

Domino Dumping, I:
Competitive Exporters

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Abstract

This paper characterizes the consequences of VER allocation systems which tie future license award to current sales at the country and/or firm level. Perfectly competitive firms have an incentive to dump today to secure an option on VER licenses tomorrow. The prospect of one distortion thus creates another, the domino effect. Privately optimal dumping in the export country takes sales away from home as well as foreign firms. Even when facing a fixed price, export country governments thus have an incentive to restrain excessive dumping with an export tax. On the other hand, if the probability of a VER being imposed by the importer rises with the volume of exports, the optimal government export policy has a force tending toward a subsidy. A sufficient condition for a subsidy is provided. The effect of countervailing duties and alternative export license allocation schemes on the behavior of firms and the export country government is also considered. World surplus is reduced by such actions, and with an endogenous probability, pre-emptive protection is welfare-improving.

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The new protectionist instruments such as VERs, VRAs, and OMAs feature licenses which are usually allocated according to previous market share. This means that future sales in a prospectively constrained market are tied to current sales. This paper initiates formal consideration of the consequences. The result is a model rich in potential to explain the proliferation of dumping behavior in the last two decades, and the coincidence of dumping behavior with VERs. For example, Finger and Murray (1989) document that over half of the antidumping cases brought in the industrial countries in the 80's eventuated in VERs.

Section I shows that perfectly competitive firms have an incentive to dump, sell below marginal cost, in all currently unconstrained markets so long as there is a positive probability of a future VER. Essentially, current sales below cost buy options in the form of rights to licenses, with dumping acting like arbitrage to ensure that the value of the option equals its price. The assumption of perfect competition conveniently isolates the arbitrage motive for dumping from those associated with imperfect competition. It is also the relevant market structure for most VER-ridden products, such as textiles, apparel, and footwear. To still further strip the point to its essentials, the potential VER is assumed not to raise the price in the importing country, as is relevant when a currently unconstrained fringe country exports to a VER-ridden market. The entire emphasis is then upon the dumping induced by the atomistic firm's cost arbitrage across the VER and no-VER situations.

An exogenous rise in the probability of a VER increases the volume of dumping, a domino effect in which one departure from free trade (probabalistically) leads to

another, so this type of behavior is called *domino dumping*. Furthermore, it is plausible to assume that a rise in the volume of imports raises the probability of dumping, strengthening the domino effect. An exogenous rise in the probability then leads to an increase in dumping which leads to a still further rise in the probability of a VER. There is of course nothing new in the idea that trade policies may be interactively determined, the best-known example being the theory of tariff warfare. The novelty here lies in the source of the interaction, which exists even when the export firms and countries have no market power in the usual sense.

Domino dumping also appears to describe and rationalize actual behavior. Other comparative static experiments show that shifts in price, VER share level, and marginal costs which increase the expected value of a license will increase the volume of dumping and the dumping margin. The positive analysis thus suggests a set of testable implications for future empirical work.

In relation to the previous literature on dumping, the domino effect is a new and appealing variation on the theme that where there is some element of intertemporal linkage between periods, investment motives can induce dumping by perfectly competitive firms (see especially Ethier (1982)). The novelty here is that the linking element does not originate in the cost structure (in Ethier's case the fixed employment contract) of the firm, but rather in the externally imposed trade policy. For imperfectly competitive firms, the dumping literature has also noted the importance of intertemporal linkage through the cost structure (for example, see Gruensprecht (1988) where the link is through learning effects), and then the anti-dumping policies followed by governments take on a strategic aspect. In future work it would be worthwhile to develop this theme for the case where the link is through the domino effect.

Optimal export policy is taken up in Section II. From the exporting countries' point of view, even if small (i.e., facing infinitely elastic demand for their exports) and even if all agents have the same knowledge of the probability of a VER, the amount of

dumping done by perfectly competitive firms will be more than optimal. Each home export firm's dumping takes expected rents away from both home and foreign firms, and the former is privately but not socially optimal. An export tax is welfare-improving, with a contingent export tax being optimal. This suggests that export promotion schemes in open markets, such as the Koreans have used in footwear, are perverse. (See Bark and de Melo (1988) for a discussion.)

On the other hand, if the probability of a VER rises with the total volume of sales to the importing country, the firms fail to see a link between present sales and expected rent, and there is an offsetting force tending to lead to a subsidy.¹ In Section III it is shown that if the elasticity of the probability of a VER with respect to total imports exceeds unity, the net effect requires a subsidy.

A response of importing countries to dumping and export subsidies has been anti-dumping and countervailing duties (lumped together for simplicity henceforward as CVDs). If levied with perfect certainty, they avert all dumping. Section IV considers the behavior of firms and the government when the probability of being caught is less than one.

Alternative export license schemes are considered in Section V. It is argued that the dominant regime, which ties licenses to past sales and forbids resale, while inefficient, may be a second-best response to the export country government's incentive-compatibility problem of ensuring sufficient dumping in currently unconstrained markets.

A significant fact for economists to explain is why resistance to protection is so low in the product groups where VERs have grown, while remaining high in other groups. The ubiquity of the domino effect in potential protected markets may help

¹The latter is similar to the Bhagwati-Srinivasan (1976) case where the level of imports is positively associated with the probability of an embargo. For their case a small country would tax imports. In our case a small country will subsidize imports.

explain the proliferation of Orderly Marketing Arrangements (OMAs). Domino dumping is efficient from the point of view of the exporter, but inefficient from the point of view of the world. The incentive of exporters to dump, together with the expected surplus to be gained from a current restriction, gives negotiators a possible reason to extend the coverage of the OMA. This is discussed in Section VI.

Rent transfer from importer to exporter as compensation for lost markets can be accomplished while avoiding many of the complications and inefficiencies of VER regimes by using taxes instead: voluntary export taxes (and reverse transfer by import taxes). With taxes, there are no current incentives to dump, and with an exogenous probability of protection the optimal current policy for all parties is free trade.

I. Perfectly Competitive Domino Dumping

A large importing country (the U.S.) imports a standardized product (footwear) from many firms and countries. Suppose a VER that limits total exports to no more than $\bar{Q}$ may be imposed by the U.S. next period with probability π . At the country level, following the standard practice, the VER will limit each country to its previous market share, or sales of $\frac{\bar{Q}}{\sum_j Q_j} Q_j$, where Q_j is the current volume of sales in country j .

The VER will not raise the price in the U.S. (The last assumption is made to provide the sharpest results, with the usual allowance for a rising price reinforcing the incentive to dump.)

A perfectly competitive firm in a particular export country (Taiwan) expects to receive licenses for the fraction λ of its current sales q if the VER is imposed. This roughly approximates current practice. λ is rationally forecast by the firm to be $\frac{\bar{Q}}{\sum_j Q_j}$.

but the firm is too small to notice its influence on total sales in deciding on output.

More formally, $\frac{q}{\sum_j Q_j}$ is arbitrarily close to zero.

Section I.1 shows that under these austere circumstances, all firms have an incentive to dump, sell below marginal cost. Section I.2 provides a harvest of comparative static results. It shows that the equilibrium dumping volume and dumping margin are increasing in variables which make a license more valuable: increases in the import price, increases in the probability of a VER (the domino effect), decreases (increases) in λ under fixed (free) entry, and decreases in the firm's marginal cost.

I.1 Privately Optimal Dumping

What is the firm's optimal sales level? Current sales earn the firm $P - m(q)$ at the margin, where $m(\cdot)$ is the increasing marginal cost function for the firm. If the VER is imposed, the license will be worth $P - m(\lambda q)$ to the firm. If the VER is not imposed the firm can freely choose sales next period, so current sales are irrelevant to this choice.

The profit maximization problem for the firm is to choose q such that the loss on current sales is balanced by the value of the option of receiving export licenses in the event of a VER. The firm sets q in order to:

$$(1) \quad \max_q \mu = (Pq - c(q)) + \pi(P\lambda q - c(\lambda q)),$$

where $c(\cdot)$ is the total cost function for firm i . With a strictly convex cost function (or with scale economies exhausted at a low level of sales so that the cost function is locally convex in the relevant region), the first order condition $d\mu/dq = 0$ yields a unique global (in the relevant region) optimum volume of current firm exports characterized by:

$$(2) \quad -(P - m(q)) = (P - m(\lambda q)) \lambda \pi.$$

Equations (1)–(2) assume no discounting for simplicity.

Proposition 1 *The prospect of a VER induces perfectly competitive firms to dump, sell below marginal cost.*

Proof: For $\lambda < 1$, $m(\lambda q) < m(q)$ by the strict convexity of the cost function. A solution to (2) may be found where $m(\lambda q) < P < m(q)$. Since $m(\cdot)$ is increasing in q , this is the only solution to the first order condition. Then $P - m(q)$ must be negative.||

The intuition of Proposition 1 is that the firm is arbitraging the option to obtain a VER license across the VER and no-VER situations. At the "free trade" level of sales for which price equals marginal cost, q^c , an added unit of sales in the present has no net effect on profits, but secures an option to receive a VER license worth $\lambda\pi[P - m(\lambda q^c)]$. Arbitrage requires expanding sales to wipe out the differential.

An alternative structure is useful in comparative static analysis. The first order condition of the firm is alternatively:

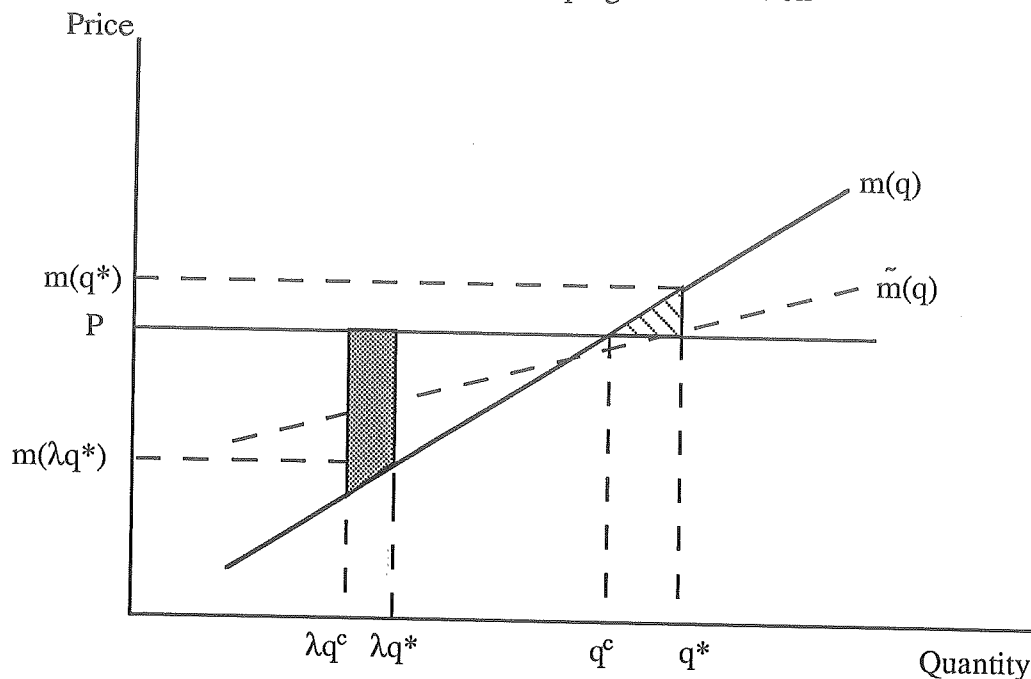
$$(2') \quad P = \frac{1}{1 + \lambda\pi} m(q) + \frac{\lambda\pi}{1 + \lambda\pi} m(\lambda q) \equiv \tilde{m}(q)$$

where $\tilde{m}(q)$ is the "average" marginal cost function. At $m(q^c) = P$, an initial sales volume with no dumping,

$$\tilde{m}(q^c) = \frac{1}{1 + \lambda\pi} P + \frac{\lambda\pi}{1 + \lambda\pi} m(\lambda q^c) < \frac{1}{1 + \lambda\pi} P + \frac{\lambda\pi}{1 + \lambda\pi} P = P.$$

"Average" profits rise with an increase in current sales until q^* is reached. Figure 1 illustrates. The given level of $\lambda\pi$ determines a fixed ratio between the length of line segment $Pm(q^*)$ and the length of line segment $Pm(\lambda q^*)$. The optimum is found by varying q until the line segments have the required ratio, meaning that the average of marginal costs on the right hand side of (2'), or $\tilde{m}(q)$, equals P . As compared to producing q^c , producing q^* gains the dark shaded area (times π) and loses the cross-hatched area.

Figure 1. Dumping Determination



Proposition 1 holds for all firms and hence for the industry. On the face of it Proposition 1 is valid only if the number of firms is constant, but it is readily extended to cover entry or exit between periods. Both cases are practically relevant. VER systems are administered by export country governments with no externally mandated restriction on their allocation across firms. Nevertheless, the allocation is typically to incumbent firms according to previous market share, with resale prohibition. This practice prevents entry/exit if carried through rigorously. On the other hand, with resale of licenses allowed as in Hong Kong, the number of firms becomes endogenous.

The simplest long run equilibrium to analyze is for the symmetric case, in which all exporting firms in the world have the same cost function. This is a severe simplification in a trade model, in which cost differences are of the essence, and is made only to allow a simple treatment of the effects of entry. For the symmetric case, world sales to the import market are $Q = nq$, where n is the number of firms and q is the

optimum scale of output for all firms. The common cost function is $c(q,n)$. With resale of licenses, the free exit condition in period two under a VER combines with the world market clearance condition to determine the optimal scale $\bar{q}$ and the optimal number of firms $\bar{n}$:

$$(3) \quad \frac{c(\bar{q},\bar{n})}{\bar{q}} = m(\bar{q},\bar{n}).$$

$$\bar{n}\bar{q} = \bar{Q}$$

The first part of (3) follows from assuming the efficient arbitrage of licenses in the second period (which includes buying up a firm in order to obtain its licenses, then shutting it down and dividing the licenses among remaining firms). Then for the first period sales decision, (2) is modified to

$$(4) \quad -(P - m(q,n)) = (P - m(\bar{q},\bar{n})) \lambda \pi,$$

where $m(\bar{q},\bar{n})$, is the rational forecast of marginal cost in period two. The free entry condition for period one is

$$(5) \quad \mu = (Pq - c(q,n)) + \pi \lambda q (P - m(\bar{q},\bar{n})) = 0.$$

The proof of Proposition 1 implicitly holds n constant, but evidently current sales are still subsidized when the number of firms is endogenous. The only case where dumping does not occur is the trivial one where the world supply schedule is infinitely elastic at the fixed minimum marginal cost, or m is constant with respect to n . In this case alone the prospect of a VER has no effect.

I.2 Comparative Statics

Changes which make licenses more valuable should lead to a rise in the volume of dumping, and of the dumping margin. The domino effect is then implied: a rise in the probability of a VER raises dumping (Simultaneously the increased volume of dumping is likely to raise the probability of a VER. The latter side of the system is

taken up in Section IV.) This intuitive supposition is now verified. In contrast to the Proposition 1 on the existence of dumping, entry/exit between periods is important to the comparative statics of dumping, and to the implications of alternative license allocation systems taken up in Section V.²

The effect of changes in π, λ (prospective policy parameters); and of shifts in P and m , the marginal cost function are traced in two different systems. For the case of no entry the comparative static derivatives are taken from differentiation of (2). For the case of free entry they are taken from differentiation of the system (4)–(5).

No Entry

The effect of changes in the exogenous variables on the firm's output is given in:

$$(6) \quad (m_q(q) + \lambda^2 \pi m_q(\lambda q)) dq = (P - m(\lambda q)) \lambda d\pi + (1 + \lambda \pi) dP \\ + \left((P - m(\lambda q)) - m_q(\lambda q) \lambda q \right) \pi d\lambda.$$

In (6) and subsequently, a subscript denotes differentiation. For the effect of cost function changes, let α be the marginal cost function shift parameter, with a rise in α reducing marginal cost:

$$(7) \quad (m_q(q, \alpha) + \lambda^2 \pi m_q(\lambda q, \alpha)) \frac{dq}{d\alpha} = (m_\alpha(q, \alpha) + \lambda \pi m_\alpha(\lambda q, \alpha)) < 0.$$

The large bracket term on the left of (6)–(7) is positive with convex costs.

The dumping margin σ equals $m(q) - P$, hence σ rises with q save possibly for the case of a change in P . However,

$$\frac{d\sigma}{dP} = m_q(q) \frac{dq}{dP} - 1 = \frac{\lambda \pi \left((m_q(q) - \lambda m_q(\lambda q)) \right)}{(m_q(q) + \lambda^2 \pi m_q(\lambda q))} > 0.$$

Thus:

²Entry at the beginning of the first period is irrelevant to the results.

Proposition 2 *With no entry,*

- (a) *The amount of dumping and the dumping margin rises with the probability of a VER, with the price, and with a fall in marginal cost;*
- (b) *The amount of dumping and the dumping margin rises with a marginal fall in the proportion of sales permitted, so long as the VER is less restrictive than the rent-maximizing level.*

Proof: (a) follows immediately from (6)–(7). (b) follows from noting that $P - m - m_q(\lambda q)\lambda q \leq 0$ defines the range of VERs less restrictive than the rent-maximizing level (i.e., the level of q which maximizes $Pq - m(q)q$). ||

Proposition 2 is also readily illustrated using Figure 1. Rises in P with the $\tilde{m}$ schedule constant must raise q and σ . Lowering the $\tilde{m}$ schedule has the same effect. Rises in π and α both lower $\tilde{m}$, the former following from

$$\tilde{m}_\pi = \frac{\lambda}{1 + \lambda\pi} (m(\lambda q) - \tilde{m}(q)) < 0.$$

Rises in λ have an ambiguous effect on $\tilde{m}$,

$$\tilde{m}_\lambda = \frac{\pi}{1 + \lambda\pi} (m(\lambda q) - \tilde{m}(q)) + \frac{\lambda\pi}{1 + \lambda\pi} m_q(\lambda q)q.$$

The first term is negative while the second is positive, hence Proposition 2(b) applies a common sense restriction on the value of λ ensure that the first term dominates the second.

Theorem 2(b) also implies that a reduction in the anticipated level of constrained sales $\bar{Q}$ increases the amount of dumping, since in the no entry case, a change in $\bar{Q}$ is indistinguishable from a change in λ at the level of the firm. This effect is sensitive to entry assumptions, as the next subsection shows.

All the experiments considered have the property of increasing the value of a license, and it is intuitive that they would increase the amount dumped and the dumping margin. They also form a set of testable implications of the theory.

Free Entry

In long run equilibrium, there is no effect of changes in λ, π , and P upon $\bar{q}$ and $\bar{n}$, since they are determined by the world market equilibrium conditions (3). The changes in q and n as the parameters P, λ , and π change are found from:

$$(8) \quad \begin{pmatrix} m_q & m_n \\ 0 & -c_n \end{pmatrix} \begin{pmatrix} dq \\ dn \end{pmatrix} = \begin{pmatrix} 1+\lambda\pi \\ -(1+\lambda\pi)q \end{pmatrix} dP + \begin{pmatrix} P-m \\ -(P-m)q \end{pmatrix} (\lambda d\pi + \pi d\lambda).$$

In forming (8) the first order condition is used to set the lower left element of the matrix on the left hand side of the equation to zero.

The second group of terms on the right hand side is proportionate to the first, price increases have the same direction of effect on scale, q , and the number of firms, n , as do increases in π and λ . The last effect is in sharp contrast to the case of no entry.

The effect of cost function shifts is obtained analogously to (7). The right hand side of (8) picks up a term equal to $-\begin{pmatrix} m_\alpha(q, n, \alpha) + \lambda\pi m_\alpha(\bar{q}, \bar{n}, \alpha) \\ -(c_\alpha(q, n, \alpha) + \lambda\pi q m_\alpha(\bar{q}, \bar{n}, \alpha)) \end{pmatrix} d\alpha$. Using $m = c/q$ in long run equilibrium, the equilibrium value of c_α equals $q m_\alpha$. Then replacing c_α with $q m_\alpha$, the effect of cost reductions on q and n is proportional to the effect of price increases. Specifically, the effect of changes in π and λ upon n and q is found by replacing the factor $1 + \lambda\pi$ in dn/dP and dq/dP with $P - m(\bar{q}, \bar{n}) > 0$. The effect of cost reductions is found by replacing the factor $1 + \lambda\pi$ with $-m_\alpha(1 + \lambda\pi) > 0$.

Solving (8) for the effect of price changes yields:

$$(9) \quad \frac{dn}{dP} = \frac{q(1 + \lambda\pi)}{c_n} > 0,$$

$$(10) \quad \frac{dq}{dP} = \frac{(1 + \lambda\pi)(c_n - q m_n)}{m_q c_n}.$$

The scale effect of a price rise, given by (10), is ambiguous in general. In the multiplicative cost function case it is zero. The total sales effect $\frac{d(nq)}{dP}$ is, however,

always positive. This follows from:

$$\begin{aligned}\frac{d(nq)}{dP} &= n \frac{dq}{dP} + q \frac{dn}{dP} \\ &= \frac{1 + \lambda\pi}{c_n} \left(n \frac{c_n - qm_n}{m_q} + q^2 \right) \text{ using (9)–(10)}.\end{aligned}$$

Now note that in a competitive long run equilibrium, the cost of production is minimized, implying $nm_n = qm_q$.³ Substituting q^2m_q for nqm_n yields:

$$(11) \quad \frac{d(nq)}{dP} = n(1 + \lambda\pi) > 0.$$

The effect of a price increase on the dumping margin $\sigma = m(q, n) - P$ is also positive.

$$\frac{d\sigma}{dP} = m_q \frac{dq}{dP} + m_n \frac{dn}{dP} - 1$$

Using (9)–(10) and the minimum marginal cost property of competitive equilibrium, this reduces to:

$$(12) \quad \frac{d\sigma}{dP} = \lambda\pi > 0.$$

Increases in λ and π obviously raise sales nq and hence marginal cost and the dumping margin. Finally, parametric reductions in marginal cost (defined as a rise in α) raise sales by enough to raise the dumping margin. To see this, note that

$$\frac{d\sigma}{dP} = m_q \frac{dq}{d\alpha} + m_n \frac{dn}{d\alpha} + m_\alpha$$

³That is, $C(Q) = \min_{n,q} \{c(q, n) \mid nq = Q\}$.

The first order conditions imply

$$\begin{aligned}c_q &= \mu \\ c + nc_n &= \mu q,\end{aligned}$$

hence

$$c = c_q q - nc_n.$$

Differentiating with respect to q ,

$$c_q = c_q + \{qc_{qq} - nc_{nq}\},$$

hence:

$$\{qc_{qq} - nc_{nq}\} = \{qm_q - nm_n\} = 0.$$

This is the Wong–Viner envelope theorem.

Following the steps taken above reduces this to:⁴

$$(13) \quad \frac{d\sigma}{d\alpha} = -\lambda\pi m_{\alpha}(\bar{q}, \bar{n}, \alpha) > 0.$$

Then:

- Proposition 3 *With free entry, (a) the amount of dumping and the dumping margin rises with increases in price, increases in the probability of a VER, reductions in marginal cost,*
- (b) the amount of dumping and the dumping margin rises with increases in the proportion of permitted sales, and*
- (c) The scale of firms' output rises or falls with such changes.*

The contrast between Proposition 2(b) and 3(b) and the paradoxical nature of 3(b) is explained by the difference between no entry and free entry combined with the assumption of a fixed price. In the event of a VER, the license premium, $P - m(\bar{q}, \bar{n})$ is fixed, and firms can sell their licenses and exit in the second period, hence the effect of a rise in λ is exactly like the effect of a rise in π . Two offsetting elements tend to restore the more intuitive result. First, if the import price falls as a result of the VER, the license will be less valuable, tending to reduce dumping with or without entry and diminishing the effect isolated in Proposition 3(b). Second, with free entry, a rise in $\bar{Q}$ will raise world equilibrium marginal cost in the event of a VER via the conditions (3), thus also reducing the license premium and the dumping done in pursuit of licenses. Rises in λ at a constant $\bar{Q}$ may be interpreted as special consideration for a particular country's exports, as indeed is a feature of actual VER systems.

These results form the basis of a positive theory of domino dumping in competitive markets. The harvest of testable implications suggests it would be fruitful to fit the model to data. In doing so, the many simplifications of the symmetric case

⁴That is, $\frac{dq}{d\alpha} = -m_{\alpha} \frac{dq}{dP} \frac{dn}{d\alpha} = m_{\alpha} \frac{dn}{dP}$, hence the steps leading to (12) yield (13).

should be removed, since asymmetry is one of the essential ingredients of international trade theory.

II. The Optimal Export Tax

Even when there is no monopoly power in trade, so that $P_Q = 0$, the export country's government has an incentive to intervene. Unlike private agents, the government can see that home firms' sales in the potentially restricted market, $Q_j = n_j q_j$ are partly taken from foreigners, which is worth the dumping margin the firms are paying, but partly from each other, which is not. Private agents "subsidize" current exports too much, so that a countervailing export tax is needed for efficiency. A pure constant-over-time export tax simply raises firms' costs whether the VER is implemented or not, and thus is inferior to a contingent export tax, which extracts some of the rent in the event of implementation of a VER.

These forces are always at work when there is some chance of a VER. They are formalized below. In contrast, export governments appear to subsidize exports in such markets. A potential rationale for such behavior lies in the externality which arises when the probability of a VER rises with the amount of imports. Private agents might incorporate a private benefit of the marginal rise in the probability into their export decision, but inevitably some of the benefit goes to other firms. Other things equal, there is an external benefit to added imports by each firm in the present period, tending toward a subsidy to correct the distortion. The simplest case arises when each firm's share in the country's exports is too small to affect the probability, the "small firm" assumption. This is developed in Section III, and a condition is derived to characterize the net effect of the forces arising from market sharing and endogenous probability. For convex costs and an elasticity of the probability of a VER with respect to imports which is greater than or equal to one, the net effect requires a subsidy.

The government's problem in export country j is

$$(14) \quad \max_{Q_j} PQ_j - C(Q_j) + \pi \left(P \frac{\bar{Q}}{\Sigma Q_j} Q_j - C \left(\frac{\bar{Q}}{\Sigma Q_j} Q_j \right) \right)$$

(14) is the profit function, which appears to ignore consumer interests in the exporting country. So long as sales of the good at home are at marginal cost, however, there is no distortion on home sales and hence no social net gain or loss from changes in sales at home. Thus (14) is equivalent to the social welfare function.⁵ In (14) the cost function C is the relevant national cost function, operating all firms at equal marginal cost. The parameter λ is replaced by $\bar{Q}/\Sigma Q_j$, allowing the government to see that home firms' sales are taken partly from each other.⁶

The first order condition is:

$$(15) \quad -(P - M) = \pi \left(P - M \left(Q_j \frac{\bar{Q}}{\Sigma Q_j} \right) \right) \frac{\bar{Q}}{\Sigma Q_j} \left(1 - \frac{Q_j}{\Sigma Q_j} \right)$$

where M is the common national marginal cost. Comparing with (2) under no entry or (4) under free entry, setting M equal to m and $\bar{Q}/\Sigma Q_j$ equal to λ , it is clear that the incentive to dump is too strong to satisfy the social optimum condition (15). To decentralize the choice of Q_j , the dumping incentive must be reduced with a contingent

⁵To see this formally, let Y and Y' be home sales in the present and the future in the event of a VER. P^* is the home price. The sum of consumer's and producer's surplus is

$$W = PQ + \int_0^Y P^*(v)dv - C(Y+Q) + \pi \left(\lambda \bar{P}Q - C(\lambda Q + Y') + \int_0^{Y'} P^*(v)dv \right)$$

The private agents implicitly maximize W with respect to Y, Y' when selling in the home market at marginal cost. The government maximizes W with respect to Q , incorporating the dependence of Y, Y' on Q . However, since changes in Y induced by changes in Q always occur at maximum values of W for given (Q, Y, Y') , $W_Y = 0$, the effect on W of a change in Q is solely the direct effect. This is isolated in the text.

⁶A completely symmetric treatment of firms and the government, in which λ is replaced in the firm's problem with $\bar{Q}/\Sigma \sum_i q_i^j$, has essentially the same implications. This is because home firms treat each other just like foreign firms. Equation (2) becomes in a Nash equilibrium:

$$(2') \quad -(P - m_i) = \pi \left(\bar{P} - m_i(\lambda q_i^j) \right) \lambda \left(1 - \frac{q_i^j}{\Sigma \sum_j q_i^j} \right)$$

Compare (2') with (2) and (6) above.

export tax, or equivalently with the government retaining and selling $Q_i/\Sigma Q_j$ per cent of the VER licenses in a free market. Thus:

Proposition 4 The optimal export tax rate equals the optimal market share times the rate of license rent.

Proof: The ad valorem tax rate τ is such that $\tau M = \frac{Q_i}{\Sigma Q_j} (P - M)$. A

unit sale earns total rent of $P - M_j$, of which the firm keeps

$\left(1 - \frac{Q_i}{\Sigma Q_j}\right) (P - M)$, with $\frac{Q_i}{\Sigma Q_j} (P - M)$ going to the government. The

firm's private incentives in (2) or (4) now agree with the social optimum in (15).||

* An important implication of Proposition 4 is that LDC schemes which subsidize exports in threatened markets are perverse policy. An example is the Korean footwear quota allocation, in which sales to open markets are rewarded with the gift of licenses to sell in restricted markets. See Bark and de Melo (1988) for a review of a large number of such schemes. It could be, however, that the analysis is lacking some element which could rationalize LDC policy. One possibility is that the government knows π but the firms' managers do not. If the firms falsely believe that the probability of a VER is zero, then (15) defines the optimal government export subsidy based on its superior information. On reflection, this rationale is unconvincing, since protectionism in the developed nations is a rather public and slow-moving process, driven by industry lobbies about which the exporting firms are likely to have knowledge at least as good as their government's.

A more promising candidate is that the probability of a VER rises with the amount of imports. The firms' market shares are assumed to be too small to allow this

effect to matter in their decision making,⁷ but the government policy-maker must take account of it. When does this lead to a subsidy? This is explored in Section III.

Another promising explanation is suggested by the observation that the contingent export tax is equivalent to a firm-level license allocation which is less than λq . Suppose that the firms believe the government will use the licenses earned by them in the first period to follow an optimal policy in the second period, which includes capturing (some of) the license rent. Knowing this, the firms will dump less. A 'time consistent' trade policy may require a subsidy. A competitive auction of export licenses by the government in a free entry equilibrium in the future period, as is typically advocated by economists (including the author), would take away all the incentive to dump in the current period and leave the government with a pure subsidy required to achieve the level of exports implied by (15). This is formally equivalent to the "firms don't know π " story, with a bit more realistic justification. In order to avoid this outcome, a second-best policy may be incentive compatible. If licenses are awarded to firms on the basis of past sales, and resale is prohibited, it becomes difficult for the government to capture the rent with a tax. This is explored in Section V.

III. Export Subsidy: the Endogenous Probability Case

Suppose the probability of a VER is a function of the amount of imports, $\pi = \pi(Q)$. It may be that the function depends on world imports, as when an import country considers initiation of a VER system for a particular product; or it may be that it depends only on the exporter's sales, as when a fringe exporter not yet constrained by a VER sells in a VER-ridden market. In the former case, used below, the export policy-

⁷This is an inessential simplification. In any case, the firms bestow external benefits on each other.

maker assumes no linkage between own exports and other countries' exports (i.e., the exporter "plays Cournot"). The policy-maker's problem is

$$(16) \quad \max_{Q_j} PQ_j - C(Q_j) + \pi(\Sigma Q_j) \left(P \frac{\bar{Q}}{\Sigma Q_j} Q_j - C\left(\frac{\bar{Q}}{\Sigma Q_j} Q_j\right) \right).$$

The first order condition is

$$\begin{aligned} - (P - M) &= \pi \left(P - M(Q_j \frac{\bar{Q}}{\Sigma Q_j}) \right) \frac{\bar{Q}}{\Sigma Q_j} \left(1 - \frac{Q_j}{\Sigma Q_j} \right) \\ &\quad + \frac{\bar{Q}}{\Sigma Q_j} \pi' Q_j \left(P - \frac{C(\frac{\bar{Q}}{\Sigma Q_j} Q_j)}{Q_j} \right), \text{ or} \\ (17) \quad - (P - M) &= \pi \lambda (P - M) \left(1 - \frac{Q_j}{\Sigma Q_j} \right) + \pi \lambda \left(P - \frac{C}{Q_j} \right) \eta \frac{Q_j}{\Sigma Q_j}, \end{aligned}$$

where η is the elasticity of the probability of a VER with respect to import volume, $\pi' \Sigma Q / \pi$.

The second term on the right hand side of (17) acts to increase the subsidy to exports paid by the economy as a whole, reflecting the fact that the odds of receiving a quota license are raised by greater exports today. The first term is the social optimum net subsidy when the probability is exogenous and reflects the combination of a corrective export tax and the firms' own dumping incentives. What is the net effect on the optimal policy in (17)?

The firms' present dumping margin is given by (2) in the case of no entry and (4) in the case of free entry. Let $\bar{m}$ be marginal cost when there is a VER, equal to $m(\lambda q)$ in the case of no entry and $m(\bar{q}, \bar{n})$ in the case of free entry. At the optimum quantities, the firms' present exports must be subsidized as

$$(P - \bar{m}) \lambda \pi < \pi \lambda (P - M) \left(1 - \frac{Q_j}{\Sigma Q_j} \right) + \pi \lambda \left(P - \frac{C}{Q_j} \right) \eta \frac{Q_j}{\Sigma Q_j}.$$

Recognizing that $\bar{m} = M$ in a competitive economy, and that $C/Q = c/q$ with identical firms, the subsidy condition is

$$(18) \quad \frac{P - \bar{m}}{P - c/q} < \eta.$$

With convex costs, or in long run competitive equilibrium, marginal costs weakly exceed average costs, so the term on the left is less than or equal to one. The elasticity on the right can be on either side of unity. We summarize the results as

Proposition 5

(i) *Exports should be subsidized whenever the elasticity of the probability of a VER with respect to total imports exceeds unity, and*

(ii) *the optimal ad valorem tax rate τ solves*

$$m\tau = \left(P - m - \left(P - \frac{c}{q} \right) \eta \right) \frac{Q_i}{\sum Q_j}.$$

The parameter η plays a key role in potentially justifying an export subsidy, so it is important to explore its underlying structure. First note that the elasticity of the probability of a VER with respect to total imports η can be nonzero despite a country being small in the sense of not affecting the importers' price. The probability is a reduced form of a political economy model in which total imports push against a political loss function which can rise more steeply than consumers' marginal benefit falls. The elasticity can also easily exceed unity. The Appendix shows how this can arise, and for concreteness provides:

Corollary *If imports alone matter to the probability of a VER and if the distribution is uniform, exports should be subsidized.*

The corollary is significant because it shows that a subsidy is not an esoteric possibility.

IV. Dumping, Countervailing Duties and Export Policy

A realistic complication is that firms which dump and governments which subsidize exports are subject to countervailing duties levied by the import country. The attractiveness of a social or private subsidy to exports is obviously reduced if countervailing duties are imposed by the importing country. A full countervailing duty

(CVD) which is imposed with certainty in the event of either dumping or export subsidy is sufficient to deter these activities. But proving dumping and hence imposing the CVD is fraught with uncertainty due to the importer's lack of information on the exporter's costs. Suppose the fixed probability of proving dumping is $\beta < 1$, and the fixed probability of a VER is π . Does the exporter still dump? Does the government still tax exports?

Privately Optimal Dumping

If the product of β and the elasticity of marginal cost with respect to output is large, dumping is ruled out. For large elasticity of marginal cost with respect to output, even a small probability of being caught dumping will deter the activity.

The relevant profit function for the firm is composed of four parts now instead of two.⁸ To economize on space, only the no entry case is presented. The qualitative results are the same for the case of free entry. $\pi(1-\beta)$ is the joint probability of a VER without a countervailing duty (CVD). This event earns revenue as in Section I, trading off with the present loss on dumped goods. In addition, if a CVD is imposed, the firm will face a lower net price in the second period of $P + [P - m(q)]$. Revenue will be this net-of-duty price times either λq (with probability π) or q' (with probability $(1-\pi)$), where the future level of non-VER constrained exports $q' = \phi(q)$ is implicitly determined by

$P + [P - m(q)] = m(q')$. The firm's profit is:

$$\begin{aligned} &Pq - c(q) + \pi(1-\beta)(P\lambda q - c(\lambda q)) \\ &+ \pi\beta((P + (P - m(q)))\lambda q - c(\lambda q)) \\ &+ (1-\pi)\beta((P + (P - m(q)))\phi(q) - c(\phi(q))). \end{aligned}$$

This simplifies to:

⁸The firm's future profit when there is no VER and no CVD is irrelevant to the decision about current dumping.

$$Pq - c(q) + \pi(P\lambda q - c(\lambda q)) + (1-\pi)\beta((P + (P-m(q)))\phi(q) - c(\phi(q))).$$

The firm's optimal dumping export is the solution to

$$(19) \quad \max_q \quad Pq - c(q) + \pi(P\lambda q - c(\lambda q)) + (1-\pi)\beta((P + (P-m(q)))\phi(q) - c(\phi(q))) \\ + \pi\beta[P-m(q)]\lambda q$$

subject to $P-m(q) \leq \sigma < 0$,

where σ is arbitrarily small in absolute value.

If the firm does not dump, i.e., the constraint is binding in the problem above, the relevant profit maximization problem decomposes into two single period conventional problems with no second period tax. The first order condition implies (using the marginal cost equals net price rule in the second period):

$$(20) \quad -(P - m(q))(1 + \lambda\pi\beta) \leq \lambda\pi(P - m(\lambda q)) \\ - \beta m_q(q)(\pi\lambda q + (1 - \pi)q').$$

The second term on the right hand side represents the effect of the marginal dumping m_q in the first period upon revenues in the second period via the offsetting CVD. (20) is more intuitively rewritten as

$$(20') \quad -\frac{P - m(q)}{m(q)}(1 + \lambda\pi\beta) \leq \lambda\pi \frac{P - m(q)}{m(q)} - \beta\theta \frac{\pi\lambda q + (1 - \pi)q'}{q},$$

where θ is the elasticity of marginal cost with respect to exports, $qm_q(q)/m(q)$. The second term is the product of $\beta\theta$ and a ratio which must be less than one. (20') cannot be satisfied with equality, dumping is not optimal, for large $\beta\theta$. Even for interior solutions with dumping, the second term reduces the amount of dumped exports, using the comparative static results of Section I. Thus:

Proposition 6 Countervailing duties with any probability of being caught will reduce the amount of domino dumping. Sharply rising marginal costs will choke off dumping even for a small probability of being caught.

Export Policy

The government policy maker's problem with π and β fixed differs from (20') in multiplying the first term on the right hand side by $\left(1 - \frac{Q}{\Sigma Q}\right)$, as in the comparison of (2) and (15). The formalization is straightforward, hence omitted. Dumping could be privately optimal, allowing an interior solution to (20'), but not socially optimal. This stands in contrast to the strong result of Proposition 4, where some dumping should always be allowed. Endogenous π tends to incline the government intervention toward a subsidy, as in Section III.

The final new influence is endogenous β , which might be assumed to rise with imports, or with the dumping margin. The US currently confronts policy-makers in export countries with a β function which rises sharply with imports at a critical value, since exceeding the "surge control" limit of a thirty per cent annual growth in imports automatically triggers an ITC investigation. With CVDs placed at the country level, for a fixed level of π ,⁹ intuition suggests that the dumping of firms is greater than socially optimal on this account, leading to a larger corrective export tax. On the other hand, this result cannot be guaranteed, and a subsidy can arise on this account.

The social optimization incorporates the elasticity of β with respect to Q and adds a term to (20). The influence of a rise in β on profits for given q acts through the last two terms on the right hand side of (19). The assumption of given q is legitimate due to the envelope theorem for optimal q . The fourth term on the right hand side of (19) is always negative, while the third term is positive (under the positive profits assumption). The net effect of the two has either sign, with a positive sign when β is near one, since this drives $P - m$ close to zero. In this case, paradoxically, the effect of endogenous β on government policy acts to raise exports over the privately optimal level.

⁹An intriguing possibility is that the ITC investigation may result in a higher probability of VERs; i.e., the probability of a VER and of a CVD are jointly determined. This is assumed away for simplicity.

V. Export License Allocation Policy

From the point of view of the government the cost function of the firm, $c(q,n)$ is efficiently operated when marginal and average cost are equal:

$$m(q,n) = \frac{c(q,n)}{q}.$$

This defines the efficient scale of the firm, q^* , as a function of n , the number of firms, $q^*(n)$. In the standard case of long run competitive equilibrium, free entry and exit with zero profits assures an efficient number of firms. The new element here is that VER license allocations can affect the number of firms in the equilibrium under the VER. The government may wish to assure an efficient number of firms in the VER constrained situation, n^* , which differs from the efficient number of firms in the first period when exports secure a claim to future VER licenses. Rational firms will anticipate this, potentially leading to a different level of first period output.

The government can achieve the efficient solution under two allocation systems. First, it can guarantee licenses to incumbent firms according to the previous rule of λ percent of first period exports, *and authorize resale in a competitive market*. In this case, the right number of licenses is obtained by first period sales, while the second period resale provision allows some incumbent firms to sell their licenses and exit in order to maximize profits and achieve an efficient scale for remaining firms.

Alternatively, the efficient solution can be achieved by offering all firms a share of licenses equal to $\theta\%$ of their first period sales with probability ω ; where θ is rationally forecast by the firms to be the ratio of efficient scale in the second period with a VER to the efficient scale in the first period and ω is rationally forecast to be the ratio of the number of firms in the second period in the event of a VER to the number of firms in the first period. The product $\omega\theta$ equals λ , the fraction of future to current sales. The

second interpretation, while artificial, emphasizes the power of an entry policy, such as any restrictions on resale.

Under either interpretation, this is a convenient benchmark result, but it depends on the government acting only to maximize industry profits. With any other government concerns such as revenue or balance of payments constraints, the result goes away, since agents know that the government will have an incentive to capture the rent from their sunk investment in first period sales. A subsidy may then be necessary.

No Subsidy Case

The second interpretation is offered first. If the probability of being a rent-receiving firm in the event of a VER is equal for all firms, the rational expectation of it equals the ratio of the efficient number of firms with a VER, $\bar{n}$, to the number of firms in the competitive equilibrium, n^c . If the ratio of licenses received to current output is θ , the marginal risk-neutral firm will enter or exit when

$$(21) \quad - (P - a(q^*(n^c), n^c)) = \pi(\bar{P} - a(q^*(n^c)\theta, \bar{n})) \frac{\bar{n}}{n^c} \theta ,$$

where $a(q^*)$ is the average (equal to marginal) cost at the efficient scale of output.

Comparing (21) with (4) the difference lies in the replacement of $\theta n^c/n^*$ with λ .

For the nation as a whole, the level of exports in the event of a VER is reduced by the proportion $\bar{Q}/\Sigma Q$ as in Section II. To be consistent with the firms' decisions, θ must be set such that

$$(22) \quad \frac{\bar{n}}{n^c} \theta = \frac{\bar{Q}}{\Sigma Q} .$$

That is, the government offers to give licenses to an efficient number of firms in the ratio of efficient firm scale in the VER situation to the efficient scale in the period one situation. This is credible to firms, since it is the maximizing behavior of the government at the start of period two when the VER is imposed in the absence of any other constraints. Thus 'time-consistency' is achieved. If the exporter's firms take a

nontrivial part of the total market, Section II shows that a second period export tax or reduction of the number of licenses given to firms is optimal.

Alternatively, the allocation can be achieved by allowing resale of export licenses in a competitive market. An export license in long run competitive equilibrium in the VER state is worth $P - a(q^*(n^c)\theta, n^c)$, since the license-inclusive cost of export will then just be covered by the price P . In the first period, firms will dump sufficient exports to satisfy (21)–(22). Thus *resale not only permits rationalization of production in the VER period, but it provides the correct stimulus to first period sales.*

Subsidy Case

The most plausible case for subsidy arises when the government is perceived to be revenue-hungry. The sunk cost of dumping the exports in period one is irrelevant to the government at the outset of period two, so it may as well take all the VER rent, either by

- (i) initially selling all the licenses created for it by the demand of the import government, or
- (ii) by taxing the resale of licenses. The firms accurately foresee this, and thus refuse to dump at all in the first period. The only way to achieve the optimal amount of exports is to subsidize the first period exports, in an amount sufficient to achieve (15). Thus the time-consistent export policy requires a subsidy.

A second-best method of restoring the incentive to dump may be prevalent in practice. That is to credibly guarantee a proportionate share of the VER to all firms producing in the first period, while prohibiting resale in order to credibly remove that activity from potential taxation. The reasoning is that license resale on public exchanges creates revenues which would be easy to monitor and thus cheap to tax. The resale prohibition policy is suboptimal due to the inefficient number of firms which are frozen into production in the second period. The incentive compatibility of granting such a

peculiarly limited property right in market incumbency may help shed insight on such practices.

A deeper understanding of these forces awaits further work. An important element will be concern for how the government is disciplined in its appetite by a concern for its reputation.

VI. Toward a Theory of OMAs

Competition among countries as well as firms to boost current export volume in order to secure licenses in the future is wasteful from the point of view of the world, (i.e., Paretian efficiency). If it could be avoided, there is a surplus to be divided. OMAs may be interpretable as institutions to capture the resulting surplus. In this section, first the social waste proposition is established, and then the possible application to OMAs is discussed.

The Loss from Dumping

In the simplest case, the probability of the VER is fixed. The import price could rise with the imposition of the VER, but this is inessential. If the VER is imposed, the future world surplus will be based on $\bar{Q}$, with probability π and if it does not the world surplus will be based on Q^c , the free trade value, with probability $1-\pi$. In the present, since in the aggregate the exporters are unable to increase total sales in the event of the VER, the best policy is to trade the free trade quantity Q^c , where marginal benefit equals marginal cost.

Matters are more complex if the probability of a VER is endogenous. The possible normative meaning of the VER must now be acknowledged. Nevertheless, assume the Paretian planner's objective function can be modelled independently of the

political interest model which lies behind the probability.¹⁰ Maximum expected world surplus is thus the criterion. The maximum world surplus in the first period, associated with free trade, has sales which are too high since the last unit of sales creates no net gain in the first period (marginal current benefit equals marginal current cost), but incurs a marginal loss in the second period, since it raises the probability of a VER. The optimal global policy is to restrict trade somewhat in the first period in order to avert a worse outcome later. Considering the dumping incentives of export firms and governments, a global policy must a fortiori be restrictive.

In a companion paper, I consider the incentives of import country governments. These are suppressed here by the assumption of a fixed price. With import price varying, when the probability of a VER is endogenous, the import country government trades off the temporary gain from the first period subsidy paid by foreigners against the future loss of surplus due to a higher probability of a VER. The net effect can go either way (though the terms of trade effect is likely to dominate), but at the world level there must be a loss due to the subsidy competition.

OMAs

Orderly Marketing Agreements are multilateral, multi-commodity VER systems which have expanded greatly in several key product areas, such as textiles and apparel, while not becoming universal. In textiles, the archetype, some of the industrial democracies initially requested a few bilateral VERs with the important exporting nations. Within a few years, the number of importing and exporting nations covered expanded greatly, while the number of products covered expanded albeit at a slower pace.

A significant fact for economists to explain is why the usual executive branch resistance to expanded protection in the democracies is so low within such product

¹⁰In future work it would be desirable to explore this issue more deeply. The elements isolated here will be part of the story.

groups, while remaining high in others. A lesser puzzle is why exporters have not been more resistant (lack of market power combined with the compensation paid in VER rent is an obvious explanation). This paper has shown that the incentive of exporters to dump, together with the expected world surplus to be gained from a current restriction, gives negotiators a possible reason to extend the OMA to cover products currently not restrained, where they are subject to the domino effect. A current restriction "pre-empt" the potential later, more severe restriction. Furthermore, a round of negotiations which excludes some categories from protection may also serve to reduce the subjective probability of future protection used by exporters in calculating their optimal dumping margin. Thus it is possible that the Orderly Marketing Arrangement does indeed serve the cause of liberal trade. This story must play a role in an eventual theory of OMAs. Political economy models undoubtedly also have a role in the full explanation.

Formally, suppose information arrives to all agents giving a new value of the probability of a VER by shifting the probability function $\pi(Q)$. The simplest case to follow is when the probability is initially zero, with the information being a shift in attitudes among the electorate in one importing country. The current negotiations between exporters and importers can increase the world surplus by immediately shifting the current value of trade to its optimal level with a VER less binding than the prospective one. The gain can be shared if the rent is shared, which in fact seems common in practice.¹¹ Then a protectionist deal can be struck which is mutually welfare-improving. Negotiations which do not choose to extend VERs to some categories also may create surplus by reducing the probability of a VER and hence the wasteful competition for markets.

¹¹For example the Japanese auto VERs created rents shared between US dealers and Japanese manufacturers. Why rent-sharing exists is an important topic only sketched here. The system of allocation of licenses is so narrowly defined, with such restrictions on resale, that it tends to create bilateral monopoly. The solution to the bargaining model produces a rent share which could be supposed to approximate that needed to ensure mutual gains from the intervention.

Economists have generally been hostile to OMAs and VERs. The official defense of negotiation over VERs is that it averts protection; this has been taken as disinformation. OMAs are taken as newspeak. The issues raised by domino dumping suggest a more careful look. Like the U.S. general who destroyed a Vietnamese village in order to save it, the U.S. Special Trade Representative can claim to be setting VERs in order to trade freely. Like war, a VER trading regime is a situation in which bad may be good.

Voluntary Export Tax Regime

The fundamental problem is with the inefficiencies created by the use of quantitative restrictions. An alternative is a voluntary export tax regime, in which protection, when it comes, is achieved by a combination of export and import taxes which divide the revenue. No private dumping incentives exist, and with an exogenous probability of protection the optimal current policy of both governments is free trade, which is also Pareto efficient. Unlike the VER regime, free trade is thus a stable outcome because it is not subject to the domino effect.

On the other hand, if the probability of protection is endogenous, Paretian efficient protection requires some restriction in the current period, as in the VER regime. In the absence of the need to restrain private incentives to dump, however, this seems to be a rather esoteric consideration, unlikely to lead to current intervention.

Appendix: The Probability of a VER Function

From the point of view of the exporters, the dichotomous policy variable {VER,no VER} is assumed to depend on whether or not an index y exceeds an unknown critical value Y . The index y is dependent on the value of aggregate imports, a vector of exogenous political variables, and a random error term. LOGIT or PROBIT models are familiar to most readers. These or related methods may be assumed to be used by the export country planners to form the estimated function $\pi(\Sigma Q, Z)$ based on data from past incidents of protection in similar countries and industries.

Let $y = \alpha_0 + \alpha_1 \Sigma Q + \gamma' Z + u$ where Z is the vector of political variables and u is the zero mean random error term. The probability that y is less than or equal to Y , which equals $1 - \pi$, is the same as the probability that the random draw of u is less than or equal to $u^* = Y - \alpha_0 - \alpha_1 \Sigma Q - \gamma' Z$. The larger is ΣQ , the lower is the limit u^* , hence the lower is $1 - \pi$ and the larger is π . Thus it is the cumulative density function of u which gives the shape of $\pi(\Sigma Q, \cdot)$.

The elasticity of $1 - \pi$ with respect to u^* is denoted ϵ , with the VER probability elasticity η being:¹²

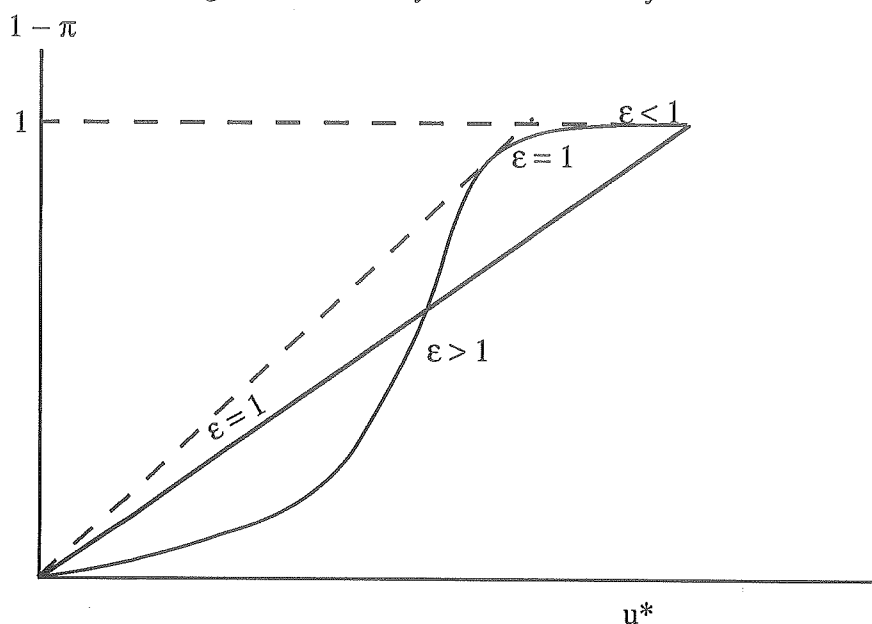
$$\eta = \frac{1 - \pi}{\pi} \epsilon \frac{\Sigma Q}{y} \alpha_1.$$

For the normal and kindred "lazy S" cumulative density functions, ϵ is greater than or equal to one from a zero probability up to a critical value and less than one in the upper tail. For a uniform cumulative density function, ϵ is unity everywhere provided the lower limit of the distribution is zero. Figure 2 illustrates.

¹² $\frac{\partial \pi}{\partial u^*} = - \frac{\partial(1-\pi)}{\partial u^*}$, hence $\frac{u^* \partial \pi}{\pi \partial u^*} = - \frac{1-\pi}{\pi} \frac{\partial(1-\pi)}{\partial u^*} \frac{u^*}{1-\pi} = - \frac{1-\pi}{\pi} \epsilon$;

and the elasticity of u^* with respect to ΣQ is $-\frac{\Sigma Q}{y} \alpha_1$.

Figure 2. Elasticity of the Probability of No VER



Based on the diagram, the probability model above and Proposition 5, the case for subsidizing exports rests on (i) values of total imports high enough so that the u^* is low enough to lie in the "non-tail" region, combined with (ii) a probability model in which the influence of ΣQ in the index y is large relative to other forces, and (iii) such that the probability of no VER in the absence of intervention is substantial.

For concreteness, and to provide an example sufficient to yield a subsidy, consider the limiting case in which imports alone matter, $\alpha_1 \frac{\Sigma Q}{y} = 1$ with the uniform distribution. Let Q_L denote the lower limit of total imports above which a VER becomes possible and Q_H the upper limit at which the VER is certain. Then

$$\pi = \frac{Q - Q_L}{Q_H - Q_L},$$

where Q is the current level of total imports. Let Q^* denote the no-subsidy level of imports. The elasticity η works out to be:

$$\eta = \frac{Q^*}{Q^* - Q_L}.$$

The elasticity is greater than unity for Q_L positive, which seems to be a common sense requirement for the case analyzed.¹³ Then in Section III:

Corollary *If imports alone matter to the probability of a VER and if the distribution is uniform, exports should be subsidized.*

¹³Suppose the lower limit is negative. This implies that even if imports are zero, there is some probability of a VER.

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