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An Example of Procompetitive Trade Policies

José Luis Moraga-González

and

Jean-Marie Viaene

Erasmus University, Tinbergen Institute and CESifo

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José Luis Moraga-González

Erasmus University, Tinbergen Institute and CESifo

Jean-Marie Viaene†

Erasmus University, Tinbergen Institute and CESifo

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Abstract

The procompetitive effects of trade policies are analyzed in a foreign duopoly model of vertical product differentiation. A uniform tariff policy complying with the Most Favored Nation (MFN) clause is welfare superior to free trade because of a pure rent-extracting effect. A nonuniform tariff policy yields an even higher level of social welfare because of procompetitive effects. The optimal policy is sensitive to firms' cost asymmetries: if these are high, imports of low quality are subsidized and imports of high quality face a tariff; otherwise, both imports face a tariff. Regional Trade Agreements (RTAs) are examples of such nonuniform tariff policies. They yield higher welfare than free trade because they are procompetitive; moreover, a RTA with a low-quality producing country yields larger gains than a RTA with a high-quality producing country because the former enables the importer to extract foreign rents.

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†*Addresses for correspondence:* Moraga-González: Erasmus University, Department of Economics, H7-17, PO Box 1738, 3000 DR Rotterdam, The Netherlands. Phone: +31 10 4088905, Fax: +31 10 4089149. Email: moraga@few.eur.nl; Viaene: Erasmus University, Department of Economics, H8-8, PO Box 1738, 3000 DR Rotterdam, The Netherlands. Phone: +31 10 4081397, Fax: +31 10 4089146. Email: viaene@few.eur.nl.

1 Introduction

The publication of the Boskin report on the upward bias of U.S. inflation (Boskin *et al.*, 1996) has led to renewed research on the impact of product quality on prices and volumes of transactions. Differences in product quality are particularly important in international trade where firms in developing and transition economies have different concerns for quality standards. It is the key point of Greenaway *et al.* (1995) who show that intra-industry trade characterized by different levels of quality is a significant proportion of trade. Central to the research agenda is the issue that, if product quality matters, the response of firms to government policies, and the effects of such policies on social welfare, can differ markedly from that of received theory. In this regard, the aim of the paper is to show that welfare-enhancing trade policies also lead to more competitive equilibria. Because of the procompetitive nature of trade policy in these markets, a Regional Trading Agreement (RTA) is shown to be welfare superior to free trade and the Most Favored Nation (MFN) clause.

To model the oligopolistic competition between firms we employ a model of vertical product differentiation. This model captures an important characteristic of oligopolistic firms namely, that they select product-design strategies to differentiate their goods from the rivals prior to the market competition stage. Also, a number of stylized facts have shaped our framework:

- Surveys such as "The Image of European Products" conducted by the Chambre de Commerce et d'Industrie de Paris, or others like the Bozall-Gallup Worldwide Quality Poll, give a direct quality ranking to the goods manufactured in Europe, USA and Japan. Econometric studies using these surveys establish a tight link between quality and development costs (Crozet and Erkel-Rousse, 2000).

- Many studies of product introductions in foreign markets associate firm success with the understanding of buyer needs abroad (Porter, 1990). Specific foreign preferences like the American desire for convenience, the German love for ecology, the Japanese taste for compactness and the Scandinavian concern for safety are determining elements in the design and sophistication of products like automobiles. Important costs of quality development are therefore involved and these typically differ across producers. In our model, cost asymmetries between foreign firms enable us to show the existence of a *unique* refined pure-strategy equilibrium and do matter for the design of the optimal tariff policy.

- Many industrialized, transition and developing countries do not produce manufactured goods like computers, electronics, domestic appliances, cars and trucks, etc. and their demand is entirely satisfied by imports. For example, Fershtman *et al.* (1999) examine tax reforms in the automobile market in Israel, a country that does not produce cars and whose demand is fully satisfied by imports.[1]

- In the last decade more regional trade agreements 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 that produce goods of distinct qualities. It is therefore important to build a framework than can examine some welfare aspects of these trade arrangements.

These features are introduced in a third market model where two foreign firms operating in two different countries export a quality-differentiated good to the home market which has no domestic production. Consumers of the importing country have diverse preferences for quality. In order to meet preferences, firms incur a fixed cost of quality development. Like in *pure* vertical differentiation models, quality improvements are assumed to fall primarily on fixed costs and involve no increase in unit variable cost (Shaked and Sutton, 1983). The active government, located in the importing country, maximizes domestic 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.

In our model a single pure-strategy asymmetric equilibrium arises. In the benchmark free trade equilibrium, the inefficient firm produces a low-quality variant while the most efficient firm manufactures a high-quality one. We show that national welfare can be increased by levying a

[1] Though quality differentials are normally associated with highly technological and industrialized goods, they also exist among seemingly identical goods like agricultural products, freedom from disease being then one important aspect of quality. For instance, the European Community is the major destination for the world's peanut exports and is the largest consuming region that does not produce them (see, e.g., Raboy and Simpson, 1992).

[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).

tariff on the country producing high quality, or by giving a subsidy to the country producing low quality. Interestingly, these two policies are *procompetitive* in the sense that they result in a decline in the hedonic prices (price-to-quality ratios) of both variants. A subsidy on low-quality imports results in quality upgrading and price decreases while a tariff on high-quality imports results in price decreases but in quality downgrading. The optimal trade policy calls for a *nonuniform* tariff policy and is sensitive to the extent of cost asymmetries between firms: when development costs are not too dissimilar, it consists of imposing a tariff on both types of imports; when cost differences are large, welfare is maximized by imposing a tariff on the high-quality producing country and subsidizing the low-quality producing one. This result leads to a number of new insights:

- In the literature on trade reforms, gains from trade liberalization rely significantly on the procompetitive effects caused by freer trade (Vousden, 1990; Hertel, 1994). In our framework, it is instead the imposition of an optimal trade policy that enhances social welfare and leads to a more competitive market equilibrium. The rationale behind this policy is as follows. In the absence of government intervention, firms position their products on the quality spectrum strategically with the aim of reducing competition. By applying the optimal policy, the activist government affects the relative costs of firms such that the quality gap between their products is minimized and thus market competitiveness enhanced. Interestingly, in addition to extracting rent from foreign firms, the optimal policy turns out to be procompetitive.

- Our analysis advances a different argument in favor of economic integration. The nature of the optimal trade policy implies that the domestic government has an incentive to deviate from free trade or from a tariff policy complying with the MFN clause. A possible deviation is to form a RTA, which is a nonuniform tariff policy because goods imported from the member country does not face a tariff while similar goods imported from the non-member country face some tariff. This leads to procompetitive effects and higher welfare compared to free trade and the MFN clause. The largest welfare improvement is realized when the domestic economy forms a RTA with a low-quality producing country, which has typically incentives to join. In this sense, product quality considerations provide support for 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.

- Our model addresses a classical question: what is the optimal trade policy of the consuming nation? In this regard, it extends the literature on trade policy against foreign market power

(Helpman and Krugman, 1989, ch. 4) to a setting where products are vertically differentiated. While in the former literature the optimal policy consists of a positive tariff, in our framework a tariff-cum-subsidy maximizes home country's welfare when development costs are very different.

The functioning of vertically differentiated markets has attracted substantial attention in the Industrial Organization literature.[3] The trade literature, besides documenting the importance of these markets[4], has focussed on the incidence of various trade policies on the quality of imports and on social welfare under different market structures. For example, Herguera *et al.* (2002) study the implications of specific import tariffs while Moraga-González and Viaene (2003) examine the optimal trade and industrial policies of transition economies. Another type of research has examined the persistence of quality leadership after countries open up to international trade (Motta *et al.,* 1997*).* In a third market model, Zhou *et al.* (2002) analyze the robustness of the profit-shifting argument in the presence of vertical product differentiation.[5] The latter analysis is the closest to ours but differs in a number of ways. First, while they focus on the strategic use of export subsidies by two policymakers, we examine a framework where the importing country is the sole policymaker. This distinction is important because while the strategic profit-shifting argument is central to their model it plays no role in our framework. Second, while they examine the interaction between developing and developed countries by assuming very large cost asymmetries between firms, we also allow for low cost asymmetries. This distinction matters because trade policies are sensitive to the extent of cost asymmetries and can induce firms to leapfrog each other on the quality ladder. This possibility is excluded by assumption in Zhou *et al.* (2002).

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 selects the optimal trade policy. Section 5 evaluates alternative trade policy regimes such as RTAs. Finally, Section 6 discusses the results and the Appendix contains the proofs.

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[3]See, e.g., Mussa and Rosen, 1978; Gabszewicz and Thisse, 1979; Shaked and Sutton, 1982, 1983; Motta, 1993; Cremer and Thisse, 1994; Lehman-Grube, 1997; Ronnen, 1991; Crampes and Hollander, 1995.

[4]See, e.g., Feenstra, 1988; Greenaway *et al.,* 1995; Fontagné *et al.,* 1998; Anderton, 1999.

[5]The literature also includes Krishna (1987, 1990), Das and Donnenfeld (1987) who 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.

2 The Model

We examine an international duopoly model of vertical product differentiation with asymmetric costs. 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: $U = \theta q - p$, if he buys a unit of a good of quality q at price p, and 0 otherwise. Consumers buy at most one unit. Suppose that the consumer-specific quality taste parameter θ is uniformly distributed over $[0, \overline{\theta}]$, $\overline{\theta} > 0$.

There are two firms located in two different countries which produce and export the good 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 that $c_1 > c_2$, i.e., foreign firms are asymmetric regarding their setup technologies. Once the quality of the good is determined, we assume that production takes place at a common marginal cost which is normalized to zero.[6]

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 (subsidy) policy (t_1, t_2) on imports to maximize national welfare, where t_i is the *ad valorem* tariff (subsidy) levied on imports from country $i = 1, 2$.[7] 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.[8]

[6] The specification of the cost function could be more general without affecting results qualitatively. For example, Moraga-González and Viaene (2003) use cost functions with a degree of homogeneity $k \geq 2$ in qualities. While larger k values affect results quantitatively they do not alter them qualitatively.

[7] This timing of moves assumes that the government can credibly commit to a certain trade policy. According to Brander (1995) most international trade observers agree in that governments often possess credible commitment devices. For example, when tariff rates are set after negotiations among several parties, they usually remain fixed until the next round of negotiations. However, another literature on time-consistent strategic trade policy has pointed out that policy may be sensitive to the different assumptions about government precommitment (see e.g. Goldberg, 1995 and Leahy and Neary, 1999). In our model, in absence of commitment, the government would simply maximize revenues and firms would respond by not entering the market; this implies that the government must commit to its trade policy for the market to exist.

[8] We are ignoring the possibility that foreign governments engage in *retaliatory* trade policies (Collie, 1991; Bagwell and Staiger, 1999). The rationale behind this assumption is that international firms often serve many markets and this impedes foreign governments to *target* retaliations against a specific country. An analysis of a three-player retaliatory game like the one that would arise in our setting involves major difficulties, among them the fact that the strategy of one of the players (domestic government) is two-dimensional.

3 Market Equilibrium

We first derive the equilibrium outcome of the price competition stage. To do so, we first present the demands faced by the two foreign firms. 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.[9] To obtain domestic demands for the two qualities, denote by $\widetilde{\theta}$ the consumer who is indifferent between purchasing the two varieties. From the utility function, $\widetilde{\theta} = (p_h - p_l)/(q_h - q_l)$. Define now $\widehat{\theta}$ 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:

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

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 the pair of demands in (1), 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 $\pi_1 = (1-t_1)p_l D_l(.) - c_1 q_l^2/2$. On the other hand, the rival firm chooses p_h to maximize its profits $\pi_2 = (1 - t_2)p_h D_h(.) - c_2 q_h^2/2$. Solving the pair of reaction functions in prices, we obtain the subgame equilibrium prices of the two variants:

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

A number of observations are in line here. First, notice that $p_h/q_h \geq p_l/q_l$. Therefore, in equilibrium, the hedonic price of the high-quality good is higher than that of 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, via firms' quality selection q_h and q_l.

Consider now stage two where firms select qualities. In this stage, firms take (t_1, t_2) as given, anticipate the equilibrium prices of the continuation game given in (2), and choose their qualities to maximize profits. In particular, firm 1 chooses q_l to maximize:

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

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

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:

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

This equation gives the equilibrium product differentiation μ as an implicit function of relative costs and ad valorem tariffs. 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 $\mu > 1.75$. 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.*

Since equilibrium μ is obtained from (3), it is now straightforward to solve for equilibrium qualities, and to rewrite equilibrium demands and prices, from (1) and (2) respectively, as follows:

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

$$p_l = \frac{\overline{\theta}(\mu - 1)q_l}{(4\mu - 1)},\ p_h = \frac{2\overline{\theta}(\mu - 1)q_h}{(4\mu - 1)} \tag{5}$$

$$q_l = (1 - t_1)\frac{\overline{\theta}\mu^2(4\mu - 7)}{c_1\left(4\mu - 1\right)^3} \tag{6}$$

$$q_h = (1 - t_2)\frac{4\overline{\theta}\mu(4\mu^2 - 3\mu + 2)}{c_2\left(4\mu - 1\right)^3} \tag{7}$$

Equation (3) together with (4) to (7) 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 (5): $p_h/p_l = 2\mu$. 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. Moreover, both hedonic prices p_h/q_h and p_l/q_l, which are obtained from (5), increase in μ. On this basis, we shall refer to a trade policy that leads to a decrease in μ as *procompetitive.* Vice versa, a policy that increases μ is called *anti-competitive*. We also observe from (4) that the relationship between μ and the quantities sold is negative. This is because, as the quality gap widens, higher prices lead to a reduction in demands.

So far we have assumed that firm 1 produces low quality and firm 2 high quality. 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 2 *If $c_1(1-t_2)/(1-t_1) > c_2$, firm 1 produces low quality and firm 2 high quality in the unique equilibrium of the continuation game. If $c_1(1-t_2)/(1-t_1) < c_2$, firm 1 produces high quality and firm 2 low quality in the unique equilibrium of the continuation game. When $c_1(1-t_2)/(1-t_1) = c_2$, firm 1 may produce either high or low quality.*

The proof is available from the authors upon request.[10] We simply provide here a sketch of the proof. First, we show that when c_2 is sufficiently low compared to $c_1(1-t_2)/(1-t_1)$, the assignment in which the high quality is produced by firm 1 and low quality is produced by firm 2 is not subgame perfect because the latter firm, which is highly efficient, finds it profitable to deviate and leapfrog the former firm. However, when the cost asymmetry between the firms is small, the proof uses 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. In the case that $c_1(1-t_2)/(1-t_1) = c_2$, the equilibrium selection refinement has no bite and both assignments can be equilibria.

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

[10] It can also be downloaded from http://www.tinbergen.nl/~moraga.

of domestic consumer surplus and tariff revenues,[11] i.e., $W = S + t_1 p_l D_l(.) + t_2 p_h D_h(.)$. 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 (5), (6), and (7), consumers surplus can be conveniently written as:

$$S = \frac{\overline{\theta}\mu^2(4\mu + 5)q_l}{2(4\mu - 1)^2} \tag{8}$$

where μ is given by (3) and q_l by (6). On the other hand, tariffs revenues obtained from imports are given by $R_1 = t_1 p_l D_l(.)$ and $R_2 = t_2 p_h D_h(.)$. After substitution of (4) and (5) we obtain:

$$R_1 = \frac{t_1\overline{\theta}\mu(\mu - 1)q_l}{(4\mu - 1)^2}, \; R_2 = \frac{t_2 4\overline{\theta}\mu^2(\mu - 1)q_l}{(4\mu - 1)^2} \tag{9}$$

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

$$W(t_1, t_2; c_1, c_2) = A(\mu(t_1, t_2), t_1, t_2) * q_l(\mu(t_1, t_2), t_1) \tag{10}$$

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 (6).

Let us now examine the effects of trade policy on the domestic economy in the benchmark case of free trade. Using Lemma 2, we know that low quality is produced in country 1 while high quality is produced in country 2. We first consider the cases of uniform and nonuniform tariffs and then derive the optimal policy.

Uniform Tariff Policy

With uniform tariffs, the active government levies a common tariff on imports from countries 1 and 2, that is, it sets $t_1 = t_2 = t > 0$. From (3) 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.*

[11] 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 instead).

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,[12] 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. 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.[13]

Nonuniform Tariffs

When tariffs are nonuniform 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 is anti-competitive and 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 is procompetitive and 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.

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 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 (which results in an increase in p_h), and the number of

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

[13] 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). However, as we shall see, non-uniform tariffs can be designed to be either procompetitive or anti-competitive and therefore their implications will differ substantially from the monopoly settings of the earlier literature.

consumers served 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, a tariff levied on the imports from country 2 functions as a *procompetitive* device because hedonic prices fall; by contrast, a tariff levied on the imports proceeding from country 1 is *anti-competitive*.

It is important to note that Proposition 2 also applies to the case where comparative statics is performed around uniform trade policies other than free trade.

Optimal Trade Policy

The preceding results indicate that there exist incentives for the activist government to deviate from free trade or 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.[14] The next result describes the nature of the socially optimal trade policy.

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

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 1, which also reproduces the welfare levels achieved under free trade and under the MFN clause.

[14] In the present context, an interesting 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 preferential duty lower than the existing tariff to a particular country and therefore subdivides this tariff 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, our analysis hints at potential positive welfare effects of the GSP.

The optimal policy complying with the MFN clause is derived by maximizing social welfare (10) under the constraint $t_1 = t_2 = t$. For any c_1/c_2, under the MFN principle, firms are taxed at the positive rate

$$t^{MFN} = \frac{1}{2}\left[1 - \frac{\mu(4\mu+5)}{2(\mu-1)(4\mu+1)}\right] \tag{11}$$

where μ is the solution to (3). It is clear from (11) that the MFN clause tariff increases with the quality gap μ but is bounded below 0.25. Moreover, 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.

In Figure 1, for any c_1/c_2, the vertical distance between W^{MFN} and W^{FT} represents the pure rent-extracting effect of the MFN policy shown in Proposition 1. 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.

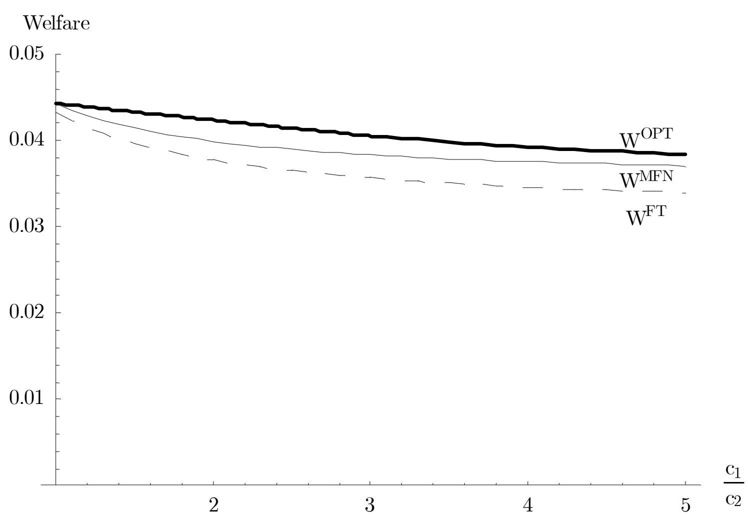

Figure 1: The optimal trade policy

5 Regional Trade Agreements

Figure 1 illustrates that the activist government has incentives to deviate from the MFN principle. RTAs, formally approved by the WTO, are possible deviations from the MFN policy and approximate the nature of the optimal trade policy. Our framework is thus suitable to examine some welfare aspects of these trade agreements.

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 from zero. In our model, consider the case where the domestic authority desires to form a RTA with one of the two foreign countries.[15] 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 free trade. Consider the two possible trade agreements of our framework, both leading to a decrease in the quality gap and thus 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, or (b) a zero tariff on low-quality imports from country 1 together with a positive tariff on high-quality imports from country 2. Given this, the question that arises is: which of the two trade agreements does yield the highest welfare gains? We find that the RTA with the low-quality producing country is always welfare superior to the alternative trade agreement. This is illustrated in Figure 2, where the maximum welfare levels obtained under a RTA with the high-quality producing country (W^{RTA_2}) are compared with those 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, we calculate the welfare level in the case of a RTA with country 1 by maximizing the social welfare function (10) with respect to t_2 subject to the constraints $t_1 = 0$ and $c_1(1 - t_2) \geq c_2$ (Lemma 2).

It is clear from Figure 2 that higher welfare gains are obtained under a RTA with country 1 than under a RTA with country 2. The former agreement extracts rents from country 2 through a tariff and, in addition, is procompetitive. The latter agreement is also procompetitive but does not extract foreign rent. 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.

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

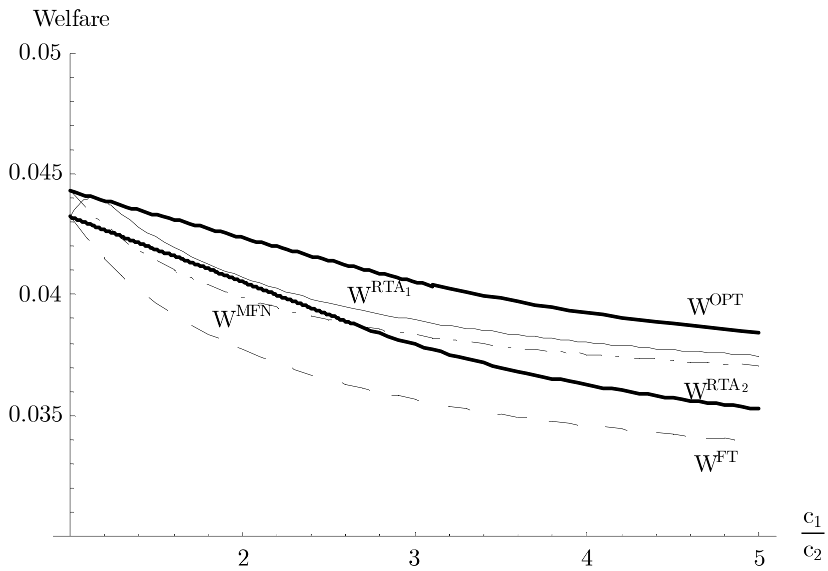

Figure 2: Regional trade agreements

The question that arises now is whether the low-quality producing country benefits from a regional trade agreement. It is easy to show that the answer to this question depends on the initial tariff policy. Interestingly, starting from the MFN clause, a RTA leads to higher profits for the low-quality firm and therefore gives incentives for this country to sign the agreement. However, this might not be the case if one starts from, for example, free trade or the optimal policy. In those cases liberalization in other areas might be needed to reach an agreement; in this connection, 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.

6 Conclusion

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 identifying the pro- or anti-competitive nature of trade policy and determining the optimal tariff policy in the set of alternatives under oligopoly. The existence of distinct qualities gives rise to an optimal policy consisting of setting a nonuniform tariff policy. The optimal policy is sensitive to firms' cost asymmetries: if these are high, imports of low quality are subsidized and imports of high quality face a tariff; otherwise, both imports face a tariff. 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 trade agreement. In this regard, our theory shows that RTAs are welfare superior to free trade because firms end up competing more aggressively. The largest gains are obtained when the domestic country joins the low-quality producing country. Moreover, the latter has typically an incentive to join.

7 Appendix

Proof of Lemma 1: 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 (3) 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.

Proof of Proposition 1: Since μ is insensitive to t, statements (i) and (ii) follow directly from inspection of equations (5), (6) and (7). Since q_l falls, observation of (8) 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:

$$W = \frac{\overline{\theta}\mu q_l}{(4\mu-1)^2}\left[\frac{\mu(4\mu+5)}{2} + t(\mu-1)(1+4\mu)\right] \tag{12}$$

From (6), it follows that $dq_l/dt = -q_l/(1-t)$. Then,

$$\frac{dW}{dt} = \frac{\partial W}{\partial q_l}\frac{dq_l}{dt} + \frac{\partial W}{\partial t} = \frac{\overline{\theta}\mu q_l}{(1-t)(4\mu-1)^2}\left[-\frac{\mu(4\mu+5)}{2} + (1-2t)(\mu-1)(4\mu+1)\right] \tag{13}$$

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 $dW/dt|_{t=0} > 0$. ■

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 (7) 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 (7) and (5), 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 (5) 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 (4)). (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 (8), (9) and (6), 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. ■

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 $(\bar{t}_1, \bar{t}_2) = \arg\max W_2(t_1, t_2)$ subject to $c_2 \geq c_1(1-t_2)/(1-t_1)$. Hence $W_1(t_1^*, t_2^*)$ and $W_2(\bar{t}_1, \bar{t}_2)$ denote the maximum level of welfare attained under Assignments 1 and 2, respectively.

As noted above, finding (t_1^*, t_2^*) consists of maximizing (10) subject to the constraint that $c_1(1-t_2)/(1-t_1) \geq c_2$. Differentiating (10) with respect to t_1 and t_2 yields:

$$\frac{dW}{dt_1} = \frac{W}{(1-t_1)}\left[\frac{\mu\overline{\theta}(1-t_1)(\mu-1)}{A(.)(4\mu-1)^2} - 1 + \alpha\beta\right] \tag{14}$$

$$\frac{dW}{dt_2} = \frac{W}{(1-t_2)}\left[\frac{4\mu^2\overline{\theta}(1-t_2)(\mu-1)}{A(.)(4\mu-1)^2} - \alpha\beta\right]. \tag{15}$$

The explicit values of α and β are cumbersome and therefore omitted. From (14) we have:

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

This expression together with (15) 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:

$$t_2 = \frac{1}{4\mu}\left(\frac{4\mu^2 - 11\mu - 2}{4(\mu-1)} - t_1\right) \tag{16}$$

This equation gives the relationship between t_1 and t_2. From (16) it follows that $t_2 > 0$ if and only if $t_1 < \left(4\mu^2 - 11\mu - 2\right)/4(\mu-1)$. Since $t_1 \leq 1$, it suffices to show that $\left(4\mu^2 - 11\mu - 2\right)/4(\mu-1) > 1$, 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 (3) 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). The numerical analysis we have conducted reveals 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 (18) and the qualities produced by firm 1 and 2 are given in (19) and (20), respectively. 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 numerically solve the model for different cost parameters. In Figure 3 we have represented $W_1(t_1^*,t_2^*)$ and $W_2(\overline{t}_1,\overline{t}_2)$.

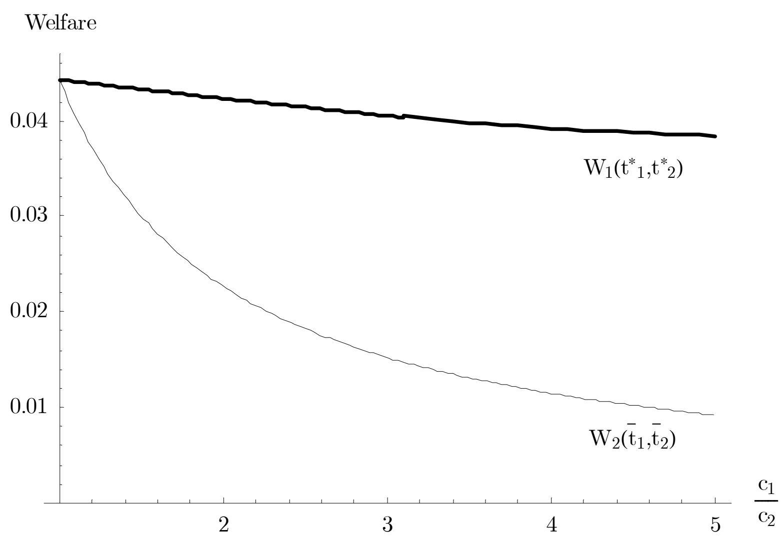

Figure 3

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 that $c_1(1-t_2)/(1-t_1) > c_2$ holds. ■

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Supplementary Appendix

(not for publication)

to **Procompetitive Trade Policies**

by José Luis Moraga-González and Jean-Marie Viaene

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 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:

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

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 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:

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

From this equality, we obtain that λ must satisfy:

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

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, $\mu_1 = 5.6335$, $\lambda_1 = 1.2578$ 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 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 (4)-(7). 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 (3) and (18) are equal except for the LHS; therefore, they yield different solutions. Let $\widetilde{\mu}$ denote the solution to (18). Under Assignment 2, firm 1 (the most inefficient) produces high quality given by

$$\widetilde{q}_h = (1 - t_1)\frac{4\overline{\theta}\widetilde{\mu}(4\widetilde{\mu}^2 - 3\widetilde{\mu} + 2)}{c_1\left(4\widetilde{\mu} - 1\right)^3} \tag{19}$$

while firm 1 produces low quality given by

$$\widetilde{q}_l = (1 - t_2)\frac{\overline{\theta}\widetilde{\mu}^2(4\widetilde{\mu} - 7)}{c_2\left(4\widetilde{\mu} - 1\right)^3}. \tag{20}$$

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 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 (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 solve our model numerically 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.

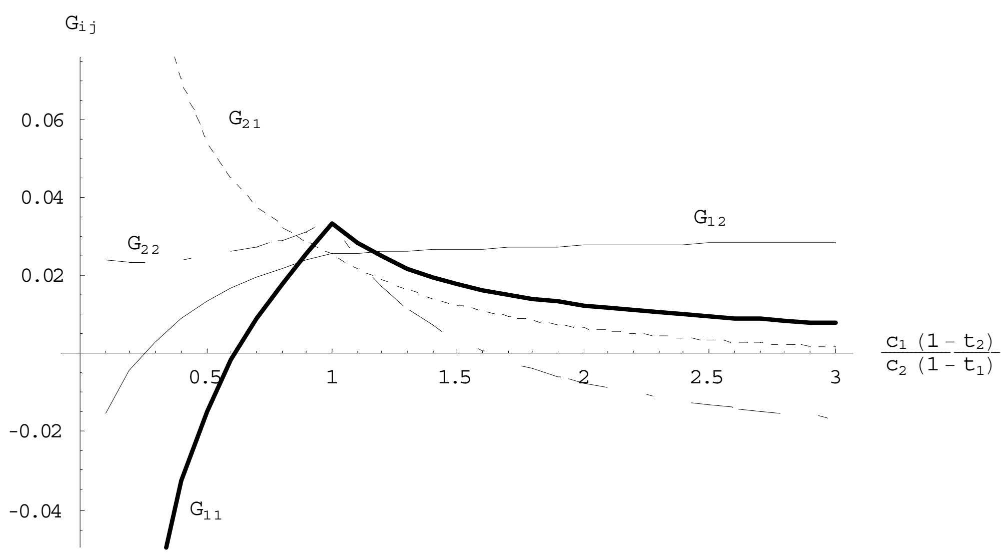

Figure 5

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 remains valid.

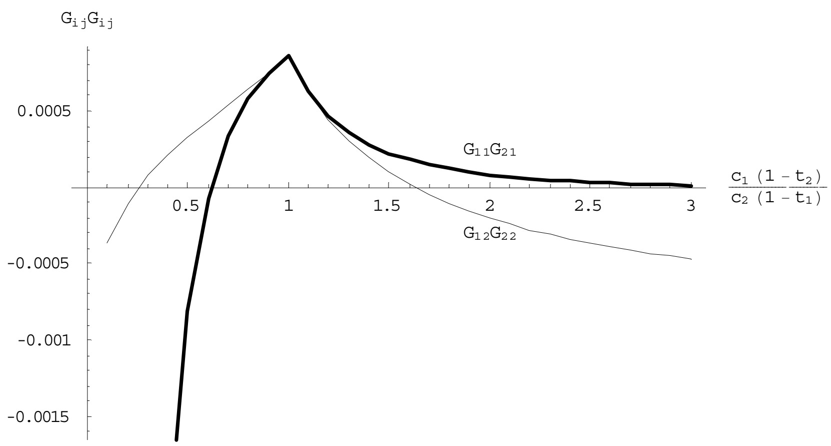

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Figure 6