the envelop theorem, dπ^{*ed}/dφ = (∂c(x^*)/∂φ) [D'(c(x^*))(c(x^*)-C(x^*)) + D(c(x^*))] / [N(1-φ)]. Since by assumption, c(x^*) < p^m, [D'(c(x^*))(c(x^*)-C(x^*)) + D(c(x^*))] > 0. Also, ∂c(x^*)/∂φ is positive. Therefore dπ^{*ed}/dφ > 0. Since $\pi^{*ed} > \pi^{*m}$ for φ = 1 and 0 = $\pi^{*ed} < \pi^{*m}$ for φ = 0, by continuity, there is φ* with the properties indicated in Proposition 1.

Proof of Proposition 2

Depending on the level of tariff protection, domestic firms either behave softly and accommodate foreign entry or behave aggressively and drive the foreign firms out of the market. In order to see which is the optimal tariff, we first look for the two tariffs that maximize social welfare under entry accommodation and entry deterrence, respectively. Then, the optimal tariff is the one among these two tariffs that induces the highest social welfare.

Case 1: entry accommodation

If D(p^m)(p^m – C)/(N+n) > D(c+t)(c+t – C)/N the domestic firms coordinate on their monopoly price, the foreign firms are active in the market, and the domestic welfare is given by W(p^m, t). This is the case when the level of tariff protection is low. In this case the effect of the tariff on welfare is given by

$$dW(p^m, t)/dt \ = \ \gamma \ D(p^m) \ \ n/(N+n) \ > \ 0$$

The tariff has no effect on the domestic profits nor on consumer surplus. Its impact on the social welfare is due to its positive effect on tariff rents. Therefore, in order to induce the highest social welfare, the government has to set the highest tariff for which p^m is still the optimal price. We denote this level by t^p which is implicitly defined by

$$D(p^m)(p^m - C) \,/\, (N+n) \ = \ D(c+t^p)(c+t^p - C) \,/\, N$$

if $t^p > 0$ and $t^p = 0$ otherwise.

Case 2: entry deterrence

If $D(c+t)(c+t - C)/N \geq D(p^m)(p^m - C)/(N+n)$ domestic firms charge c+t for their product. Due to this aggressive pricing, the foreign firms are kept out of the market. c+t is the optimal strategy for the domestic firms if the level of tariff is higher than t^p. In this case

$$dW(c+t,\ t)/dt \ = \alpha\ dCS(c+t)/dt + \beta\ D(c+t) + \beta\ (c+t - C)\ dD(c+t)/dt$$

where the consumer surplus is given by

$$CS(p) = \int_p^\infty D(y)dy$$

Using Leibnitz's Rule, the above derivative becomes

$$dW(c+t,\ t)/dt \ = -\ (\alpha\text{-}\beta)\ D(c+t) + \beta\ (c+t - C)\ dD(c+t)/dt$$

Since $dD(c+t)/dt < 0$, $\alpha \geq \beta$ implies $dW(c+t,\ t)/dt < 0$. Therefore the government should set the lowest level of tariff under which the domestic firms deter foreign entry, namely t^p.

It can be the case that $D(c)(c - C)/N \geq D(p^m)(p^m - C)/(N+n)$, for instance because the number of foreign competitors n is very high. In that case, it is optimal for the government to set $t = 0$ (free trade). Any higher tariff t will reduce consumer surplus, raise domestic profits but not yield any revenue from the tariffs. For $\alpha \geq \beta$, this cannot be optimal because the reduction in consumer surplus is not compensated by the rise in domestic profits. Hence the government always makes sure that domestic firms set the limit price.

The optimal tariff policy

The above discussion suggests that the optimal tariff is t^p. We still need to clarify if the level of tariff protection should be right below or right above t^p. Namely we still have to see which will be the resulting outcome in the pricing game – monopoly price or limit price. In order to see this we need to compare $W(p^m, t^p)$ and $W(c+t^p, t^p)$.

From the way t^p is defined we know that for a given level of innovation, domestic firms earn the same profits under entry deterrence as under entry accommodation. The differences in the two levels of social welfare then stem from differences in tariff rents and in consumer surpluses. While the tariff revenue is higher under entry accommodation, the consumer surplus is enhanced when domestic firms price aggressively and drive their foreign rivals out of the market. If the government puts enough weight on the consumer surplus, it will try to get the price as low as possible, even if this implies no revenue from tariffs. If this is the case, γ should be such that

$$\alpha\,[\mathrm{CS}(c+t^p) - \mathrm{CS}(p^m)] > \gamma\, n/(N+n)\, \mathrm{D}(p^m)\, t^p$$

or, using the formula for CS

$$\gamma < \gamma^*$$

where

$$\gamma^* = \alpha \frac{(N+n)\int_{c+t^p}^{p^m} D(z)dz}{nD(p^m)t^p}$$

Proof of Proposition 3

Most of the results given in this proposition are already proved in Proposition 2. The new things brought by Proposition 3 are related with the restriction that we impose on t^p, namely it should be positive.

In this case the level of technological spillovers, φ, plays an important role. We know from Proposition 1 that when the breach of intellectual property rights is small enough ($\varphi > \varphi^*$), under free trade domestic firms can invest in R&D to the extent that limit pricing at $p = c(x)$ is optimal. If the government does not rule out setting a tariff $t > 0$ in this case, it would make firms lazy as they will be protected from foreign competition anyway by the tariff and hence there is less reason to invest in R&D. This fact together with the negative effect that positive tariffs have on the market price will lead to lower consumer surplus under tariff protection. Since if IPR protection is strong enough, domestic firms limit price and hence there are no imports and no tariff rents, the best thing the government can do is to allow for free trade (t=0).

If IPR protection is weak ($\varphi < \varphi^*$), under free trade domestic firms collude on the monopoly price and accommodate foreign entry. Then the government can decide to use positive tariffs to make consumers better off. If the government has a great love for tariff revenues ($\gamma > \gamma^*$) it will set tariffs such that foreign firms sell on the domestic market as well.