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A Theory of Managed Trade

By KYLE BAGWELL AND ROBERT W. STAIGER*

This paper proposes a theory that predicts low levels of protection during periods of "normal" trade volume coupled with episodes of "special" protection when trade volumes surge. This dynamic pattern of protection emerges from a model in which countries choose levels of protection in a repeated game facing volatile trade swings. High trade volume leads to a greater incentive to defect unilaterally from cooperative tariff levels. Therefore, as the volume of trade expands, the level of protection must rise in a cooperative equilibrium to mitigate the rising trade volume and hold the incentive to defect in check. (JEL *411, 422*)

Two major trends have dominated the postwar history of trade policy in industrailized countries. One is the dramatic multilateral reduction in tariffs negotiated under the General Agreement on Tariffs and Trade (GATT).[1] The other is the move toward "special" protection that has occurred as the industrialized countries of the world have become more integrated and as volatility in trade flows has become a more important source of domestic disruption. The rise in special forms of protection is epitomized by the growing use of Voluntary Export Restraints (VERs), Orderly Market Arrangements (OMAs), and tariffs that are tailor-made to suit the needs of particular sectors.[2] These policy tools are typically utilized by countries to limit the rate of expansion of imports or exports from that which would occur absent intervention. The term "managed trade" is often invoked to characterize the current international trading environment, since it consists of a relatively low "baseline" or "normal" level of protection combined with the use of special protection to dampen underlying changes in trade flows.

The low baseline level of protection sustained by countries suggests that a static noncooperative Nash equilibrium view is inadequate to explain existing levels of protection. One alternative is to view the existing trading environment as the result of explicit agreements among countries. This approach to explaining levels of protection has been taken by Wolfgang Mayer (1981) and Raymond Riezman (1982). However, such explicit agreements require the existence of a workable enforcement mechanism, and at the international level it is unclear what that mechanism might be. A second alternative is to consider only self-enforcing agreements or tacit cooperation among countries. As Avinash Dixit (1987) and Richard Jensen and Marie Thursby (1984) have shown, the (credible) threat of future punishment can sustain a more liberal trading environment than that predicted under the static Nash equilibrium. These models can help explain how countries are able to sustain a relatively liberal trading environment in "normal" periods. However, they remain silent on the issue of "special" protection, since they take each

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[1]In the United States, for example, the average tariff level on dutiable imports (the ratio of duties collected to dutiable imports) fell from 53.5 percent in 1933 to 5.2 percent in 1982 (U.S. Trade Representative, 1984, p. 187).

[2]The increasing relative importance of special protection as an instrument of international trade policy has been widely noted. See, for example, S. A. B. Page (1979) and C. Fred Bergsten and William Cline (1983) for attempts to quantify this trend.

period to be the same as every other. In this regard, W. Max Corden (1974, pp. 175–76) has argued that countries rarely initiate protection for the purpose of capturing terms-of-trade *gains*, presumably because of the fear of future retaliation by their trading partners, but that countries do employ protection for its terms-of-trade effects in periods when their terms-of-trade would otherwise *decline*. Corden argues that retaliation by trading partners is less likely during such periods. This suggests that episodes of "special" protection might usefully be viewed as part of a tacit international agreement in a *changing* environment.

We attempt to formalize this view by considering the way in which sustainable levels of protection in tacit cooperative equilibria are affected by changes in the underlying trade volume. Since potentially exploitable terms-of-trade effects will embody greater potential national welfare gains the greater is the underlying volume of trade, periods of high trade volume are likely to correspond to periods of great incentive to exercise one's power over the terms-of-trade. If the trade volume is large enough, the immediate gains from protection may outweigh the losses from punishment, and free trade will be unsustainable. However, this does not imply that international cooperation need break down. Countries can cooperatively utilize protection during periods of exceptionally high trade volume to mitigate the incentive of any country to unilaterally defect, and in so doing can avoid reversion to the noncooperative Nash equilibrium. Thus, surges in the underlying trade volume lead to periods of "special" protection as countries attempt to maintain some level of international cooperation. In this sense, the model we develop below depicts managed trade as the outcome of tacit cooperation among countries in the presence of volatile trade swings.

We adopt a very simple partial equilibrium framework within which to make these points. Section I lays out the basic model under the assumption of free trade and calculates the underlying free trade volume as a function of the parameters of the model. Section II solves for the static Nash equilibria in the quota and tariff games. Our results here are similar to those developed in Dixit (1987). These equilibria constitute the credible (subgame perfect) punishments in the dynamic game of the following section, the threat of which will be used to support tacit cooperation. The dynamic model for the quota and tariff games is analyzed in Section III, where it is shown that equilibrium trade policy becomes more restrictive during periods of high (free) trade volume. This result is reminiscent of a related point made by Julio Rotemberg and Garth Saloner (1986a) in the context of a repeated oligopoly model with demand shocks.[3] Our modeling approach is clearly inspired by their work. Section IV adds a second sector and considers the model's implications for the relationship between bilateral trade imbalances and protection. Section V discusses the generality of our results and considers several extensions. Section VI offers some conclusions.

I. Free Trade

We begin with the characterization of free trade in a very simple partial equilibrium model of trade in a single sector between two countries. Let the world (two-country) output in the sector be fixed at 2. At the beginning of any period, the distribution of world output between the "domestic" (no *) and the "foreign" (*) country is determined by a commonly known distribution function $F(e)$ that generates foreign output $e \in [0,1]$, with domestic output then given by $2-e$. On the demand side, the domestic and foreign countries are assumed to have identical linear demands $C = \alpha - \beta P$ and $C^* = \alpha -$

[3]In concluding, Rotemberg and Saloner (1986a) conjecture that their framework could yield a prediction of trade wars occurring in states of depressed demand. Our paper addresses a different issue, but in a similar spirit. Also, Riezman (1987) introduces random terms-of-trade shocks into the tariff model of Dixit (1987) and notes that shocks to the terms-of-trade that increase the current gain from defection will increase the likelihood of Nash reversion. His concern, however, is with the effect of unobservability of shocks and tariffs on the ability of countries to sustain low cooperative tariffs.

βP^*, respectively, where $C(C^*)$ is the consumption level of the domestic (foreign) country and $P(P^*)$ is the domestic (foreign) country price. Competitive firms supply the product in each country. For simplicity, we assume that production costs are zero and that $\alpha > 2$.

Free trade will ensure that a single price P^f prevails in both markets so that $P = P^* = P^f$. The equilibrium condition that world supply equals world demand, $2 = C(P^f) + C^*(P^f)$, determines the free trade price P^f as $P^f = (\alpha - 1)/\beta$. Thus, consumption levels under free trade are given by $C(P^f) = C^*(P^f) = 1$. Finally, the free trade volume V^f is given by $V^f = 2 - e - C(P^f) = C^*(P^f) - e = 1 - e$. In periods when $e = 1$, both countries have equal supply and there will be no trade between them. When $e < 1$, the domestic country exports the quantity $1 - e$. Hence, the domestic (foreign) country is the exporter (importer), and free trade volume rises as e falls away from 1. This completes the characterization of trade volume under conditions of free trade.

II. A Static Model of Protection

In this section we characterize the set of static Nash equilibria for the simple model of the previous section when countries choose either trade taxes or quotas. These equilibria will serve as credible (subgame perfect) punishments in the dynamic games considered in the next section, the threat of which can support tacit cooperation in a repeated setting.

The two countries are assumed to observe the current realization of e, and thus the trade volume that would prevail in the period under free trade, $V^f = 1 - e$, and then to choose simultaneously their protective policies for the period.[4] The domestic country is thus choosing export taxes or quotas while the foreign country chooses corresponding import policies.[5] Each country's objective is to maximize its sum of producer surplus, consumer surplus, and rents from protection.[6]

Consider first the determination of the static Nash equilibrium when countries choose trade quantities directly in the form of import and export quotas. Provided that quota licenses are either auctioned off by the governments of each country or simply given to their respective firms, the country whose quota binds—the country with the smaller quota—will capture all the quota rents. This means that as long as there is trade, each country can always do better by tightening its quota beyond that set by its trading partner, which leads to the well-known property that the unique static Nash equilibrium in the quota game is autarky (see, for example, Edward Tower, 1975). Thus, regardless of the realization of e and the underlying free trade volume V^f, the static Nash equilibrium in the quota game ensures that no trade will take place.

We turn now to the determination of the static Nash equilibrium level of protection when the domestic and foreign countries choose specific export and import taxes $\tau(V^f)$ and $\tau^*(V^f)$, respectively, as functions of the observed free trade volume.[7] To begin, the actual volume of trade following the realization of the free trade volume V^f and the selection of trade taxes $\tau(V^f)$ and $\tau^*(V^f)$ is easily characterized. If trade occurs, then effective prices to producers in the domestic (exporting) country must be equal across countries and world supply and demand must also be equal. Since (non-negative) taxes cannot reverse the free di-

[4]Our results would not be significantly altered if countries had common and imperfect information about V^f when choosing policies. If, however, each country had some private information about the current V^f, then the analysis would be considerably more complex. For an analysis of the role of private information in finitely repeated tariff games, see Jensen and Thrusby (1989).

[5]We discuss in Section V an extension of our results to two sectors in which only import-restricting policies can be used.

[6]Countries are not concerned with risk sharing in this partial equilibrium setting, since national income, and thus the marginal utility of national income, is unaffected by shocks in this single sector. See Section V for a discussion of the case where sectoral income smoothing motivates trade policy intervention.

[7]Our results are essentially unchanged if countries set *ad valorem* tariffs.

rection of trade, we have $P^* - P = \tau + \tau^*$ and $2 = C(P) + C^*(P^*)$. Trade will occur when trade taxes are not prohibitive; in our model, it is easy to show that trade occurs provided

$$(1) \qquad 2V^f/\beta > \tau + \tau^*.$$

Now, assuming that (1) holds, we have $P(\tau, \tau^*) = (\alpha - 1)/\beta - (\tau + \tau^*)/2$ and $P^*(\tau, \tau^*) = (\alpha - 1)/\beta + (\tau + \tau^*)/2$, which gives prices as functions of trade taxes for the domestic and foreign country.[8]

Letting $W(V^f, \tau, \tau^*)$ and $W^*(V^f, \tau, \tau^*)$ represent domestic and foreign country welfare, respectively, given by the sum of the country's consumer surplus, producer surplus, and tariff revenue, we have when (1) holds

$$(2) \quad W(V^f, \tau, \tau^*) = \int_{P(\tau,\tau^*)}^{\alpha/\beta} C(P)\,dP + \int_0^{P(\tau,\tau^*)} [1 + V^f]\,dP + \tau X(V^f, P(\tau, \tau^*)),$$

$$(3) \quad W^*(V^f, \tau, \tau^*) = \int_{P^*(\tau,\tau^*)}^{\alpha/\beta} C^*(P^*)\,dP^* + \int_0^{P^*(\tau,\tau^*)} [1 - V^f]\,dP^* + \tau^* M(V^f, P^*(\tau, \tau^*)),$$

where we have written each country's output in terms of the underlying free trade volume V^f, and where $X(V^f, P(\tau, \tau^*))$ and $M(V^f, P^*(\tau, \tau^*))$ are domestic export supply and foreign import demand, respectively, written as functions of V^f and tariff-distorted prices.

The remaining possibility is that (1) fails. Now trade taxes prohibit trade. This possibility corresponds to autarky, with domestic and foreign prices given, respectively, by $P(V^f) = (\alpha - 1 - V^f)/\beta$ and $P^*(V^f) = (\alpha - 1 + V^f)/\beta$ and welfare

$$(4) \quad W(V^f, \tau, \tau^*) = \int_{P(V^f)}^{\alpha/\beta} C(P)\,dP + \int_0^{P(V^f)} [1 + V^f]\,dP,$$

$$(5) \quad W^*(V^f, \tau, \tau^*) = \int_{P^*(V^f)}^{\alpha/\beta} C^*(P^*)\,dP^* + \int_0^{P^*(V^f)} [1 - V^f]\,dP^*.$$

With the payoff functions now defined by (2), (3), (4), and (5), a *Nash equilibrium* for the static tariff game can be defined as a pair of tariff functions, $\tau_N(V^f)$ and $\tau_N^*(V^f)$, such that for every $V^f \epsilon [0,1]$, $\tau_N(V^f)$ maximizes $W(V^f, \tau, \tau_N^*(V^f))$ over τ and $\tau_N^*(V^f)$ maximizes $W^*(V^f, \tau_N(V^f), \tau^*)$ over τ^*.

To solve for Nash equilibria, we first characterize best-response correspondences, $\tau_R(V^f, \tau^*)$ and $\tau_R^*(V^f, \tau)$, defined, respectively, as the maximizers of $W(V^f, \tau, \tau^*)$ and $W^*(V^f, \tau, \tau^*)$. If (1) holds, $dW(V^f, \tau, \tau^*)/d\tau = V^f/2 - (3\beta\tau + \beta\tau^*)/4$, and $W(V^f, \tau, \tau^*)$ is strictly concave in τ. Hence,

$$(6) \quad \tau_R(V^f, \tau^*) = 2V^f/3\beta - \tau^*/3, \qquad \text{if } \tau^* < 2V^f/\beta.$$

If instead $\tau^* \geq 2V^f/\beta$, then by (1) any τ generates autarky. The domestic country welfare is then independent of its tariff, and so

$$(7) \quad \tau_R(V^f, \tau^*) = [0, \infty), \text{ if } \tau^* \geq 2V^f/\beta.$$

Similar calculations for the foreign country

[8]Note that as long as tariffs are not prohibitive so that (1) holds, prices will only be affected indirectly by the realization of e, through τ and τ^*. The absence of a direct impact of e on prices is due to the perfect negative correlation across countries of the supply shocks we consider. While a useful simplifying assumption, we argue in Section V that our results will be preserved in much more general models.

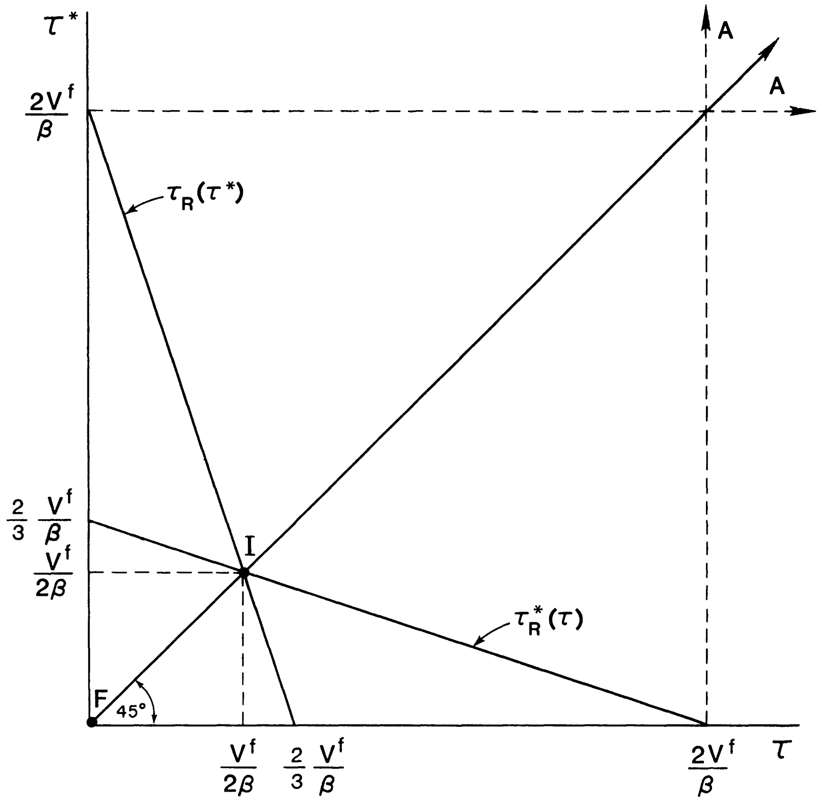

FIGURE 1

give the exactly symmetric best-response correspondence $\tau_R^*(V^f, \tau)$.

There are thus two disjoint sets of Nash equilibria. The interior equilibrium, found by solving (6) and its symmetric counterpart, has $\tau_N(V^f) = V^f/2\beta = \tau_N^*(V^f)$. The other equilibrium set corresponds to autarky. Any (τ, τ^*) such that $\tau \geq 2V^f/\beta$ and $\tau^* \geq 2V^f/\beta$ forms a no-trade Nash equilibrium with $\tau_N(V^f) = \tau$ and $\tau_N^*(V^f) = \tau^*$ for all V^f. Figure 1 illustrates the sets of Nash equilibria for the static tariff game.

To summarize, the static tariff game between countries generates two sets of equilibria: an interior Nash equilibrium and a set of autarky Nash equilibria. The static quota game has autarky as its unique Nash equilibrium.

Finally, we note that the equilibrium payoff configurations in the static tariff and quota games can be unambiguously ranked. In all (tariff and quota) autarky equilibria, payoffs are given by (4) and (5). Setting τ and τ^* in (2) and (3) first equal to zero and then equal to the Nash interior tariffs, it is straightforward to verify that welfare is highest for both countries under free trade and higher in the interior Nash equilibrium than in the autarky Nash equilibria if and only if $V^f > 0$.[9]

[9]Harry Johnson (1953–54) notes that one country may prefer the (internal) Nash tariff equilirium to free trade if its import demand is sufficiently elastic relative to that of its trade partner. John Keenan and Riezman (1988) have linked this possibility to differences in country size. While the symmetry in our model, which results in common interior Nash tariffs, does not allow this possibility to arise, the main complication it would introduce to our analysis is to alter the focus from symmetric to asymmetric tariff equilibria. See also the discussion in Section V.

III. A Dynamic Model of Protection

We now extend the model to allow for repeated interaction. In particular, we explore the sense in which a dynamic environment enables countries to lower protection from the levels that would prevail in a static setting and characterize the relation between the achieved protection and trade volume.

The dynamic game upon which we focus is simply the static game studied above infinitely repeated. Thus, at the start of any period, a value for e (and thereby V^f) is realized and observed by all. Current period protection policies are then set, and current welfare is determined. At the beginning of the next period, all past choices are observed and a new value for e (and thus V^f) is determined. We assume that e is drawn from the same distribution independently every period.

We examine symmetric (subgame perfect) Nash equilibria, in which the countries cooperate with low, common protection levels and credibly threaten to forever revert to a static Nash equilibrium if cooperation is violated. In the tariff game, common cooperative tariff levels imply that both countries share symmetrically in the cooperative tariff rents. Analogously, in the quota game, we assume that quota rents are shared symmetrically in the cooperative equilibrium.[10]

As discussed above, the most preferred symmetric trade policy is free trade, and lower symmetric levels of protection are always preferred jointly to higher symmetric levels of protection. For some values of V^f, we will see that the threat of reversion is sufficient to generate free trade. However, for other values of V^f, free trade cannot be maintained and the cooperative level of protection entails positive symmetric tariffs.

We consider first the tariff game. The cooperative trade tax function, $\tau_c = \tau_c(V^f)$, must provide each country with no incentive to defect. That is, for every V^f, the expected discounted welfare to each country under the strategy $\tau_c(V^f)$ must be no less than the welfare achieved by the country when defecting and thereafter receiving the expected discounted welfare associated with a static Nash equilibrium. Clearly, a country choosing to defect does best by selecting a tariff on its reaction curve. Thus, from (6), if countries are cooperating and allowing trade, the optimal tariff with which to defect is

$$\tau_D(V^f,\tau_c) = 2V^f/3\beta - \tau_c/3 = \tau^*_D(V^f,\tau_c). \tag{8}$$

We now fix V^f and a cooperative tariff level τ_c and characterize the static incentive to defect. Let

$$\Omega(V^f,\tau_D(V^f,\tau_c),\tau_c) \equiv W(V^f,\tau_D(V^f,\tau_c),\tau_c) - W(V^f,\tau_c,\tau_c) \tag{9}$$

$$\Omega^*(V^f,\tau_c,\tau_D(V^f,\tau_c)) \equiv W^*(V^f,\tau_c,\tau_D(V^f,\tau_c)) - W^*(V^f,\tau_c,\tau_c) \tag{10}$$

represent the respective static gains from defection for the domestic and the foreign country.

Figure 2 illustrates the static incentive to defect from the cooperative tariff $\tau_c \geq 0$. The foreign import demand curve is given by the downward sloping line with slope $-1/\beta$. The domestic export supply curve is given by the upward sloping line with slope $1/\beta$. The cooperative tariff τ_c results in prices $P^*(\tau_c,\tau_c)$ and $P(\tau_c,\tau_c)$ in the foreign and the domestic country, respectively. The

[10]It is natural to focus on common protection levels in this simple model, where countries are assumed symmetric. Moreover, one can show that symmetric rent sharing supports the highest degree of cooperation in this model. A more general model is discussed in Section V, where our basic conclusions hold but asymmetries play a real role. See also Robert Feenstra and Tracy Lewis (1987), who find in a different context that sharing the rents from protection allows countries to avoid trade wars.

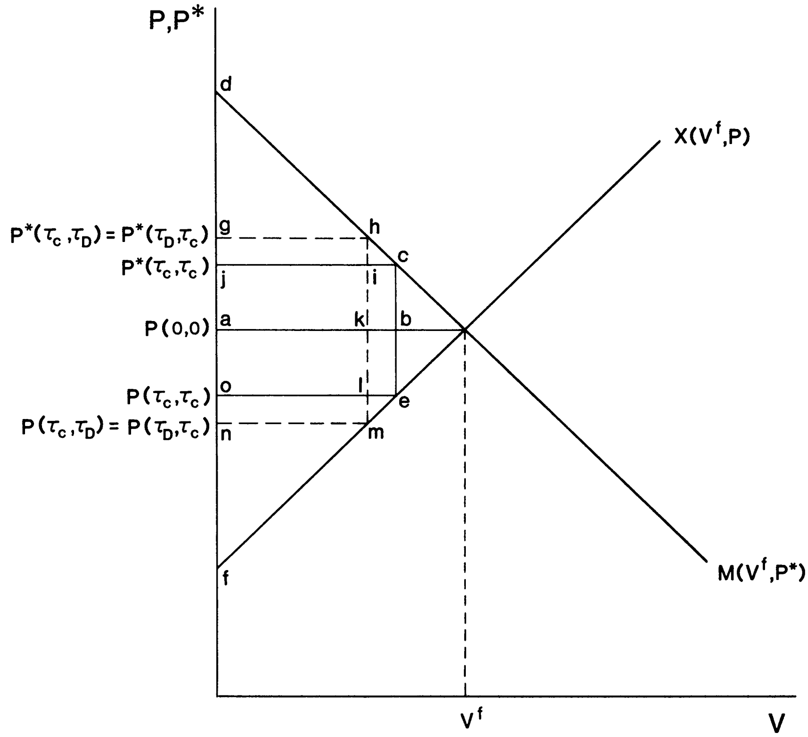

FIGURE 2

foreign gain from trade under τ_c is the sum of the surplus from trade, given by the area of the triangle *djc*, and the foreign share of cooperative tariff revenues, given by the area of the rectangle *jcba*. The domestic gain from trade under τ_c is analogously given by the sum of the areas of the triangle *oef* and the rectangle *oeba*.

Now consider a defection from τ_c. We know from (8) that both countries will defect to the same τ_D. Hence, whichever country defects, prices will be $P^*(\tau_c,\tau_D)= P^*(\tau_D,\tau_c)$ and $P(\tau_c,\tau_D)= P(\tau_D,\tau_c)$ in the foreign and domestic countries, respectively. The foreign static gain from defection is then given by the net increase in its collection of tariff revenues, represented by the difference between the rectangles *onml* and *kbci*, minus the efficiency loss in its surplus from trade, represented by the triangle *hic*. Analogously, the domestic exporter's static gain from defection is given by *gjih* − *kbel* − *mle*. As is evident from Figure 2, the equivalence

$$\Omega(V^f,\tau_D(V^f,\tau_c),\tau_c)=\Omega^*(V^f,\tau_c,\tau_D(V^f,\tau_c))$$

holds for all $\tau_c \geq 0$. All results concerning the static incentive to defect can therefore be expressed in the domestic country notation.

Using the envelope theorem, we find that

$$(11) \quad \frac{d\Omega(V^f,\tau_D(V^f,\tau_c),\tau_c)}{dV^f} = [\tau_D(V^f,\tau_c)-\tau_c]/2,$$

$$(12) \quad \frac{d\Omega(v^f,\tau_D(V^f,\tau_c),\tau_c)}{d\tau_c} = \frac{\beta}{4}[5\tau_c-\tau_D(V^f,\tau_c)]-\frac{V^f}{2}.$$

Using (8), we see that $\Omega(V^f, \tau_D(V^f, \tau_c), \tau_c)$ is strictly increasing in V^f and strictly decreasing in τ_c if and only if

$$(13)\qquad \tau_c < V^f/2\beta.$$

Provided that the cooperative tariff is below the static interior Nash tariff, the incentive to defect from a fixed τ_c is larger the larger is V^f and the smaller is τ_c.

These conditions are simple to interpret. As the underlying free trade volume increases, the incentive to defect gets larger. This occurs because the terms-of-trade gains from defection are applied to a larger trade volume, that is, because more tariff revenue is collected from one's trading partner under defection when the underlying trade volume is high. The incentive to defect can be mitigated by increasing the cooperative tariff, which acts to reduce the volume of trade. Thus, when the trade volume surges, one might suspect that a high τ_c would be required to avoid defection. This is indeed what we will find.

Having characterized the static incentive to defect, our next step is to examine the expected future loss suffered by a country that defects. Letting E be the expectations operator with expectations taken over V^f and δ be the discount factor, we represent the respective present discounted values of the expected future gain from not defecting today for the domestic and the foreign country as

$$(14)\qquad \frac{\delta}{1-\delta}\left[EW(V^f, \tau_c(V^f), \tau_c(V^f)) - EW(V^f, \tau_N(V^f), \tau_N(V^f))\right] \equiv \omega(\tau_c(\cdot)),$$

$$(15)\qquad \frac{\delta}{1-\delta}\left[EW^*(V^f, \tau_c(V^f), \tau_c(V^f)) - EW^*(V^f, \tau_N(V^f), \tau_N(V^f))\right] \equiv \omega^*(\tau_c(\cdot)).$$

Since e (and thus V^f) is i.i.d. across periods, ω and ω^* are independent of the current value of V^f as well as the current value of $\tau_c(V^f)$. The function $\tau_c(\cdot)$ will affect ω and ω^*, however, since the function's distributional characteristics influence the corresponding expected values. Observe that ω and ω^* will be strictly positive when $\delta > 0$ and $\tau_c(V^f) < \tau_N(V^f)$ for all V^f, in which case the threat of future punishment is meaningful.

We focus on the case where punishment involves infinite reversion to the interior Nash tariff equilibrium of the static game.[11] Using (2) and (3), we then have

$$(16)\qquad \omega(\tau_c(\cdot)) = \omega^*(\tau_c(\cdot)) = \frac{\delta}{(1-\delta)}\left[\frac{\sigma_{v^f}^2 + (EV^f)^2}{8\beta} - \frac{\beta}{2}\left[\sigma_{\tau_c}^2 + \left(E\tau_c(V^f)\right)^2\right]\right],$$

where $\sigma_{v^f}^2$ is the variance of V^f and $\sigma_{\tau_c}^2$ is the variance of $\tau_c(V^f)$. Note that the expected future gain from cooperating is higher when $\sigma_{v^f}^2$ and EV^f are higher, holding fixed $\tau_c(V^f)$.[12] This reflects the fact that the gains associated with cooperation (low protection) are increasing and convex in the underlying free trade volume.

[11] The case of reversion to autarky is similar, as detailed in Bagwell and Staiger (1988). The autarky threat actually generates the most cooperation possible, since it is the harshest punishment that countries will endure. (This point is made at a general level by Dilip Abreu, 1988). Yet, its very severity makes it somewhat less plausible than the threat to revert to the interior equilibrium, As Dixit (1987) notes, the possibility of autarky reversion is also significant for the tariff game since the existence of two static Nash equilibria makes possible cooperation even in finite horizon settings. (See Jean-Pierre Benoit and Vijay Krisna, 1985, and James Friedman, 1985, for more general discussions of this issue.)

[12] The assumption of linear demand generates a welfare function that is quadratic in τ. Since the Nash tariff is linear in V^f, only the mean and variance of V^f appear in (16). The higher-order moments might be important with nonlinear demand.

We have now characterized both the immediate gain from defection and the expected future loss. Both expressions are identical across countries, which enables us to focus on the domestic country henceforth. Now for credible cooperation to occur, the cooperative trade tax function, $\tau_c(V^f)$, must be such that at every V^f, no country has incentive to defect, or

$$(17)\quad \Omega\big(V^f,\tau_D(V^f,\tau_c(V^f)),\tau_c(V^f)\big) \le \omega(\tau_c(\cdot)).$$

This is our fundamental "no defection" condition, which implicitly defines a cooperative trade tax function.

There will in general be many functions that satisfy (17). To characterize the "most cooperative" trade tax function, we hold ω fixed at a constant level and solve for the lowest, nonnegative τ_c satisfying (17).[13] This process generates a trade tax function, with independent variables V^f and ω, and determines the necessary properties that the most cooperative trade tax function must satisfy.

To begin, fix $\omega > 0$. For $V^f = 0$, (8) and (9) establish that $\Omega(0,\tau_D(0,0),0) = 0$, so that (17) is satisfied by $\tau_c = 0$. Holding τ_c fixed at zero and increasing V^f, we know from (11) that $\Omega(V^f,\tau_D(V^f,0),0)$ increases monotonically. If ω is not too large, which will always be the case if δ is not too large, then there exists a critical value of $V^f, \bar{V}^f$, such that $\Omega(\bar{V}^f,\tau_D(\bar{V}^f,0),0) = \omega$.

Solving this explicitly gives

$$(18)\qquad \bar{V}^f = \sqrt{6\beta\omega}\,.$$

Hence, free trade is sustainable for $V^f \in [0,\bar{V}^f]$.

For more extreme values of V^f, where $V^f \in (\bar{V}^f,1]$, (17) will be violated at $\tau_c = 0$. From (12), τ_c must then rise above zero to reestablish (17). Explicit calculation yields the following representation of the most cooperative tax rule:

$$(19)\quad \tau_c(V^f,\omega) = \begin{cases} 0, & \text{if } V^f \in [0,\bar{V}^f] \\ \dfrac{V^f-\bar{V}^f}{2\beta} & \text{if } V^f \in [\bar{V}^f,1] \end{cases}.$$

The corresponding cooperative trade volume is given by

$$(20)\quad V^c = \begin{cases} V^f & \text{if } V^f \in [0,\bar{V}^f] \\ \dfrac{V^f+\bar{V}^f}{2} & \text{if } V^f \in [\bar{V}^f,1] \end{cases}.$$

The next figure summarizes (19) and (20). Figure 3 plots τ_c and V^c as a function of V^f. The threat to revert to the static interior Nash equilibrium supports free trade over a range of moderate trade volume. Intuitively, if the underlying free trade volume is low, then the (current) incentive to defect with a tariff is low, even if the natural flow of trade is unrestricted ($\tau_c = 0$). Once the trade volume becomes extreme, the trade tax function increases with the magnitude of the volume. Here, the incentive to defect is large because the natural flow of trade is high, and so the volume of trade must be mitigated somewhat ($\tau_c > 0$, $V^c < V^f$) in order to prevent defection.

The above analysis characterizes the necessary features of the optimal trade tax function and gives us an expression $\tau = \tau_c(V^f,\omega)$. The analysis was conducted under the assumption of an exogenously given ω. In fact, as (16) illustrates, ω depends on the $\tau_c(\cdot)$ function, $\omega = \omega(\tau_c(\cdot))$. To establish existence of the optimal trade tax function, we must ensure that these equations are consistent, so that the ω with which we began is also the ω value that $\tau_c(V^f,\omega)$ generates. Substituting the first equation into the second and using (16), (18), and (19), we can write the resulting equations as $\tilde{\omega}(\omega) = \omega$, since $\omega(\tau_c(\cdot))$ is independent of V^f. The

[13] A focus on the most cooperative equilibrium seems natural here, since countries are free to communicate about which self-enforcing equilibrium they will settle on, and the most cooperative equilibrium is the only symmetric equilibrium that is not Pareto dominated. Indeed, the GATT may be viewed as a forum within which the most cooperative (self-enforcing) trading arrangements are codified.

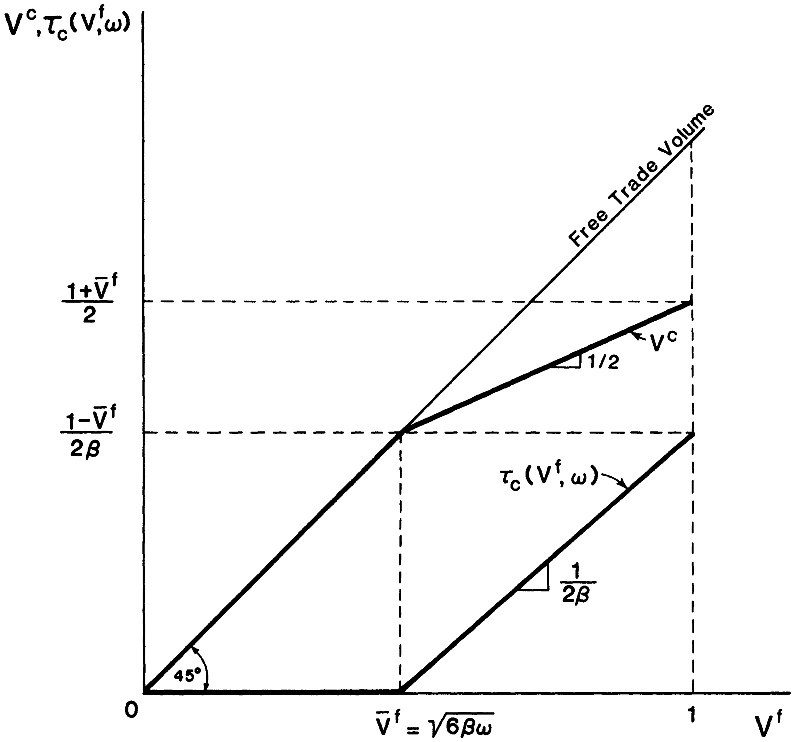

FIGURE 3

most cooperative trade tax function can then be represented as $\tau_c = \tau_c(V^f)$, when the largest $\hat{\omega}$ such that $\hat{\omega} \in (0, 1/6\beta)$ and $\tilde{\omega}(\hat{\omega}) = \hat{\omega}$ is substituted into $\tau_c(V^f, \omega)$.

We must now prove that such a fixed point does exist. Observe first that a fixed point does occur at $\hat{\omega} = 0$, corresponding to the continual play of the static interior equilibrium. This follows since $\tau_c(V^f, 0) = \tau_N(V^f)$, by (19). To explore the possibility of a positive root, we explicitly calculate $E\tau_c(V^f)$ from (18) and (19) and use (16) to get

$$(21) \quad \tilde{\omega}(\omega) = \frac{\delta}{8\beta(1-\delta)}\left[\sigma_v^{2f} + (EV^f)^2 - \int_{\bar{V}^f}^{1} (V^f - \bar{V}^f)^2 dF(V^f)\right],$$

if $\omega \in [0, 1/6\beta]$, where $F(V^f)$ is the distribution function for V^f. It is now straightforward to verify that with primes denoting derivatives, $\tilde{\omega}(\omega = 0) = 0$, $\tilde{\omega}'(\omega = 0) = \infty$, $\tilde{\omega}'(\omega = 1/6\beta) = 0$, and $\tilde{\omega}''(\omega) < 0$ for $\omega \in [0, 1/6\beta]$. Hence, a necessary and sufficient condition for a unique fixed point $\hat{\omega} \in (0, 1/6\beta)$ is $\tilde{\omega}(1/6\beta) < 1/6\beta$, or

$$(22) \quad \delta < \frac{4}{3\left[\sigma_v^{2f} + (EV^f)^2\right] + 4} \equiv \delta_N.$$

This will clearly hold if δ and/or $[\sigma_v^{2f} + (EV^f)^2]$ is sufficiently small. Thus, under this condition, the threat of interior Nash reversion generates a unique, most cooperative trade tax rate, with the properties given in Figure 3.

If instead (22) fails, then $\tilde{\omega}(1/6\beta) \geq 1/6\beta$. Since $\tau_c(V^f, \omega) = 0$ for all $\omega \geq 1/6\beta$, this case corresponds to free trade for every V^f. Taking these results together, we have now established a unique, most cooperative trade tax function, which can be expressed solely in terms of V^f and other exogenous parameters, such as δ, σ_V^{2f}, and EV^f.

The trade tax function is easily understood. When δ and $[\sigma_V^{2f}+(EV^f)^2]$ are small and (22) holds, the threat of interior Nash reversion is unimpressive. Intuitively, since δ is small, future losses from defection are not weighted heavily, while a small $[\sigma_V^{2f}+(EV^f)^2]$ implies that the reduced trade volume induced by the reversion is not expected to be large or variable and does not therefore represent a great loss in welfare. This case corresponds to Figure 3 with ω defined via the fixed point condition in terms of exogenous variables. If on the other hand δ and $[\sigma_V^{2f}+(EV^f)^2]$ are large and violate (22), then the reversion threat is acute, and so free trade is sustainable for all V^f.

Note that (19) and (21) together imply that surges in trade volume will tend to lead to greater increases in protection the more "unusual" they are for the sector under consideration. That is, the level of protection sustainable in the cooperative equilibrium of the dynamic tariff game will depend on the realization of V^f and its mean EV^f on the one hand, and on the variance of V^f, σ_V^{2f}, on the other. If free trade is sustainable when $V^f = EV^f$, then all else equal, a given increase in V^f above EV^f will be associated with a higher cooperative tariff the more "unusual" is the trade volume surge (the smaller is σ_V^{2f}).

To summarize, we have demonstrated that a high natural trade volume increases the incentive to defect. Protection is then needed to mitigate the volume of trade, thus sustaining the cooperative equilibrium. Higher values of δ and $[\sigma_V^{2f}+(EV^f)^2]$ act to make punishment more severe, and therefore make cooperation easier facing any given free trade volume V^f.[14]

[14]The threat to revert to a static Nash equilibrium is not in this model renegotiation-proof, as defined by Joseph Farrell and Eric Maskin (1987). Our basic conclusion as to the relation between trade volume and protection is consistent with the potential for renegotiation, however. To construct punishment schemes that will not be renegotiated, specify asymmetric tariffs (off the equilibrium path) so that the country that did not cheat enjoys the punishment phase.

The basic results of our analysis also carry through if countries explicitly choose trade quantities (quotas) rather than prices (taxes).[15] In particular, suppose countries set import and export quotas, and then either give the chosen quantity of quota licenses to their firms or auction them off. As noted in Section III, the unique static Nash equilibrium of this game is autarky, which then characterizes the credible punishment for defection.[16] While as in the tariff game the current incentive to defect from the tacit cooperative quota is increasing in underlying trade volume, it is greater for a given trade volume in the quota game than in the tariff game, since defection in the quota game secures *all* the rents of protection for the defecting country.[17] Calculations similar to those above yield the following representation of the most cooperative quota rule $q^c(V^f,\omega)$:

$$(23)\quad q_c(V^f,\omega) = \begin{cases} V^f \text{ for } V^f \in [0,\bar{V}^f] \\ \dfrac{V^f}{2} - \dfrac{\sqrt{(V^f)^2 - 4\beta\omega}}{2} \\ \qquad \text{for } V^f \in (\bar{V}^f,1]. \end{cases}$$

Figure 4 summarizes (23). Here the cooperative quota level $q_c(V^f,\omega)$ is plotted against the underlying free trade volume V^f. For low to moderate levels of V^f, free trade is sustainable and is reflected in a movement along the 45° line. When V^f passes the threshold value of $\bar{V}^f = \sqrt{6\beta\omega}$, however, free trade is no longer sustainable as a cooperative equilibrium. Moreover, any

[15]Rotemberg and Saloner (1986b) develop a model to analyze the effect of quotas on the ability of firms to collude. We differ in focusing on tacit cooperation between governments when firms are competitive.

[16]Since there is no interior static equilibrium for the quota game, we focus on the autarky threat, which is the threat that generates the most cooperation. See also fn. 11.

[17]In terms of Figure 2, defection in the quota game captures the additional revenue rectangle *aklo* (*ajik*) for the importer (exporter), increasing the static gains from defection above that in the tariff game.

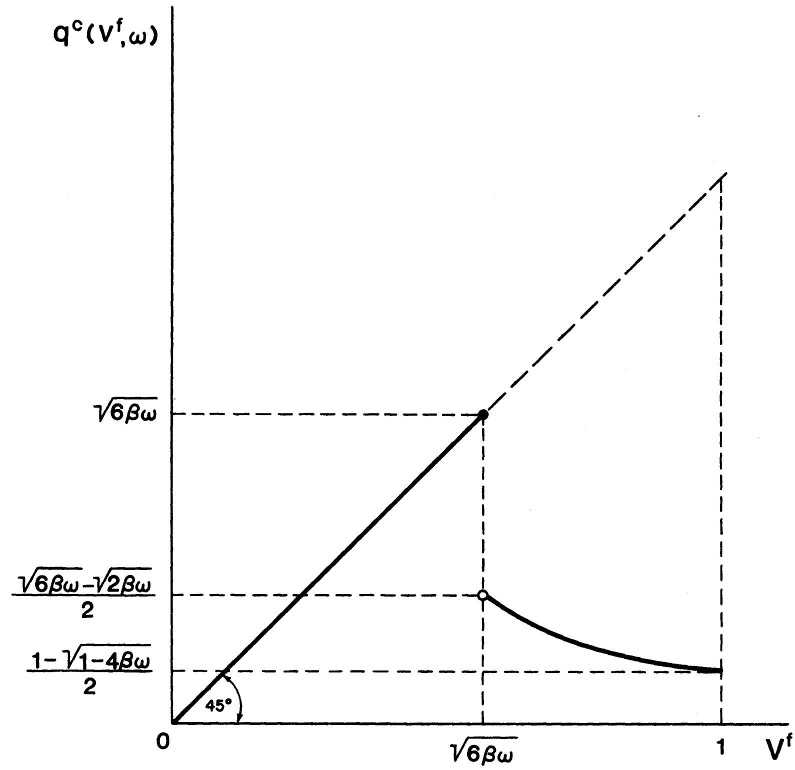

FIGURE 4

quota that restricts trade by less than the quota to which countries would optimally defect from free trade will only *increase* the static incentive to defect: since such a quota could not bind under defection, it would simply reduce the current welfare under cooperation for both countries but have no impact on current welfare under defection. For this reason, Figure 4 shows a discontinuity at $\bar{V}^f$, with higher free trade volumes leading to a discrete tightening of the trade restricting cooperative quota. At this lower cooperative quota, the optimal defection entails slightly tightening the quota so as to secure all cooperative quota rents. By choosing a sufficiently low cooperative quota, the countries reduce the size of cooperative quota rents and thus the incentive to defect.[18]

IV. Protection and the Trade Balance

In this section we explore how the relationship between trade *volume* and protection analyzed in the previous section translates into a relationship between trade *balance* and protection. While the model developed above relates levels of protection most directly to trade volume, there is a

[18]It is interesting to compare the levels of cooperation attainable in the tariffs and quota games. The autarky threat always provides the most cooperation, for a given policy instrument. Incentives to cheat are highest, however, when quotas are used, since all rents can be captured by defection. Thus, the threat of autarky reversion in the tariff game generally supports the most liberal trading environment. Whether quotas are preferred to tariffs with the interior reversion threat depends on the impatience of countries: the more the future is valued, the more likely it will be that tariffs with the threat of interior Nash reversion are inferior to quotas in supporting liberal trade. This comparison is further analyzed in Bagwell and Staiger (1988).

large informal empirical literature on trade imbalance as a determinant of protection, and it may be useful to explore the implications of our model in this regard.

The basic insight developed in the previous sections is that the incentive to defect unilaterally from cooperative tariff levels is highest when trade volume is highest: therefore, as the volume of trade expands, the level of protection rises in a cooperative equilibrium to mitigate the rising trade volume and hold the incentive to defect in check. When applied to a single sector as in the previous section, this implies that periods of greater than average trade volume will be associated with higher than average protection. We now show that when applied in the aggregate, this implies that the relationship between aggregate trade imbalance and the level of protection will depend on the sectoral makeup of the imbalance. A widening trade imbalance will be associated with greater levels of protection to the extent that the deficit (surplus) country's imports (exports) increase. However, a widening trade imbalance will be associated with lower levels of protection to the extent that the deficit (surplus) country's exports (imports) fall.

To show this, we consider the addition of a second sector to the model of the previous section and explore the relationship between the bilateral trade imbalance associated with trade between the home and foreign countries and their levels of protection. For simplicity, we suppose that the home and the foreign country trade only in these two products, and that there is a large rest of the world with which both countries also trade, so that the bilateral trade in these two goods is small relative to each country's total world trade. Thus, we stay within the partial equilibrium frameword of the previous sections and focus on the relationship between bilateral trade imbalance and protection.[19]

To keep things simple, suppose that the second product is identical to the first in every way except that while the first good is exported by the home country, the second good is exported by the foreign country. In particular, suppose foreign (home) output of good 1 is given by $e \in [0,1]$ $(2-e)$ and that the home (foreign) output of good 2 is given by $e \in [0,1]$ $(2-e)$. As before, e is determined independently in each period by the commonly known distribution $F(e)$. Under this setup, free trade volumes will be identical in the two sectors and the results of the previous section imply that the two goods will share identical levels of protection in the cooperative equilibrium for every realization of e (and thus V^f). Therefore, $\tau_c^1 = \tau_c^2 = \tau_c$ for all V^f, and τ_c is increasing in V^f. But the bilateral trade balance will be given by

$$(24) \qquad TB = [2-e-C_1]-[C_2-e]$$
$$= 2-(C_1+C_2)$$
$$= 2-(C_1+C_1^*) = 0,$$

where the second-to-last equality follows from the symmetry of the setup which ensures that $C_2 = C_1^*$.

What we have shown is that observations on the trade balance are not generally sufficient to determine the path of protection: in the extreme case illustrated here, the trade balance is always zero, independent of the value of V^f, even though the cooperative level of protection will change with V^f, as was the case in the previous section. Hence, to predict the relationship between trade imbalance and protection, our model suggests that information on the sectoral makeup of the trade imbalance will be needed.[20]

[19]See Bergsten (1982) on the importance of Japan–U.S. bilateral trade imbalance in determining levels of protection between the two countries.

[20]A separate issue that arises with the introduction of more than one sector is the notion of multimarket contact developed by B. Douglas Bernheim and Michael Whinston (1987). The central idea is that multimarket contact allows the pooling of incentive constraints over markets: if slack exists in the incentive constraints of some markets, pooling may augment the degree of cooperation sustainable in other markets. In the special two-sector case considered above, there is no gain from pooling incentive constraints since the sectors are identical in all relevant ways. More gener-

V. Extensions

We discuss in this section several further extensions that can be introduced to the model. We begin by exploring the generality of the relationship between underlying free trade volume and the incentive for countries to defect that characterizes the model of the previous sections. The property that at least one country's incentive to defect from free trade rises during periods when the underlying free trade volume is high is crucial in generating the positive correlation between cooperative protection levels and trade volume depicted above. We now examine the generality of this relationship and provide support for a presumption in its favor.

Expressions (25) and (26) depict, respectively, the domestic (exporting) and foreign (importing) country's static incentive to defect from free trade for general export supply $(X(k, P))$ and import demand $(M(k^*, P^*))$ functions:

$$(25)\quad \Omega(k,k^*,\tau_D,0) = \left[P^*(k,k^*,\tau_D,0) - P^f\right] \times X(k,P(k,k^*,\tau_D,0)) - \int_{P(k,k^*,\tau_D,0)}^{P^f} \left[X(k,P) - X(k,P(k,k^*,\tau_D,0))\right] dP.$$

$$(26)\quad \Omega^*(k,k^*,0,\tau_D) = \left[P^f - P(k,k^*,0,\tau_D)\right] M(k^*,P^*(k,k^*,0,\tau_D)) - \int_{P^f}^{P^*(k,k^*,0,\tau_D)} \left[M(k^*,P^*) - M(k^*,P^*(k,k^*,0,\tau_D))\right] dP^*.$$

The first term in expressions (25) and (26) is the tariff revenue collected from one's trading partner. The second term in each expression is the efficiency loss in the surplus from trade associated with defection. The parameters k and k^* represent general positive shift parameters in the export supply and import demand functions, respectively. Thus, by definition $\partial X(k,P)/\partial k > 0$ and $\partial M(k^*,P^*)/\partial k^* > 0$ for all P and P^* and, provided $\partial X(k, P)/\partial P > 0$ and $\partial M(k^*,P^*)/\partial P^* < 0$, then $dV^f/dk > 0$, and $dV^f/dk^* > 0$.

We focus on the implications of a shift in the export supply or import demand function for the incentive to defect in the country where the shock originates; that is, we consider the signs of $d\Omega(\cdot)/dk$ and $d\Omega^*(\cdot)/dk^*$. We wish to establish a presumption that these two derivatives are positive, thereby ensuring that at least one country's incentive to defect from free trade rises whenever the underlying free trade volume rises. Using (25) and (26), direct calculation establishes the following:

$$(27)\quad \frac{d\Omega(\cdot)}{dk} > 0 \text{ iff } \frac{\partial X(k,P^f)}{\partial k}\left[\frac{P^f}{\eta_x^f + \eta_m^f}\right] > \int_{P(k,k^*,\tau_D,0)}^{P^f} \frac{\partial X(k,P)}{\partial k} dP,$$

$$(28)\quad \frac{d\Omega^*(\cdot)}{dk^*} > 0 \text{ iff } \frac{\partial M(k^*,P^f)}{\partial k^*}\left[\frac{P^f}{\eta_x^f + \eta_m^f}\right] > \int_{P^f}^{P^*(k,k^*,0,\tau_D)} \frac{\partial M(k^*,P^*)}{\partial k^*} dP^*,$$

where η_x^f and η_m^f are, respectively, the price elasticities of export supply and import demand (taken positively) evaluated at free trade. The right-hand side of (27) gives the additional efficiency loss from τ_D suffered by the defecting home country associated with the outward shift of its export supply function. Likewise, the right-hand side of (28) gives the additional efficiency loss from τ_D suffered by the defecting foreign country

ally, however, the ability of governments to pool incentive constraints across sectors is likely to undermine a strict sector-by-sector relationship between trade volume and protection. Instead, a surge in overall bilateral trade volume would lead to an overall rise in bilateral protection.

associated with the outward shift of its import demand function. The left-hand side of these two expressions captures the impact of the terms-of-trade changes associated with the shock on each country's incentive to defect: the less elastic are the export supply and import demand functions at free trade, the greater will be the (free trade) terms-of-trade loss for the country within which the shock originates, and the greater will be the corresponding gain from defection.

From (27) and (28) it is clear that a shock to the export supply or import demand function that takes the form of an increase in k or k^*, respectively, will increase the incentive to defect from free trade for the country within which the shock occures provided that $\eta_x^f + \eta_m^f$ are sufficiently small, that is, provided that the elasticities of export supply and import demand evaluated at free trade are sufficiently small. But in the context of a defection, this is likely to be the case, since the relevant elasticities are very short run in nature; that is, they reflect the time it takes for one's trading partner to detect a defection and respond. Thus, with a negligible (immediate) response of export supplies and import demands to a small price change from P^f, conditions (27) and (28) are likely to be satisfied, and at least one country's incentive to defect from free trade will rise whenever the underlying free trade volume rises. This supports the presumption in favor of an increasing relationship between free trade volume and the incentives of at least one country to defect from free trade, and suggests that the flavor (though not the transparency) of our results would be preserved in much more general settings.[21]

We turn next to the interpretation of the export tax. While it is true that import taxes are more commonly utilized than are export taxes, the latter are nonetheless observed, especially in the primary product markets of developing countries.[22] Still, it is interesting to ask whether our basic results would be preserved in a world in which the imposition of export taxes were politically infeasible. In this regard, it is possible to amend the two-sector model considered in Section IV with an *ad hoc* requirement that countries are unable to impose export taxes, perhaps because of political pressures. In this amended model, there is a unique static Nash equilibrium in which each country imposes the import tax $\tau_R(V^f, 0) = 2V^f/3\beta$ on its import good. Cooperation in an infinite-horizon setting is then made possible with the threat to forever revert to the static equilibrium if a defection from a low tariff is ever observed. Our basic result readily extends to this model. During periods of high-volume trade, each country will have a large incentive to deviate to the tariff $2V^f/3\beta$ on its import good. This incentive is reduced only if the cooperative tariff is allowed to rise somewhat, so that each country is appeased in its import market. Thus, even if countries have no direct control over the volume of trade in their export sector, higher trade volume will continue to correspond to higher protection.

Finally, we have chosen to focus on governments that pursue protection for its terms-of-trade effects, and thus have considered a model in which full international cooperation would entail the maintenance of free trade in all periods. However, the basic insights we have developed are consistent with other government objectives. For example, suppose instead that import protection is used by governments to mitigate sudden drops in the real income of import-competing producers. Such an objective is

[21]We have also assumed throughout that e is i.i.d. through time. Rotemberg and Saloner (1986a) have made the analogous assumption for their model, but this approach has been criticized by John Haltiwanger and Joseph Harrington (1987). As applied to our model, the criticism is that if a high V^f today makes more likely a high V^f tomorrow, then the cost of defection today rises for both countries. The predictions of the i.i.d. model are reversed, however, only if δ is sufficiently large. Since the small δ case seems especially appropriate for elected governments, the possibility of correlated shocks is likely to be consistent with our conclusions for an interesting range of parameters.

[22]See, for example, *World Development Report 1986*, especially chap. 4, for a discussion of the export tax policies of developing countries.

in the spirit of Corden's (1974) Conservative Social Welfare Function. If trade volume into the importing country surges, either because of a "good" supply realization abroad or a "bad" supply realization at home, the importing country may respond with "special" protection even under full international cooperation. However, the fully cooperative response typically will trade off the desire to maintain the real income of import-competing producers at home not only with the interests of domestic consumers, but with the interests of the export sector abroad as well, and thus results in less complete maintenance of import-competing producer incomes than would be individually optimal. Thus, the workings of such a model would be qualitatively similar to the model we have studied here: unusual surges in trade volume would tend to be associated with unusually large static gains from defection to a high tariff for the government of the importing country, and an increase in the equilibrium level of protection (above its fully cooperative level but still below the noncooperative choice) would be required to avoid a complete breakdown in cooperation, that is, a tariff war.[23]

VI. Conclusions

We have attempted to develop a theory of managed trade that correlates periods of unusually high trade volume with increased protection. While the model we have chosen is special in a number of ways, the insights it generates appear to be much more general.

In particular, the notion that periods of unusually high trade volume present countries with an unusually strong incentive to defect from cooperative trading arrangements seems to be quite general and forms the heart of our analysis. Given this, it follows naturally that countries will attempt to manage the volume of trade with protective instruments that serve to dampen fluctuations in trade volume. Trade management can then be understood as an attempt by countries to maintain the self-enforcing nature of existing international cooperation.

Finally, in exploring the sustainable level of tacit cooperation among countries in a volatile environment, we have made no formal distinction between special protection devices that are provided for explicitly in the GATT and those that are not. The "safeguards" provisions of the GATT, whereby countries are given the right to raise protection in the event of unforseen developments, may to some extent represent an explicit institutional manifestation of our ideas.[24] Our analysis suggests a role for safeguard provisions when trade volume is unexpectedly high as a means of avoiding a reversion to noncooperative interaction among countries. In this light, the recent proliferation of safeguard "substitutes," for example, VERs and OMAs, may reflect the general inadequacy of the existing safeguards provisions to maintain the credibility of the rest of the GATT system.

[23]This particular interpretation is also suggestive of the way in which international agreements, even if constrained to be self-enforcing in nature, may help to limit the policy discretion of a government vis-à-vis its own private sector, thereby alleviating time-consistency problems of the kind studied in Staiger and Guido Tabellini (1987).

[24]Consistent with this interpretation is the observation of Kenneth Dam (1970): "One may conclude that the GATT escape clause is a useful safety valve for protectionist pressures and does not undercut in any serious way the advantages of the GATT tariff negotiating system. Insofar as the excape clause is a political 'prerequisite' to the membership in the GATT of certain contracting parties—most notably the U.S.—the argument in its favor is even stronger" (pp. 106–107). For a discussion of GATT safeguards, see also J. David Richardson (1988).

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