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ABSTRACT

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 setting facing volatile trade swings. High trade volume leads to a greater incentive to unilaterally defect 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.

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I. Introduction

Two major trends have dominated the post war history of trade policy in industrialized countries. One is the dramatic multilateral reduction in tariffs negotiated under the GATT. 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. 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 standard non-cooperative Nash equilibrium view is inadequate to explain existing levels of protection. One alternative way to view the existing trading environment is that it is the result of explicit agreements among countries. This approach to explaining levels of protection has been taken by Mayer (1981) and 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 Dixit (1987) and Jensen and 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 period to be the same as every other. In this regard, Corden (1974) has argued that countries rarely initiate protection for the purpose of capturing terms-of-trade gains, presumably due to 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 non-cooperative 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. The next section 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 III 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 IV, 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 Rotemberg and Saloner (1986), who argue that collusion is made more difficult by high demand states, and thus that price must be held down during such states.[1] Section V adds a second sector and considers the model's implications for the relationship between bilateral trade imbalances and protection. Section VI discusses the generality of our results and considers several extensions. Section VII concludes.

II. Free Trade

We begin with the characterization of free trade in a simple partial equilibrium model of trade in a single sector between two countries. While we choose a very simple model as the starting point of our analysis, we argue in section VI that the flavor of our conclusions will be preserved in much more general models.

Consider, then, a single sector in which trade takes place between two countries. For simplicity, the world (two-country) output in the sector is fixed at 2. At the beginning of any period, the distribution of world output between the "domestic" and the "foreign" country is determined by a commonly known distribution function $F(e)$ that generates domestic output $e \epsilon [0,2]$ with foreign output then given by $2-e$. Since the direction of trade between the two countries in any period will depend on the realization of e, we will use '$*$' to denote variables associated with the importing country. Accordingly, we define Q (Q^*) as the output level in the exporting (importing) country. On the demand side, each country is assumed to have an identical linear demand

$$C = \alpha - \beta P, \; C^* = \alpha - \beta P^*,$$

where C (C^*) is the consumption level of the exporting (importing) country and P (P^*) is the exporting (importing) country price. Competitive firms supply the product in each country. For simplicity, we assume 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 $P^f = \frac{\alpha-1}{\beta}$. Thus, consumption levels for the exporting and the importing country under free trade are given by $C(P^f) = C^*(P^f) = 1$. Finally, the free trade volume V^f is given by

$$V^f = Q - C(P^f) = C^*(P^f) - Q^*$$
$$= |e-1|.$$

In periods when $e=1$, both countries have equal supply and there will be no trade between them. When $e>1$ ($e<1$), the domestic (foreign) country exports the quantity $e-1$ ($1-e$). Hence, free trade volume rises as e moves away from 1. This completes the characterization of trade volume under conditions of free trade.

III. 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 $V^f = |e-1|$, and then to simultaneously choose their protective policies for the period. Each country's objective is to maximize its sum of producer surplus, consumer surplus, and rents from protection. It is perhaps simplest to think of the two countries as jointly choosing a level of bilateral trade in the sector (through their choice of trade restrictions) as well as an international division of the rents from protection. In the case where the policy instruments set by the two governments are trade taxes, they can be thought of either as explicit taxes on trade or as import and export license fees that implicitly define corresponding trade quotas. The alternative set up we consider is one in which countries choose trade quantities directly through the choice of quotas.

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, 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 countries choose specific export and import taxes, $\tau(V^f)$ and $\tau^*(V^f)$ respectively, as functions of the observed free trade volume.[2] To begin, the actual nature 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 exporting country must be equal across countries and world supply and demand must also be equal. Since (nonnegative) taxes can never reverse the free direction 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

$$1)\quad \frac{2V^f}{\beta} > \tau + \tau^*$$

Now, assuming that 1) holds, we can collect equations to get

$$P(\tau,\tau^*) = (\alpha-1)/\beta - (\tau+\tau^*)/2;\ P^*(\tau,\tau^*) = (\alpha-1)/\beta + (\tau+\tau^*)/2$$

We now have prices as functions of trade taxes for the exporting and the importing country when 1) holds.[3]

Letting $W(V^f,\tau,\tau^*)$ and $W^*(V^f,\tau,\tau^*)$ represent exporting and importing 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 used the fact that $Q = [1+V^f]$ and $Q^* = [1-V^f]$, and where $X(V^f, P(\tau,\tau^*)) = [1+V^f] - C(P(\tau, \tau^*))$ and $M(V^f, P^*(\tau,\tau^*)) = [1-V^f] - C^*(P^*(\tau,\tau^*))$ are export supply and import demand, respectively, written as functions of the underlying free trade volume V^f and tariff-distorted prices.

The remaining possibility is that

$$4)\quad \frac{2V^f}{\beta} \le \tau + \tau^*$$

in which case 1) fails. Here, trade taxes prohibit trade. In general, this possibility corresponds to autarky, with prices for the country that would export absent prohibitive tariffs and for the country that would import absent prohibitive tariffs given, respectively, by

$$P(V^f) = (\alpha-1-V^f)/\beta; \; P^*(V^f) = (\alpha-1+V^f)/\beta$$

and welfare

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

$$6)\quad W^*(V^f,\tau,\tau^*) = \int_{P^*(V^f)}^{\alpha/\beta} C^*(P^*)dP^* + \int_0^{P^*(V^f)} [1-V^f]dP^*$$

With the payoff functions now defined by 2), 3), 5), and 6), a __Nash equilibrium__ for the static tariff game can be defined as a pair of tariff functions, $\tau_N(V^\ell)$ and $\tau_N^*(V^\ell)$, such that for every $V^\ell \in [0,1]$, $\tau_N(V^\ell)$ maximizes $W(V^\ell,\tau,\tau_N^*(V^\ell))$ over τ and $\tau_N^*(V^\ell)$ maximizes $W^*(V^\ell,\tau_N(V^\ell),\tau^*)$ over τ^*. To solve for Nash equilibria, we first characterize best response correspondences, $\tau_R(V^\ell,\tau^*)$ and $\tau_R^*(V^\ell,\tau)$, defined, respectively, as the maximizers of $W(V^\ell,\tau,\tau^*)$ and $W^*(V^\ell,\tau,\tau^*)$.

If 1) holds,

$$\frac{dW(V^\ell,\tau,\tau^*)}{d\tau} = \frac{V^\ell}{2} - \left(\frac{3\beta\tau + \beta\tau^*}{4}\right)$$

and $W(V^\ell,\tau,\tau^*)$ is strictly concave in τ. Hence,

$$7) \quad \tau_R(V^\ell,\tau^*) = \frac{2V^\ell}{3\beta} - \frac{\tau^*}{3}, \quad \text{if} \quad \tau^* < \frac{2V^\ell}{\beta}$$

If instead $\tau^* \geq \frac{2V^\ell}{\beta}$, then by 1) any τ generates autarky. The exporting country welfare is then independent of its tariff, and so

$$8) \quad \tau_R(V^\ell,\tau^*) = [0,\infty), \quad \text{if} \quad \tau^* \geq \frac{2V^\ell}{\beta}.$$

Similar calculations for the importing country give

$$9)\quad \tau_R^*(V^f,\tau) = \frac{2V^f}{3\beta} - \frac{\tau}{3}, \quad \text{if} \quad \tau < \frac{2V^f}{\beta}$$

$$10)\quad \tau_R^*(V^f,\tau) = [0,\infty), \quad \text{if} \quad \tau \geq \frac{2V^f}{\beta}.$$

There are thus two disjoint sets of Nash equilibria. The interior equilibrium, found by simultaneously solving 7) and 9), is

$$11)\quad \tau_N(V^f) = \frac{V^f}{2\beta} = \tau_N^*(V^f).$$

The other equilibrium set corresponds to autarky. Any $(\tau,\tau*)$ such that $\tau \geq \frac{2V^f}{\beta}$ and $\tau* \geq \frac{2V^f}{\beta}$ forms a no trade Nash equilibrium. 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 5) and 6). Setting τ and $\tau*$ in 2) and 3) equal to zero and equal to the Nash interior tariffs given by 11), it is then 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 $V^f > 0$.[4]

IV. 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 thus V^f) is realized and observed by all. Current period protection policies are then set, and current welfare 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.[5]

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.[6]

As discussed above, the most preferred symmetric trade policy is free trade, and, in general, 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 can not 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 7) and 9), if countries are cooperating and allowing trade, the optimal tariff with which to defect is

$$12)\quad \tau_D(V^f,\tau_c) = \frac{2V^f}{3\beta} - \frac{\tau_c}{3} = \tau_D^*(V^f,\tau_c)$$

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

$$13)\quad \Omega(V^f,\tau_d(V^f,\tau_c),\tau_c) = W(V^f,\tau_D(V^f,\tau_c),\tau_c) - W(V^f,\tau_c,\tau_c)$$

$$14)\quad \Omega^*(V^f,\tau_c,\tau_D(V^f,\tau_c)) = W^*(V^f,\tau_c,\tau_D(V^f,\tau_c)) - W^*(V^f,\tau_c,\tau_c)$$

represent the respective static gains from defection for the exporting and the importing country.

Figure 2 illustrates the static incentive to defect from the cooperative tariff $\tau_c \geq 0$. The (importing country's) import demand curve is given by the downward sloping line with slope $-\frac{1}{\beta}$. The (exporting country's) export supply curve is given by the upward sloping line with slope $\frac{1}{\beta}$. The cooperative tariff τ_c results in prices $P*(\tau_c,\tau_c)$ and $P(\tau_c,\tau_c)$ in the importing and exporting country, respectively. The importer's gain from trade under τ_c is the sum of the trade surplus, given by the area of the triangle djc, and the importer's share of cooperative tariff revenues, given by the area of the rectangle jcba. The exporter's 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 (12) that both countries will defect to the same τ_D. Hence which ever 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 importing and exporting countries, respectively. The importer's 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 trade surplus, represented by the triangle hic. Analogously, the exporter's static gain from defection is given by gjih - kbel - mℓe. As is evident from Figure 2, the equivalence $\Omega(V^\ell,\tau_D(V^\ell,\tau_c),\tau_c) = \Omega*(V^\ell,\tau_c,\tau_D(V^\ell,\tau_c))$ holds for all $\tau_c \geq 0$. All results concerning the static incentive to defect can therefore be expressed in the exporting country notation.

Using the envelope theorem, we find that

$$15)\quad \frac{d\,\Omega\,(V^\ell,\tau_D(V^\ell,\tau_c),\tau_c)}{d\,V^\ell} = [\tau_D(V^\ell,\tau_c) - \tau_c]/2$$

$$16)\quad \frac{d\,\Omega\,(V^f,\tau_D(V^f,\tau_c),\tau_c)}{d\,\tau_c} = \frac{\beta}{4}[5\tau_c - \tau_D(V^f,\tau_c)] - \frac{V^f}{2}$$

Using 12), we have 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

$$17)\quad \tau_c < \frac{V^f}{2\beta}$$

Provided that the cooperative tariff is below the static 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, i.e. because more tariff revenue is collected from one's trading partner under defection when the underlying trade volume is high.[7] 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 which 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 exporting and the importing country as

18) $\frac{\delta}{1-\delta}\,[EW(V^f, \tau_c(V^f), \tau_c(V^f)) - EW(V^f, \tau_N(V^f), \tau_N(V^f))] = \omega(\tau_c(\cdot))$

19) $\frac{\delta}{1-\delta}\,[EW^*(V^f, \tau_c(V^f), \tau_c(V^f)) - EW^*(V^f, \tau_N(V^f), \tau_N(V^f))] = \omega^*(\tau_c(\cdot))$

Since e (and thus V^f) is i.d.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 first consider the case where punishment involves infinite reversion to the interior Nash tariff equilibrium of the static game. Note also that a credible alternative to this punishment scheme involves infinite reversion to the autarky equilibrium. This will be considered further below.

Using 2) and 3) we now have

20) $\omega(\tau_c(\cdot)) = \omega^*(\tau_c(\cdot)) = {}^{\delta}/_{(1-\delta)}\left[\frac{\sigma^2_{V^f} + (EV^f)^2}{8\beta} - \frac{\beta}{2}\,[\sigma^2_{\tau_c} + (E\tau_c(V^f))^2]\right]$

where $\sigma^2{}_{v^f}$ is the variance of V^f and $\sigma^2_{\tau_c}$ is the variance of $\tau_c(V^f)$.

Note that the expected future gain from cooperating is higher when σ_v^{2f} and EV^f are higher, holding fixed $\tau_c(V^f)$.[8] This reflects the fact that the gains associated with cooperation (low protection) are increasing and convex in the underlying free trade volume.

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 exporting 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

$$21) \quad \Omega(V^f, \tau_D(V^f, \tau_c(V^f)), \tau_c(V^f)) \le \omega(\tau_c(\cdot)).$$

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

There will in general be many functions which satisfy 21). 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 21).[9] This process generates a trade tax function, with independent variables V^f and ω, and determines the necessary properties which the most cooperative trade tax function must satisfy.

To begin, fix $\omega > 0$. For $V^f = 0$, 12) and 13) establish that $\Omega(0, \tau_D(0,0), 0) = 0$, so that 21) is satisfied by $\tau_c = 0$. Holding τ_c fixed at zero and increasing V^f, we know from 15) 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

22) $\Omega(\overline{V}^f, \tau_D(\overline{V}^f, 0), 0) = \omega.$

Solving 22) explicitly gives

23) $\overline{V}^f = \sqrt{6\beta\omega}$

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

For more extreme values of V^f, where $V^f \in [\overline{V}^f, 1]$, 21) will be violated at $\tau_c = 0$. From 16), τ_c must then rise above zero to reestablish 21). Explicit calculation yields the following representation of the most cooperative tax rule

24) $$\tau^c(V^f, \omega) = \begin{cases} 0, & \text{if } V^f \in [0, \overline{V}^f] \\ \dfrac{V^f - \overline{V}^f}{2\beta} & \text{if } V^f \in [\overline{V}^f, 1] \end{cases}$$

The corresponding cooperative trade volume is given by

25) $$V^c = \begin{cases} V^f & \text{if } V^f \in [0, \overline{V}^f] \\ \dfrac{V^f + \overline{V}^f}{2} & \text{if } V^f \in [\overline{V}^f, 1] \end{cases}$$

The next two figures summarize 24) and 25). Figure 3 plots τ_c as a function of V^f, the trade volume that would prevail under free trade. 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 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 ($\tau_c > 0$) in order to prevent defection.

Figure 4 presents the same information, but with direct emphasis on the quantity restrictions implicit in the cooperative trade tax. While the trade volume that would arise with free trade, V^f, is still plotted on the horizontal axis, the actual cooperative trade volume, V^c, is now plotted on the vertical axis. Free trade corresponds to the 45° line. Past a threshold level, free trade is not sustainable and greater trade volume results in greater restraint of trade.

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 20) 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 which $\tau_c(V^f, \omega)$ generates. Substituting the first equation into the second and using 20), 23), and 24), we can write the resulting equation as $\tilde{\omega}(\omega) = \omega$, since $\omega(\tau_c(\cdot))$ is independent of V^f. The most cooperative trade 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 24). To explore the possibility of a positive root, we explicitly calculate $E\tau_c^2(V^f)$ from 23) and 24) and use 20) to get

$$26)\quad \tilde{\omega}(\omega) = \frac{\delta}{8\beta(1-\delta)}\,[\sigma_v^{2f} + (EV^f)^2 - \int_{\overline{V}^f}^{1} (V^f-\overline{V}^f)^2\, dF(V^f))]$$

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 $\omega''(\omega) < 0$ for $\omega \in [0,1/(6\beta)]$. Hence, as Figure 5 illustrates, 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

$$27)\quad \delta < \frac{4}{3[\sigma_v^{2f} + (EV^f)^2] + 4} = \delta_N$$

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 Figures 3 and 4.

If instead 27) fails, then $\omega(1/(6\beta)) \geq 1/(6\beta)$. Since $\tau_c(V^f,\omega) = 0$

for all $\omega \geq 1/(6\beta)$, this case corresponds to free trade for every V^{ℓ}. Taking these results together, we have now established a unique, most cooperative trade tax function, which can be expressed solely in terms of V^{ℓ} and other exogenous parameters, such as δ, $\sigma_V^{2\ell}$, and EV^{ℓ}.

The trade tax function is easily understood. When δ and $[\sigma_V^{2\ell} + (EV^{\ell})^2]$ are small and 27) 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 $[\sigma_V^{2\ell} + (EV^{\ell})^2]$ 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 and 4 with ω defined via the fixed point condition in terms of exogenous variables. If on the other hand δ and $[\sigma_V^{2\ell} + (EV^{\ell})^2]$ are large and violate 27), then the reversion threat is acute, and so free trade is sustainable for all V^{ℓ}.

Note that 24) and 26) 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^{ℓ} and its mean EV^{ℓ} on the one hand, and on the variance of V^{ℓ}, $\sigma_V^{2\ell}$, on the other. If free trade is sustainable when $V^{\ell} = EV^{\ell}$, then all else equal, a given increase in V^{ℓ} above EV^{ℓ} will be associated with a higher cooperative tariff the more "unusual" is the trade volume surge (the smaller is $\sigma_V^{2\ell}$).

More cooperation is also given by a stronger form of punishment. In particular, suppose now that defection is followed by infinite reversion to the static autarky equilibrium. Letting $\tau_A(V^{\ell})$ be an autarky equilibrium strategy, define

$$28)\quad \omega_A(\tau_c(\cdot)) = \frac{\delta}{1-\delta}\, EW(V^f, \tau_c(V^f), \tau_c(V^f)) - EW(V^f, \tau_A(V^f), \tau_A(V^f))].$$

$\omega_A^*(\tau_c(\cdot))$ can be defined analogously. Using 2), 3), 5), and 6), explicit calculations give

$$29)\quad \omega_A(\tau_c(\cdot)) = \omega_A^*(\tau_c(\cdot)) = \frac{\delta}{1-\delta}\, [\frac{\sigma_V^{2\,f} + (EV^f)^2}{2\beta} - \frac{\beta}{2}\, [\sigma_{\tau_c}^2 + (E\tau_c(V^f))^2]]$$

Observe that $\omega_A(\tau_c(\cdot)) > \omega(\tau_c(\cdot))$ for fixed $\tau_c(V^f)$, since $[\sigma_V^{2\,f} + (EV^f)^2]$ plays a stronger role in the autarky case. Intuitively, a high expected free trade volume and variance implies a large loss with autarky, since trade is completely restrained in the autarky equilibrium. This in turn implies a larger value for ω under autarky, suggesting greater cooperation, as we now show to be the case.

Arguing as above and writing 29) as $\tilde{\omega}_A(\omega)$, we find that

$$30)\quad \tilde{\omega}_A(\omega) = \frac{\delta}{8\beta(1-\delta)}\, [4[\sigma_V^{2\,f} + (EV^f)^2] - \int_{\overline{V}^f}^{1} (V^f - \overline{V}^f)^2\, dF(V^f)]$$

Thus, $\tilde{\omega}_A(\omega)$ involves a parallel shifting of $\omega(\omega)$, by amount $\frac{3\delta}{8\beta(1-\delta)}[\sigma_V^{2\,f} + (EV^f)^2]$. Exactly analogous arguments establish a unique, most cooperative trade tax function. In the case of autarky, however, a fixed point $\hat{\omega}_A \in (0, 1/(6\beta))$, exists if and only if $\tilde{\omega}_A(1/(6\beta)) < 1/(6\beta)$, or

$$31) \quad \delta < \frac{1}{3[\sigma_V^{2f} + (EV^f)^2] + 1} = \delta_A$$

Now, it is straightforward to verify that $\delta_N > \delta_A$. Thus, if $\delta \geq \delta_N$, then either form of reversion is sufficient to generate free trade for all V^f. Alternatively, if $\delta_N > \delta \geq \delta_A$, then the threat to revert to autarky always gives free trade, but the interior reversion threat only gives free trade for V^f near zero, as in Figures 3 and 4. Finally, if $\delta_A > \delta$, then both forms of reversion provide only limited free trade. However, the fixed point for the autarky case is easily shown to be larger than that for the interior case, for reasons discussed above, and so the range of free trade is larger and the cooperative taxes are lower under autarky, as shown in Figure 6.

The autarky threat is in fact optimal over all punishment schemes, since it represents the most severe punishment which countries will endure.[10] The extreme severity of the autarky threat, however, may make it implausible.[11] We have thus also explored a softer form of punishment, where reversion is to the interior equilibrium. The intuition established for these two cases then makes it easy to evaluate other punishment schemes. For example, temporary reversions represent an even milder form of punishment, and thus generate a relatively high level of protection.[12] As Dixit (1987) notes, the autarky equilibrium is also significant, because it enables cooperation even in finite-horizon settings.

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. Similarly, as discussed above, stronger forms of punishment generate less protection.

The basic results of our analysis also carry through if country's explicitly choose trade quantities (quotas) rather than prices (taxes). 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. Hence punishment in this game is characterized exactly as in the tariff game analyzed above with Nash reversion to autarky. It is also easily shown that if the two countries set import and export quotas that differ, the country whose quota binds (the one with the smaller quota) captures all the quota rents. Finally, as in the tariff game, the greatest amount of cooperation will be supported by equal sharing of the quota rents in the tacit cooperative equilibrium. Thus, 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 <u>all</u> the rents of protection for the defecting country.[13] Calculations similar to those above yield the following representation of the most cooperative quota rule $q^c(V^f,\omega)$:

$$32) \quad q^c(V^f,\omega) = \begin{cases} V^f & \text{for } V^f \in [0,\overline{V}^f] \\ \dfrac{V^f}{2} - \dfrac{\sqrt{(V^f)^2 - 4\beta\omega}}{2} & \text{for } V^f \in (\overline{V}^f,1] \end{cases}$$

Figure 7 summarizes (32). 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 $\overline{V}^f = \sqrt{6\beta\omega}$, however, free trade is no longer sustainable as a cooperative equilibrium. Moreover, any quota that restricts trade by less than the quota to which countries would optimally defect from free trade will only <u>increase</u> 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 7 shows a discontinuity at $\overline{V}^f$, 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.

Finally, it is interesting to compare the levels of cooperation attainable in the tariff and quota games. The complexity of $q_c(V^f,\omega)$ in (32) makes for a complicated $\tilde{\omega}(\omega)$ function. However, the following points can be established. If $\delta \geq \delta_N$, so that countries care sufficiently about the future, then all regimes (quota, autarky tariff, and interior tariff) sustain free trade for all trade volume realizations. For $\delta \in (\delta_A, \delta_N)$, the quota and autarky tariff regimes support free trade over all trade volumes, while the interior tariff regime does not. Finally, for δ sufficiently small, so that countries care sufficiently little about the future, more liberal trade can be supported for any free trade volume under the autarky tariff regime than under the interior tariff regime, which in turn can support more liberal trade than the quota regime.

We conclude that the threat of autarky reversion in the tariff game will generally support the most liberal trading environment. However, whether trade will be more liberal under a regime in which countries set quotas or under a regime of tariffs with the threat of interior Nash reversion depends on the degree to which countries care about the future: 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.

V. 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 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 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 framework of the previous sections, and focus on the relationship between bilateral trade imbalance and protection.[14]

To keep things simple, suppose that the second product is identical to the first in every way except that when the first good is imported by the home country, the second good is exported. In particular, suppose as before that the home (foreign) country's endowment of good 1 is given by e_1 $(2-e_1)$ and that the home (foreign) country's endowment of good 2 is given by $e_2 = 2 - e_1$ (e_1). Let '*' now represent the importer (exporter) of good 1

(2). Furthermore, since e_1 and e_2 are symmetric around 1, 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_1 (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

$$
\begin{aligned}
33)\quad TB^* &= [e_2 - C_2] - [C_1 - e_1] \\
&= [2 - e_1 - C_2] - [C_1 - e_1] \\
&= 2 - (C_1 + C_2) \\
&= 2 - (C_1 + C_1^*) \\
&= 0
\end{aligned}
$$

where the second-to-last equality follows from the symmetry of the set up 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.

We note finally a separate issue that arises with the introduction of more than one sector: this is the notion of multimarket contact developed by Bernheim and Whinston (1987). The central idea is that multimarket contact allows the pooling of incentive constraints over markets: if there exists slack 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 generally, 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.

VI. Extensions

We discuss in this section a variety of further extensions which 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 (34) and (35) depict, respectively, the exporting and importing country's static incentive to defect from free trade for general export supply $(X(k,P))$ and import demand $(M(k^*,P^*))$ functions:

$$(34)\quad \Omega(k,k^*,\tau_D,0) = [P^*(k,k^*,\tau_D,0) - P^f]X(k,P(k,k^*,\tau_D,0)) - \int_{P(k,k^*,\tau_D,0)}^{P^f} [X(k,P) - X(k,P(k,k^*,\tau_D,0))]dP$$

and

$$(35)\quad \Omega^*(k,k^*,0,\tau_D) = [P^f - P(k,k^*,0,\tau_D)]M(k^*,P^*(k,k^*,0,\tau_D)) - \int_{P^f}^{P^*(k,k^*,0,\tau_D)} [M(k^*,P^*) - M(k^*,P^*(k,k^*,0,\tau_D))]dP^*$$

The first term in expressions (34) and (35) is the tariff revenue collected from one's trading partner. The second term in each expression is the efficiency loss in trade surplus 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,

$$(36)\quad \frac{\partial X(k,P)}{\partial k} > 0; \quad \frac{\partial M(k^*,P^*)}{\partial k^*} > 0 \quad \forall P,\ P^*$$

and provided $\frac{\partial X(k,P)}{\partial P} > 0$ and $\frac{\partial M(k^*,P^*)}{\partial P^*} < 0$,

$$(37)\quad \frac{dV^f}{dk} > 0; \quad \frac{dV^f}{dk^*} > 0.$$

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, i.e., we consider the signs of $\frac{d\Omega(\cdot)}{dk}$ and $\frac{d\Omega^*(\cdot)}{dk^*}$. 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. Under the assumption that both countries initially share a common optimal defection tariff τ_D, and using (34) and (35), direct calculation establishes the following:

$$(38)\quad \frac{d\Omega(\cdot)}{dk} > 0 \quad \text{iff} \quad \frac{\partial X(k,P^f)}{\partial k}\left[\frac{P^f}{\eta_x^f + \eta_m^f}\right] > \int_{P(k,k^*,\tau_D,0)}^{P^f} \frac{\partial X(k,P)}{\partial k}\, dP$$

$$(39)\quad \frac{d\Omega^*(\cdot)}{dk^*} > 0 \quad \text{iff} \quad \frac{\partial M(k^*,P^f)}{\partial k^*}\left[\frac{P^f}{\eta_x^f + \eta_m^f}\right] > \int_{P^f}^{P^*(k,k^*,0,\tau_D)} \frac{\partial M(k^*,P^*)}{\partial k^*}\, dP^*$$

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 (38) gives the additional efficiency loss from τ_D suffered by the defecting exporting country which is associated with the outward shift of the export supply function. Likewise, the right hand side of (39) gives the additional efficiency loss from τ_D suffered by the defecting importing country which is associated with the outward shift of the 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, all else the same, the greater will be the corresponding gain from defection.

From (38) and (39) 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 occurs provided that η_x^f and η_m^f are sufficiently small, i.e., 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, i.e., 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 (38) and (39) are likely to be satisfied, ensuring that 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.

We turn next to the interpretation of the export tax. It is certainly true that import taxes are more commonly observed than are export taxes.[15]

Moreover, in multi-good, general equilibrium models, the Lerner symmetry theorem between export and import taxes establishes that export taxes can indeed be formally ignored as well. In our partial equilibrium model, however, export taxes are actively employed.

Our modeling approach can be defended on several levels. The basic point we develop is that protection is positively correlated with the volume of trade, since high volume creates a large incentive to defect from tacit cooperation. This intuition would also find representation in a multi-good, general equilibrium model featuring only import taxes. We believe, however, that a partial equilibrium model offers a simpler, and more appropriate, characterization of observed trade wars, which are typically within narrow product groups. In this setting, export taxes can not be ignored on a purely formal basis, and so we have constructed a general model allowing for both export and import taxes.

It is possible, however, to amend the general model with an ad hoc requirement that countries are unable to impose export taxes, perhaps due to political pressures. In this amended model, there is a unique static Nash equilibrium in which the importing country chooses the import tax $\tau_R(V^f, 0) = \frac{2}{3}\frac{V^f}{\beta}$. 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, the importing country will have large incentive to deviate to the tariff $\frac{2}{3}\frac{V^f}{\beta}$. This incentive is reduced only if the cooperative tariff is allowed to rise somewhat, so that the importing country is appeased. Thus, even if the exporting government has no control over the volume of trade, higher protection will continue to correspond to higher trade volume.

Our general model also admits alternative interpretations for the export tax which are consistent with empirical observations. In particular, one interpretation of our model is that the export and import taxes are really export and import license fees which implicitly define corresponding trade quotas. An important consideration is then the allocation of quota rents. VER's would correspond to the collection of rents by the exporting country; whereas, the importing country would collect the rents if it auctioned import licenses. Our finding that the most cooperative tariff rule is symmetric corresponds to a sharing of the rents. This is perhaps suggestive of a role for "tariff quotas," in which tariffs are applied only to imports exceeding the limit, as Feenstra and Lewis (1987) suggest in a different context.

We have assumed throughout that e is i.i.d. through time. Haltiwanger and Harrington (1987) have recently criticized Rotemberg and Saloner's use of the i.i.d. assumption in their oligopoly model, arguing that if demand follows a cyclical path, then high demand increases the immediate benefit of defection but may also portend high demand states for the future, which acts to increase the cost of defection. Analogously, in our model, if a high V^f portends a sequence of high V^fs, then the cost of defection rises for both countries. As Haltiwanger and Harrington note, however, the implications of the i.i.d. model are reversed only if δ is sufficiently large. But, as Dixit (1987) has argued, it is the small δ case that is likely to be relevant in the present context, since governments may be presumed to face very short time horizons. Thus, while correlated shocks would surely effect the statement of our results, it appears that our basic conclusions would survive this extension for a range of sufficiently small δs.

Finally, we have chosen to focus on governments that pursue protection for its terms-of-trade effects. However, the basic insights we have developed are consistent with other government objectives. For example, suppose instead that trade policy is set by governments with a very specific purpose in mind, namely, to maintain the status quo income level of import competing producers (and their factors of production). Such an objective is in the spirit of Corden's (1974) Conservative Social Welfare Function. Absent protection, a "good" supply realization in the exporting country would result in higher trade volume at a lower world price, and would reduce the (real) income of import competing producers in the importing country. A "bad" supply realization in the importing country would, absent protection, lead to higher trade volume at a higher world price but, provided that product demand is not too inelastic, still reduce the (real) income of the import competing producers in the importing country. Thus, the workings of such a model would be qualitatively similar to the model we have studied here: unusual surges in trade volume would 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 would be required to avoid a complete breakdown in international cooperation, i.e. a tariff war.

VII. 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, we have emphasized the role of VERs and OMAs in sustaining tacit cooperation among countries in volatile environments. An explicit institutional manifestation of our ideas may be found in the safeguard provisions of the GATT, whereby countries are given the right to raise protection in the event of unforseen developments.[16] Our analysis suggests a role for safeguard provisions when trade volume is unexpectedly high, as a means of maintaining the credibility of the GATT system and avoiding a reversion to noncooperative interaction.

FOOTNOTES

1. In concluding, Rotemberg and Saloner (1986) conjecture that, when applied to the study of tariff wars, 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). Assuming that countries adopt trigger strategies which require free trade if free trade prevailed last period and infinite reversion otherwise, he 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. Thus for this reason, while the general idea that shocks can effect the incentives to defect is considered, it is not formally developed.

2. Our results would differ if countries set ad valorem tariffs, but not in a qualitatively important way.

3. 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 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 VI that our results will be preserved in much more general models.

4. Johnson (1953/54) notes that one country may prefer the (internal) Nash tariff equilibrium to free trade if its import demand is sufficiently elastic relative to that of its trading partner. Keenan and Riezman (1988) have linked this possibility to differences in country size. While the symmetry in our model, reflected in the common interior Nash tariffs defined by (11), 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 VI.

5. Correlated shocks are discussed in section VI.

6. 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 VI, where our basic conclusions hold but asymmetries play a real role.

7. See section VI for a discussion of the generality of this relationship.

8. The assumption of a linear demand generates a welfare function which is quadratic in τ. Since the Nash tariff is linear in V^f, only the mean and variance of V^f appear in (20). The higher order moments might be important with nonlinear demand.

9. A focus on the most cooperative equilibrium seems quite natural in this context, since countries are free to communicate openly 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, GATT may be viewed as a forum within which the most cooperative (self-enforcing) trading arrangements are codified.

10. For a general treatment of optimal punishment strategies, see Abreu (1988).

11. In particular, one might expect that the countries would choose to "renegotiate" strategies if ever autarky were expected. This incentive is also present when reversion to the interior equilibrium is expected, but it is especially acute in the autarky situation. While the particular equilibria we analyze are not renegotiation-proof, we note that our basic conclusion as to the relation between trade volume and protection is consistent with the potential for renegotiation. To construct punishment schemes which will not be renegotiated, specify asymmetric tariffs (off the equilibrium path), so that the country which did not cheat enjoys the punishment phase. For more on the notion of renegotiation-proof equilibria, see Farrell and Maskin (1987).

12. In fact, a temporary reversion to the interior (autarky) equilibrium can be identified with an infinite reversion to the interior (autarky) equilibrium at a lower δ value. Thus, the above analysis is perhaps most plausible for small δ, where we have seen that trade is restricted.

13. In terms of Figure 2, defection in the quota game captures the additional revenue rectangle $ak\ell o$ for the importer or $ajik$ for the exporter, thus increasing the static gains from defection above that in the tariff game.

14. See, for example, Bergsten (1982) on the importance of the Japan-U.S. bilateral trade imbalance in determining levels of protection between the two countries.

15. See, however, Conybeare (1987), who notes that wool exports from medieval England were heavily taxed to induce monopoly supply. An export tax can also be identified with the more popular strategy of cartelization.

16. For a discussion of safeguards, see Richardson (1988).

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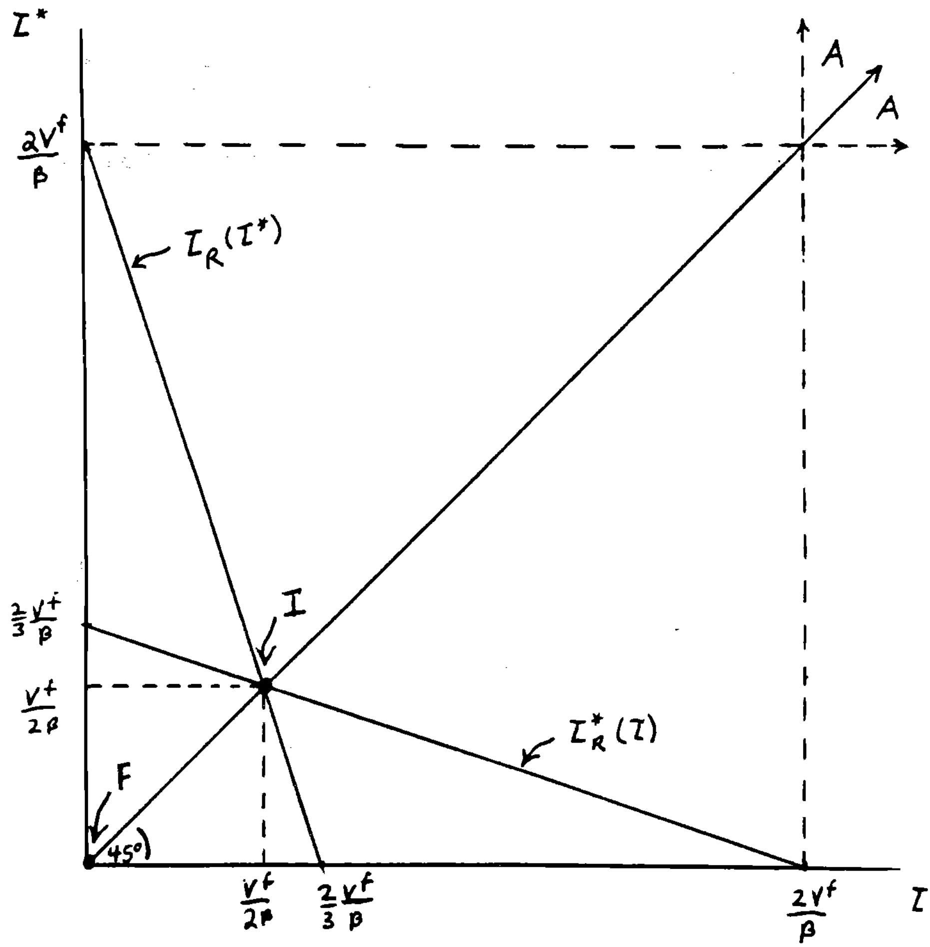


A = Autarky
I = Interior
F = Free Trade

Figure 1

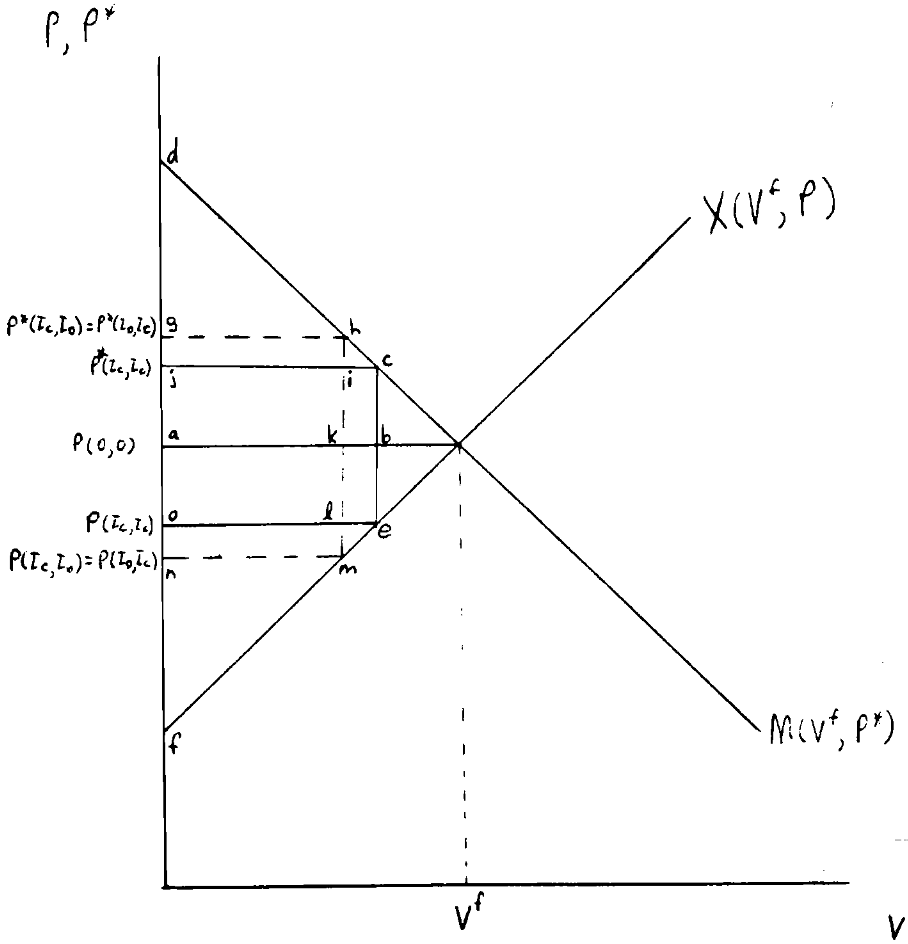
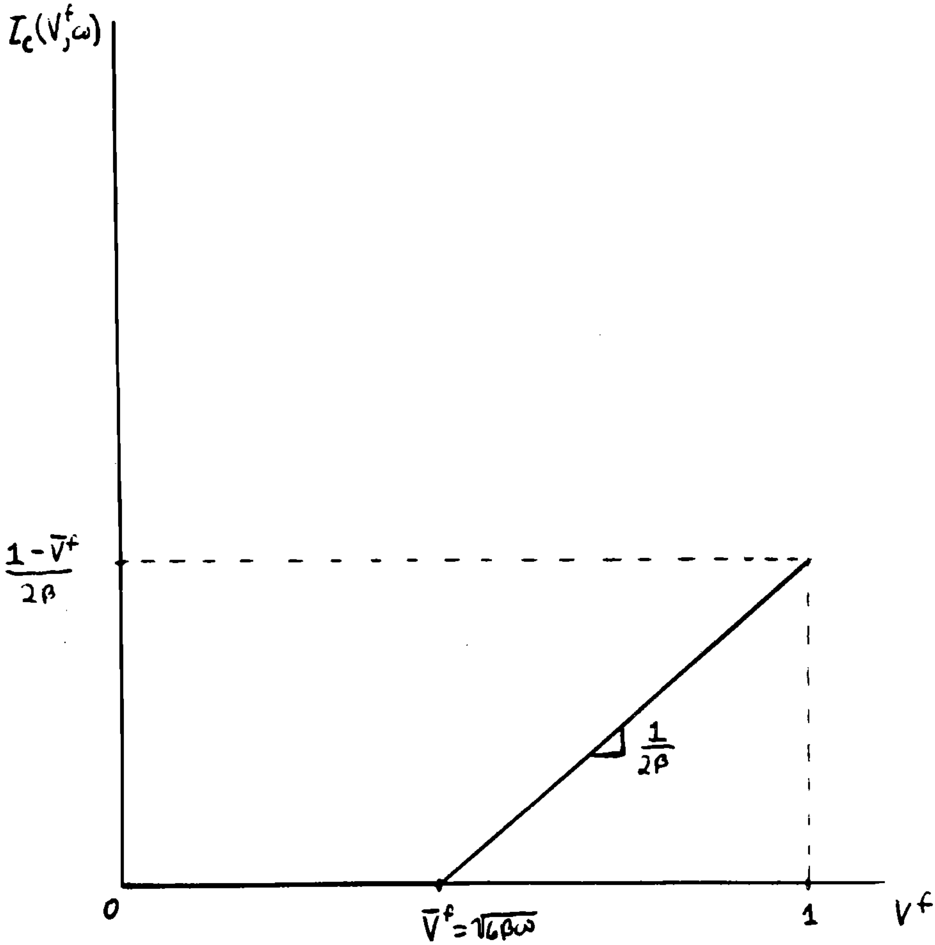

P, P*
d
X(Vf, P)
P*(Ic, Io) = P*(Io, Ic)
g
h
P*(Ic, Ic)
c
j
i
P(0,0)
a
k
b
P(Ic, Ic)
o
l
e
P(Ic, Io) = P(Io, Ic)
n
m
f
M(Vf, P*)
Vf
V

Figure 2



$I_c(V^f,\omega)$
$\frac{1-\bar{V}^f}{2\beta}$
$\frac{1}{2\beta}$
0
$\bar{V}^f=\sqrt{6\beta\omega}$
1
V^f

Figure 3

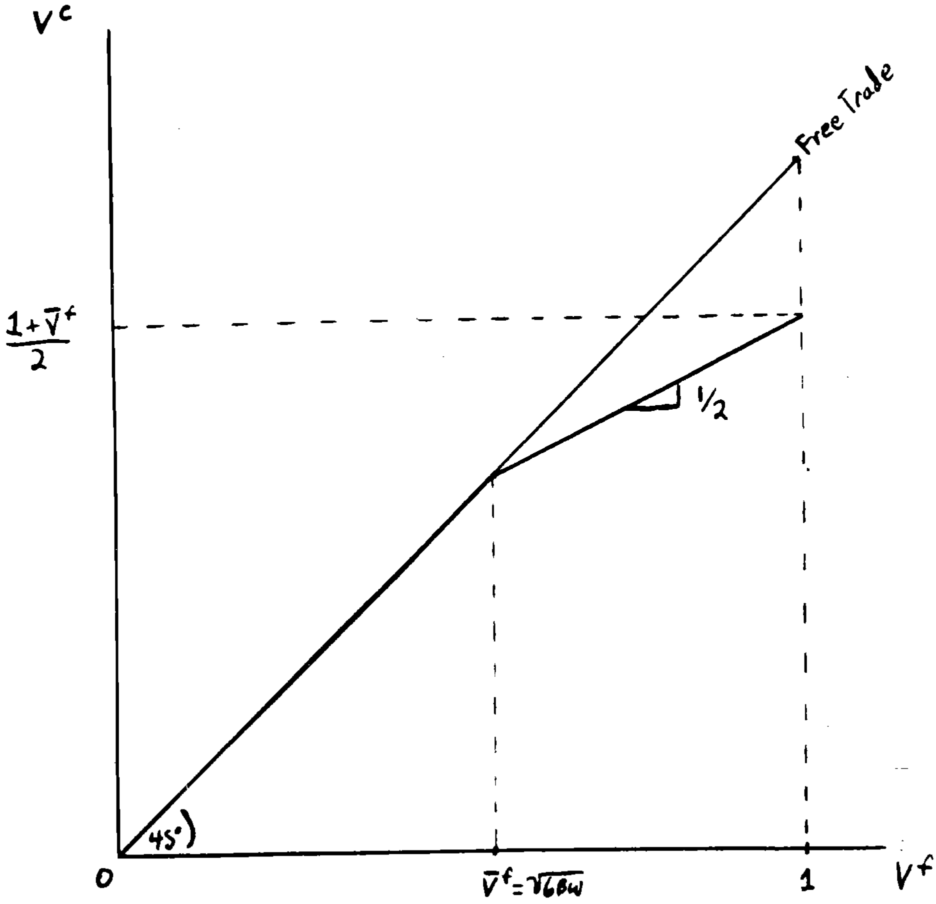
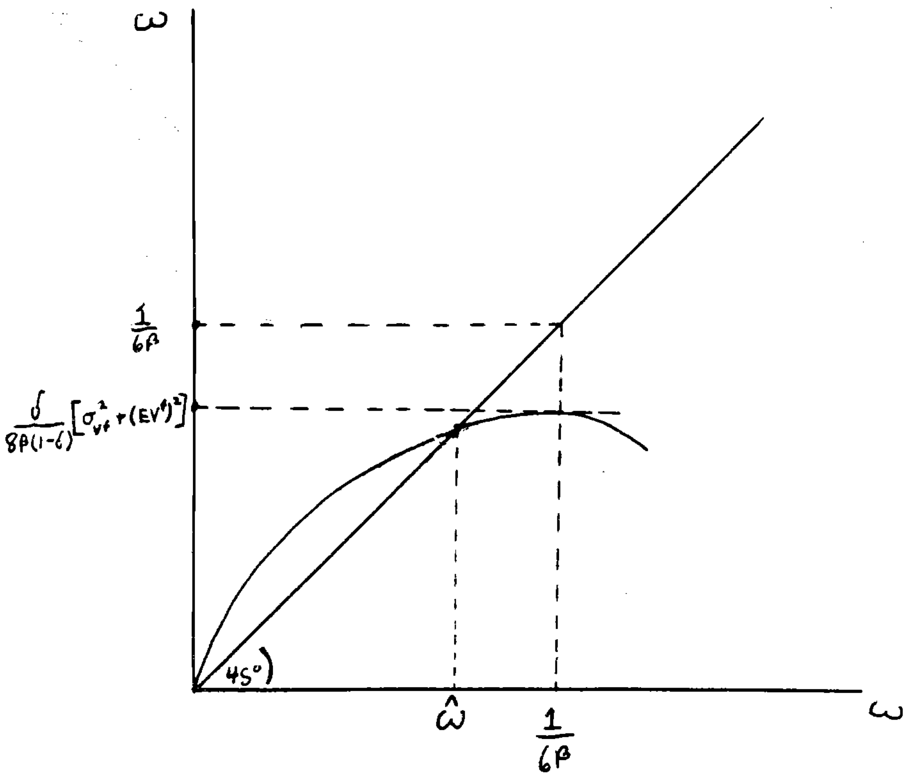


Figure 4



ω
$\frac{1}{6\beta}$
$\frac{\delta}{8\beta(1-\delta)}\left[\sigma_{vf}^2+(EV^f)^2\right]$
$45°$
$\hat{\omega}$
$\frac{1}{6\beta}$
ω

Figure 5

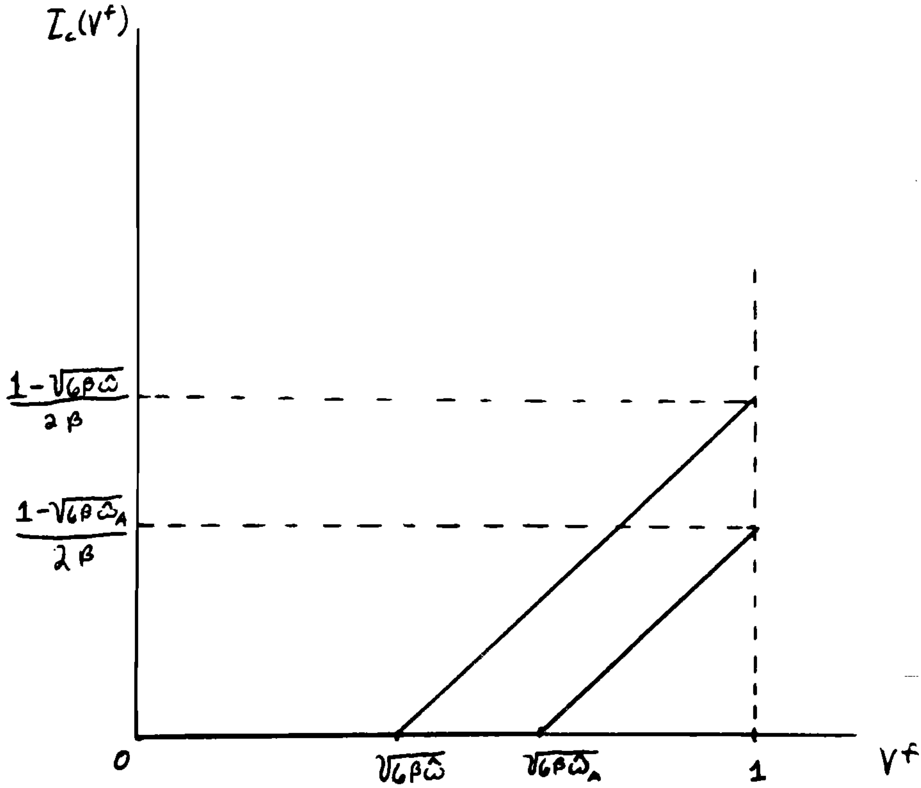
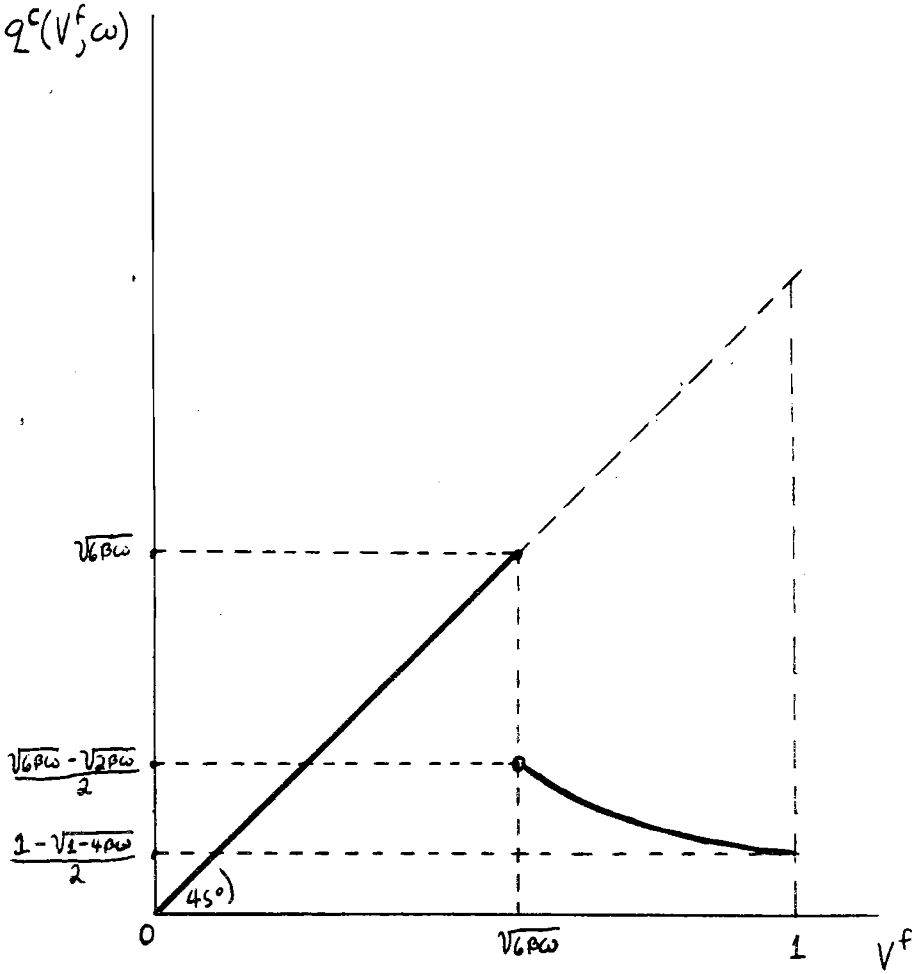

$I_c(V^f)$
$\frac{1-\sqrt{6\beta\hat{\omega}}}{2\beta}$
$\frac{1-\sqrt{6\beta\hat{\omega}_A}}{2\beta}$
0
$\sqrt{6\beta\hat{\omega}}$
$\sqrt{6\beta\hat{\omega}_A}$
1
V^f

Figure 6



$q^c(V^f, \omega)$
$\sqrt{6\beta\omega}$
$\frac{\sqrt{6\beta\omega} - \sqrt{2\beta\omega}}{2}$
$\frac{1 - \sqrt{1-4\beta\omega}}{2}$
45°
0
$\sqrt{6\beta\omega}$
1
V^f

Figure 7