

# Tariff Retaliation and the Free Trade Argument\*

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## Abstract

The effects of tariff wars on welfare are analysed for the case of trade between two countries with outputs of the traded good given exogenously. Assuming mild conditions, it is shown that if there are non-zero tariffs for which welfare-maximizing equilibrium holds, then free trade is not strictly preferable when the countries' outputs are equal, and if they are not equal is strictly disadvantageous to the country with the smaller output. Therefore, the main result of the paper is that free trade is not sustainable in an asymmetric context nor in a symmetric situation.

**Key Words:** Commercial policy; Trade negotiations; Market Structure and Firms Strategy; Multinational Firms, Free Trade.

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## 1. Introduction

It is well known that although large countries can manipulate the terms of trade to their advantage by using tariffs, the equilibrium finally reached following retaliation and successive counter-retaliations may leave all countries worse off than under free trade. For example, Baumol and Blinder (1985) assert that when every country imposes optimal tariffs on its imports, everyone is likely to lose in the long run. However, it was pointed out many years ago (Johnson 1953-54) that this outcome is not absolutely certain. In his seminal work on tariff retaliation, with the premise that each country adopts a Cournot-type assumption regarding its rival's reaction to a change in its own tariff, Johnson showed that a country will be better off as a result of a tariff war if its relative market power in world trade is sufficiently large. Johnson's argument can be understood by means of the simple offer curve diagram in Fig.1, (Wong 1995),

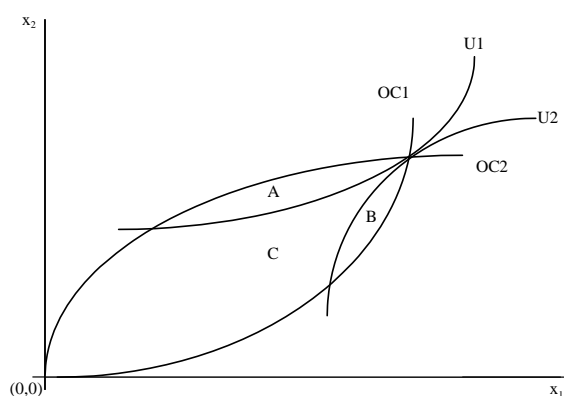


Fig. 1

in which  $x_i$  denotes country  $i$ 's exports to country  $j$  ( $j=3-i$ ),  $OC_i$  is country  $i$ 's offer curve under free trade (which intersects  $OC_j$  at the point of free trade equilibrium), and  $U_1$  and  $U_2$ , the utility isolines corresponding to the utilities achieved at free trade equilibrium, are tangential to each other at the equilibrium point. A tariff war shifts the equilibrium point from its position under free trade, but where final stable equilibrium is achieved depends on the precise nature of the offer curve and utility isolines of each country. If the equilibrium settles in region A, then country 1 gains from the tariff war; if it settles in region B, country 2 gains; if it falls in region C, both countries lose. The possibility that stable equilibrium may fall in region A or region B is of course very important for explaining the widespread existence of tariffs: a country that gains from a tariff war will not agree to free trade.

Since Johnson's paper, many studies have investigated the question of what variables determine the achievement of stable equilibrium outside region C. Johnson himself noted the importance of the elasticities of demand and supply. Dixit (1987) synthesized the theoretical literature and outlined some of its implications Kenan and Riezman (1988) have found conditions under which a large country wins tariff wars. The importance of countries size for best response tariff function, retaliatory tariffs and welfare was revisited recently by Syropoulus (2002). Chan (1991) has shown that the more dependent on trade a country is, the more likely it is to lose in a tariff bargaining game. Bohara, Gawande and Kaempfer (1998) analyzed empirically the effects of market size and trade

dependence applying these factors to the pattern of tariff retaliation between the United States of America and Canada.

Because of the assumptions on which their analyses were based, a common finding of these and other studies is that if the countries are mutually symmetric they will all be worse off as a consequence of the tariff war and only if a country differs in some way from the other countries involved can it benefit from a tariff war. In fact, Riezman (1982) showed that free trade is not an element of the negotiation set between asymmetric countries, and is therefore never the outcome. In summary, symmetric countries always benefit from free trade and asymmetric countries, although they can also benefit from free trade, could be damaged from free trade.

The above literature on Nash equilibrium tariffs assumes that industries are competitive. However our paper makes comparisons between the Nash equilibrium welfare levels and the free trade welfare level when firms are imperfectly competitive. In this scenario, country size play a different role in tariff retaliatory processes. In particular, the paper proves that under an asymmetric context and independently of the degree of asymmetry, any tariff equilibrium is always worst for at least one country than free trade. Moreover, even if the countries are symmetric, free trade is never more advantageous to all countries than an equilibrium with non zero tariffs, what means that the free trade argument does not hold.

We note that the imposition of optimal tariffs is not necessarily optimal policy from

a global perspective (Kaempfer 1989), and that, contrariwise, it may be justified by external factors such as the exploitation of international market power in a context of imperfect competition (Brander and Spencer 1985). For surveys of literature clarifying the significance of imperfect competition for trade policy, see for example Helpman and Krugman (1989) and Harris (1989).

## 2. The model

Like Brander (1981) and Brander and Krugman (1983), we assume that two countries, 1 and 2, produce outputs  $e_i$  ( $i=1,2$ ) of an homogeneous good that is sold entirely in the markets of the two producing countries. In this paper, both the outputs  $e_i$  are fixed, i.e. the output of neither country depends explicitly on either its exports to or its imports from the other. Denoting the exports of country  $i$  by  $x_i$ , the quantities sold by each country in each market are therefore given by the following table.

	Market 1	Market 2
Country 1	$e_1 - x_1$	$x_1$
Country 2	$x_2$	$e_2 - x_2$
Total market quantity	$e_1 - x_1 + x_2$	$e_2 - x_2 + x_1$

The hypothesis that output is independent of imports and exports is restrictive but it is valid, of course, in the short term. Furthermore, it would appear to be applicable

when the volume of production is to a large extent determined by factors beyond the producers' control, what means that there are some inputs in the production function which are given exogenously, as in agriculture and fishing. In the said sectors, as a result of a productive process, a certain amount of output is produced and producers have to decide how to sell it in different markets (national and international markets).

As known, agriculture is a topic which historically has provoked considerable tension between countries, in particular between the EU and the US, in GATT negotiations. The purpose of this paper is to justify the existence of such conflicts by proving that the country whose volume of production is lower is always strictly better off in an equilibrium tariff situation than in a free trade situation.

The effect of this hypothesis is to integrate the two markets by making the production destined for the home market depend on exports. For an analysis of integrated and segmented markets, see Venables (1990).

The prices of the good in each market are assumed to be given as a function of market quantity  $q$  by an inverse demand function  $p(q)$  that is common to both markets. We denote by  $p_i = p_i(q_i)$  the actual prices in market  $i$ , being  $q_i = e_i - x_i + x_j$ . The only assumption made concerning the demand function is that

$$p'_k(q_k) + q_k p''_k(q_k) < 0 \tag{2.1}$$

where  $q_{ki}$  is the output placed by country  $i$  in market  $k$ . This is a fairly standard regularity condition in noncooperative models (see, e.g., Brander and Spencer (1985) and Brander and Krugman (1983)); although it can be violated if the demand curve is very convex, violation is considered unusual. Assumption 2.1 is equivalent to the four inequalities

$$(e_1 - x_1)p_1'' + p_1' < 0 \quad (2.2)$$

$$x_2p_1'' + p_1' < 0$$

$$(e_2 - x_2)p_2'' + p_2' < 0$$

$$x_1p_2'' + p_2' < 0$$

and implies that

$$p_i' < 0 \quad (i = 1, 2). \quad (2.3)$$

>From the above table, the profits  $\pi^i$  made by each country's producers, given the tariffs  $t_i$  imposed by each country  $i$  on imports, are given by

$$\pi^1(x_1, x_2, t_1, t_2) = (e_1 - x_1)p_1 + x_1(p_2 - t_2) - c_1 \quad (2.4)$$

$$\pi^2(x_1, x_2, t_1, t_2) = (e_2 - x_2)p_2 + x_2(p_1 - t_1) - c_2$$

where the  $c_i$  are the constant costs associated with the outputs  $e_i$ . In most of what

follows it is assumed that both  $x_1$  and  $x_2$  are positive, i.e. that any tariffs are non-prohibitive. Under these conditions, the first-order Cournot-Nash conditions for profit maximization are<sup>1</sup>

$$\begin{aligned}\pi_{x_1}^1(x_1, x_2, t_1, t_2) &= -(e_1 - x_1)p_1' - p_1 + x_1p_2' + (p_2 - t_2) = 0 \\ \pi_{x_2}^2(x_1, x_2, t_1, t_2) &= -(e_2 - x_2)p_2' - p_2 + x_2p_1' + (p_1 - t_1) = 0\end{aligned}\quad (2.5)$$

The second order conditions,

$$\begin{aligned}\pi_{x_1x_1}^1 &= (e_1 - x_1)p_1'' + 2p_1' + x_1p_2'' + 2p_2' < 0 \\ \pi_{x_2x_2}^2 &= (e_2 - x_2)p_2'' + 2p_2' + x_2p_1'' + 2p_1' < 0\end{aligned}\quad (2.6)$$

are satisfied by virtue of 2.2 and 2.3, which also imply that the mixed derivatives,

$$\begin{aligned}\pi_{x_1x_2}^1 &= -(e_1 - x_1)p_1'' - p_1' - x_1p_2'' - p_2' = -\pi_{x_1x_1}^1 + p_1' + p_2' \\ \pi_{x_2x_1}^2 &= -(e_2 - x_2)p_2'' - p_2' - x_2p_1'' - p_1' = -\pi_{x_2x_2}^2 + p_1' + p_2'\end{aligned}\quad (2.7)$$

satisfy

$$\pi_{x_1x_2}^1 > 0, \quad \pi_{x_2x_1}^2 > 0\quad (2.8)$$

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<sup>1</sup>>From here on derivatives are denoted by subscripts except for the derivatives of the inverse demand function.

We define

$$\begin{aligned}
D &= \pi_{x_1x_1}^1 \pi_{x_2x_2}^2 - \pi_{x_1x_2}^1 \pi_{x_2x_1}^2 & (2.9) \\
&= \pi_{x_1x_1}^1 \pi_{x_2x_2}^2 - (-\pi_{x_1x_1}^1 + p'_1 + p'_2)(-\pi_{x_2x_2}^2 + p'_1 + p'_2) \\
&= -(p'_1 + p'_2)(\pi_{x_1x_2}^1 - \pi_{x_2x_1}^2) \\
&= (p'_1 + p'_2)\{3(p'_1 + p'_2) + q_1 p''_1 + q_2 p''_2\} \text{ (by 2.6, 2.7)} \\
&> 0 \text{ (by 2.1, 2.3)}
\end{aligned}$$

Since the  $\pi^i$  are defined on a convex set  $([0, e_1] \times [0, e_2])$ , inequalities 2.6 and 2.9 imply the existence and global uniqueness of equilibrium [see Nikaido (1968)]. Note that if the equilibrium point lies on the boundary of  $[0, e_1] \times [0, e_2]$ , the first-order conditions may not be satisfied; in what follows, this situation will be pointed out explicitly whenever it arises.

### 3. Effects of tariff changes on profit-maximizing equilibria

Since  $D \neq 0$ , application of the implicit function theorem to the first-order conditions, considered as functions of  $(x_1, x_2, t_1, t_2)$ , shows that the equilibrium exports  $x_i^e$  are locally functions of the tariffs  $t_i$ . Thus differentiating the identities  $\pi_{x_i}^i(x_1^e(t_1, t_2), x_2^e(t_1, t_2), t_1, t_2) =$

0 affords the equations

$$\begin{pmatrix} \pi_{x_1x_1}^1 & \pi_{x_1x_2}^1 & 0 & 0 \\ \pi_{x_2x_1}^2 & \pi_{x_2x_2}^2 & 0 & 0 \\ 0 & 0 & \pi_{x_1x_1}^1 & \pi_{x_1x_2}^1 \\ 0 & 0 & \pi_{x_2x_1}^2 & \pi_{x_2x_2}^2 \end{pmatrix} \begin{pmatrix} x_{1t_1} \\ x_{2t_1} \\ x_{1t_2} \\ x_{2t_2} \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \\ 1 \\ 0 \end{pmatrix} \quad (3.1)$$

(in 3.1 the superscript  $e$  marking equilibrium values has been dropped, as it will be hereafter). Solving, and taking 2.6, 2.8 and 2.9 into account,

$$x_{1t_1} = -\pi_{x_1x_2}^1/D < 0 \quad (3.2)$$

$$x_{2t_1} = \pi_{x_1x_1}^1/D < 0$$

$$x_{1t_2} = \pi_{x_2x_2}^2/D < 0$$

$$x_{2t_2} = -\pi_{x_2x_1}^2/D < 0$$

**Proposition 1.**

a) *A marginal change in either country's tariff causes changes of opposite sign in each country's imports and exports.*

b) *By increasing (reducing) its tariff, a country reduces (increases) its exports less than its imports.*

**Proof.** Part (a) is the content of inequalities 3.2 . Part (b) means that  $x_{it_i} > x_{jt_i}$ , i.e. that  $-\pi_{x_i x_j}^i > \pi_{x_i x_i}^i$  (from 3.2), which follows from 2.7 and 2.3. ■

The effects of marginal tariff changes on prices in market 1 are given by

$$\begin{aligned}
\partial p_1 / \partial t_1 &= (-x_{1t_1} + x_{2t_1})p_1' & (3.3) \\
&= (1/D)(\pi_{x_1 x_2}^1 + \pi_{x_1 x_1}^1)p_1' \\
&= (1/D)(p_1' + p_2')p_1' \text{ (by 2.6, 2.7)} \\
&> 0
\end{aligned}$$

and

$$\begin{aligned}
\partial p_1 / \partial t_2 &= (-x_{1t_2} + x_{2t_2})p_1' & (3.4) \\
&= -(1/D)(\pi_{x_2 x_2}^2 + \pi_{x_2 x_1}^2)p_1' \\
&= -(1/D)(p_1' + p_2')p_1' \\
&= -\partial p_1 / \partial t_1 < 0
\end{aligned}$$

Symmetric results hold for the effects on country 2's market price. This proves part (a) of the following proposition.

**Proposition 2.**

a) *A country that marginally increases its tariff increases the price in its own market*

(and hence reduces the quantity of that market), and causes changes of equal magnitude but opposite sign in the price and quantity of the other country's market.

b) If both countries change their tariffs by the same amount  $\Delta t$ , there will be no change in the price or quantity of either market, but each country's exports will change by  $\frac{\Delta t}{p_1 + p_2}$ .

**Proof of part (b).** That the market prices and volumes do not change follows immediately from part (a). Denoting by  $x$  the change in each country's equilibrium exports (the change is the same for both countries because the market demand  $q_1 = e_1 - x_1 + x_2$  does not change), this quantity can be calculated by considering the first-order conditions on  $\pi_{x_i}^1$  at  $(x_1, x_2, t_1, t_2)$  and at  $(x_1 + \Delta x, x_2 + \Delta x, t_1 + \Delta t, t_2 + \Delta t)$ :

$$-(e_1 - x_1)p_1' - p_1 + x_1p_2' + (p_2 - t_2) = 0 \quad (3.5)$$

$$-(e_1 - x_1 - \Delta x)p_1' - p_1 + (x_1 + \Delta x)p_2' + (p_2 - t_2 - \Delta t) = 0$$

Subtracting and re-arranging,  $\Delta x = \Delta t / (p_1' + p_2')$ . ■

Whether country  $i$  increases its producers' profits if it raises its tariff on imports depends on whether  $p_i$  is greater or less than  $p_j - t_j$ , for

$$\begin{aligned}
\pi_{t_i}^i &= \pi_{x_i}^i x_{it_i} + \pi_{x_j}^i x_{jt_i} + \partial\pi^i/\partial t_i & (3.6) \\
&= \pi_{x_j}^i x_{jt_i} \quad (\text{by 2.4 and by 2.5}) \\
&= [(e_i - x_i)p_i' - x_i p_j'] x_{jt_i} \\
&= (p_j - t_j - p_i)x_{jt_i} \quad (\text{by 2.5})
\end{aligned}$$

and the latter expression is positive if  $p_i > p_j - t_j$  and negative if  $p_i < p_j - t_j$ . The dependence of a country's producers' profits on changes in the tariff of the other country depends on both the sign of  $(p_j - t_j - p_i)$  and the absolute level of the producers' exports:

$$\begin{aligned}
\pi_{t_j}^i &= \pi_{x_i}^i x_{it_j} + \pi_{x_j}^i x_{jt_j} + \partial\pi^i/\partial t_j & (3.7) \\
&= (p_j - t_j - p_i)x_{jt_j} - x_i
\end{aligned}$$

#### 4. Welfare-maximizing equilibria

We now discuss the effects of tariffs when countries desire to optimize the overall welfare derived from the good, rather than just their producers' profits. Specifically, we assume that the two countries' common price function  $p$  is the derivative of a common

utility function  $U(q)$ , and we consider welfare functions

$$u^i(t_1, t_2) = U(q_i) - p_i q_i + \pi^i(x_1, x_2, t_1, t_2) + t_i x_j \quad (4.1)$$

Our welfare concept thus embraces consumers' surplus ( $U(q_i) - p_i q_i$ ) and tariff income  $t_i x_j$ , as well as producers' profits. To investigate what values of  $t_1$  and  $t_2$  afford welfare-maximizing equilibria, we need the following lemma concerning profit-maximizing equilibria and the derivatives of the  $u^i$  when equal tariffs are imposed.

**Lemma 1.** *If both countries impose the same tariff  $t$ , then:*

a) *their market prices and quantities at profit-maximizing equilibrium are also equal,*

and

$$b) \quad u_{t_1}^1(t, t) = -2(\bar{p}')^2 \bar{q} / D + x_2$$

$$u_{t_2}^1(t, t) = 2(\bar{p}')^2 \bar{q} / D - x_1$$

$$u_{t_1}^2(t, t) = 2(\bar{p}')^2 \bar{q} / D - x_2$$

$$u_{t_2}^2(t, t) = -2(\bar{p}')^2 \bar{q} / D + x_1$$

**Proof.** a) If  $x_1 = e_1/2$  and  $x_2 = e_2/2$ , then  $q_i = (e_1 + e_2)/2$  ( $i = 1, 2$ ) and the  $p_i$  are therefore also equal. Hence under free trade ( $t_1 = t_2 = 0$ ), the values  $x_1 = e_1/2$  and  $x_2 = e_2/2$  satisfy the first-order conditions for profit equilibrium, 2.5, and by the uniqueness of equilibrium these are the only values affording equilibrium. Part (a) thus follows from part (b) of Proposition 2. In what follows we write  $\bar{q}$  for  $(e_1 + e_2)/2$  and  $\bar{p}$

and  $\bar{p}'$  for the values of  $p$  and  $p'$  at  $\bar{q}$ .

b) From 4.1, and using 3.6,

$$\begin{aligned}
u_{t_1}^1(t_1, t_2) &= p_1 q_{1t_1} - p_1' q_{1t_1} q_1 - p_1 q_{1t_1} + (p_2 - t_2 - p_1)x_{2t_1} + t_1 x_{2t_1} + x_2 \\
&= -p_1' q_1 (\pi_{x_1 x_1}^1 + \pi_{x_1 x_2}^1) / D + (p_2 - t_2 - p_1 + t_1)x_{2t_1} + x_2 \\
&= -p_1' q_1 (p_1' + p_2') / D + (p_2 - t_2 - p_1 + t_1)x_{2t_1} + x_2
\end{aligned}$$

Taking  $t_1 = t_2 = t$ , so that  $q_1 = q_2 = \bar{q}$  and  $p_1 = p_2 = \bar{p}$  (by part(a)),  $u_{t_1}^1(t, t) = -2(\bar{p}')^2 \bar{q} / D + x_2$ . The other formulae of part (b) follow from analogous calculations. ■

**Proposition 3.** *Welfare-maximizing equilibrium is incompatible with free trade.*

**Proof.** We assume, without loss of generality, that  $e_1 \leq e_2$ . By the lemma,

$$u_{t_1}^1(0, 0) - u_{t_2}^2(0, 0) = x_2 - x_1 = e_2/2 - e_1/2 \geq 0 \quad (4.2)$$

Also by the lemma,

$$\begin{aligned}
u_{t_1}^1(0, 0) + u_{t_2}^2(0, 0) &= -4(\bar{p}')^2 \bar{q} / D + \bar{q} \\
&= \bar{q}(2\bar{p}' + \bar{p}'' \bar{q}) / (3\bar{p}' + \bar{p}'' \bar{q}) \quad (\text{by 2.9}) \\
&> 0 \quad (\text{by 2.1 and 2.3})
\end{aligned} \quad (4.3)$$

Adding 4.2 and 4.3,

$$u_{t_1}^1(0,0) > 0 \tag{4.4}$$

Thus the free trade point does not satisfy the first-order conditions for welfare-maximizing equilibrium; given free trade, it is to the advantage of the country with the smaller output to impose a tariff. ■

**Proposition 4.** *If  $e_1 < e_2$ , free trade affords country 1 strictly less welfare than a welfare-maximizing equilibrium with at least one non-zero tariff, if this equilibrium exists.*

**Proof.** We first consider the total derivative of country 1's welfare with respect to a common tariff  $t$  imposed by both countries. By the lemma,

$$u_t^1(t, t) = u_{t_1}^1(t, t) + u_{t_2}^1(t, t) = x_2 - x_1 > 0 \tag{4.5}$$

Since 4.5 holds so long as  $t \leq t^*$ , where  $t^*$  is such that  $x_1(t^*, t^*) = 0$ ,

$$u^1(0,0) < u^1(t, t) \quad (0 < t \leq t^*) \tag{4.6}$$

To prove the proposition, there are three cases to consider.

1)  $0 < t_2 \leq t^*$ . In this case,  $u^1(0,0) < u^1(t_2, t_2)$  (by 4.6), and if  $(t_1, t_2)$  is an equilibrium point,  $u^1(t_2, t_2) \leq u^1(t_1, t_2)$  (by the properties of equilibrium). Hence  $u^1(0,0)$

is strictly less than  $u^1(t_1, t_2)$ .

2)  $t_2 = 0$ . Since  $u_{t_1}^1(0, 0) > 0$  (by 4.4), there exists  $\varepsilon > 0$  such that  $u^1(0, 0) < u^1(\varepsilon, 0)$ .

As before,  $u^1(\varepsilon, 0) \leq u^1(t_1, 0)$ , so  $u^1(0, 0)$  is strictly less than  $u^1(t_1, t_2)$ .

3)  $t^2 > t^*$ . As before,  $u^1(t_1, t_2) \geq u^1(t^*, t_2)$ . But for all  $t > t^*$ ,  $u^1(t^*, t) = u^1(t^*, t^*)$  (since increasing a tariff on non-existent imports can have no effect in either country; in this region of the  $(t_1, t_2)$  plane the results of Sections 2 and 3 no longer hold). Since  $u^1(t^*, t^*) > u^1(0, 0)$  (by 4.6),  $u^1(0, 0)$  is strictly less than  $u^1(t_1, t_2)$ . ■

**Proposition 5.** *If  $e_1 = e_2$ , neither country strictly prefers free trade to a welfare-maximizing equilibrium with non-zero tariffs, if this exists.*

**Proof.** The proof is the same as for Proposition 4, except that, since  $e_1 = e_2$ ,  $u_i^i(t, t) = 0$  ( $i = 1, 2$ ), so that

$$u^i(0, 0) = u^i(t^*, t^*)$$

and only the weak dominance of  $(t_1, t_2)$  over  $(0, 0)$  is proved:  $u^i(0, 0) \leq u^i(t_1, t_2)$ . ■

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