Pro-Competitive Tariffs

Ivette Jans

Howard J. Wall*

Federal Reserve Bank of St. Louis

Revised August 1998

* **Corresponding author:** Federal Reserve Bank of St. Louis, P.O. Box 442, St. Louis, MO 63166-0442, United States; E-mail: wall@stls.frb.org

We would like to thank seminar participants at Birkbeck College for their helpful comments.

Pro-Competitive Tariffs

When foreign and domestic firms can collude under free trade, a tariff can be pro-competitive because it drives a wedge between the interests of the firms. However, only if the firms meet in a small number of countries will a tariff prevent international collusion. The optimal tariff therefore depends on the effect that it has on collusion, and on the extent to which firms interact in world markets. In contrast with conventional models, the pro-competitive effect of a domestic tariff may mean that the tariff that is optimal for the domestic country is also the worldwide optimum. (JEL F13; F14)

1. Introduction

This paper examines the optimal-tariff problem when collusion between foreign and domestic firms is endogenously determined by the level of domestic tariff. Because a tariff drives a wedge between colluding firms, there may be a critical tariff level at which the market structure changes from collusion to oligopoly. This means that there is a discontinuity in the welfare function that must be taken into account when determining the optimal tariff. The approach is reminiscent of work such as Alm and Thorpe (1995), who find that taxes in a closed economy can reduce the number of imperfectly competitive firms, thus possibly lowering the optimal tax. In contrast, import tariffs are by their nature discriminatory, and can be pro-competitive in that they preclude collusion between oligopolists. This pro-competitive effect can make the optimal tariff higher than it would be in otherwise identical models with fixed market structure. However, as we show below, this depends on the extent to which the firms compete across segmented international markets.

There has been a good deal of work in the international trade literature demonstrating ways in which an import quota, or some other quantitative restriction on imports, can alter the strategic relationship between domestic and foreign firms, thus decreasing the degree of competition in an industry [see Bhagwati (1965), Itoh and Ono (1982), and Harris (1985), among

others.]. Although tariffs have generally been shown to be competition-neutral,[1] an exception arises when oligopolists play repeated non-cooperative games in which the existence of collusion depends on the level of tariff. Davidson (1984) models an oligopoly with quantity-choosing foreign and domestic firms playing an infinitely-repeated game in the domestic market.[2] If a tariff is levied, it drives a wedge between the interests of the foreign and domestic firms, and can therefore be pro-competitive if it is high enough to eliminate collusion. However, as we show below, this can have no effect on the optimal tariff unless firms meet internationally.

The purpose of the present paper is to reexamine the optimal-tariff problem by demonstrating the relationship between the extent of international contact and the effectiveness of tariffs in precluding collusion. We show that multi-country contact is necessary in order for the optimal tariff to affected, and that the optimal tariff can be higher when the resulting discontinuity is taken into account. We also show that when there is multi-market contact it is also possible that a domestically optimal tariff is also optimal for the world as a whole.

We begin with a model of the domestic market for which we consider the incentives to collude, and the effect of the tariff level on these incentives. We then extend the model to account for multi-country contact, and from this we derive the condition for equilibrium worldwide collusion. We then use this to derive the effect of a domestic tariff on worldwide collusion, and on discontinuities in the welfare function. Finally, we describe how the possibility of collusion affects the optimal tariff, and how this optimal tariff depends on the extent of firms'

[1] Of course, tariffs and quantitative restrictions can be anti-competitive when they prohibit some or all foreign firms from participating in the domestic market [as with taxes in Alm and Thorpe (1995)]. However, we are presently only concerned with the effect of trade policy on the strategic relationship between existing and active firms.

[2] Rotemberg and Saloner (1989) also consider the effect of trade policies on collusion, but they model

multi-country contact.

2. The domestic market

Throughout this paper we assume that firms play a standard infinitely-repeated non-cooperative supergame. When firms collude they act as if the firms maximize joint profits, and implicit collusion arises in equilibrium if there is a credible threat of retaliation against a cheating firm. Following Friedman (1971) the collusion is enforced by a trigger strategy in which each firm colludes as long as the others do the same, but in the event that a rival cheats, reverts to its Cournot-Nash output forever. Our model of the domestic market differs from that of Davidson (1984) and Rotemberg and Saloner (1989) in that the goods are differentiated. We do this as the simplest and most meaningful way to make the model 'international'. Intra-industry trade will not exist in a collusive infinitely-repeated game with homogenous goods and symmetric costs.[3]

Consider the domestic country's market for a differentiated good. The country is served by two firms, domestic firm 1 and foreign firm 2, there are no transport costs, and the firms have constant marginal costs, which are set to zero without loss of generality. The inverse demand functions for the two firms' goods are symmetric:

$$p_i = \alpha - x_i - \beta x_j \qquad (1)$$

where x_i denotes the output of firm i, $\alpha > 0$, and $1 > \beta > 0$. In this model, the ability of the firms to collude is enhanced by the degree of product differentiation. The sign of this effect differs across models, and depends on whether firms are price- or quantity-choosing, and on whether the

collusion between *price*-choosing firms. In their model, a tariff has no effect on the level of competition.

[3] See Fung (1991).

goods are horizontally- or vertically-differentiated. See Ross (1992), Häckner (1994), and their references. Häckner (1995) examines endogenous product differentiation in a collusive duopoly.

Our demand functions (1) are generated by a standard aggregate utility function

$$U = W + M = \alpha(x_1 + x_2) - \frac{1}{2}(x_1^2 + 2\beta x_1 x_2 + x_2^2) + M; \tag{2}$$

where *M* is expenditure on all other goods.

Duopoly

Using *t* to denote a specific import tariff levied on the foreign firm, it is straightforward to obtain the equilibrium output levels if the firms are Cournot-Nash duopolists:

$$\left(x_1^d, x_2^d\right) = \begin{cases} \left(\dfrac{\alpha(2-\beta)+\beta t}{4-\beta^2}, \dfrac{\alpha(2-\beta)-2t}{4-\beta^2}\right) & t \in [0, t^d) \\ \left(\dfrac{\alpha}{2}, 0\right) & t \in [t^d, \infty) \end{cases}. \tag{3}$$

The prohibitive tariff, at or above which $x_2^d = 0$, is $t^d = \alpha(2-\beta)/2$. At or above t^d domestic output is what it would be under a monopoly, $x_1^m = \alpha/2$. The profit levels for the firms in a duopoly are $\pi_i^d = (x_i^d)^2$, $i = 1,2$.

Collusion

If the firms collude (either implicitly or explicitly), and maximize their joint profits, their output levels

$$\left(x_1^c, x_2^c\right) = \begin{cases} \left(\dfrac{\alpha(1-\beta)+\beta t}{2(1-\beta^2)}, \dfrac{\alpha(1-\beta)-t}{2(1-\beta^2)}\right) & t \in [0, t^c) \\ \left(\dfrac{\alpha}{2}, 0\right) & t \in [t^c, \infty) \end{cases}. \tag{4}$$

Under collusion the prohibitive tariff, at or above which $x_2^c = 0$ and $x_1^c = x_1^m$, is $t^c = \alpha(1-\beta)$.

Note that under joint-profit-maximization the price of the domestic good is independent of the tariff, but that the price of the foreign good rises with the tariff. The profit levels under collusion are $\pi_1^c = \alpha x_1^c / 2$ and $\pi_2^c = (\alpha - t)x_2^c / 2$.

A valid collusion strategy is one which provides both firms with levels of profit that are at least as high as their duopoly levels. Joint-profit maximization provides such a strategy when firms face the same marginal cost, but may not when the costs are 'too' different. Because a tariff is the same as an increase in the marginal cost of the foreign firm, joint-profit maximization is not a valid collusion strategy for all tariff levels. If there are *N*-1 other markets that are identical to the domestic market, are segmented from each other, and have zero tariffs, then joint-profit maximization is a valid collusion strategy as long as

$$\pi_i^c(t) - \pi_i^n(t) + (N-1)\left[\pi_i^c(0) - \pi_i^n(0)\right] \geq 0; \quad i = 1,2. \tag{5}$$

As we point out below, (5) is satisfied for all tariff levels that are relevant to our results.

Cheating

If firm *i* cheats, it maximizes profits taking firm *j*'s output to be at its collusive allocation, x_j^c. The outputs for the firms if they cheat unilaterally are

$$\left(x_1^{ch}, x_2^{ch}\right) = \begin{cases} \left(\dfrac{\alpha(2+\beta)(1-\beta)+\beta t}{4(1-\beta^2)}, \dfrac{\alpha(2+\beta)(1-\beta)-(2-\beta^2)t}{4(1-\beta^2)}\right) & t \in \left[0, t^c\right) \\ \left(\dfrac{\alpha}{2}, \dfrac{\alpha(2-\beta)-2t}{4}\right) & t \in \left[t^c, t^d\right) \\ \left(\dfrac{\alpha}{2}, 0\right) & t \in \left[t^d, \infty\right) \end{cases} \tag{6}$$

The one-period profit that a firm obtains if it cheats is $\pi_i^{ch} = (x_i^{ch})^2$.

Comparative statics of a tariff

From above, it is easy to see that a tariff has all of the usual effects on the output and the profits of the firms. A tariff in the domestic market raises the output and the profit of the domestic firm, and lowers both for the foreign firm.

$$\frac{dx_1^j}{dt} \geq 0 \text{ and } \frac{d\pi_1^j}{dt} \geq 0 \text{ as } t \leq t^j; \quad j = d, c, ch. \tag{7}$$

$$\frac{dx_2^j}{dt} \leq 0 \text{ and } \frac{d\pi_2^j}{dt} \leq 0 \text{ as } t \leq t^j; \quad j = d, c, ch. \tag{8}$$

The key to understanding the effect of a tariff on the incentives to collude is see the relative effects of the tariff on the different tariff levels. These relative effects differ across the level of tariff. For the domestic firm:

$$\frac{d\pi_1^c}{dt} > \frac{d\pi_1^{ch}}{dt} > \frac{d\pi_1^d}{dt} > 0, \quad t \in [0, t^c). \tag{9}$$

$$\frac{d\pi_1^d}{dt} > \frac{d\pi_1^c}{dt} = \frac{d\pi_1^{ch}}{dt} = 0, \quad t \in [t^c, t^d). \tag{10}$$

$$\frac{d\pi_1^j}{dt} = 0, \quad t \in [t^d, \infty). \tag{11}$$

For the foreign firm,

$$\frac{d\pi_2^c}{dt} < \frac{d\pi_2^{ch}}{dt} < \frac{d\pi_2^d}{dt} < 0, \quad t \in [0, t^c). \tag{12}$$

$$\frac{d\pi_2^d}{dt} < \frac{d\pi_2^c}{dt} < \frac{d\pi_2^{ch}}{dt} = 0, \quad t \in [t^c, t^d). \tag{13}$$

$$\frac{d\pi_2^j}{dt} = 0, \quad t \in [t^d, 0). \tag{14}$$

The intuition and interpretations of these results are included in section 3.

3. Collusion and the tariff

Domestic-market slack

Note that under free trade $\pi_i^{ch} > \pi_i^c > \pi_i^d$, so that a one-shot game would result in a Prisoners' Dilemma, and firms could both be better off if they colluded. In our infinitely-repeated game, if a firm cheats it will do so for one period only, and then firms revert to their duopoly profits thereafter. The firms will collude in equilibrium if the one-period gain from cheating is less than the discounted loss from the infinitely-lived reversion to the duopoly outcome. In this market, the difference between the discounted gain from collusion and the one-off gain from cheating is

$$h_i(t) = \frac{1}{r}(\pi_i^c - \pi_i^d) - (\pi_i^{ch} - \pi_i^c); \quad i = 1,2. \tag{15}$$

The expression $h_i(t)$ is a measure of the slack, or excess, enforcement in the domestic market. If the firms met in the domestic market only, they collude if $h_i(t) > 0, i = 1,2$; and compete as duopolists otherwise. There is a wide range of combinations of α, β, and r for which there is slack enforcement under free trade. This is more likely the higher α is, and the lower β and r are. A greater degree of differentiation (lower β) makes is more likely that firms will collude because it makes it more difficult for a cheating firm to entice the other firm's customers. As mentioned earlier, this depends on the type of differentiation, and on the assumption that the firms are quantity-choosers. A low r is more likely to result in collusion simply as an example of the Folk Theorem for Repeated Games, which holds that noncooperative behavior can sustain the collusive outcome if the interest rate is sufficiently low.

The effect of the tariff on the domestic-market slack of the two firms can be obtained by differentiating (15) with respect to t and using (9) - (14). This leads to two propositions.

Proposition 1: Domestic-market slack for the domestic firm is: increasing in the tariff if $t \in [0, t^c)$*, decreasing in the tariff if* $t \in (t^c, t^d)$*, zero if* $t \in [t^d, \infty)$.

Starting from free trade, imposition of a small tariff will increase the single-period domestic-firm gain from collusion. Under duopoly or joint-profit maximization, the tariff will lead to a relatively large increase in the domestic firm's allocation of the market. However, this shift will be greater under joint-profit maximization so as to shift production to the relatively low cost (domestic) producer. Reinforcing this is that, starting from free trade, a small tariff will decrease the incentive to cheat. This is simply because the increase in tariff will shift collusive profit to the domestic firm, and there is less to be gained from deviating from joint-profit maximization. Thus, starting from free trade, domestic slack in the domestic market rises with the tariff up to the point at which the domestic firm is allocated the entire market, $t = t^c$. Beyond that point, the only effect of the tariff on the domestic firm is to increase the profit that it would get under duopoly. So, up to the tariff in which all of the market would be captured by the domestic firm under duopoly, $t = t^d$, the domestic firm's slack in the domestic market falls with the tariff.

Proposition 2: Domestic-market slack for the foreign firm is: decreasing in the tariff if $t \in [0, t^c)$*, increasing in the tariff if* $t \in (t^c, t^d)$*, zero if* $t \in [t^d, \infty)$.

As discussed above for the domestic firm, starting from free trade, a small increase in the tariff will lead to a greater shift of the market away from the foreign firm when the firms are colluding than when they are duopolists. Under duopoly the foreign firm competes for its share of the market when its marginal costs rise due to the tariff, but under collusion even more of the

market will be shifted to the domestic firm. Thus, a small tariff decreases the foreign firm's gains from collusion when tariffs are below the point where its collusive output would be zero, $t = t^c$. Beyond t^c the only effect of an increase of the tariff is to decrease the foreign profit that would accrue under duopoly, thus increasing the foreign single-period gain from collusion, which would be negative. Mirroring this is the effect of the tariff on the foreign single-period gain from cheating, which rises as a small tariff is imposed. This would occur because the tariff shifts profit from the foreign to the domestic firm. So, at low tariff levels, the single-period profit from cheating falls by less than that under collusion. However, beyond $t = t^c$ the foreign firm's share of the market under collusion would be zero, so, as the one-period profit from cheating falls with the tariff, so does the incentive to cheat. This effect occurs up to the tariff level that would close out the foreign firm under duopoly, $t = t^d$.

As is apparent, the specific tariff that we are examining can be interpreted as the cost differential between two potentially collusive firms. The comparative statics results (9)-(14) can then be interpreted as the relationship between the profits and the cost differential. Propositions 1 and 2 then would state the relationship between the cost-differential and market slack, and t_1' would be the maximum cost differential that would sustain collusion in a single market.

Multi-country equilibrium

Assume now that there are *N*-1 other countries with markets that are completely segmented from each other, and that foreign firm 2 is located in one of these countries. It is straightforward to show that in the supergame equilibrium the firms will produce for all countries as long as the goods are differentiated. So, whether the firms collude, or compete as duopolists, there will be reciprocal trade between the two countries, and the domestic and foreign firms will

both export to all other countries in the world. It is the interaction of the firms in all these countries that determines the market structure and the effectiveness of domestic tariffs.

For worldwide collusion it is not necessary that there is slack collusion enforcement in each country individually. Slack enforcement that arises in one market can be used to bolster enforcement in another. So, there can be collusion in one country's market even though in that market the one-period gain from cheating exceeds the infinitely-lived retaliation. In other words, in order for the firms to collude it must be that the *sum* of the incentive constraints be negative. If the interest rate *r* is sufficiently low, it will be worthwhile for firms to forego the one-off gain from cheating in return for the infinite stream of discounted gains from collusion. Using a superscript *z* to denote the market of country *z*, the firms' worldwide incentive constraints are

$$H_i = \sum_{z=1}^{N} h_{iz} = \frac{1}{r}\sum_{z=1}^{N}(\pi_{iz}^{c} - \pi_{iz}^{d}) - \sum_{z=1}^{N}(\pi_{iz}^{ch} - \pi_{iz}^{c}); \quad i = 1,2. \tag{16}$$

There will be worldwide collusion if H_1 and H_2 are both positive. To simplify matters greatly, assume that the other N-1 markets are identical to the domestic market described in the previous section. Also assume that there are no tariffs levied elsewhere in the world. Under these assumptions, the worldwide incentive constraint for firm *i* becomes simply

$$H_i(t) = h_i(t) + (N-1)h_i(0); \; i = 1,2.$$

Because we have assumed that marginal costs are constant and that markets are segmented, profit levels are independent of N. It is then obvious that under our assumptions of identical markets and firms, under free trade the number of countries plays no role in satisfying the worldwide incentive constraint. However, if a tariff is imposed in the domestic market, then the firms are no longer identical, and thus the number of countries matters. We can safely ignore the effect of the domestic tariff on H_1, domestic firm slack, because $H_1 > 0$ for any extent of

international contact and for all relevant tariff levels.

It is straightforward to see the effect of multi-market contact on the worldwide foreign incentive constraint $H_2(t)$. An increase in N leads to a parallel upward shift of the incentive constraint, so for any level of tariff, including zero, there is more slack worldwide, and it is more likely that there will be collusion. This effect of the number of the number of countries on collusion is illustrated by Figure 1, which presents the numerical example we will use throughout, in which α=3, β=0.4, and r=0.1. Recall that the shape of $H_2(t)$ as described by Proposition 2. The number of countries affects the incentive for the foreign firm to collude because cheating would mean losing (in present values) not just the profit in the domestic country, but all of the free trade profit in the other N-1 countries. At low tariff levels, $t \in [0, t_N')$, this means that it will take a higher tariff to break up collusion.

It may seem odd that at high tariffs, $t \in [0, t_N'')$, foreign firms will collude even though the tariff is high enough to preclude any foreign sales in the domestic market. This is because at such high tariff levels, although foreign profits in the domestic market under collusion (zero) are lower than under duopoly, the difference is relatively small because the domestic firm would anyway have the lion's share of the market under duopoly. However, under intermediate tariff levels, the difference between foreign profit in the domestic market under collusion and duopoly is relatively large, which would require a large N to make it worthwhile for the foreign firm to forego this profit by maintaining collusion. There may be some $\overline{N}$ that is large enough so that there are no levels of domestic tariff that will prevent worldwide collusion, which, as illustrated by Figure 1, $\overline{N} = 4$ in our example. Note again that for all tariffs for which we say there is collusion, joint-profit maximization is a valid collusion strategy and satisfies (5).

4. The optimal tariff

Domestic welfare

In order to demonstrate the potential importance of multi-country contact and collusion on welfare, we re-examine the standard question of optimal tariffs when the government of an importing country faces foreign market power.[4] In the simple framework with linear demand and either a foreign monopoly or a Cournot duopoly with one domestic and one foreign firm, the optimal tariff is unambiguously positive.[5] The costs of such a tariff are borne by domestic consumers and foreign producers, whereas the benefits go to the domestic government and any domestic firms in the industry.

As demonstrated above, the level of tariff can determine whether or not there is collusion, a result that must be accounted for when deriving the welfare function. Assume that under any fixed market structure domestic welfare from this good is the sum of consumer surplus, the domestic government's tariff revenue, and the domestic firm's worldwide profit. Recalling (2) and netting the prices (1), domestic consumer surplus under any market structure is

$$C(t) = \frac{1}{2}\left(x_1^2 + 2\beta x_1 x_2 + x_2^2\right), \tag{17}$$

where x_1 and x_2 are functions of t. Assuming that there are no tariffs in the rest of the world, domestic profit from each of the N-1 other countries is $\pi_1^j(0)$. At this stage, we only consider the actions of a single government. The logical extension would be to examine the results when the governments of all N countries can impose tariffs, which is beyond our present purpose of

[4] See Helpman and Krugman (1989), chs. 4 and 6, for the basic issues and results.

establishing the results for the benchmark situation. Using a superscript to denote market structure, domestic welfare under fixed-market-structure *j* is therefore

$$W^j(t) = C^j(t) + \pi_1^j(t) + tx_2^j(t) + (N-1)\pi_1^j(0); \quad j = d, c, m. \tag{18}$$

The specific forms of the fixed-market-structure welfare functions are

$$W^c(t) = \frac{2\alpha^2(1-\beta) + \alpha t - 3t^2/2}{4(1-\beta^2)} + (N-1)\pi_1^c(0); \tag{19}$$

$$W^c(t) = \frac{\alpha^2(2-\beta) + \alpha t - 3t^2/2}{4-\beta^2} + (N-1)\pi_1^d(0); \tag{20}$$

$$W^m = \frac{3}{8}\alpha^2 + (N-1)\pi_1^c(0). \tag{21}$$

If market structure is fixed, then for collusion or duopoly welfare is continuous and strictly-concave in the tariff, up to the relevant prohibitive tariff. As is straightforward to obtain, the optimal tariff under collusion or duopoly is $\alpha/3$. If the market structure is fixed as monopoly, because imports are zero, welfare is the same for all tariff levels. Note also that $W^c(t^c) = W^m$.

Because market structure changes at the critical tariff levels derived in the previous section, the welfare function may be discontinuous. For $N < \overline{N}$, there are few enough countries in which the firms meet that there is a range of tariff levels under which collusion will not exist, and the welfare function is

$$G(t) = \begin{cases} W^c(t) & t \in \left[0, t_N^{'}\right) \\ W^d(t) & t \in \left[t_N^{'}, t_N^{''}\right) \\ W^c(t) & t \in \left[t_N^{''}, t^d\right) \\ W^m & t \in \left[t^d, \infty\right) \end{cases} \tag{22}$$

[5] Katrak (1977) for the monopoly case, and Brander and Spencer (1984) for the duopoly case.

For this case there are two possible results for the optimal tariff. The first is for when N is small enough so that the tariff that is just high enough to prevent collusion is lower than the fixed-market-structure tariff, i.e. $t_N' < \alpha/3$, as is always the case for $N = 1$.[6] As illustrated by Figure 2a, the welfare function is discontinuous at t_N' because the market structure shifts from collusion to duopoly. However, the optimal tariff is unaffected by the possibility that the tariff prevents collusion. The optimal tariff is high enough to prevent collusion, but it is the same tariff optimum as when the market structure was fixed as duopoly or collusion.

The other possibility is when N is large enough so that the tariff above which collusion will not arise is higher than $\alpha/3$. This is illustrated by Figure 2b, the welfare function is discontinuous at t_N' and t_N'', between which there is worldwide duopoly. At t_N' the market structure changes from collusion to duopoly, and at t_N'' it changes from duopoly to collusion. It is clear that the optimal tariff is high enough to just prevent collusion, and is higher than would be chosen if the effect of tariffs on collusion were not considered. So, for the case when $N < \overline{N}$, the optimal tariff is $t^* \equiv \max[t_N', \alpha/3]$.

The other possibility is that $N < \overline{N}$, meaning that there will be worldwide collusion no matter what the domestic tariff is. In this case there are no discontinuities in the welfare function, so the optimal tariff is $\alpha/3$. Welfare cannot be increased by using a tariff to change the market structure from collusion to duopoly, so the optimal tariff is unaffected by the collusion.

---

[6] This can be verified by evaluating $\pi_2^c - \pi_2^d$ at $t = \alpha/3$. Because this is negative, the foreign firm will

World welfare

Our result regarding the optimal domestic tariff is that it may be higher than in static models with fixed market structures. Perhaps more significantly, and unlike in static models, the pro-competitive effect of the tariff means that the tariff that is optimal for the domestic country may also be optimal for the world as a whole. To illustrate this, consider the world welfare function under market structure *j*:

$$Z^j(t) = C^j(t) + (N-1)C^j(0) + \pi_2^j(t) + (N-1)\left[\pi_1^j(0) + \pi_2^j(0)\right] + tx_2^j(t); \quad j = d, c. \quad (23)$$

The components of world welfare are consumer surplus in the domestic and overseas markets, profit for the two firms in the domestic and overseas markets, and domestic tariff revenue.

Because the deadweight loss from collusion exceeds that under duopoly, world welfare is higher under duopoly for all tariff levels; i.e. $Z^d(t) > Z^c(t)$. Also, because there is no profit-shifting motive in the maximization of world welfare, world welfare decreases with the tariff under either market structure. These characteristics of the model are standard. The nonstandard aspect of our model, which makes it possible for the domestic tariff to improve world welfare, is that a tariff within a certain range can ensure worldwide duopoly instead of worldwide collusion. If $N < \overline{N}$, a tariff set at the domestic optimum *t** will be just high enough to preclude collusion throughout the world, and world welfare jumps to Z^d. This tariff will also be the world optimum as long as welfare under the tariff and duopoly is greater than under free trade and collusion; i.e. as long as $Z^d(t_N') > Z^c(0)$. This possibility is illustrate by Figure 3 with our numerical example and $N = 3$. Because collusion is more likely the greater is the degree of product differentiation, it

never collude at a tariff at or above $\alpha/3$, meaning that $t_i' < \alpha/3$.

is more likely that the domestically-optimal tariff also maximizes world welfare the lower β is.

5. Concluding remarks

When domestic and foreign firms collude, an import tariff drives a wedge between the firms, and can be pro-competitive if it is high enough to preclude collusion. However, because it is more difficult to do this the greater the multi-country contact of the firms, it might not be possible for a tariff to be used in this way. For a given extent of multi-country contact, a range of tariff levels can exist for which collusion does not arise. If so, it is always optimal for the domestic country to set the tariff at least as high as the level which just precludes collusion, although the optimal tariff under a fixed market structure may already be high enough, depending on the extent of multi-country contact. Further, it is possible that the tariff that is optimal for the domestic government may also be the tariff that maximizes world welfare. We make no claims for the generality of our model, which is very standard, but merely note the potential importance of integration on the existence of cartels.

As with any model of collusion, one must be careful before applying the results to actual policy. There are variations on the model that would have to be explored before any firm policy options can be considered. The first arises because, as we noted earlier, these models are sensitive to whether the firms are quantity-choosing or price-choosing, and to the type of differentiation. A second arises because we have modeled the collusive strategy as one in which the firms maximize joint profit, although joint-profit maximization is just one of many valid collusion strategies. Third, in our model there is no possibility of direct or indirect side payments, although there may be ways for domestic firms to compensate the foreign firm when it faces a tariff, even though direct payments would be difficult under existing anti-trust laws. And

fourth, Friedman's trigger strategy, which is the standard starting point, might be too extreme a form of punishment. Perhaps the carrot and stick strategy of Abreu (1986) is more appropriate, although it is not obvious to us whether this would alter our results to any great extent.

There are also extensions regarding our application of collusion to an international context. First, our assumptions of linear costs and complete market segmentation lead to a greatly simplified model in which the only effect that the domestic tariff has on the rest of the world is the possibility of preventing collusion. With non-constant marginal costs a tariff in the domestic market would change the marginal cost for the other markets. The tariff's effects would also be more wide-ranging if there was some degree of arbitrage across national markets. Second, the structure of the game is such that there is collusion or duopoly worldwide, but there is no possibility of firms colluding in some countries and competing in others. Such a complicated game would clearly have implications for our results, although at this stage we maintained the convention of Bernheim and Whinston (1990).

References

Abreu, D., 1986, Extremal equilibria of oligopolistic supergames, *Journal of Economic Theory 39*, 191-225.

Alm, J. and S.G. Thorpe, 1995, Taxation, imperfect competition, and discontinuities, *International Tax and Public Finance 2*, 419-438.

Bernheim, B.D. and M.D. Whinston, 1990, Multimarket contact and collusive behavior, *Rand Journal of Economics 21*, 1-26.

Bhagwati, J., 1965, On the equivalence of tariffs and quotas, in R.E. Baldwin *et al*, eds., *Trade, Growth, and the Balance of Payments: Essays in Honor of Gottfried Haberler*, North-Holland.

Brander, J.A., 1995, Strategic trade policy, in G.M. Grossman and K. Rogoff, eds., *Handbook of International Economics, vol. 3*, North-Holland.

Brander, J.A. and P.R. Krugman, 1983, A 'reciprocal dumping' model of international trade, *Journal of International Economics 15*, 313-321.

Brander, J.A. and B.J. Spencer, 1984, Trade warfare: Tariffs and cartels, *Journal of International Economics 16*, 227-242.

Davidson, C., 1984, Cartel stability and tariff policy, *Journal of International Economics 17*, 219-237.

Friedman, J., 1971, A non-cooperative equilibrium for supergames, *Review of Economic Studies 28*, 1-12.

Fung, K.C., 1991, Collusive intra-industry trade, *Canadian Journal of Economics 24*, 391-404.

Häckner, J., 1994, Collusive pricing in markets for vertically differentiated products, *International Journal of Industrial Organization 12*, 155-177.

———, 1995, Endogenous product design in an infinitely repeated game, *International Journal of Industrial Organization 13*, 277-299.

Harris, R., 1985, Why voluntary export restraints are 'voluntary', *Canadian Journal of Economics 18*, 799-809.

Helpman, E. and P.R. Krugman, 1989, *Trade Policy and Market Structure*, MIT Press.

Itoh, M. and Y. Ono, 1982, Tariffs, quotas, and market structure, *Quarterly Journal of Economics 97*, 295-305.

Katrak, H., 1977, Multinational monopolies and commercial policy, *Oxford Economic Papers 29*, 283-291.

Krugman, P.R., 1989, Industrial organization and international trade, in R. Schmalansee (ed.), *Handbook of Industrial Organization, vol. II*, North-Holland.

Martin, S., 1993, *Advanced Industrial Economics*, Blackwell.

Ross, T.W, 1992, Cartel stability and product differentiation, *International Journal of Industrial Organization 10*, 1-13.

Rotemberg, J.J. and G. Saloner, 1989, Tariffs vs. quotas with implicit collusion, *Canadian Journal of Economics 22*, 237-244.

Figure 1
Worldwide Foreign-Firm Slack

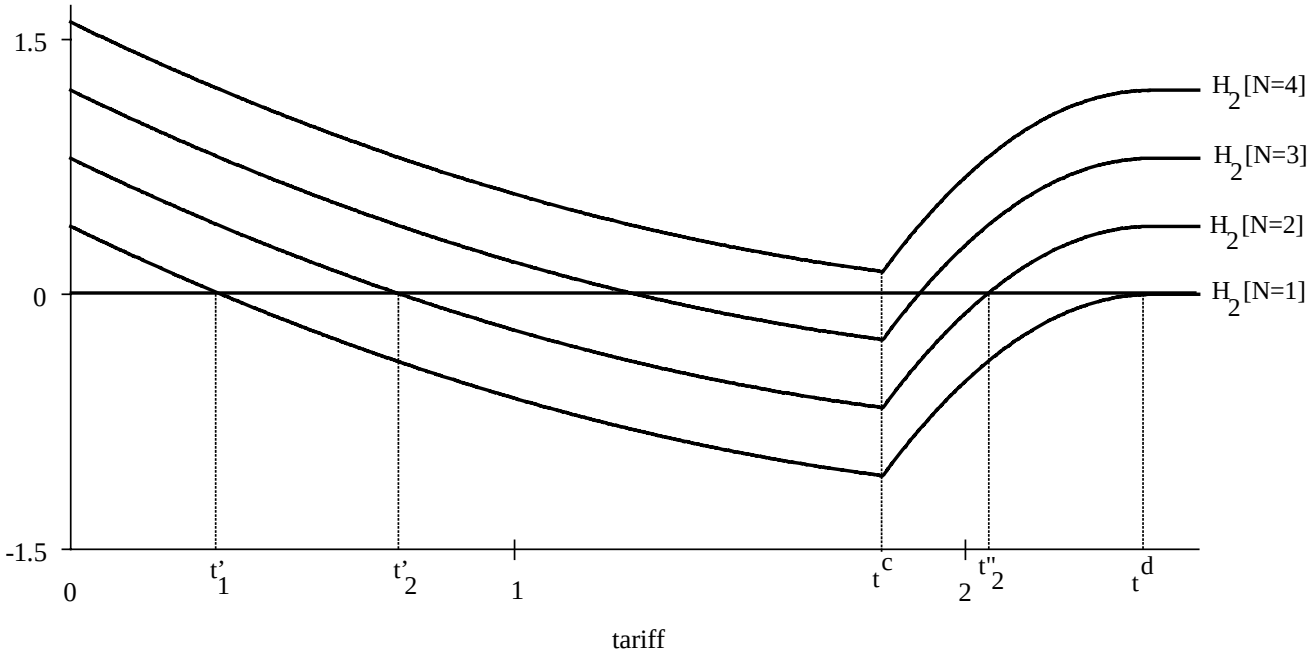

Figure 2a
Domestic Welfare with N=1

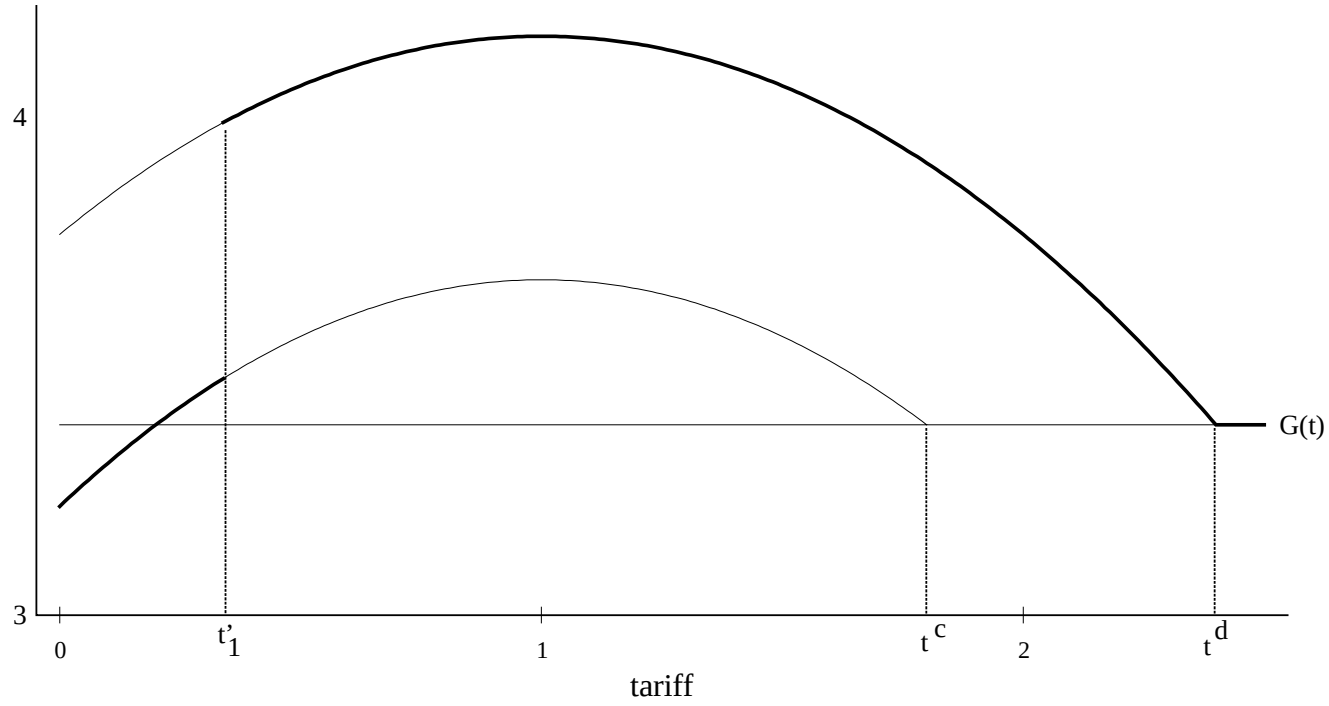

Figure 2b
Domestic Welfare with N=3

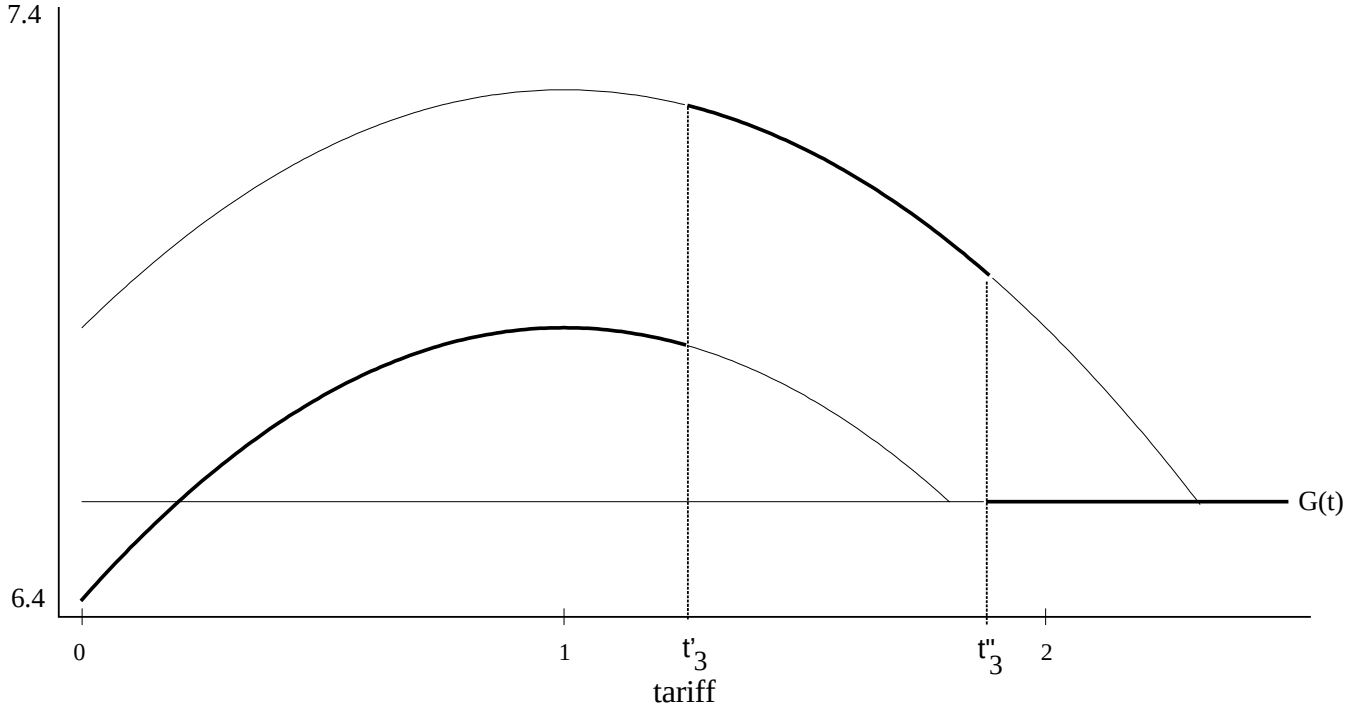

Figure 3
World Welfare with N=3