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PROCOMPETITIVE TRADE POLICIES

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Abstract

We study the procompetitive effects of trade policies against a foreign oligopoly in a model of vertical product differentiation. We show that a uniform tariff policy like the Most Favored Nation (MFN) clause is always welfare superior to free trade because of a pure rent-extraction effect. However, a nonuniform tariff policy is, in addition, procompetitive and thus yields a higher level of social welfare. The first best policy typically consists of giving a subsidy to the country producing low quality and levying a tariff on the country producing high quality. Regional Trade Agreements (RTYs) are examples of nonuniform tariff policies. We show that these arrangements yield higher welfare than free trade and, moreover, that a RTA with a low-quality producing country yields larger gains than a RTA with a high-quality producing country.

JEL Classification: F12, F13, F15.

Keywords: endogenous quality, most favored nation (MFN) clause, procompetitive policies, regional trade agreements.

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1 Introduction

The existence of increasing returns to scale and imperfect competition has led to a number of contributions on the concepts of comparative advantage and gains from trade. A clear interpretation of existing theorems is generally obtained in terms of the procompetitive output changes resulting from trade (see, e.g. Schweinberger, 1996). In the literature on trade reforms, gains from trade liberalization rely significantly on the procompetitive effects caused by freer trade in the sense that it forces price down closer to marginal cost (Vousden, 1990; Hertel, 1994). Yet to date there is almost no literature on the procompetitive effects of imposing a trade policy. This is the principal purpose of this paper, which will employ a model of vertical product differentiation.

Models of vertical product differentiation capture an important characteristic of oligopolistic markets where firms select product-design strategies prior to the market competition stage. The importance of these markets in the volume of international trade has been documented in a number of empirical studies (see e.g. Feenstra, 1988; Greenaway *et al.*, 1995; Fontagné *et al.*, 1998). The monopoly problem is discussed in Mussa and Rosen (1978), Sheshinski (1976) and Spence (1975, 1976). Gabszewicz and Thisse (1979) and Shaked and Sutton (1982) study firms' quality choice in oligopoly. They establish the well-known result that firms have generally an incentive to choose distinct quality levels in an attempt to relax competition in the market. Extensions include Motta (1993) who compares product differentiation under Bertrand and Cournot competition; Cremer and Thisse (1994) who study the effects of commodity taxation; Lehman-Grube (1997) who examines the persistence of the high-quality advantage; and Ronnen (1991) and Crampes and Hollander (1995) who analyze the incidence of quality standards in duopoly settings. The international trade literature has focussed on the incidence of various trade policies on the quality of imports and on social welfare under different market structures. Krishna (1987, 1990) and Das and Donnenfeld (1987) study tariffs and quotas under monopoly. In a duopoly consisting of a domestic and a foreign firm Das and Donnenfeld (1989), Ries (1993) and Herguera *et al.* (2000) analyze the effects of quantity and quality restrictions, while Reitzes (1992) focuses on tariffs when buyers have different preferences for brands. Closer to our setting, Zhou *et al.* (2000) look at the robustness of traditional strategic trade policy in a third market model.

Though the literature is extensive, it is surprising that little attention has been paid to the procompetitive nature of trade policy in these markets. We consider vertical product differentiation in a third market model and asks the classical question what is the optimal trade policy of the consuming nation. In our model the buying country is the sole policy maker, whereas in other third market models (see, e.g. Brander, 1995; Zhou *et al.*, 2000) one of the producing countries is the sole policy maker. This distinction is important because while the strategic profit-shifting argument is central to most traditional models, it plays no role in our framework. Besides extracting rents, trade policy in our model can be designed to be procompetitive instead.[1]

We consider a framework in which two foreign firms operating in different countries export a quality-differentiated good to the home market which has no domestic production. Local consumers of the importing country have diverse preferences for the sole product attribute, quality. We assume that the local market is not entirely served in equilibrium, i.e., the market size is endogenous. In order to meet preferences, firms incur a fixed cost of quality development. Firms' cost conditions are like in pure vertical differentiation models, that is quality improvement falls primarily on fixed costs and involve a negligible increase in unit variable cost (Shaked and Sutton, 1983). The activist government is located in the importing country and pursues the maximization of national welfare by means of ad valorem tariffs and/or subsidies.[2] We study a three-stage game. In the first stage, the activist government chooses a trade policy against imports from the two foreign countries. In the second stage, foreign firms select the qualities to be produced, and incur the fixed costs. Finally, in the third stage, firms indulge in price competition and demand is satisfied. The nature of the game gives a special role to quality which, once set, can be modified only in the long-run. In addition, the local government acts as a Stackelberg leader vis-à-vis foreign firms.

There are two distinctive features of our model worth pointing out. First, as opposed to most existing vertical differentiation models, we allow firms to differ in their quality setup

[1] Likewise, our model can also be viewed as an extension to the literature on trade policy against foreign market power (Helpmann and Krugman, 1989, ch.4) by considering oligopoly and endogenous product quality.

[2] It is more and more common for tariffs and subsidies to be specified in ad valorem terms, i.e., as a percentage of the selling price. The US International Trade Commission has indeed made suggestions to convert most specific, compound and complex rates of duty to their ad valorem equivalents (see http://www.usitc.gov).

technologies. Many studies of product introductions in foreign markets associate success with the understanding of buyer needs abroad (Porter, 1990). Specific foreign preferences like the American desire for convenience, the German love for ecology (and Autobahn), the Japanese taste for compactness and the Scandinavian concern for safety are determining elements in the design and sophistication of products. Important costs of quality development are therefore involved. In our model, cost asymmetries between foreign firms enable us to show the existence of a *unique* refined pure strategy equilibrium where the inefficient firm produces a low-quality variant and the efficient one manufactures a high-quality variant. Second, the economy we postulate is relevant in many industrialized, transition and developing countries which do not produce manufactured goods like computers, electronics, cars and trucks, etc. and whose demand is satisfied by imports. For example, Fershtman *et al.* (1999) examine tax reforms in the automobile market in Israel, a non-producer of cars. Although quality differentials are normally associated with industrialized goods, they exist among commodities as well, freedom from disease being then an important aspect of quality. For example, the European Community is the major destination for the world's peanut exports and is the largest consuming region that does not produce (see, e.g. Raboy and Simpson, 1992).

In our model a single pure-strategy asymmetric equilibrium arises. We show that starting from free trade, national welfare can be increased either by levying a tariff on the high-quality product or by subsidizing the low-quality good. The first best policy consists of a subsidy on the low-quality product and a tax on the high-quality good. Optimal trade policy is in this case a procompetitive device. The reason is that in the absence of government intervention, firms optimally choose "extremes" on the quality spectrum with the aim at reducing competition. By applying the optimal policy, the activist government affects the relative costs of firms such that the quality gap between firms is reduced and market competitiveness increased.

Our framework allows us to deal with other important issues. First, there is an ongoing debate on whether the WTO rules have an economic rationale. In the WTO's tariff guidelines, it is noted that countries should comply with the Most Favored Nation (MFN) clause. This principle, a central pillar of international trade policy, treats activities of a particular foreign country at least as favorably as activities of other countries. Free trade is a special case of the MFN principle, in that tariffs are uniformly set to zero. In this paper, as the optimal tariff policy calls for nonuniform tariffs, it is shown that neither free trade nor the MFN principle are optimal. Second, a Regional Trading Agreement (RTAs) is another form of a nonuniform tariff policy because goods imported from member countries face a zero tariff while similar goods imported from non-member countries face a positive tariff. In this regard, our theory shows that RTAs are welfare superior to free trade. Moreover, the largest welfare improvement is realized when the domestic economy forms a RTA with a low-quality producing country. In this sense, vertical product differentiation provides little support for a transatlantic trade agreement but favors instead the membership of East European countries in the European Union, or the proposal for a Free Trade Area of the Americas where NAFTA would be extended southwards.

The remainder of the paper is organized as follows. The next section describes the model. Section 3 derives the firms' optimum and the market equilibrium. Section 4 studies the effects of uniform and nonuniform tariffs, and selects the optimal policy. Section 5 evaluates alternative trade policy regimes like RTAs. Finally, Section 6 includes a discussion of the results and the Appendix contains some proofs to facilitate the reading.

2 The Model

Suppose that a population of measure 1 lives in the importing country, which we shall also refer to as the domestic economy. Preferences of consumer θ are given by the quasi-linear (indirect) utility function:

$$U = \begin{cases} \theta q - p & \text{if he buys a unit of a good of quality } q \text{ at price } p \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

Consumers buy at most one unit. Suppose that the consumer-specific quality taste parameter θ is uniformly distributed over $[0, \overline{\theta}]$, $\overline{\theta} > 0$.[3]

There are two firms located in two different countries which produce and export the good

[3] As Tirole (1988, p. 96) argues, θ can also be interpreted as the reciprocal of the marginal utility of income.

in question. Both firms and respective countries are indexed $i = 1, 2$. Firms must incur the fixed cost of quality development $C_i(q) = c_i q^2/2$, $i = 1, 2$. Suppose without loss of generality that $c_1 > c_2$, i.e., foreign firms are asymmetric regarding their setup technologies.[4] Once the quality of the good is determined, we assume that production takes place at a common marginal cost which is normalized to zero.[5]

Heterogeneity in consumer tastes implies that it is optimal for the two firms to differentiate their goods by choosing different quality levels. Let us denote high-quality by q_h and low-quality by q_l, $q_h \geq q_l$. Suppose also, for the moment, that $p_h \geq p_l$, that is the firm producing a higher quality charges a higher price.[6] Domestic demand functions for the two qualities are obtained as follows. Denote by $\widetilde{\theta}$ the consumer who is indifferent between purchasing the two varieties. From (1), $\widetilde{\theta} = (p_h - p_l)/(q_h - q_l)$. Define $\widehat{\theta}$ as the consumer indifferent between acquiring the low-quality good and nothing at all, i.e. $\widehat{\theta} = p_l/q_l$. A consumer θ buys high quality if $\overline{\theta} \geq \theta \geq \widetilde{\theta}$, and low quality if $\widetilde{\theta} > \theta \geq \widehat{\theta}$, and nothing otherwise. Therefore:

$$D_l(.) = \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} - \frac{p_l}{\overline{\theta} q_l}, \; D_h(.) = 1 - \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)}. \tag{2}$$

We study a complete information three-stage game. First, the domestic government acts as a Stackelberg leader vis-à-vis foreign firms and chooses a tariff policy (t_1, t_2) on imports to maximize national welfare, where t_i is the *ad valorem* tariff levied on imports from country $i = 1, 2$. Foreign firms act as followers and thus take tariffs as given. In the second stage of the game, foreign firms choose the qualities to produce, and incur the fixed costs. Finally, in the third stage, firms indulge in price competition and demand is satisfied. The appropriate solution concept is subgame perfect equilibrium. The model is solved by backward induction.

[4] Besides foreign preferences, factor costs and sophistication of demand in the manufacturing countries are also other important determinants of relative cost differences (Motta *et al.*, 1997).

[5] The specification of the cost function could be more general without affecting qualitative results. For example, Moraga and Viaene (2001) use cost functions with a degree of homogeneity $k (k \geq 2)$ in qualities. While larger k values affect results quantitatively they don't qualitatively.

[6] We check below that this is actually satisfied in the equilibrium of the subgame.

3 Market Equilibrium

Let us now derive the equilibrium outcome in stage 3, i.e., price competition. 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 the pair of demands in (2), the pair of tariff rates $(t_1,\ t_2)$ and quality choices $(q_h,\ q_l)$ as given, the problem of firm 1 consists of finding p_l so as to maximize:

$$\pi_1 = (1 - t_1)p_l \left(\frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} - \frac{p_l}{\overline{\theta} q_l} \right) - \frac{c_1 q_l^2}{2}.$$

On the other hand, the rival firm chooses p_h to maximize its profits:

$$\pi_2 = (1 - t_2)p_h \left(1 - \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} \right) - \frac{c_2 q_h^2}{2}.$$

Solving the pair of reaction functions in prices, we obtain the subgame equilibrium prices of the two variants:

$$p_h = \frac{2\overline{\theta} q_h (q_h - q_l)}{4q_h - q_l},\ \ p_l = \frac{\overline{\theta} q_l (q_h - q_l)}{4q_h - q_l}. \tag{3}$$

A number of observations are in line here. First, notice that from (3) we obtain $p_h/q_h > p_l/q_l$. Therefore, in equilibrium, the hedonic price of the high-quality good is strictly higher than the low-quality one. Second, observe that prices do not directly depend on tariff rates or development costs. However, as we shall see, they will do so, indirectly, through firms' quality selection q_h and q_l.

Consider now the firms' quality selection. In this second stage, firms take (t_1, t_2) as given, anticipate the equilibrium prices of the continuation game obtained in (3), and choose their qualities to maximize profits. In particular, firm 1 chooses to produce q_l to maximize:[7]

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

[7] This expression is the reduced-form profit equation of a low-quality firm. It is obtained by substituting the equilibrium prices of the goods (equation (3)) into the profits expression.

Likewise, firm 2 selects q_h to maximize:

$$\pi_2 = (1-t_2)\frac{4\overline{\theta}q_h\left(q_h - q_l\right)}{\left(4q_h - q_l\right)^2} - \frac{c_2 q_h^2}{2}.$$

Since $q_h \geq q_l$, we can define $\mu = q_h/q_l$, $\mu \geq 1$. Variable μ represents the *quality gap* between firms. It measures the *degree of product differentiation* and, as we shall see, it relates to the extent of price competition. Using the definition of μ, the ratio of first order conditions in qualities can be written as:

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

This equation gives the equilibrium product differentiation μ as an implicit function of relative costs and ad valorem tariffs. There exists a unique solution to this third degree polynomial in μ satisfying $\mu \geq 1$. The next lemma shows the response of μ to changes in the primitive parameters of the model c_1 and c_2, and in the policy variables t_1 and t_2.

Lemma 1 *Quality gap μ increases in firms' relative development costs c_1/c_2. Moreover, it increases in t_1 and decreases in t_2.*

Proof. Consider the functions $g_1(t_1,t_2,c_1,c_2) = c_1(1-t_2)/c_2(1-t_1)$ and $g_2(\mu) = \mu^2(4\mu-7)/(4(4\mu^2-3\mu+2))$. Note that $dg_1/dt_1 = c_1(1-t_2)/c_2(1-t_1)^2 > 0$, $dg_1/dt_2 = -c_1/(1-t_1)c_2 < 0$ and $dg_2/d\mu = \mu(16\mu^3-24\mu^2+45\mu-28)/4\left(4\mu^2-3\mu+2\right)^2 > 0$. Therefore, as (4) must be satisfied in equilibrium, holding t_2 constant, μ increases as t_1 increases. Holding t_1 constant, μ decreases as t_2 increases. Likewise, we can show that μ increases with c_1/c_2. ■

This result allows us to write the solution to (4) in a compact form:

$$\mu = F\left(\frac{c_1(1-t_2)}{c_2(1-t_1)}\right), \tag{5}$$

with $F'(\cdot) > 0$. This unique real solution is depicted in Figure 1 for several parameter constellations. Observe that μ is always larger than 1.75 for any parametrical point (c_1, c_2, t_1, t_2) and that the relationship is almost linear.

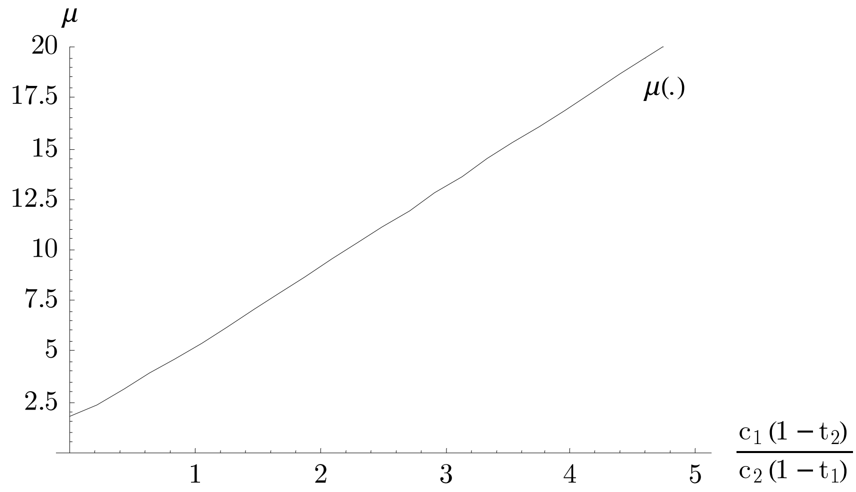

Figure 1: Quality gap related to relative costs and tariffs.

Since equilibrium μ is obtained from (4), it is now straightforward to solve for equilibrium qualities, and rewrite equilibrium demands and prices, from (2) and (3) respectively, as follows:

$$D_l = \frac{\mu}{4\mu - 1}, \ D_h = \frac{2\mu}{4\mu - 1} \tag{6}$$

$$p_l = \frac{\overline{\theta}(\mu - 1)q_l}{(4\mu - 1)}, \ p_h = \frac{2\overline{\theta}(\mu - 1)q_h}{(4\mu - 1)} \tag{7}$$

$$\widehat{\theta} = \frac{\overline{\theta}(\mu - 1)}{(4\mu - 1)} \tag{8}$$

$$q_l = (1 - t_1)\frac{\overline{\theta}\mu^2(4\mu - 7)}{c_1 (4\mu - 1)^3} \tag{9}$$

$$q_h = (1 - t_2)\frac{4\overline{\theta}\mu(4\mu^2 - 3\mu + 2)}{c_2 (4\mu - 1)^3} \tag{10}$$

Equation (4) together with (6) to (10) characterize the market equilibrium obtained from stages 2 and 3 of our game. The variable μ is central to our analysis. To see why, take the ratio of domestic prices in (7): $p_h/p_l = 2\mu$. The variable μ is therefore a measure of domestic price competition among the two firms: an increase in μ relaxes price competition and price differences rise. Hedonic prices p_h/q_h and p_l/q_l are also obtained from (7), and both are increasing in μ. From (6) we observe a negative relationship between μ and the quantities sold because, as the quality gap widens, higher transaction prices lead to a reduction in demands. Also, the position of the marginal consumer given by (8) increases with μ, implying that the number of consumers not served in the market, $(1 - D_h - D_l)$, increases as well.

So far we have assumed that firm 1 produces low quality and firm 2 high quality. However, it may very well happen 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 2 *Firm 1 produces low quality and firm 2 high quality in the unique equilibrium of the continuation game if and only if the inequality* $c_1(1 - t_2)/(1 - t_1) > c_2$ *holds. When* $c_1(1 - t_2)/(1 - t_1) = c_2$ *firm 1 may produce either high or low quality.*

Proof. See the Appendix.

The Appendix provides a general proof of this result for c_2 sufficiently low compared to $c_1(1-t_2)/(1-t_1)$. In this case, the assignment in which the high quality is produced by firm 1 and low quality is produced by firm 2 is not a subgame perfect equilibrium because the latter firm, which is highly efficient, finds it profitable to deviate and leapfrog the former firm. When the cost asymmetry between the firms is small, the proof requires a more powerful equilibrium concept, namely, the risk-dominance criterion of Harsany and Selten (1988). This refinement selects away the equilibrium in which firm 1 produces high quality whenever $c_1(1 - t_2)/(1 - t_1) > c_2$, i.e., as long as firm 2 is more efficient than firm 1 in relative terms. Since $c_1 > c_2$, this condition is trivially satisfied for $t_1 = t_2$. We shall later show that the optimal tariff policy, though nonuniform, satisfies this inequality as well.

4 Trade Policy

Finally, in the first stage of the game, the domestic government chooses the optimal tariff policy that 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.[8]

$$W = S + t_1 p_l D_l(.) + t_2 p_h D_h(.)$$

Consumers surplus is given by:

$$S = \int_{\frac{p_h - p_l}{q_h - q_l}}^{\overline{\theta}} (xq_h - p_h)dx + \int_{\frac{p_l}{q_l}}^{\frac{p_h - p_l}{q_h - q_l}} (xq_l - p_l)dx$$

Employing (7), (9), and (10), consumers surplus can be conveniently written as:

$$S = \frac{\overline{\theta}\mu^2(4\mu + 5)q_l}{2(4\mu - 1)^2} \tag{11}$$

where μ is given by (4) and q_l by (9). On the other hand, tariffs revenues obtained from imports are given by:

$$R_1 = t_1 p_l D_l(.), \; R_2 = t_2 p_h D_h(.).$$

After substitution of (6) and (7) we obtain:

$$R_1 = \frac{t_1 \overline{\theta}\mu(\mu - 1)q_l}{(4\mu - 1)^2}, \; R_2 = \frac{t_2 4\overline{\theta}\mu^2(\mu - 1)q_l}{(4\mu - 1)^2} \tag{12}$$

Using the previous expressions we can write the social welfare function of the domestic

[8] Note that, in line with the observation above and to economize on space, we only write down here the social welfare expression corresponding to the case where firm 1 produces low quality (see the proof of Proposition 3 below for the case where firm 1 produces high quality).

economy as:

$$W(t_1, t_2; c_1, c_2) = A(\mu(t_1, t_2), t_1, t_2) * q_l(\mu(t_1, t_2), t_1) \tag{13}$$

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 (9).

4.1 Effects of Uniform and Nonuniform Tariffs

We now examine the effects of trade policy on the domestic economy. We first consider the case of uniform tariffs, that is, when the domestic government applies a common tariff on imports from countries 1 and 2.

Uniform Tariff Policy

Starting from free trade, the impact of a uniform tariff policy obtains by setting $t_1 = t_2 = t > 0$. From (4) it is clear that the quality gap μ remains unaltered after this policy change. This enables us to state the following result:

Proposition 1 *Starting from free trade, a small uniform tariff on all imports results in (i) a downgrade in the quality of all imports, (ii) a decrease in the domestic price of the goods, (iii) a decrease in consumer surplus, and (iv) an increase in social welfare. Consequently, free trade is not optimal.*

Proof. Since μ is insensitive to t, statements (i) and (ii) follow directly from inspection of equations (7), (9) and (10). Since q_l falls, observation of (11) reveals that consumer surplus declines, which proves (iii). 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:

$$W = \frac{\overline{\theta}\mu q_l}{(4\mu - 1)^2}\left[\frac{\mu(4\mu + 5)}{2} + t(\mu - 1)(1 + 4\mu)\right] \tag{14}$$

We note that, from (9), it follows that $dq_l/dt = -q_l/(1-t)$. Then,

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

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 $c_1 \geq c_2$ and tariff rates are equal, the solution in (4) is bounded above 5. To see this, note that the RHS of (4) is increasing in μ, while its LHS is constant; therefore, the lowest value of μ solving (4) obtains when $c_1 = c_2$. In such a case, μ is approximately equal to $5.25123 > 5$. Therefore, it follows that $dW/dt|_{t=0} > 0$. ■

Proposition 1 indicates that a small uniform tariff against foreign firms is welfare enhancing. A tariff is attractive here due to a rent-extraction effect,[9] that is, income is taken away from foreign firms and transferred to local consumers to compensate them for the loss in consumer surplus that is caused by the downgrade in the quality of imports.[10] We note that a uniform tariff policy does not change the competitive conditions in the local market because the quality gap between imports of the two countries remains unaltered.

The MFN Principle

It is now straightforward to switch our attention to an application of Proposition 1, namely to consider the MFN principle. As noted already, the equilibrium product differentiation μ is independent of the MFN clause since tariff rates are similar. Applying this principle to our framework is equivalent to maximize social welfare (14) with respect to t. The first order condition follows from (15). Solving for the MFN tariff yields:

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

[10] It is possible to compare our results with those obtained when demand is satisfied by a foreign monopolist (Krishna, 1987; Das and Donnenfeld, 1987). We also obtain that the imposition of a tariff results in a downgrade of the quality of the imports, which has a negative impact on social welfare. Unlike these two papers where the effect of the tariff on the quantity of imports is ambiguous, it is zero here because the policy does not affect the terms of competition between firms. In our setting the policy brings about a substantial increase in tariff revenues which more than offsets the decrease in social welfare caused by the quality downgrading. In contrast, in the monopoly settings a tariff on imports may increase welfare even if tariff revenues are disregarded. This happens when the typical quantity distortion introduced by a monopolist is substantially reduced.

Corollary 1 *For any c_1/c_2, under the MFN principle, firms are taxed at the positive rate*

$$t^{MFN} = \frac{1}{2}\left[1 - \frac{\mu(4\mu+5)}{2(\mu-1)(4\mu+1)}\right] \tag{16}$$

where μ is the solution to equation (4).

Proof. t^{MFN} follows from isolating t in (15). It only remains to prove that the optimal MFN clause tariff is positive. Note that $t^{MFN} > 0$ if and only if $4\mu^2 - 11\mu - 2 > 0$, which holds for all $\mu > 3$. Since, as noted in the proof of Proposition 1, μ is bounded above 5, the result follows. ■

We now elaborate on several aspects of this result. First, we note that the MFN clause tariff increases with the quality gap, i.e., $dt^{MFN}/d\mu > 0$, but is bounded below 0.25. Second, since by Lemma 1 product differentiation increases in c_1/c_2, it follows that the MFN clause tariff increases in cost asymmetries as well. Finally, the welfare gains achieved by the MFN clause as compared to free trade are larger the greater the differences in firms' costs. This is illustrated in Figure 2, where we have represented the social welfare levels under free trade (W^{FT}) and the MFN clause (W^{MFN}) for distinct levels of firms' cost asymmetries.

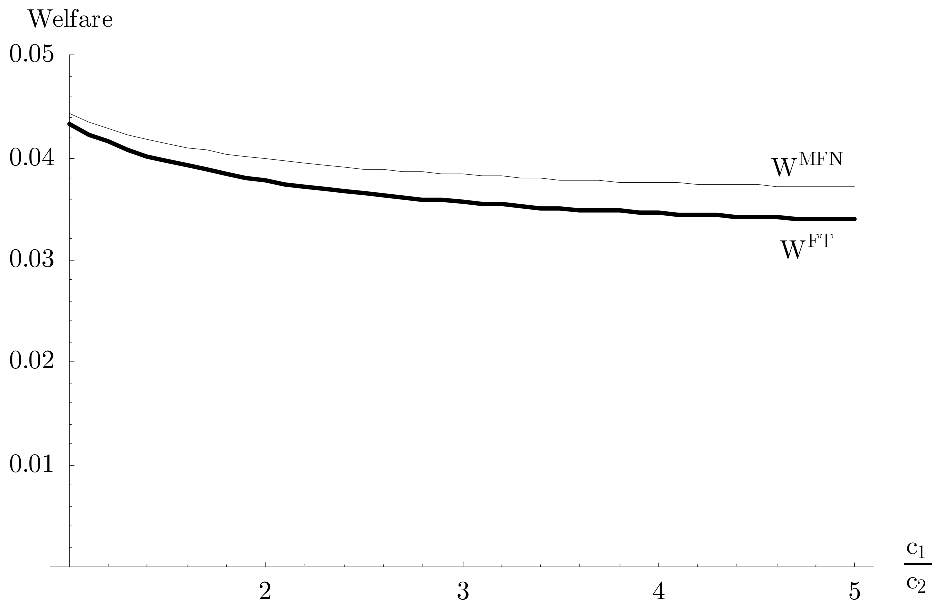


Figure 2: The MFN clause

Nonuniform Tariffs

Le us consider now the case of nonuniform tariffs, that is, when the government imposes distinct tariffs on imports proceeding from different countries. As Lemma 1 shows, a nonuniform trade policy alters the equilibrium quality gap. Thus, besides extracting rents from foreign firms, a nonuniform tariff modifies the degree of local price competition between firms. Starting from free trade, the impact of a nonuniform tariff policy on our equilibrium is:

Proposition 2 *(i) Starting from free trade, a small tariff on country 1 where the low-quality variant is produced leads to: (a) a downgrade in the quality of both variants, (b) an increase in the price of the high-quality product, (c) a reduction in the price of the low-quality good, (d) a reduction in the quantities sold and in the number of consumers being served, (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 leads to: (a') a downgrade in the quality and price of both variants and (b') an increase in the quantities sold and in the number of consumers being served, (c') a decrease in consumer surplus and (d') an increase in social welfare.

Proof. See the Appendix.

Proposition 2 shows that the effects of an asymmetric tariff policy are sensitive to whether the low-quality or the high-quality firm is conferred a cost disadvantage 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 (which results in an increase in p_h), and the number of active consumers falls. As tariff revenues are small, a tariff on the low-quality good ends up being welfare retarding. By contrast, a tariff on the high-quality firm fosters competition between firms (which results in lower equilibrium prices of both variants) and increases market size. 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, we note that a tariff levied on the imports from country 2 functions as a *procompetitive* device; by contrast, a tariff levied on the imports proceeding from country 1 is *anticompetitive.*

We note that Proposition 2 can be extended to the case where comparative statics is performed around the MFN equilibrium rather than around the free trade equilibrium.

Corollary 2 *Starting from the MFN clause tariff policy, social welfare can be increased by (1) slightly lowering the tariff rate on the low-quality good or (2) slightly raising the tariff on the high-quality good, if and only if* $\alpha\beta < 4\mu/(1+4\mu)$.

The proof is omitted as it follows that of Proposition 2. We note that the condition $\alpha\beta < 4\mu/(1+4\mu)$ is generally fulfilled in our model, where $\alpha = c\left(\partial\mu/\partial c\right)/\mu$ with $c = c_1(1-t_2)/c_2(1-t_1)$, and $\beta = \mu\left(\partial W/\partial\mu\right)/W$. Notice that α is the elasticity of the quality gap μ with respect to the relative unit costs in (4), which by Lemma 1 is positive, and that β is the elasticity of welfare W with respect to the quality gap μ, which is also positive. This corollary clearly indicates that there exist incentives for the activist government to deviate from the MFN principle and apply a nonuniform tariff policy. The reason for this is that a finely tuned nonuniform tariff is a procompetitive policy, thus yielding higher welfare gains for the domestic country.[11]

4.2 Optimal Trade Policy

The principal conclusion of the preceding section is the non-optimality of uniform tariff policies, including free trade. Formally, this is not surprising because the optima found before are constrained, in the sense that tariffs are restricted to be zero in the case of free trade, or identical in the case of the MFN clause. The next result describes the nature of the socially optimal trade policy.

[11] In the present context, a possible way to impose a nonuniform tariff policy is to include two distinct entries for the good in question, one which specifies the characteristics of the low-quality variant, the other for the high-quality one. A typical example of such a policy is the Generalized System of Preferences (GSP). Under this scheme, the President of the United States may give a duty less than the scope of an existing tariff rate line to a particular country and therefore subdivides this line to accomplish the desired treatment. As a favorable treatment is often given to developing and transition economies which are typical producers of low-quality products, Corollary 2 hints at potential positive welfare effects of GSP.

Proposition 3 *The optimal trade policy is such that: (i) It satisfies* $c_1(1-t_2)/(1-t_1) > c_2$*. As a result, firm 1 produces low quality and firm 2 produces high quality; (ii) It consists of a tariff on country 2 and a subsidy (tariff) on country 1 when cost asymmetries are sufficiently large (small).*

Proof. See the Appendix.

The nature of the optimal trade policy can be explained as follows. Under free trade or under the MFN clause, firms choose 'extremes' in the quality spectrum aiming at reducing price competition. In contrast, by imposing the optimal tariff policy, the government tries to combine the beneficial procompetitive effects of a tariff on high quality and a subsidy on low quality (Proposition 2). As a result, the optimal policy tends to minimize the quality gap and thus is strongly procompetitive. The welfare consequences of this policy can be seen in Figure 3, which also reproduces the welfare levels achieved under free trade and under the MFN clause. For any c_1/c_2, the vertical distance between W^{MFN} and W^{FT} represents a pure rent-extracting effect. By contrast, the distance between W^{OPT} and W^{MFN} shows the additional gains obtained by enhancing price competition between firms in the domestic market.

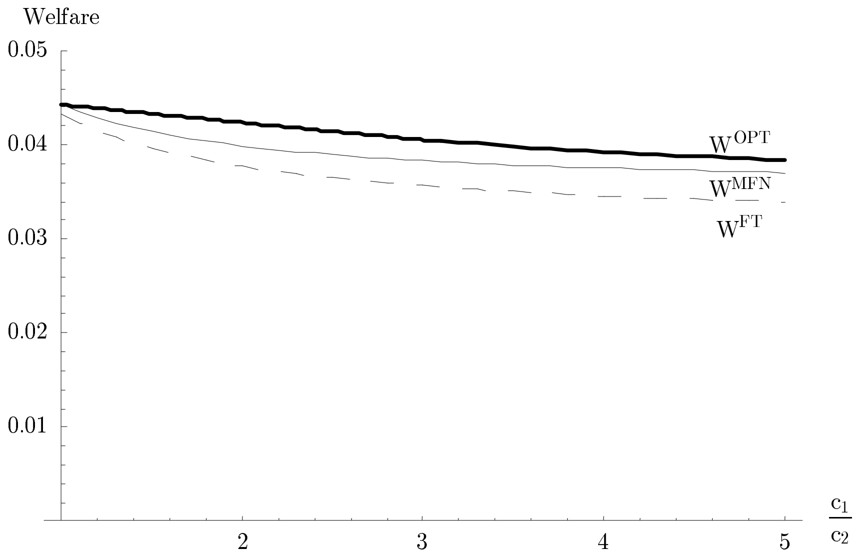


Figure 3: The optimal trade policy

5 Regional Trade Agreements

In the last decade more regional trade agreements (RTAs) came into force than ever before (World Bank, 2000). This trend has continued over the recent past and currently many new initiatives for special trade agreements are being negotiated within Europe, Asia and the two American continents. A number of these proposals involve transition and developing countries, which produce goods of distinct qualities. In this regard, our framework is suitable to examine some welfare aspects of these trading arrangements.

The principal feature of RTAs is the discriminatory treatment which favors members relative to non-members: goods imported from member countries face a zero tariff while similar goods imported from non-member countries face a tariff distinct than zero. In our model, consider the case where the domestic authority desires to form a RTA with one of the two foreign countries.[12] Then:

Proposition 4 *As compared to free trade, a Regional Trade Agreement with either of the countries is welfare improving.*

As the proof of this result follows directly from Proposition 2, we give an intuitive reasoning instead. The main reason why these agreements are welfare improving is because they contribute to enhance competition more than what free trade does. Consider the following two trading agreements which lead to a decrease in the quality gap, and to an increase in price competition and welfare: (a) a zero tariff on high-quality imports from country 2 together with a subsidy on low-quality imports from country 1 (Proposition 2(i)), or (b) a zero tariff on low-quality imports from country 1 together with a positive tariff on high-quality imports from country 2 (Proposition 2(ii)). Given this, the question that arises is which of the two trade agreements yields the highest welfare gains. We find that the RTA with the low-quality producing country is always welfare superior to the alternative trade agreemnent. This is illustrated in Figure 4, which shows the maximum welfare levels obtained under a RTA with the high-quality producing country (W^{RTA_2}), and under a RTA with the low-quality producing country (W^{RTA_1}). These are the highest welfare levels than can be obtained in each case. For example, in the case of a RTA with country 1, the welfare levels

[12] In our model, a RTA with both countries is nothing else than free trade.

are obtained by maximizing the social welfare function (13) with respect to t_2 subject to the constraints $t_1 = 0$ and $c_1(1 - t_2) \geq c_2$ (Lemma 2).

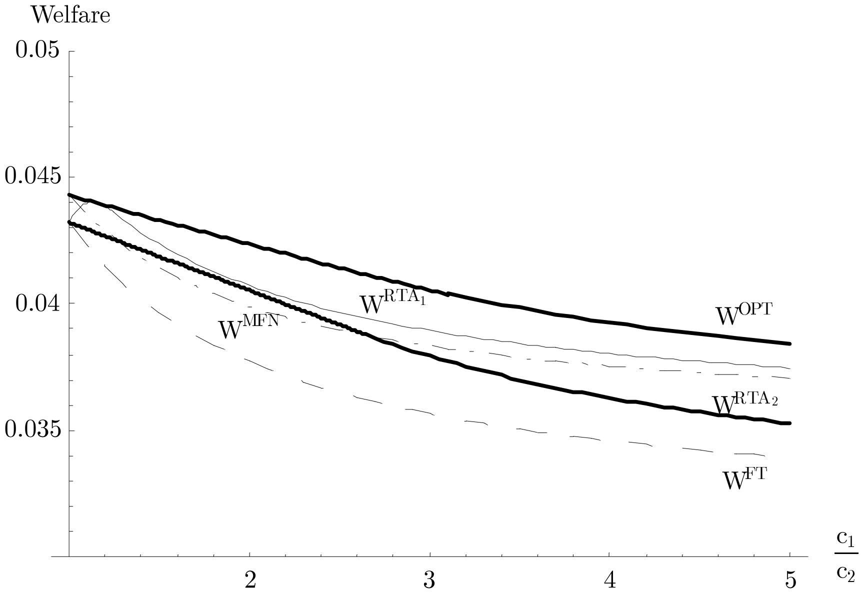


Figure 4: Regional trade agreements

It is clear from Figure 4 that a RTA with country 1 yields higher welfare gains than a RTA with country 2. The reason for this outcome is that the former extracts rents from country 2 through a tariff and, in addition, is procompetitive. The latter is also procompetitive but, in contrast, it does not extract foreign rents. For the sake of ranking tariff policies, the graph also reproduces the welfare levels achieved under free trade, the MFN clause and the optimal policy. It reveals than a RTA with country 1 does better than the MFN clause for the majority of the cost parameters. This highlights the importance of the procompetitive effect associated to this trade agreement.

6 Discussion

This paper has considered the procompetitive effects of tariff policies in a context where products contain different quality attributes and where domestic demand is met by imports from two foreign firms located in two different countries. We have argued that a single refined pure-strategy asymmetric equilibrium arises whenever consumers have heterogenous tastes on quality. While prior research has indicated how social welfare can be improved by altering quality through taxation in monopoly settings, our analysis has refined the discussion by determining the optimal tariff policy in the set of alternatives under oligopoly. The existence of distinct qualities gives rise to a first best policy consisting of setting a nonuniform tariff policy. This policy is more attractive than, for example, a MFN clause because, besides extracting rents, it fosters competition between the firms in the domestic market.

Alternatively, the government may consider the formation of a regional agreement. In this regard, our theory shows that RTAs are welfare superior to free trade because firms end up competing more agressively. Moreover, the largest gains are obtained when the domestic country joins the low-quality producing country. However, according to the same reasoning, the latter may have no incentive to join unless liberalization in other areas is granted as well. It is interesting to observe that regional trade agreements seldom address only trade barriers. For example, Ethier (1998) argues that regional trade agreements give newcomers a marginal advantage compared to non-participating countries in attracting foreign direct investments, which then give access to a larger market.

There are other observations in line here. First, our setting implicitly assumes that the activist government can credibly commit to its policy choice before the firms make their decisions. According to Brander (1995) most international trade observers agree in that governments often possess credible commitment devices. For example, when tariff rates are set by multilateral negotiations they usually remain fixed until the next round of negotiations. Of course we are aware of the recent literature dealing with time-consistent strategic trade policy. The main contribution of this literature is to show how the optimal trade policy is sensitive to the timing of policy moves (see e.g. Goldberg, 1995; Leahy and Neary, 1999; Herguera *et al.,* 2001). The second remark is related to the assumption that the only activist government is located in the home country. Of course, this is a simplifying assumption since foreign countries can engage into retaliatory trade policies (see e.g. Collie, 1991). Finally, our market structure ignores the possibility of entry in the domestic market which can be ensured by appropriately choosing entry costs (see e.g. Donnenfeld and Weber (1992) for a model of sequential entry). Alternative models could therefore be used to study questions similar to those raised in our model assuming a non-committal government or possible retaliatory policies.

7 Appendix

Proof of Lemma 2: 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 equilibrium candidate 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 equation $\mu^2(4\mu - 7)/4(4\mu^2 - 3\mu + 2) = k_1$ with $k_1 = c_1(1 - t_2)/c_2(1 - t_1) > 0$. 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 to deviate from it, i.e., no firm has an incentive to leapfrog its rival's choice. Equilibrium profits under Assignment 1 can be written as:

$$\pi_{1,l} = \frac{\overline{\theta}^2(1 - t_1)^2\mu_1^3(4\mu_1 - 7)(4\mu_1^2 - 3\mu_1 + 2)}{2c_1(4\mu_1 - 1)^6} \text{ and } \pi_{2,h} = \frac{16c_1(1 - t_2)^2}{c_2(1 - t_1)^2}\pi_{1,l}. \qquad (17)$$

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 the low-quality good generates higher profits as compared to the high-quality good, which is not the case here. The same reasoning, however, suggests 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:

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

From this equality, we obtain that λ must satisfy:

$$\frac{(4\lambda^2-3\lambda+2)}{(4\lambda-1)^3} = \frac{(4\mu_1^2-3\mu_1+2)}{\left(4\mu_1-1\right)^3}\frac{\mu_1c_1}{c_2},$$

i.e., $f(\lambda) = f(\mu_1)\mu_1c_1/c_2$. Denote the solution to this equation as λ_1. Since $\mu_1c_1/c_2 > 1$ and $f'(\cdot) < 0$, it follows $\lambda_1 < \mu_1$. Moreover, the larger c_1/c_2, the greater is μ_1c_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:

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

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

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

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 do this by means of one example. First, note that equation (4) is a cubic equation in μ. Notice also that its RHS is increasing 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 (4) satisfying $\mu \geq 1.75$. Now, given this, notice that there also exists a solution to equation $f(\lambda) - kg(\mu) = 0$. Indeed, this is also a cubic equation in λ that writes $(4\lambda^2 - 3\lambda + 2)/kg(\mu) = (4\lambda - 1)^3$. 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 i.e. $t_1 = t_2$. Then, $\mu_1 = 5.6335$, $\lambda_1 = 1.2578$ and therefore $16h(\lambda_1)(1 - t_h)^2 = -4.1582 \times 10^{-3} < 0 < h(\mu_1)(1 - t_l)^2 = 3.1208 \times 10^{-3}$. 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 the unique refined equilibrium is Assignment 1 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 (4) and demands, qualities and prices obtain from (6)-(10). 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:

$$\frac{c_2(1 - t_1)}{c_1(1 - t_2)} = \frac{\mu^2(4\mu - 7)}{4(4\mu^2 - 3\mu + 2)}. \tag{18}$$

We note that equations (4) and (18) are equal except for the LHS. Therefore, they yields different solutions. Let $\widetilde{\mu}$ denote the solution to (18). Under Assignment 2, firm 1 (the most inefficient) produces high quality given by

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

while firm 1 produces low quality given by

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

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

		q_h	$\widetilde{q}_l$
Firm 1	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 the 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 (4) and (18) –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 simulate our model for several values of the ratio $c_1(1 - t_2)/c_2(1 - t_1)$. Figure 5 depicts the gains G_{11}, G_{21}, G_{12} and G_{22} as a function of this ratio.

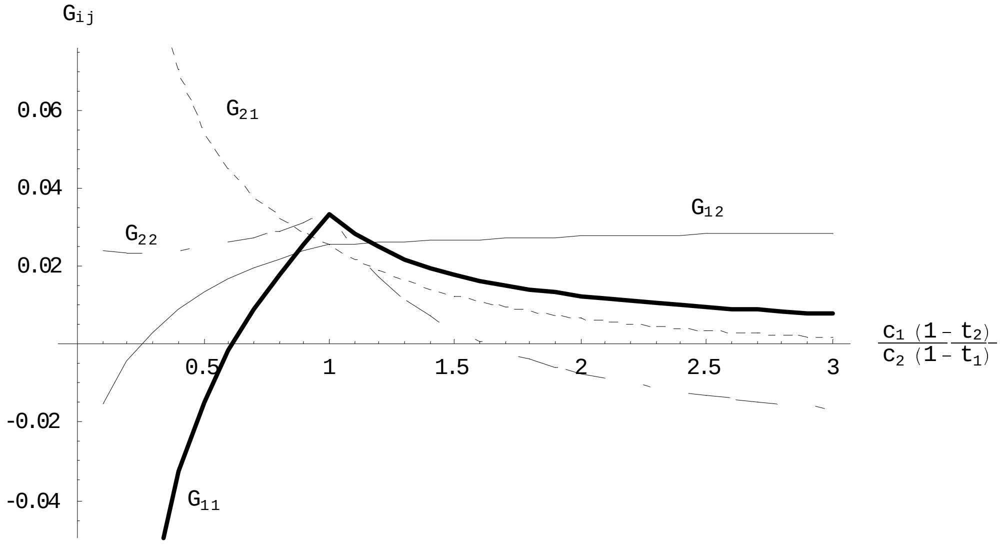
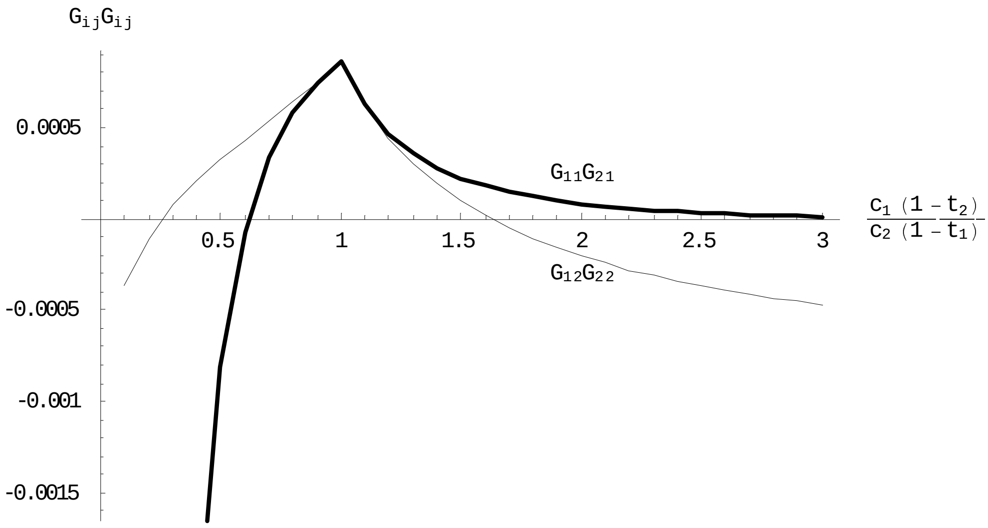


Figure 5

Inequality $G_{11}G_{21} > G_{12}G_{22}$ can be evaluated by observing Figure 6. 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 does not change.



■

Figure 6

Proof of Proposition 2: (i) First, notice that by Lemma 1, $\partial\mu/\partial t_1 > 0$. (a) Note that $dq_h/dt_1 = (\partial q_h/\partial\mu)(\partial\mu/\partial t_1)$. From (10) 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 (10) and (7), 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 (7) 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 result follows from the fact that $dD_i/d\mu < 0$, $i = 1,2$ (see (6)). (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 (11), (12) and (9), 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 (4) 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 (4) 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 therefore omitted. ■

Proof of Proposition 3: An element of complication that arises in the study of the optimal trade policy is that, since the government moves first in the game, he must anticipate the equilibrium of the continuation game. As noted in Lemma 2, firm 1 produces low quality in the unique equilibrium of the subsequent game if and only if the government chooses a tariff policy such that $c_1(1-t_2)/(1-t_1) > c_2$. We shall show that this is indeed the case, which means that the government has no interest in inducing the most inefficient firm to produce high quality. The proof proceeds as follows. We first study the problem of choosing the best tariff policy for the market configuration where firm 1 produces low quality and firm 2 high quality. Second, we compute the best tariffs against firm 1 producing high quality and firm 2 low quality. We finally compare the welfare levels attained under these two alternative scenarios and the result follows.

For any c_1 and c_2, let us define $W_j(t_1,t_2)$, $j=1,2$ as the social welfare under any policy mix (t_1,t_2) in Assignment j. Denote by (t_1^*,t_2^*) the maximizer of $W_1(t_1,t_2)$, i.e., $(t_1^*,t_2^*) = \arg\max W_1(t_1,t_2)$ subject to $c_2 \leq c_1(1-t_2)/(1-t_1)$. Likewise, let $(\overline{t}_1,\overline{t}_2) = \arg\max W_2(t_1,t_2)$ subject to $c_2 \geq c_1(1-t_2)/(1-t_1)$. Hence $W_1(t_1^*,t_2^*)$ and $W_2(\overline{t}_1,\overline{t}_2)$ denote the maximum level of welfare attained under Assignments 1 and 2, respectively.

As noted above, finding (t_1^*,t_2^*) consists of maximizing (13) subject to the constraint that $c_1(1-t_2)/(1-t_1) \geq c_2$. Differentiating (13) with respect to t_1 and t_2 yields:

$$\frac{dW}{dt_1} = \frac{W}{(1-t_1)}\left[\frac{\mu\overline{\theta}(1-t_1)(\mu-1)}{A(.)(4\mu-1)^2} - 1 + \alpha\beta\right] \tag{19}$$

$$\frac{dW}{dt_2} = \frac{W}{(1-t_2)}\left[\frac{4\mu^2\overline{\theta}(1-t_2)(\mu-1)}{A(.)(4\mu-1)^2} - \alpha\beta\right]. \tag{20}$$

The explicit values of α and β are cumbersome and therefore omitted. From (19) we have:

$$\alpha\beta = 1 - \frac{\overline{\theta}(1-t_1)\mu(\mu-1)}{A(.)(4\mu-1)^2}$$

This expression together with (20) gives the relation

$$A(.)(4\mu-1)^2 - \overline{\theta}(1-t_1)\mu(\mu-1) = 4\overline{\theta}(1-t_2)\mu^2(\mu-1)$$

Using the expression for $A(\cdot)$ given above, this equation reduces to:

$$16t_2\mu(\mu-1) + 4t_1(\mu-1) = \mu(4\mu-11) - 2.$$

We can isolate t_2 to obtain:

$$t_2 = \frac{1}{4\mu}\left(\frac{4\mu^2 - 11\mu - 2}{4(\mu-1)} - t_1\right) \tag{21}$$

This equation gives the relationship between t_1 and t_2. From (21) it follows that $t_2 > 0$ if and only if $t_1 < (4\mu^2 - 11\mu - 2)/4(\mu-1)$. Since $t_1 \leq 1$, it suffices to show that $(4\mu^2 - 11\mu - 2)/4(\mu-1) > 1$, which holds if and only if $4\mu^2 - 15\mu + 2 > 0$. This last inequality is satisfied for all $\mu > 4$; since we are assuming that $c_1(1-t_2)/(1-t_1) > c_2$, any solution to (4) satisfies $\mu > 5$. Therefore $t_2 > 0$.

To show that t_1 can be positive or negative depending on parameters, we note that when cost asymmetries are very small, i.e., $c_1 \simeq c_2$, then it is necessarily the case that $t_1 \simeq t_2$ (otherwise the constraint $c_1(1-t_2)/(1-t_1) > c_2$ would be violated). Simulations we have conducted have shown that when cost asymmetries are very large, this constraint is not binding and then it is the case that firm 1 is subsidized.

Assume now the contrary, i.e., that the government tariff policy is some (t_1, t_2) satisfying $c_1(1-t_2)/(1-t_1) < c_2$. Then, as noted in Lemma 2, the unique equilibrium of the continuation game is such that high quality is produced in country 1 and low quality in country 2. In such a case, the equilibrium product differentiation is given by $\widetilde{\mu}$ solution to

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

and the qualities produced by firm 1 and 2 are, respectively,

$$\widetilde{q}_h = (1-t_1)\frac{4\overline{\theta}\widetilde{\mu}(4\widetilde{\mu}^2-3\widetilde{\mu}+2)}{c_1\left(4\widetilde{\mu}-1\right)^3};\ \widetilde{q}_l = (1-t_2)\frac{\overline{\theta}\widetilde{\mu}^2(4\widetilde{\mu}-7)}{c_2\left(4\widetilde{\mu}-1\right)^3}.$$

Welfare is given by

$$W_2(t_1,t_2) = \frac{\overline{\theta}}{(4\widetilde{\mu}-1)^2}\left[\frac{\widetilde{\mu}^2(4\widetilde{\mu}+5)}{2} + t_2\widetilde{\mu}(\widetilde{\mu}-1) + 4t_1\widetilde{\mu}^2(\widetilde{\mu}-1)\right]\widetilde{q}_l.$$

As defined above, $(\overline{t}_1, \overline{t}_2) = \arg\max W_2(t_1,t_2)$. Unfortunately, $W_1(t_1^*, t_2^*)$ cannot be explicitly compared with $W_2(\overline{t}_1, \overline{t}_2)$. Thus, we have chosen to solve the model for different cost parameters. In Figure 7 we have represented $W_1(t_1^*, t_2^*)$ and $W_2(\overline{t}_1, \overline{t}_2)$.

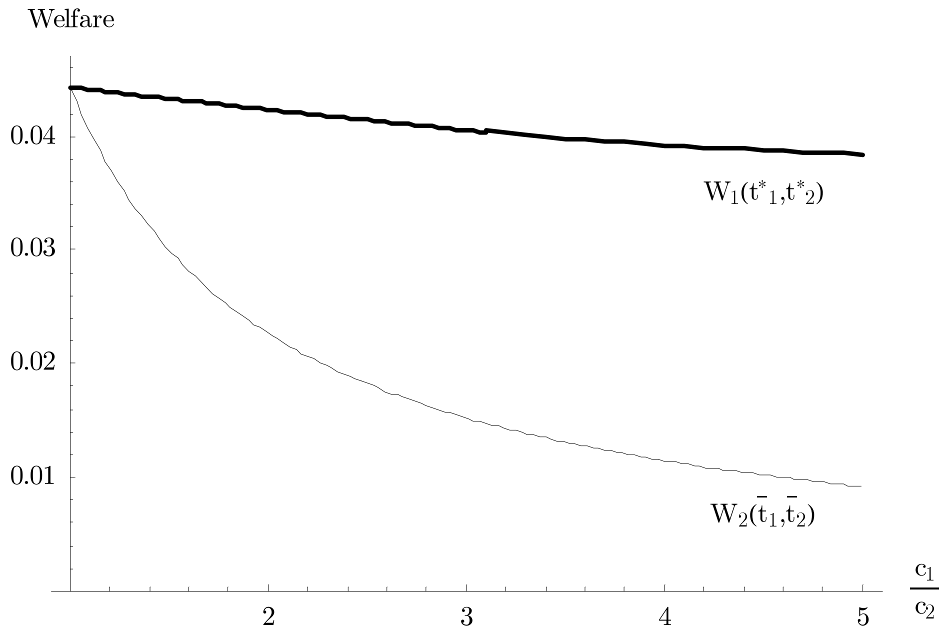


Figure 7

It is clear that the government has no interest in choosing a tariff policy so that firm 1 produces high quality and firm 2 low quality. We conclude then that the inequality $c_1(1-t_2)/(1-t_1) > c_2$ holds. ■

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