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Optimal Tariffs and Retaliation with Perfect Foresight

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This paper extends the previous work in optimal tariffs and retaliation. The two types of retaliation considered before are based on a Cournot model and a Stackelberg model. The naive belief on the part of at least one of the countries in these models is replaced by perfect foresight on the part of both countries, in that each country knows how the other will respond to a change in tariffs. The problem is expressed as an infinite horizon dynamic programming model in which each country maximizes consumer or producer surplus, subject to the other country's reaction function.

I. Introduction

The theory of optimal tariffs has progressed through several stages in the past few years. The textbook theory, following the work of Johnson (1953), considers the case of two countries that attempt to maximize some form of social welfare by imposing a tariff to shift the offer curves. Initially, a Cournot behavioral assumption was used to explain the reaction (or lack of it) to a change in a tariff. In this case, each country is naive in that it believes that the other's tariff will not change from its current level. The well-known result is a tariff war, resulting in either an equilibrium point, or a tariff cycle.

Relaxing the Cournot assumption, Tower (1975) treats retaliation as a Stackelberg leader/follower situation. In this scenario, country one perceives itself as a leader, and country two as a follower. Country two assumes that country one's tariff will not change from its current level, however, country one realizes that two is attempting to maximize welfare based on one's tariff; so one maximizes its own tariff subject to this dependence.

Bhagwatti and Srinivasan (1976) considered a slightly different approach, by

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analyzing a case involving quantitative restrictions. In their model, country two is essentially a follower and will apply some restriction, based on the level of exports by country one in the previous period. Country one believes that two may retaliate, but it does possess perfect foresight. That is, there is some probability (as a function of one's exports) that country two will impose a quota. Thursby and Jensen (1983) attempt to express retaliation in terms of conjectural variations. Each country has some belief about how the other will respond.

This belief does not have to be consistent with the true responses, and they show how a country will choose its tariff given different beliefs about the level of retaliation. Marshak and Selton (1978) and Radner (1980) and Bresnahan (1981) treat a similar problem in microeconomic theory dealing with duopoly and oligopoly retaliation. Friedman (1977) summarizes the reaction function literature, and then develops a game theoretic approach to the oligopoly problem. He concludes that the game theory model is better because it demonstrates additional noncooperative equilibria. More recently, Holt (1985) attempted an experimental examination of consistent conjectures, but used the earlier, incorrect Bresnahan formulation. See (1983) for an improved version.

The difference between the previous literature and this paper, is that this paper presents a more explicit model of the retaliation process, and it finds perfect foresight solutions. Each country knows the *process* by which the other makes decisions. That is, each country solves a simultaneous optimization problem. In spirit, the model is closest to Bresnahan's 1983 comment, but this paper treats time explicitly, so it avoids the confusion of mixing state and control variables in a partial differential equation model. A good treatment of the dynamic control theory which underlies the solution presented here can be found in Kamien and Schwartz (1981).

The fundamental question that has not been answered in the literature is: What happens if both countries recognize their interdependence, and realize that the other will retaliate? The objective of this paper is to examine the equilibrium tariffs (if any) that occur when each country realizes that the other will respond in some fashion to a change in their own tariff. Further, in equilibrium, each country's belief is "correct" in the sense that the other country will behave in a manner consistent with the beliefs of the first country.

This paper shows that there is a solution to the perfect foresignt problem. In the general model, there are an infinite number of solutions, however, there are important cases that do have a finite number of solutions. In particular, this paper will consider the case where the two countries are identical. In this case, there are five perfect foresight solutions. One is a no retaliation case, and the other four can be classified as "full retaliation" and "opposite retaliation". In the full retaliation case, an increase in a tariff by country one will be met by an equal increase by country two. In the opposite retaliation cases, an increase by one will be met with an equal decrease by country two.

II. General Model

Consider the problem from the perspective of country one. It is trying to maximize the discounted present value of welfare over time by imposing a tariff T_1 (t) at time (t). Note that the welfare gained from trade can be expressed as a function of both tariffs : T_1 (t) and T_2 (t). Since T_1 (t) is under the direct control of country one, it is called the control variable. Observe that at time (t), from the standpoint of country one, $T_2(t-1)$ has already been imposed, and is exogenous. Hence, it defines the state of the system and is called the state variable. To introduce foresight, country one must have some belief about the tariff that country two will impose in the next period. Since there are essentially only two variables in the system, this belief must be a function of $T_1(t-1)$ and $T_2(t-1)$. Hence, country one attempts to maximize the discounted present value of its welfare function (U) subject to its belief about how two will respond to changes in tariffs. This type of problem can be solved with dynamic programming techniques.

Summarizing, at any time (t), country one starts with a belief about two's tariff

$$T_2(t) = g[T_1(t-1),\ T_2(t-1)] \tag{1}$$

The optimization process generates an optimal tariff for country one that is a function of the last period tariffs :

$$T_1^* = h^*[T_1(t-1),\ T_2(t-1)] \tag{2}$$

Likewise, country two starts with a belief about one's tariff

$$T_1(t) = h[T_1(t-1),\ T_2(t-1)] \tag{3}$$

and derives an optimal tariff

$$T_2^* = g^*[T_1(t-1),\ T_2(t-1)] \tag{4}$$

The important point is that if h^* h and g^* g, then the belief functions are equivalent to the "actual" responses, perfect foresight exists, and the problem is solved. Hence, in order to generate perfect foresight solutions, it is necessary to find two functions (g and h) such that these relationships hold. Essentially, it is just a matter of solving a system of first order difference equations. Note that the response functions are generated from the optimization process, they are not ad hoc specifications. That is, the foresight in this model extends to the tariff formation *process* used by the other country.

To show that this method works, consider a simple linear model, where net consumer and producer surplus from trade, along with tariff revenue are used to approximate welfare. The supply and demand curves can be given as

$$Qs = a_1 + b_1 P$$
$$Qd = a_2 - b_2[P + T_1(t) + T_2(t)] \tag{5}$$

where country one is exporting some good, and imposing a specific export tariff $T_1(t)$, while country two imposes a specific import tariff $T_2(t)$. Since the supply and demand curves are linear, it is possible to reduce the utility approximations to quadratic functions in $T_1(t)$ and $T_2(t)$. Further, using results from dynamic programming, the discounted (by δ) present value of welfare can be written as

$$K[T_2(t)] = \max\{[a + bT_1(t) + cT_2(t) + gT_1(t)T_2(t) + eT_1(t)^2 + fT_2(t)^2] + \delta K[T_2(t+1)]\} \tag{6}$$

Because of the quadratic surplus functions, country one's belief about two's reaction will be linear, and can be written

$$T_2(t+1) = \mu + \alpha T_1(t) + \beta T_2(t) \tag{7}$$

The linearity conditions also result in a quadratic description for the value function K, such that

$$K[T_2(t)] = B_0 T_2(t) + B_1 T_2(t)^2 \tag{8}$$

Assuming that the coefficients to the conjectural equation (7) are given, the above system can now be solved for an optimal $T_1(t)$:

$$T_1^*(t)=(-h-S\mu)/Y-\alpha(S/Y)T_1(t-1)-\beta(S/Y)T_2(t-1) \quad (9)$$

where

$$h=b+\alpha\delta B_0+2\alpha\delta\mu B_1$$
$$Y=2e+2\alpha^2\delta B_1$$
$$S=g+2\alpha\delta\beta B_1$$
$$B_0=\frac{(c+2\delta\beta\mu B_1)-(b+2\alpha\delta\mu B_1)(S/Y)}{[\alpha\delta(S/Y)+(1-\delta\beta)]}$$
$$2B_1(1-\delta\beta^2)=2f-(S/Y)^2/Y \quad (10)$$

At this point, given a country's belief about how the other will respond to changes in tariffs, we can find optimal tariffs for that country. The next step is to show that this method can be used to generate perfect foresight solutions. Note that since the utility measure is symmetric with respect to $T_1(t)$ and $T_2(t)$, a set of equations is created for country two that is symmetric to the set of equations (10). The symmetric variables for country two will be labelled with an apostrophe (′).

To generate perfect foresight solutions, recall equations (1) through (4). Country one begins with a belief about two's response and generates a tariff process that is dependent on last period's tariffs by both countries. Country two begins with a similar belief about one's tariff, and derives an optimal tariff that is dependent on the tariffs in the last period. To generate perfect foresight solutions, we merely need to equate the coefficients in one's belief function with the actual process that country two follows. Using this process, three new equations are added to country one's optimization process :

$$\alpha^2=\beta'^2(S'/Y')(Y/S)$$
$$h'/Y'=h/S$$
$$(S/Y)(S'/Y')=1 \quad (11)$$

Country two's process also gains three equations by symmetry :

$$\alpha'^2=\beta'^2(S/Y)(Y'/S')$$
$$h/Y=h'/S'$$
$$(S'/Y')(S/Y)=1 \quad (12)$$

Observe that there are ten basic variables in this system : B_0, B_1, μ, α, β, and their symmetric counterparts. At first glance, there are also ten equations in the system :

(10) and (11) and their counterparts. However, observe that (12) contains an equation already in (11), and two of the equations in (12) can be reduced to one of the equations in (11). Hence, there are only eight unique equations. The conclusion is that there are an infinite number of perfect foresight solusions that can exist. Of course, that Stackelberg leader/leader case has long been konwn to generate an indeterminate solution, however, because the process has now been modelled more precisely, it is possible to examine particular cases that may be of interest. The main point is that any perfect foresight solution can be described by these equations. To generate specific solutions, it is only necessary to provide the additional equations, or restrictions of interest.

III. Specific Case of Identical Countries

One case that yields interesting results is to consider what happens when the two countries involved are identical (not just symmetric). That is, the magnitude of the slopes of the supply and demand curves in equation (5) are the same : $b_2 = -b_1$. The reason this case yields a solution is that all of the symmetric equations and variables are equal to their counterparts, so we only need five equations to solve for the remaining five variables. The reason it is of interest is because the solutions, and economic interpretation, are not intuitively obvious.

A. Solutions

The details of the solution of the above equations are left to an appendix which is available from the author, and the results and some comments are given here. The major solutions to the case can be classified as : no retaliation, full retaliation, and opposite retaliation. First, consider the no retaliation case, which occurs because $\alpha = \beta = 0$:

$$B_1 = b_1/6$$
$$B_0 = -(a_1 + a_2)/3$$
$$\alpha = \beta = 0$$
$$\mu = (a_1 + a_2)/2b_1(1/2)$$
$$T_1^* = T_2^* = \mu \tag{13}$$

The second case, generated by setting $\alpha = \beta$, and $S = -Y$ results in the following values :

$$B_1 = b_1/2$$
$$B_0 = -(a_1 + a_2)/2$$
$$\alpha = \beta = \pm\sqrt{1/2\delta}$$
$$\mu = (a_1 + a_2)/2b_1(1 - \alpha)$$
$$T_1^* = T_2^* = \mu/(1 - 2\alpha) \tag{14}$$

The final case, generated by $\alpha = -\beta$ and $S = Y$ results in

$$B_1 = b_1/2$$
$$B_0 = -(a_1 + a_2)/2[1/(1 + \alpha\delta)]$$
$$\alpha = -\beta = \pm\sqrt{1/4\delta}$$
$$\mu = (a_1 + a_2)/2b_1[1/2(1 + \alpha\delta)]$$
$$T_1^* = T_2^* = \mu \tag{15}$$

Before evaluating the results on a case-by-case basis, two additional points need to be considered. The first question is whether or not the results are maximum points and not minimum ones. Maximizing the right hand side of equation (2) with respect to $T_1(t)$ generated the optimal tariff by solving

$$0 = b + gT_2(t) + 2eT_1(t)$$
$$+ \alpha\delta\{B_0 + 2B_1[\mu + \alpha T_1(t) + \beta T_2(t)]\} \tag{16}$$

The second derivative of this equation with respect to $T_1(t)$ yields a second order condition (SOC) such that

$$SOC = 2e + 2\alpha^2\delta B_1$$

or, substituting in the proper values

$$SOC = b_1(\alpha^2\delta - 3/4) \tag{17}$$

which is negative for all the cases, so the points are indeed maximum values.

B. Stability

The second question to consider is whether or not a given solution is stable. That is, the solutions for the optimal tariffs as outlined in equation (10) represent a system of two linear difference equations. The steady state solution of them is important, but it is also constructive to ask whether or not the system would return to that particular value if it was perturbed by some amount. Writing the equations in their symmetric form yields

$$T_1(t)^* = \mu + \alpha T_1(t-1) + \beta T_2(t-1)$$
$$T_2(t)^* = \mu + \beta T_1(t-1) + \alpha T_2(t-1) \qquad (18)$$

Using these two equations, writing the homogenous system in matrix form yields

$$\begin{vmatrix} m-\beta & -\alpha \\ -\alpha & m-\beta \end{vmatrix} \begin{vmatrix} A \\ B \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \end{vmatrix} \qquad (19)$$

In order for a non-trivial solution to exist, the coefficient matrix must be singular, hence, its determinant must be equal to zero. The two roots to the characteristic equation are then

$$m_1 = \alpha + \beta$$
$$m_2 = -\alpha + \beta \qquad (20)$$

For a solution to be stable, the absolute value of the roots must be less than one.

Ⅳ. No Retaliation "Cournot"

Consider the easier case first. From equation (8), the Cournot case is defined by setting $\alpha = 0$, $\mu = 0$ and $\beta = 1$, implying country one thinks that two's tariff will be constant over time, regardless of the actions in the previous period by the other country. However, a constant tariff is also generated when $\alpha = 0$ and $\beta = 0$. This case will be called the "no retaliation," case, but it is similar to the familiar Cournot case. Since the Cournot case has been covered fairly extensively in the literature, all that needs to be done is to determine if there are any new twists introduced in the perfect foresight analysis. First, putting $\alpha = 0$ into equation (17) indicates that the solution is indeed a maximum. Second, from equation (20), both roots of the characteristic equation are equal to zero. Which means that the system is degenerate. The equilibrium quantity can be solved for

$$Qe = (a_1 + a_2)/4 \qquad (21)$$

Notice that none of the results for this case are dependent on the discount factor (δ). Also observe that $dT_1^*/dT_2 = 0$ in equilibrium. That is, there is no response to a change in either country's tariff. Of course, in equilibrium, there is also no incentive to change. Hence, it is fairly clear that perfect foresight does hold, in that neither country expects the other to alter its tariff, and neither country does change.

In order to compare the various cases, it is useful to examine the level of welfare in the current period. Observe first that T_1 must equal T_2 in equilibrium (denoted T^*) ; and using equation (8), welfare for either country can be expressed as

$$U = a + (b + c)T^* + (g + e + f)T^{*2} \tag{22}$$

Using the definitions of the variables (a − g) yields

$$U = a - b_1/2T^{*2} \tag{23}$$

For the no retaliation case, it reduces easily to

$$U = (a_1 + a_2)^2/8b_1(1 - 1/4) \tag{24}$$

which is greater than zero.

The interesting point about this case is that it *does* represent a perfect foresight solution. It is also useful because it provides a base point to use in comparison with the other cases.

V. Full Retaliation

In this case, where $\alpha = \beta$ and $S = -Y$, there are two subcases, created by the positive and negative square roots used in finding α and β. Since the optimal tariffs are dependent on α and β, it is necessary to consider both cases separately in most respects. However, for both cases, the second order condition is fulfilled—since it is dependent on the square of α. Also, by using the absolute value, it can be seen that, in each sub-case, one root is greater than one, and one is degenerate, implying that neither solution is stable. However, stability is not a serious problem in perfect foresight, because, the only possible solutions are these fixed equilibria. In true perfect foresight, there can be no doubt (or adjustment) about the final solution.

A. Subsidy sub−case

Using the positive square roots as the first sub−case, the optimal tariffs from equation (14) are

$$T_1^* = \frac{(a_1 + a_2)(\sqrt{2\delta} - 1)}{2b_1(\sqrt{2\delta} - 2)} \tag{25}$$

One way to understand the results is to examine the values for the tariffs (denoted T^*) for differing values of the discount factor (δ). When δ is equal to one,

$$T^* = -(a_1 + a_2)/(2b_1\sqrt{2}) \tag{26}$$

From the equilibrium quantity under free trade, $a_1 + a_2$ must be greater than zero. Since b_1 is the slope of the supply curve it is positive as well, so the optimal tariffs in this case are negative, or subsidies as they are usually called. For a discount factor equal to one−half, T^* is equal to zero−which is free trade. In the limiting case, as the discount factor goes to zero, the optimal tariffs approach

$$T^* = (a_1 + a_2)/4b_1 \tag{27}$$

which is the equilibrium tariff level for the no retaliation case. It is clear that as the discount factor decreases from one to zero, the optimal tariffs monotonically increase from a subsidy to no tariff to the no retaliation tariff level.

Why does one−half yield the free−trade solution ? The easiest way to answer the question is to split welfare into two categories : current welfare, and discounted future welfare. In steady state equilibrium, the actual welfare received in any period is a constant, so the discounted future value is merely an infinite geometric series. When the discount factor is one−half, the discounted sum is exactly equal to the welfare received in the current period. That is, when each country expects the other to retaliate in full, the optimal tariff will be zero if society places an equal weight on current welfare and future welfare. However, if society values future consumption more, then each country will employ subsidies to ensure that the other country will not impose a tariff in the future (diminishing the more important welfare). If society values current more than future welfare, then each country will impose a tariff now, in order to increase current welfare−even if it carries a cost of lower welfare in the future.

For this case, the steady state value of current welfare is given by

$$U = (a_1 + a_2)^2/8b_1[1 - (1 - \alpha)^2/(1 - 2\alpha)^2] \tag{28}$$

First note that this value is always positive. Secondly, to determine how welfare changes as the discount factor varies, first differentiate (28) with respect to α. The result is

$$U/\quad \alpha = -(a_1 + a_2)^2/4b_1(1 - \alpha)(1 - 2\alpha)^{-3} \tag{29}$$

Since $\alpha/\quad \delta$ is always negative, current welfare increases when the discount factor increases if the discount factor is between zero and one－half. If the discount factor is between one－half and one, and increasing, current welfare will decrease. Note that when the discount factor increases between one－half and one, the total welfare level increases, but welfare accruing from the current period decreases.

B. Tariff sub－case

The second sub－case is very similar to the first sub－case. All of the formulas are the same, but it uses the negative roots for α and β. As a result, the optimal tariffs are

$$T^* = \frac{(a_1 + a_2)(\sqrt{2\delta} + 1)}{2b_1(\sqrt{2\delta} + 2)} \tag{30}$$

When the discount factor is one,

$$T^* = (a_1 + a_2)/2b_1\sqrt{2} \tag{31}$$

As the discount factor approaches zero, in the limit,

$$T^* = (a_1 + a_2)/4b_1 \tag{32}$$

Note that equation (32) is the no retaliation equilibrium level again.

In this second sub－case, as society's value of future consumption decreases ; the discount factor goes from one to zero ; the optimal tariff monotonically decreases from a finite level (trade still exists) to the no retaliation tariff. Observe that the current welfare in this case is also given by equation (23), and it is always positive. In order to examine the change in current welfare with respect to changes in the discount factor, recall equation (24). Since $\alpha/\ \delta$ is now positive, the sign of $K/\ \delta$ is now negative. Which means that as the discount factor increases, the steady state level of tariffs increases, causing the current welfare to decrease.

The primary difference between the sub−cases is the response of one country to its tariff in the last period. In the first case, if either country increased its tariff in the last period, both countries will increase their tariff in the current period, and there will be a continuous increase in the tariffs. In the second sub−case, an oscillating pattern will develop, because if country one increased its tariff in period one, both countries will decrease their tariff in period two; and increase them in period three, etcetera.

Ⅵ. Opposite Retaliation

In the last case, where $\alpha = -\beta$ and $S = Y$, there are also two sub−cases, created by the positive and negative square roots in finding α and β. Note that the second order condition is fulfilled for both sub−cases, since it depends on the square of α. Also, the system is not stable, since one root is zero, and the absolute value of the other is greater than one.

A. Low Tariff

The steady state tariff in this case is

$$T_1^* = T_2^* = (a_1 + a_2)/2b_1\ 1/2(1 + \alpha\delta) \tag{33}$$

Note that this value is always positive. Further, when the discount factor equals one,

$$T^* = (a_1 + a_2)/2b_1\ (1/3) \tag{34}$$

Once again, as the discount factor approaches zero, the optimal tariff monotonically approaches the no retaliation tariff level.

The current level of utility is found by

$$U = (a_1 + a_2)^2/8b_1[1 - 1/4(1 + \alpha\delta)^2] \tag{35}$$

It is clear that as the discount factor increases, the optimal tariff decreases, and the level of welfare increases.

B. High Tariff

The formulas for this sub–case are very similar to those in the last one, since the only difference is the sign of the α term. Once again, as the discount factor approaches zero, the optimal tariffs approach the no retaliation level. However, as the discount factor approaches one, the tariffs monotonically increase until they reach the no–trade level when the discount factor is equal to one (the discount rate is zero). Of course, as the tariffs increase, the welfare (from trade) decreases to zero.

VII. Comparison of Cases

For this model, there are now three classes of perfect foresight solutions. Since two of them have two sub–cases, there are five possible solutions. In order to compare the solutions, it is necessary to observe the values of the tariffs for different values of the discount factor. Note that all of the tariff formulas have a common structure–a common constant term that is multiplied by some fraction. This fraction is dependent only on the discount factor in all the cases. The current welfare in the cases can be written in a similar manner, where the multiplier is one minus the square of the tariff multiplier.

The multipliers for the tariffs are plotted against the discount factor in Figure 1, and the current welfare multipliers are displayed in Figure 2, where a lower line represents a higher tariff. Note that the values all converge to the no retaliation case when discount factor is zero (the future has no value). The tariffs are essentially ranked from low to high as follows : full retaliation (subsidy sub–case) ; opposite retaliation (low tariff) ; no retaliation ; full retaliation (tariff) ; opposite retaliation (high tariff). The two highest tariffs cross when the discount factor equals $(3/2 - \sqrt{2})$; as do the corresponding welfare values. The subsidy–case welfare crosses the no retaliation level when the discount factor equals (8/9). It crosses the opposite retaliation (low tariff) welfare when the discount factor solves

$$0 = 2\delta^2 - (19 + 2\sqrt{2})\delta + 16 \tag{36}$$

It should be noted that the rankings of the welfare must be approached with caution. That is, a country does not really choose which solution should exist based on which one carries higher welfare. There are five solutions to the problem that are consistent with perfect foresight. Each one arises from a different set of beliefs about how the other country will react to changes in tariffs. Each one is independent of the other solution, in that the countries cannot "move" from one solution to another. Any change must first occur in the beliefs of the countries. The rankings of the welfare are relevant only because they show which set of beliefs is the most beneficial. For example, if the prevailing solution was no retaliation, and a country wanted to increase its welfare by moving to the full retaliation case, the only way to get there is to change beliefs by each country about how the other will react.

Since the no retaliation case has already been described, consider the full

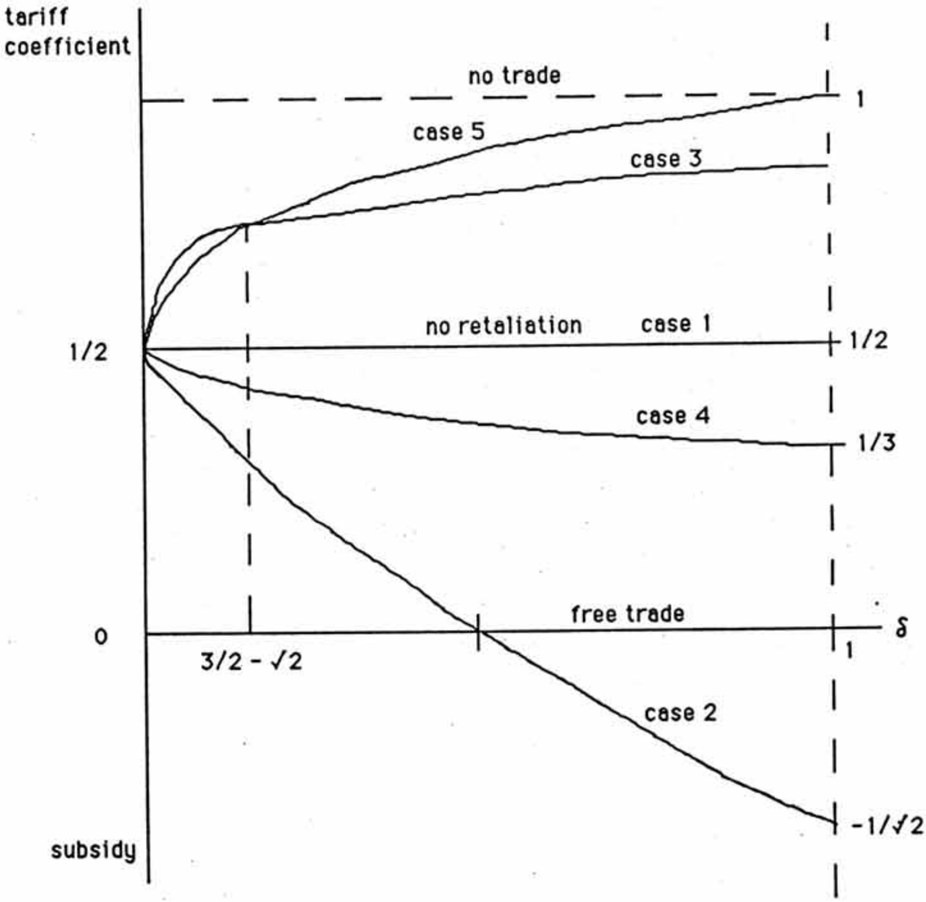

Figure 1.

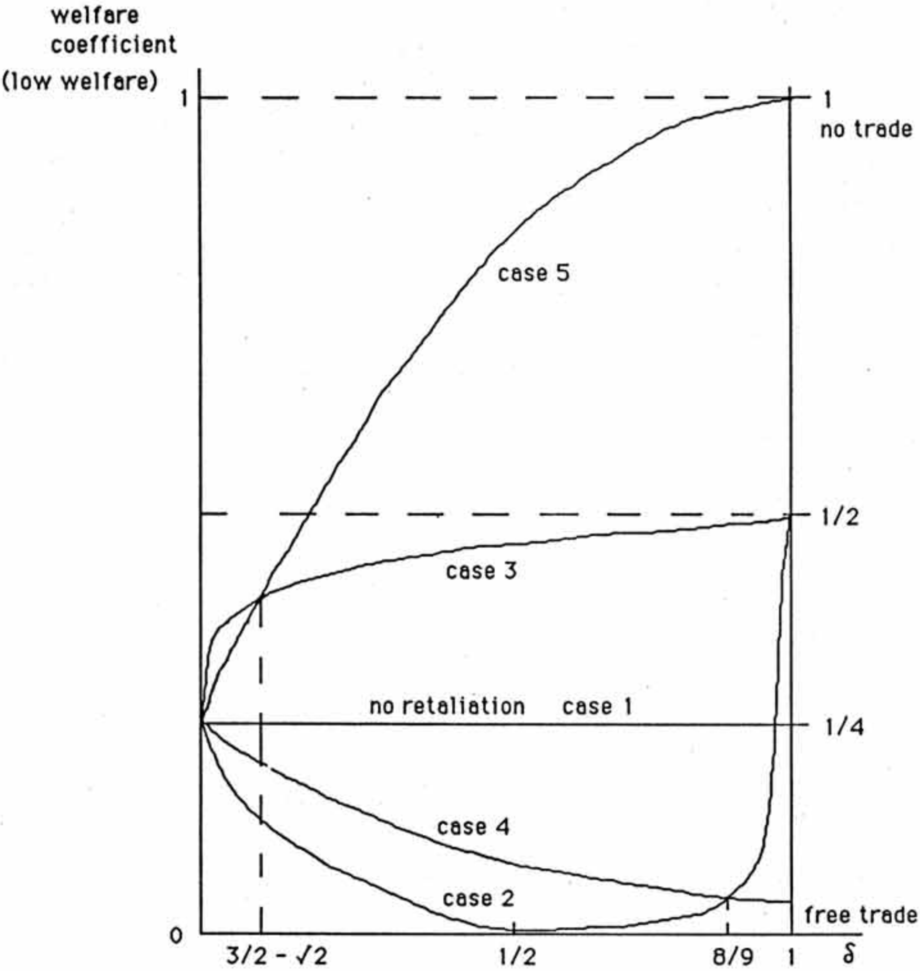

Figure 2.

retaliation case. Note that there are actually two reactions of interest in the model. The reaction by the other country to a tariff change, and the response by the first country to its own tariff change in the last period. In this case, both reactions are in the same direction. In the first sub–case, if a country raises its tariff, both effects will cause the two countries to match the other's tariff increase indefinitely. Hence, at equilibrium, neither country has an incentive to change the tariff, for fear of the ultimate retaliation. In the second sub–case, both tariffs will again move together (up in the same time period, or down in the same time period). However, since a country's reaction to the foreign change is negative, it is not fear of retaliation that causes an equilibrium point. Rather, a country knows that if it increases its tariff, the other country will merely decrease its tariff by the same amount to negate the change ; hence eliminating any possible gain in consumer or producer surplus. Possibly the reason this equilibrium tariff level is higher than the first is because the country with the higher tariff will get more tariff revenue, and tariff revenue is now a more significant factor since changes in consumer and producer surplus are negated. The reaction of a country to changes in its tariff from the previous period causes the tariff level (out of equilibrium) to oscillate. This oscillation provides a moderating influence on the equilibrium tariff level.

In the opposite retaliation case, in a given time period, the two tariffs are always moving in opposite directions. For the first sub−case, a response to a change in the other country's tariff is in the same direction. That is, there is the fear of retaliation again. Note that since the response to changes in one's own tariff is negative, an oscillation pattern develops again−distorting the discounted welfare sum, and causing a slightly higher tariff than the first case of the full retaliation. This oscillation is removed in the second sub−case, and the opposite retaliation is much clearer. Here, if a country raises its tariff, the other will decrease its tariff, and this process will continue indefinitely. In this sub−case, if society's social discount rate is zero, the equilibrium tariffs are high enough to completely eliminate trade.

VIII. Couclusion

The primary focus of this paper has been to show that it is possible to find an optimal tariff for which both countries possess perfect foresight. In fact, there are three major types of solutions which can be categorized according to the beliefs that lead to them. First, there is the no retaliation equilibrium, in which both countries believe that neither will change its tariff. Next is the full retaliation situation, in which both countries believe that the other will exactly match a tariff increase or decrease. The final solutions come about when both countries believe that any tariff increase will be met with an equal decrease by the other country−negating the change, and merely redistributing the tariff revenue. The tariff levels in these three cases range from subsidies, through Cournot tariff levels, to trade−prohibiting tariffs.

The importance of this study is twofold. First, it extends the existing literature on optimal tariffs and consistent conjectures. Second, it demonstrates that there are several important equilibria under perfect foresight conditions. In particular, even if perfect foresight exists, there are three major levels of tariffs that can arise−leading to three completely different levels of welfare. Which tariff structure prevails will depend on the beliefs that are held by the participating countries. Hence, if a nation were to become embroiled in a "tariff war," the outcome will be determined by the beliefs that each country holds. For example, the results indicate that (for most levels of the discount factor), the highest welfare levels are created when each country believes that enactment of a tariff will result in a retaliatory tariff being imposed. Therefore, the policy conclusion is that if a nation wishes to provide high welfare levels, they must retaliate whenever another country imposes a tariff.

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