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On the Pro-competitive Effects of Regional Trading Agreements

José L. Moraga-González
VU University Amsterdam and
University of Groningen
email: j.l.moragagonzalez@vu.nl

Jean-Marie Viaene
Erasmus University Rotterdam
email: viaene@few.eur.nl

Abstract. We explore the pro-competitive effects of trade policies in a model where a competitive fringe of domestic firms compete with a foreign duopoly exporting vertically differentiated goods. We show that discriminatory nonuniform tariff policies are preferred over the Most Favored Nation (MFN) clause because, besides extracting rents from foreign firms, they foster competition in the market. Regional Trading Agreements (RTAs), which favor members relative to non-members, are examples of such nonuniform tariff policies.

1 Introduction

The collapse of global trade talks in Cancun in September 2003 challenged the role of the World Trade Organization (WTO) and the multilateral trading system that it supports. The greater difficulty in reaching multilateral agreements provides countries with incentives to search for more effective ways to liberalize their trade, mainly via regional trading agreements (RTAs). In the last fifteen years, more RTAs have come into force than ever before. As a result of this trend, Mongolia was in July 2005 the only WTO member not being part of a RTA (see WTO website). Recent notifications of RTAs include the agreements between the USA and Morocco, Singapore and the Republic of Korea, Turkey and Tunisia, Moldova and Bulgaria, The EU and Egypt, etc.

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Differences in quality play an important role in international trade. For example, Hallak (2006) shows in a sample of 60 countries that there are large differences in the quality of products that are exported. This is also the key point in Greenaway et al. (1995) who show that intra-industry trade characterized by different levels of quality is a significant proportion of trade. As many of the new RTA proposals involve countries with different concerns for quality standards, the aim of this paper is to examine how quality considerations affect the desirability of RTA initiatives.

In our model, a competitive fringe of domestic firms compete with a foreign duopoly exporting vertically differentiated goods. A realistic feature of this type of models is that oligopolistic firms select product-design strategies to differentiate their goods from rivals prior to the market competition stage (see e.g. Motta *et al.* 1997; Herguera *et al.* 2002; Zhou *et al.* 2002; Moraga-González and Viaene 2005). We show that an importing country improves its welfare by levying a tariff on the country producing high quality or by subsidizing low-quality imports. These non-uniform trade policies are pro-competitive inasmuch as they lead to a decline in (hedonic) prices. It is important to note that in the literature on trade reforms, gains from trade rely traditionally on the pro-competitive effects caused by freer trade (Vousden 1990; Hertel 1994). In contrast, it is the imposition of particular trade policies that enhances social welfare and leads to more competitive market equilibria in our framework. To the best of our knowledge, this finding is novel.

RTAs, formally approved by the WTO, are examples of nonuniform trade policies due to the discriminatory treatment favoring members relative to nonmembers. We show that RTAs can lead to more competitive equilibria in the sector under study and thus contribute to a higher welfare level than under free trade. Product quality considerations provide a rationale for discrimination among sources of supply and it is just the discriminatory treatment of a RTA that makes it attractive from a welfare viewpoint.

The idea that international trade increases competition is old (see e.g. Helpman and Krugman 1989). However, much work has focused on the gains arising from firm selection and greater product variety (see e.g. Melitz 2003; and Arkolakis, Costinot, and Rodríguez-Clare 2012), while keeping markups constant. Gains from greater product variety are also present in our paper. We show that these gains can be made even larger using a discriminatory trade liberalization policy, which results in lower markups and higher quality products. Though our model is highly stylized, our focus on market power and vertical differentiation sets our paper apart from those studying the effects of trade liberalization on markups in monopolistically competitive environments

(see e.g. Melitz and Ottaviano 2008; and Arkolakis, Costinot, Donaldson and Rodríguez-Clare 2012).

The remainder of the paper is organized as follows. The next section describes the model and Section 3 derives the market equilibrium. Section 4 presents the analysis of trade policies and Section 5 considers the welfare implications of RTAs. Finally, Section 6 concludes. The Appendix contains the proofs to ease the reading.

2 The Model

Consider an international market consisting of a domestic economy and two foreign countries, the latter indexed $i = 1, 2$. Assume there is a population of measure 1 at home. A domestic consumer is characterized by a taste parameter θ, which is uniformly distributed over $[0, \overline{\theta}]$, $\overline{\theta} > 0$. The preferences of consumer θ are given by the quasi-linear utility function: $U = V + \theta q - p$, if he buys a unit of a good of quality q at price p. Consumers buy at most one unit.

Assume the domestic economy hosts a competitive sector, which produces a *numeraire* good at marginal cost. The quality of the numeraire is normalized to zero. Domestic firms face competition from exports by foreign firms. Assume each foreign country hosts a single firm, indexed $i = 1, 2$. Foreign firms choose the quality of their products. The fixed cost of quality development is $C_i(q) = c_i q^2/2$, $i = 1, 2$. Let $c_1 > c_2$, i.e., firm 2 has a more efficient R&D technology than firm 1. Once foreign firms determine the quality of their goods, production takes place at a common marginal cost. Let us normalize marginal costs to zero for simplicity.[1]

We study a three-stage game. First, the domestic government acts as a Stackelberg leader vis-à-vis foreign firms and chooses a tariff (subsidy) policy t_i on imports from country $i = 1, 2$ to maximize national welfare.[2] Foreign firms, which act as followers and take tariffs as given, choose qualities in the second stage. Finally, firms export their goods to the domestic market and

[1] This cost specification captures the distinctive features of pure vertical product differentiation models, where the costs of quality improvements mainly fall on fixed costs and involve only a small or no increase in unit variable costs (Shaked and Sutton 1982). The normalization adopted here is without loss of generality provided that the main bulk of costs falls on fixed costs rather than on variable costs.

[2] This timing of moves assumes that the government can credibly commit to a certain trade policy. In our model, in absence of commitment, the government would simply maximize revenues and firms would respond by not entering the market. Most international trade observers agree in that governments possess credible ways to commit (Brander 1995).

compete in prices with the local producers. We solve the model by backward induction.[3]

3 Market Equilibrium

We first derive the equilibrium of the price competition stage. Heterogeneity in consumer tastes implies that it is optimal for the two foreign firms to differentiate their goods by choosing different quality levels (Shaked and Sutton 1982). Let us denote high quality by q_h and low quality by q_l, $q_h > q_l$. Suppose also, for the moment, that $p_h > p_l$, i.e., high quality commands a higher price. Demands for low quality, for high quality and for the numeraire follow from straightforward calculations (see e.g. Motta *et al.* 1997; Moraga-González and Viaene 2005):

$$D_l(\cdot) = \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} - \frac{p_l}{\overline{\theta} q_l},\ D_h(\cdot) = 1 - \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)},\ D_n(\cdot) = 1 - D_l - D_h. \quad (1)$$

Firm 1 might in principle choose to produce a variant whose quality is either lower or higher than that of the competitor. Assume, for the moment, that firm 1 produces low quality. Taking tariff rates $(t_1,\ t_2)$ and quality choices $(q_h,\ q_l)$ as given, firm 1 chooses p_l to maximize $\pi_1 = (1-t_1)p_l D_l(\cdot) - c_1 q_l^2/2$. The rival firm sets p_h to maximize $\pi_2 = (1-t_2)p_h D_h(\cdot) - c_2 q_h^2/2$. Solving the reaction functions in prices yields the subgame equilibrium prices of low quality and high quality:

$$p_h = \frac{2\overline{\theta} q_h (q_h - q_l)}{4q_h - q_l},\ p_l = \frac{\overline{\theta} q_l (q_h - q_l)}{4q_h - q_l}. \quad (2)$$

Consider now stage two where foreign firms select qualities. In this stage, firms take (t_1, t_2) as given, anticipate the continuation equilibrium prices in (2) and choose their qualities to maximize profits:

$$\pi_1 = (1-t_1)\frac{\overline{\theta} q_l q_h (q_h - q_l)}{(4q_h - q_l)^2} - \frac{c_1 q_l^2}{2},\ \pi_2 = (1-t_2)\frac{4\overline{\theta} q_h (q_h - q_l)}{(4q_h - q_l)^2} - \frac{c_2 q_h^2}{2}.$$

Since $q_h > q_l$, we can define the variable $\mu = q_h/q_l$, $\mu > 1$, which represents the *quality gap* between foreign firms. We shall see later that μ relates to the

[3] We are ignoring the possibility that foreign governments engage in *retaliatory* trade policies (Collie 1991; Bagwell and Staiger 1999). The rationale is that international firms often serve many markets and this impedes foreign governments to *target* retaliations against specific countries.

extent of price competition in the international market. Using μ, the ratio of first order conditions in qualities can be written as:

$$\frac{c_1(1-t_2)}{c_2(1-t_1)} = \frac{\mu^2(4\mu-7)}{4(4\mu^2-3\mu+2)}. \tag{3}$$

This equation gives an implicit relation between the equilibrium quality gap μ, the ad valorem tariffs and firms' development costs. There exists a unique real solution to this third degree polynomial for any parametrical point (c_1, c_2, t_1, t_2) which satisfies $\mu > 1.75$. It is easily seen that quality gap μ increases in c_1 and t_1 and decreases in c_2 and t_2.

Once equilibrium μ is obtained from (3), it is straightforward to solve for equilibrium qualities, demands and prices:

$$q_l = (1-t_1)\frac{\overline{\theta}\mu^2(4\mu-7)}{c_1(4\mu-1)^3},\ q_h = (1-t_2)\frac{4\overline{\theta}\mu(4\mu^2-3\mu+2)}{c_2(4\mu-1)^3} \tag{4}$$

$$D_l = \frac{\mu}{4\mu-1},\ D_h = \frac{2\mu}{4\mu-1},\ D_n = \frac{\mu-1}{4\mu-1} \tag{5}$$

$$p_l = \frac{\overline{\theta}(\mu-1)q_l}{(4\mu-1)},\ p_h = \frac{2\overline{\theta}(\mu-1)q_h}{(4\mu-1)} \tag{6}$$

Equation (3) along with (4)-(6) fully characterize the market equilibrium. The variable μ is central to our analysis. Taking the ratio of domestic prices in (6) yields: $p_h/p_l = 2\mu$. Thus, μ is a measure of domestic price competition among the two foreign firms: an increase in μ relaxes price competition and price differences rise. Moreover, both hedonic prices p_h/q_h and p_l/q_l, which follow from (6), increase in μ. As a result, we refer to a trade policy that leads to a decrease (increase) in μ as *pro-competitive (anti-competitive)*. We also observe from (5) that the relationship between μ and the market shares of the foreign firms is negative. This is because, as the quality gap widens, higher prices lead more consumers to opt for the numeraire.

So far we have assumed that the quality produced by the foreign firm 1 is lower than that of the foreign firm 2. However, it may very well be that firm 1 produces high quality instead. The next result states the conditions under which the first assignment in qualities is the unique equilibrium of the subgame analyzed above.

Lemma 1 *If* $c_1/(1-t_1) > c_2/(1-t_2)$, *firm 1 produces low quality and firm 2 high quality in the unique equilibrium of the continuation game. If* $c_1/(1-t_1) <$

$c_2/(1-t_2)$, *firm 1 produces high quality and firm 2 low quality in the unique equilibrium of the continuation game. When* $c_1/(1-t_1) = c_2/(1-t_2)$, *firm 1 may produce either high or low quality.*

The proof proceeds in two steps.[4] We first show that when $c_2/(1-t_2)$ is sufficiently low compared to $c_1/(1-t_1)$, the assignment where high quality is produced by firm 1 is not subgame perfect because firm 2, which is highly efficient, finds it profitable to deviate and leapfrog the former firm. When the cost asymmetry between firms is small, the proof uses the risk-dominance criterion of Harsany and Selten (1988). This refinement selects away the equilibrium where firm 1 produces high quality provided that firm 2 is more efficient than firm 1 in relative terms. If $c_1/(1-t_1) = c_2/(1-t_2)$, the refinement has no bite and both quality assignments can be equilibria.

4 Trade Policy

Finally, in the first stage of the game, the domestic government maximizes domestic social welfare. We assume that the proceeds obtained from import taxation are uniformly distributed among the consumers. Therefore social welfare equals the (unweighted) sum of domestic consumer surplus and tariff revenues, i.e., $W = S + t_1 p_l D_l(.) + t_2 p_h D_h(.)$. Consumers surplus is given by:

$$S = V + \int_{\frac{p_h - p_l}{q_h - q_l}}^{\overline{\theta}} (\theta q_h - p_h)\,d\theta + \int_{\frac{p_l}{q_l}}^{\frac{p_h - p_l}{q_h - q_l}} (\theta q_l - p_l)\,d\theta$$

Employing μ, (6) and (4), consumers surplus can be conveniently written as:

$$S = V + \frac{\overline{\theta}\mu^2(4\mu+5)q_l}{2(4\mu-1)^2} \tag{7}$$

Tariffs revenues obtained from imports are given by $R_1 = t_1 p_l D_l(.)$ and $R_2 = t_2 p_h D_h(.)$. Substitution of (5) and (6) yields:

$$R_1 = \frac{t_1\overline{\theta}\mu(\mu-1)q_l}{(4\mu-1)^2},\ R_2 = \frac{t_2 4\overline{\theta}\mu^2(\mu-1)q_l}{(4\mu-1)^2} \tag{8}$$

Using the previous expressions we can write domestic social welfare as:

$$W(t_1, t_2; c_1, c_2) = V + A(\mu(t_1, t_2), t_1, t_2) * q_l(\mu(t_1, t_2), t_1) \tag{9}$$

[4] This and subsequent proofs are available from the authors upon request. They can also be downloaded from http://www.tinbergen.nl/~moraga.

where $A(.) = \overline{\theta}[\mu^2(4\mu+5)/2 + t_1\mu(\mu-1) + 4t_2\mu^2(\mu-1)]/(4\mu-1)^2$ and q_l is given by (4).

Let us now examine the effects of trade policy on the domestic economy. For this we consider free trade as the benchmark case. By virtue of Lemma 1, we know that under free trade low quality is produced in country 1 while high quality is produced in country 2.

Non-discriminatory Tariff Policy

Suppose the domestic government levies a common tariff on imports from countries 1 and 2, i.e., $t_1 = t_2 = t > 0$. From (3) it follows that the quality gap μ remains unaltered after this policy. As a result:

Proposition 2 *Starting from free trade, a small uniform tariff on all imports results in: (i) no change in competitive conditions, (ii) a downgrade in the quality of all imports, (iii) a decrease in the price of the imports, (iv) a decrease in consumer surplus, and (v) an increase in social welfare. Consequently, free trade is not optimal.*

A small uniform tariff against foreign firms is welfare enhancing because of a rent-extraction effect:[5] income is taken away from foreign firms and given to the consumers. This effect is of first-order compared to the loss in consumer surplus caused by the downgrade in the quality of imports. We note that a *uniform* tariff policy does not change the competitive conditions in the market and thus the market share of the local industry remains unaltered.[6] A straightforward extension of Proposition 2 is the Most Favored Nation (MFN) principle. Applying this principle here is equivalent to maximize welfare in (9) with respect to t. Solving for the MFN tariff yields:

$$t^{MFN} = \frac{1}{2}\left[1 - \frac{\mu(4\mu+5)}{2(\mu-1)(4\mu+1)}\right],$$

where μ solves (3). The MFN tariff increases with the quality gap but is bounded below 25%. More importantly, it does not affect international competitive conditions.

[5] This is in line with Brander and Spencer (1981) and Helpman and Krugman (1989, ch. 4), who analyze a *homogeneous* product market.

[6] Since the intensity of competition does not change with a uniform tariff in our setting, this intervention leads to effects similar to those under *monopoly* (Krishna 1987; Das and Donnenfeld 1987). Next we show that a discriminatory policy can be designed to be either pro-competitive or anti-competitive.

Discriminatory Tariff Policy

In this case the government imposes distinct tariffs on imports proceeding from different countries. As mentioned above, a nonuniform trade policy alters the equilibrium quality gap and, besides extracting rents from foreign firms, it modifies the extent of competition between them.

Proposition 3 *(i) Starting from free trade, a small tariff on country 1 where the low-quality good is produced is anti-competitive and leads to: (a) a downgrade in the quality of both foreign goods, (b) an increase in the price of the high-quality product, (c) a reduction in the price of the low-quality good, (d) a fall in the imports from both countries and an increase in the market share of the numeraire good, (e) a reduction in consumer surplus and (f) a decrease in social welfare.*

(ii) Starting from free trade, a small tariff on country 2 where the high-quality variant is produced is pro-competitive and leads to: (a) a downgrade in the quality and price of both foreign goods, (b) an increase in imports from both foreign countries and a decrease in the market share of the numeraire good, (c) a decrease in consumer surplus and (d) an increase in social welfare.

The effects of an asymmetric tariff policy are sensitive to whether the low-quality or the high-quality firm is conferred a cost advantage as a result of the tariff. Both policies downgrade qualities, which tends to reduce consumer surplus in either case. However, a tariff on the low-quality producing country has two additional pervasive effects on welfare: price competition between the firms is relaxed thereby increasing hedonic prices and reducing the number of consumers who buy quality products. As tariff revenues are small, a tariff on the low-quality good ends up being welfare reducing. In contrast, a tariff on the high-quality firm fosters competition between firms thereby lowering foreign prices and reducing the market share of the numeraire good. Though the overall impact of a tariff on high quality is a fall in consumer surplus, tariff revenues more than offset this loss and welfare rises. In summary, a tariff levied on the imports from country 2 functions as a *pro-competitive* device; by contrast, a tariff levied on the imports proceeding from country 1 is *anti-competitive*. Thus, in the latter case, the domestic country improves its welfare by subsidizing low-quality imports.

5 Regional Trading Agreements

Consider now the formation of a RTA. In our framework there are two possibilities: the domestic economy can form a RTA with either country 1 or country 2. The objective of this section is to study the impact of each RTA on domestic welfare via the *particular sector* under consideration.

The principal feature of a RTA, formally approved by the WTO, is its discriminatory treatment favoring members relative to non-members: goods imported from a member country face a zero tariff while similar goods imported from a non-member country face a tariff distinct from zero. It is just this discriminatory nature of a RTA that leads to our main result:

Proposition 4 *As compared to free trade, (a) a RTA with country 2 and a subsidy on low-quality imports from country 1, or (b) a RTA with country 1 and a positive tariff on high-quality imports from country 2 are welfare improving.*

This proposition follows directly from Proposition 3. By adhering to a RTA, the domestic government affects the relative costs of the exporting firms in such a way that the quality gap decreases thereby fostering competition. A RTA with the low-quality producing country extracts rents from country 2 through a tariff and, in addition, is pro-competitive. By contrast, a RTA with the high-quality producing country is pro-competitive but at the cost of subsidizing low-quality imports. This suggests that the former RTA is preferred to the latter. This is also revealed by numerical simulations of the model. Moreover, when cost differences are not too small, these simulations show that only such RTA is welfare superior to the MFN clause.

The positive welfare effects of Proposition 4 can be explained in terms of standard partial equilibrium concepts of economic integration. Traditionally, the pros and cons of integration rest on the relative merits of trade creation and trade diversion, each with different welfare implications. Unlike trade creation, a trade diverting RTA can be welfare reducing. To check whether trade diversion arises in our framework, we refer the reader to (5) where D_l and D_h represent imports from the foreign suppliers. The following monotonicity results can be obtained:

$$\frac{dD_l}{d\mu} < 0, \ \frac{dD_h}{d\mu} < 0 \tag{10}$$

When a RTA is formed with the low-quality producer, trade diversion can only arise if D_h drops as it represents the amount of trade diverted by this RTA. In our framework the contribution of a RTA is to reduce μ and, hence,

to increase both D_l and D_h. Trade diversion is therefore excluded and double trade creation is obtained instead.

6 Conclusions

This paper has explored the pro-competitive effects of trade policies in a model where a competitive fringe of domestic firms compete with a foreign duopoly exporting vertically differentiated goods. We have shown that discriminatory nonuniform tariff policies are preferred over the Most Favored Nation (MFN) clause because, besides extracting rents from the foreign firms, they foster competition in the marketplace.

Regional Trading Agreements (RTAs), which favor members relative to non-members, are examples of such discriminatory tariff policies. Our paper shows that RTAs can be welfare superior to free trade because firms end up competing more aggressively. The largest gains are obtained when the domestic economy joins the low-quality producing country.

Regional trading agreements often address other issues like labor mobility, foreign investment and competition policy. For example, Ethier (1998) argues that regional trading agreements give newcomers a marginal advantage compared to non-participating countries in attracting foreign direct investments, which then give access to a larger market. Hopefully, our model provides a suitable framework that can be extended to include some of these broader issues.

7 Appendix

Proof of Lemma 1: For any given pair of tariffs (t_1, t_2), there may potentially be two equilibrium quality configurations in our continuation game. In the first equilibrium candidate, low quality is produced by firm 1, while in the second low quality is produced by firm 2. We shall refer to the first quality configuration as Assignment 1, and to the second as Assignment 2.

In the first case, μ is the solution to the equation $\mu^2(4\mu-7)/4(4\mu^2-3\mu+2) = k_1$, where $k_1 = c_1(1-t_2)/c_2(1-t_1) > 0$. Denote this solution as μ_1. In the second case, μ is the solution to $\mu^2(4\mu-7)/4(4\mu^2-3\mu+2) = k_2$, with $k_2 = c_2(1-t_1)/c_1(1-t_2)$. Denote this solution as μ_2. In addition, we define

$$f(x) = \frac{4x^2-3x+2}{(4x-1)^3} \text{ and } g(x) = \frac{x^3(4x-7)}{4(4x-1)^3},$$

with $f'(x) < 0$, $f''(x) > 0$, $g'(x) > 0$, and $g''(x) < 0$ for all $x \geq 7/4$.

We first we study the conditions under which Assignment 1 is an equilibrium. To do so, we prove that both firms' profits at the proposed equilibrium are non-negative and that no firm has an incentive leapfrog its rival's choice. Equilibrium profits under Assignment 1 can be written as:

$$\pi_{1,l} = \frac{\overline{\theta}^2(1-t_1)^2\mu_1^3(4\mu_1-7)(4\mu_1^2-3\mu_1+2)}{2c_1(4\mu_1-1)^6} \text{ and } \pi_{2,h} = \frac{16c_1(1-t_2)^2}{c_2(1-t_1)^2}\pi_{1,l}. \tag{11}$$

It is easy to check that $\mu_1'(k_1) > 0$; then, in equilibrium, for any parametrical constellation, it must be the case that $\mu_1 \geq 7/4 = 1.75$. This actually implies that q_l and q_h are positive and that firms' benefits are non-negative.

We now check the conditions under which no firm has an incentive to deviate by leapfrogging the rival's choice. The case of "downward" leapfrogging only makes sense if selling a low-quality good generates higher profits than a high-quality good, which is not the case here. There is, however, potential for "upward" leapfrogging. Suppose firm 1 deviates by leapfrogging its rival. In such a case, firm 1 would select $q \geq q_h$ to maximize deviating profits:

$$\widetilde{\pi}_{1,h} = (1-t_1)\frac{4\overline{\theta}q^2(q-q_h)}{(4q-q_h)^2} - \frac{c_1q^2}{2}$$

The first order condition is:

$$(1-t_1)\frac{4\overline{\theta}q(4q^2-3qq_h+2q_h^2)}{(4q-q_h)^3} - c_1q = 0$$

Define $\lambda \geq 1$ such that $q = \lambda q_h = \lambda\mu_1 q_l$. Then, we can write:

$$q = (1-t_1)\frac{4\overline{\theta}\lambda(4\lambda^2-3\lambda+2)}{c_1(4\lambda-1)^3} = \lambda q_h = \lambda(1-t_1)\frac{4\overline{\theta}\mu_1(4\mu_1^2-3\mu_1+2)}{c_2\,(4\mu_1-1)^3}$$

From this equality, we obtain that λ must satisfy:

$$\frac{(4\lambda^2-3\lambda+2)}{(4\lambda-1)^3} = \frac{(4\mu_1^2-3\mu_1+2)}{(4\mu_1-1)^3}\frac{\mu_1 c_1}{c_2},$$

i.e., $f(\lambda) = f(\mu_1)\mu_1 c_1/c_2$. Denote the solution to this equation as λ_1. Since $\mu_1 c_1/c_2 > 1$ and $f'(\cdot) < 0$, it follows $\lambda_1 < \mu_1$. Moreover, the larger c_1/c_2, the greater is $\mu_1 c_1/c_2$ and the larger the difference between λ_1 and μ_1.

We can now compare deviating profits $\widetilde{\pi}_{1,h}$ with those at the proposed equilibrium $\pi_{1,l}$. Deviating profits can be written as:

$$\widetilde{\pi}_{1,h} = (1-t_1)^2\frac{8\overline{\theta}^2 h(\lambda_1)}{c_1}$$

with $h(x) = \left(x^3(4x-7)(4x^2-3x+2)\right)/(4x-1)^6$, and $h'(x) > 0$. Equilibrium profits are:

$$\pi_{1,h} = (1-t_1)^2\frac{\overline{\theta}^2 h(\mu_1)}{2c_1}$$

Dividing these two expressions we get:

$$\frac{\widetilde{\pi}_{1,h}}{\pi_{1,l}} = \frac{16h(\lambda_1)}{h(\mu_1)}$$

Firm 1 does not deviate whenever $\widetilde{\pi}_{1,h} \leq \pi_{1,l}$, i.e., if and only if $16h(\lambda_1) \leq h(\mu_1)$. Since as c_1/c_2 increases μ_1 increases while λ_1 decreases, it is clear that there exists some critical level of c_1/c_2 for which the inequality above holds and firm 1 has no interest in deviating. To complete the proof we need to show that the parametrical space for which the equations above have real well-defined solutions and the above inequality is fulfilled is not empty. We prove this by providing an example. First, note that equation (3) is cubic in μ and that its RHS increases in μ. Therefore, since any valid set of parameters (c_1, c_2, t_1, t_2) satisfies $\frac{c_i(1-t_j)}{c_j(1-t_i)} > 0$, $i, j = 1, 2$, $i \neq j$, there is always a real solution to (3) satisfying $\mu \geq 1.75$. Notice now that there also exists a solution to equation $f(\lambda) - kg(\mu) = 0$, which is also cubic in λ, and can be written as $(4\lambda^2-3\lambda+2)/kg(\mu) = (4\lambda-1)^3$. Since the LHS is ever positive, the solution

satisfies $\lambda \geq 1$, as required. It can be shown that primitive parameters exist for which Assignment 1 is an equilibrium of the continuation game. Suppose $c_1 = 1.1$ and $c_2 = 1$ and a MFN clause tariff policy ($t_1 = t_2$). Then, $\mu_l = 5.6335$, $\lambda_l = 1.2578$ and therefore $16h(\lambda_l)(1-t_h)^2 = -4.1582 \times 10^{-3} < 0 < h(\mu_l)(1-t_l)^2 = 3.1208 \times 10^{-3}$. This proves that for sufficiently large cost differences Assignment 1 is an equilibrium. Similarly, it is easy to prove that when the cost asymmetry between the firms is large, Assignment 2 is not an equilibrium. We omit this proof to economize on space.

In the second part of the proof we apply the risk-dominance criterion of Harsany and Selten (1988) to show that Assignment 1 is the unique refined equilibrium if and only if $c_1/(1-t_1) > c_2/(1-t_2)$. Again, consider first Assignment 1. This is the case fully developed in the main body of the paper. In this candidate equilibrium, product differentiation is given by the solution to (3) and demands, qualities and prices obtain from (5)-(4). Consider now Assignment 2. In this case a new candidate equilibrium can be derived following exactly the same steps outlined in Section 3. In this case, the equilibrium product differentiation is given by the solution to:

$$\frac{c_2(1-t_1)}{c_1(1-t_2)} = \frac{\mu^2(4\mu-7)}{4(4\mu^2-3\mu+2)}. \tag{12}$$

We note that equations (3) and (12) are equal except for the LHS; therefore, they yield different solutions. Let $\widetilde{\mu}$ denote the solution to (12). Under Assignment 2, firm 1 (the most inefficient) produces high quality given by

$$\widetilde{q}_h = (1-t_1)\frac{4\overline{\theta}\widetilde{\mu}(4\widetilde{\mu}^2-3\widetilde{\mu}+2)}{c_1\,(4\widetilde{\mu}-1)^3} \tag{13}$$

while firm 1 produces low quality given by

$$\widetilde{q}_l = (1-t_2)\frac{\overline{\theta}\widetilde{\mu}^2(4\widetilde{\mu}-7)}{c_2\,(4\widetilde{\mu}-1)^3}. \tag{14}$$

Given any pair of tariffs (t_1, t_2), firms must choose between Assignment 1 and 2. This choice is represented in the following matrix:

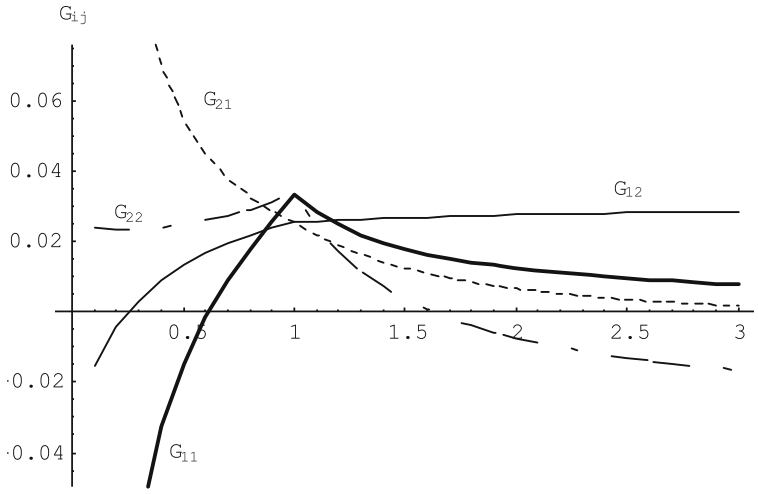
Firm 2

Firm 1		q_h	$\widetilde{q}_l$
	q_l	$\pi_l(q_h,q_l), \pi_h(q_h,q_l)$	$\pi_l(\widetilde{q}_l,q_l), \pi_h(\widetilde{q}_l,q_l)$
	$\widetilde{q}_h$	$\pi_l(q_h,\widetilde{q}_h), \pi_h(q_h,\widetilde{q}_h)$	$\pi_h(\widetilde{q}_h,\widetilde{q}_l), \pi_l(\widetilde{q}_h,\widetilde{q}_l)$

where $\pi_l(\widetilde{q}_l, q_l)$ and $\pi_h(\widetilde{q}_l, q_l)$ denote the payoffs to firm 1 and firm 2, respectively, when the former chooses to produce the low-quality given by Assignment 1 and the latter chooses to produce the low-quality given by Assignment 2. Payoffs $\pi_l(q_h, \widetilde{q}_h)$ and $\pi_h(q_h, \widetilde{q}_h)$ are similarly interpreted.

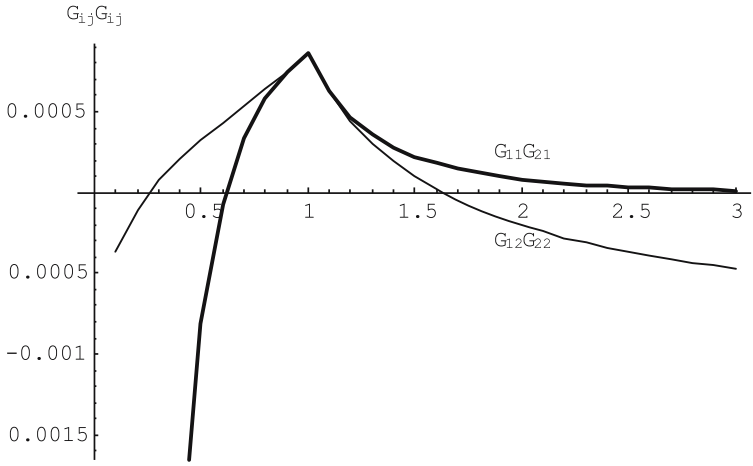
Let $G_{11} = \pi_l(q_h, q_l) - \pi_l(q_h, \widetilde{q}_h)$ be the gains firm 1 obtains by predicting correctly that firm 2 will choose Assignment 1. Likewise, $G_{12} = \pi_h(\widetilde{q}_h, \widetilde{q}_l) - \pi_l(\widetilde{q}_l, q_l)$ denotes the gains firm 1 derives by forecasting correctly that firm 2 will select Assignment 2. Similarly, for firm 2 we have $G_{21} = \pi_h(q_h, q_l) - \pi_h(\widetilde{q}_l, q_l)$ and $G_{22} = \pi_l(\widetilde{q}_h, \widetilde{q}_l) - \pi_h(q_h, \widetilde{q}_h)$. It is said that Assignment 1 risk-dominates Assignment 2 whenever $G_{11}G_{21} > G_{12}G_{22}$.

Unfortunately, the theoretical application of this criterion to our game is difficult because the solution to equations (3) and (12) –and by implication the maximizers of $\pi_l(q_h, q_l)$, $\pi_h(q_h, q_l)$, $\pi_l(\widetilde{q}_l, q_l)$, $\pi_h(\widetilde{q}_l, q_l)$ $\pi_l(q_h, \widetilde{q}_h)$, $\pi_h(q_h, \widetilde{q}_h)$ $\pi_h(\widetilde{q}_h, \widetilde{q}_l)$ and $\pi_l(\widetilde{q}_h, \widetilde{q}_l)$– cannot be obtained explicitly. Thus, we have chosen to solve our model numerically for several values of the ratio $c_1(1-t_2)/c_2(1-t_1)$. Figure 1 depicts the gains G_{11}, G_{21}, G_{12} and G_{22} as a function of this ratio.



Inequality $G_{11}G_{21} > G_{12}G_{22}$ can be evaluated by observing Figure 2. This graph shows $G_{11}G_{21}$ and $G_{12}G_{22}$ as a function of relative costs. It can be seen that $G_{11}G_{21} > G_{12}G_{22}$ if and only if relative costs are greater than 1. This implies that Assignment 2 is ruled out whenever domestic firm is (relatively) less efficient than foreign firm. Otherwise, assignment 1 is selected away. We have

conducted a number of simulations with different polynomial cost functions and the selection criterion remains valid.



□

Proof of Proposition 2: Since μ is insensitive to t, statements (*ii*) and (*iii*) follow directly from inspection of equations (4) and (6). Since q_l falls, observation of (7) reveals that consumer surplus declines, which proves (*iv*). Since consumer welfare decreases with the tariff, this intervention can only be socially desirable if and only if it allows government to extract a sufficiently large amount of foreign rents. When the tariff policy is uniform social welfare reduces to:

$$W = \frac{\overline{\theta}\mu q_l}{(4\mu-1)^2}\left[\frac{\mu(4\mu+5)}{2} + t(\mu-1)(1+4\mu)\right] \tag{15}$$

From (4), it follows that $dq_l/dt = -q_l/(1-t)$. Then,

$$\frac{dW}{dt} = \frac{\partial W}{\partial q_l}\frac{dq_l}{dt} + \frac{\partial W}{\partial t} = \frac{\overline{\theta}\mu q_l}{(1-t)(4\mu-1)^2}\left[-\frac{\mu(4\mu+5)}{2} + (1-2t)(\mu-1)(4\mu+1)\right] \tag{16}$$

The sign of dW/dt depends on the sign of the expression in square brackets. In a neighborhood of free trade ($t = 0$), we have $sign\{dW/dt|_{t=0}\} = sign\{2\mu^2 - 5.5\mu - 1\} > 0$ for all $\mu > 3$. We now note that since $c_1 > c_2$ and tariff rates are equal, the solution in (3) is bounded above 5. To see this, note that the RHS of (3) is increasing in μ, while its LHS is constant; therefore, the lowest value

of μ solving (3) obtains when $c_1 \simeq c_2$. In such a case, μ is approximately equal to $5.25123 > 5$. Therefore, it follows that $dW/dt|_{t=0} > 0$. This completes the proof. □

Proof of Proposition 3: (*i*) First, notice that from (3), $\partial\mu/\partial t_1 > 0$. (*a*) Note that $dq_h/dt_1 = (\partial q_h/\partial\mu)(\partial\mu/\partial t_1)$. From (4) we have $\partial q_h/\partial\mu = -(1-t_2)8\overline{\theta}(5\mu+1)/c_2(4\mu-1)^4 < 0$. Thus, $dq_h/dt_1 < 0$. Since $q_l = q_h/\mu$, and q_h falls while μ increases with t_1, then $dq_l/dt_1 < 0$. (*b*) Using (4) and (6), we can rewrite $p_h = (1-t_2)8\overline{\theta}^2\mu(\mu-1)(4\mu^2-3\mu+2)/c_2(4\mu-1)^4$. Note that $dp_h/dt_1 = (\partial p_h/\partial\mu)(\partial\mu/\partial t_1)$. Since $\partial p_h/\partial\mu = (1-t_h)8\overline{\theta}^2(12\mu^3-19\mu^2+14\mu+2)/c_2(4\mu-1)^5 > 0$, it follows that $dp_h/dt_1 > 0$. (*c*) From (6) we have $p_l = p_h/2\mu$. Then, $p_l = \overline{\theta}(\mu-1)q_h/\mu(4\mu-1)$. Observe that $\overline{\theta}(\mu-1)/\mu(4\mu-1)$ decreases with $\mu \geq 5.25123$, and so with t_1. Note also that q_h falls with t_1. Thus, $dp_l/dt_1 < 0$. (*d*) This follows from the fact that $dD_i/d\mu < 0$, $i = 1,2$ (see equation (5)). (*e*) Consumer surplus can be written as $S = \overline{\theta}\mu(4\mu+5)q_h/2(4\mu-1)^2$. It can be seen that both factors $\overline{\theta}\mu(4\mu+5)/2(4\mu-1)^2$ and q_h fall with μ. Therefore $dS/dt_1 < 0$. (*f*) Using (4), (7) and (8), the relevant expression of social welfare is $W = \overline{\theta}^2\mu^3(4\mu-7)(1-t_1)(\mu(4\mu+5)+2t_1(\mu-1))/2c_1(4\mu-1)^2$. We need the sign of

$$\left.\frac{dW}{dt_1}\right|_{t_1=0} = \left.\frac{\partial W}{\partial t_1}\right|_{t_1=0} + \left.\frac{\partial W}{\partial\mu}\frac{\partial\mu}{\partial t_1}\right|_{t_1=0}.$$

We note that

$$\left.\frac{\partial W}{\partial t_1}\right|_{t_1=0} = -\frac{\overline{\theta}^2\mu^3(4\mu-7)(4\mu^2+3\mu+2)}{2c_1(4\mu-1)^5} < 0$$

$$\left.\frac{\partial W}{\partial\mu}\right|_{t_1=0} = \frac{\overline{\theta}^2\mu^3(16\mu^3-24\mu^2+45\mu+35)}{c_1(4\mu-1)^6} > 0$$

From equation (3) we have that

$$\left.\frac{\partial\mu}{\partial t_1}\right|_{t_1=0} = \frac{c_2\mu^3(4\mu-7)^2}{4c_1(16\mu^3-24\mu^2+45\mu-28)} > 0.$$

Using again (3) to substitute c_2/c_1 in this expression, yields

$$\left.\frac{\partial\mu}{\partial t_1}\right|_{t_1=0} = \frac{\mu(4\mu-7)(4\mu^2-3\mu+2)}{16\mu^3-24\mu^2+45\mu-28} > 0.$$

Now we are ready to compute the total derivative

$$\left.\frac{dW}{dt_1}\right|_{t_1=0} = -\frac{\overline{\theta}^2\mu^3(4\mu-7)(128\mu^6+32\mu^5+40\mu^4-154\mu^3+79\mu^2-370\mu+56)}{c_1(4\mu-1)^5(128\mu^4-224\mu^3+408\mu^2-314\mu+56)} < 0.$$

This completes the proof of (i). The proof of (ii) is analogous and omitted to save space. □

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References

Arkolakis, C., A. Costinot and A. Rodríguez-Clare (2012), 'New Trade Models, Same Old Gains?', *American Economic Review*, 102(1), 94–130.

Arkolakis, C., A. Costinot, D. Donaldson and A. Rodríguez-Clare (2012), 'The Elusive Pro-Competitive Effects of Trade', unpublished manuscript.

Bagwell, K. and R. W. Staiger (1999), 'An Economic Theory of GATT,' *American Economic Review* 89(1), 215-248.

Brander, J. A. (1995) 'Strategic Trade Policy', in G. Grossman and K. Rogoff (Eds.), *Handbook of International Economics,* (Amsterdam: North-Holland) vol. 3, 1395-1455.

Brander J. A. and B. J. Spencer (1981), 'Tariffs and the Extraction of Monopoly Rents', *Canadian Journal of Economics* 14-3, 371-389.

Collie, D. (1991), 'Export Subsidies and Countervailing Tariffs', *Journal of International Economics,* 31, 309-324.

Das, S. P. and S. Donnenfeld (1987), 'Trade Policy and its Impact on Quality of Imports', *Journal of International Economics,* 23, 77-95.

Ethier, W. J. (1988), 'Regionalism in a Multilateral World', *Journal of Political Economy* 106 (6), 1214-1245.

Greenaway, D., R.C. Hine and C. Milner (1995), 'Vertical and Horizontal Intra-industry Trade: A Cross Industry Analysis for the United Kingdom', *Economic Journal,* 105, 1505-1518.

Hallack, J.C. (2006), 'Product Quality and the Direction of Trade', *Journal of International Economics*, 68, 238-265.

Harsanyi, J.C. and R. Selten (1988), *A General Theory of Equilibrium in Games,* (Cambridge, MA: MIT Press).

Helpman, E. and P. R. Krugman (1989): *Trade Policy and Market Structure* (Cambridge MA: MIT Press).

Herguera, I., P. Kujal and E. Petrakis (2002), 'Trade Policies, Time Consistency, Quality Reversals and Exit in Vertically Differentiated Industries', *Journal of International Economics* 58, 467-492.

Hertel, T.W. (1994), 'The Pro-competitive Effects of Trade Policy Reform in a Small Open Economy', *Journal of International Economics*, 36, 391-411.

Krishna, K. (1987), 'Tariffs versus Quotas with Endogenous Quality', *Journal of International Economics,* 23, 97-122.

Melitz, M.J. (2003), 'The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity', *Econometrica* 71, 1695-1725.

Melitz, M.J., and G.I.P. Ottaviano (2008), 'Market Size, Trade, and Productivity,' *The Review of Economic Studies*, 75(1), 295–316.

Moraga-González, J.L. and J.-M. Viaene (2005), 'Trade Policy and Quality Leadership in Transition Economies', *European Economic Review* 49, 359-385.

Motta, M., J.-F. Thisse and A. Cabrales (1997), 'On the Persistence of Leadership or Leapfrogging in International Trade', *International Economic Review,* 38(4), 809-824.

Shaked, A. and J. Sutton (1982), 'Relaxing Price Competition through Product Differentiation', *Review of Economic Studies* 49, 3-13.

Vousden, N. (1990), *The Economics of Trade Protection* (Cambridge: Cambridge University Press).

Zhou, D., B.J. Spencer and I. Vertinsky (2002), 'Strategic Trade Policy with Endogenous Choice of Quality and Asymmetric Costs,' *Journal of International Economics* 56, 205-232.