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The effect of domestic antidumping law in the presence of foreign monopoly

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We analyze the effects of antidumping law when utilized by competitive domestic petitioners against a foreign monopolist. The monopolist reduces the cost of holding excess capacity in periods of slack foreign demand by dumping on the domestic market. Antidumping law reduces trade volume both directly (under successful petitions), and indirectly (when no petition is filed) by causing the monopolist to alter its capacity and the allocation of that capacity between markets. Finally, we consider the effects of self-enforcing agreements in which the domestic industry agrees not to file in exchange for a promise that the foreign monopolist limit exports.

1. Introduction

The belief that foreign cartels will use world markets as a 'dumping ground' for their excess capacity lies at the heart of the rationale for existing antidumping laws throughout the world. Viner (1966, p. 242) observes, for example, that the first antidumping legislation adopted in the United States, as contained in Sections 800–801 of the Revenue Act of 1916, was largely a reaction to the alleged dumping threat posed by the highly cartelized and heavily protected German industries of the period. Inspired by the concern that these industries would regularly unload their excess industrial capacity on the competitive U.S. market, the intent of the law was to protect U.S. firms from the 'unfair competition' resulting from such practices. Nor were

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these concerns necessarily without foundation. The cyclical dumping of foreign excess capacity on domestic markets is what Viner, in his classic taxonomy, termed 'long-run' or 'continuous' dumping to 'maintain full production from existing plant facilities without cutting [foreign] prices' (p. 23). Moreover, Viner concludes that of the 10 types of dumping included in his taxonomy of motives, it 'is probable that this is the most prevalent type of dumping' (p. 28).[1]

In this paper we explore the effects of antidumping law when utilized by competitive domestic petitioners against a foreign monopolist.[2] We consider a foreign monopolist facing stochastic market demand in a segmented foreign market who must set capacity before market demand uncertainty is resolved. Once demand is observed, the monopolist sets foreign market price and makes foreign market sales subject to its capacity constraints. Any 'excess' capacity not used for foreign market sales can be sold in the competitive domestic market at market-clearing prices. Within this setting, the foreign firm typically carries excess capacity in low-demand states, which it then 'dumps' on the domestic market. This set-up captures in a simple way the periodic excess capacity central to the phenomenon of cyclical dumping, and it is with respect to this excess capacity that antidumping law has its impact.

We find that the introduction of domestic antidumping law leads to the filing of antidumping suits and to the imposition of duties whenever foreign demand is sufficiently soft. Intuitively, low foreign demand leads to large foreign excess capacity, which can be kept from the domestic market by an antidumping suit. Thus, the use of antidumping law leads directly to lower imports in periods of soft foreign demand. However, we also find that such filing behavior leads the foreign monopolist to reduce its capacity, since domestic antidumping suits raise the cost of carrying excess capacity in low-demand states. With foreign export volume determined by foreign capacity in excess of that needed to supply the foreign market, the smaller capacity choice leads to lower trade volume over a range of strong demand realizations in which no petitions are filed. Moreover, for a range of intermediate demand states, the foreign monopolist reduces its foreign market price and reallocates capacity away from exports to avoid the filing of an antidumping suit by domestic firms. Thus, the presence of domestic

[1]As an illustration, Viner quotes from the Report of the United States Industrial Commission (USIC) of 1901, which we reproduce here: 'A few exporters indicate that prior to 1898 prices were lower abroad than at home, and that this condition was brought about in order to keep a stable market in this country, and as one establishment puts it, "We want the foreign market to cut our price in, so as not to disturb the domestic market". "Naturally enough", says one correspondent, "when American mills or factories are short of orders and trade is at a low ebb, they sell in foreign markets at cheaper rates in order . . . to keep their men employed and their works running"' [USIC (1901, p. 729)].

[2]The impact of antidumping law on firm behavior in a noncooperative oligopolistic setting has been explored recently by Dixit (1988), Ethier (1988), Gruenspecht (1988), and Prusa (1988), and by Staiger and Wolak (1990a) in an oligopolistic setting where firms tacitly collude.

antidumping law leads generally to lower foreign export volume, even in periods when no antidumping suit is filed.[3]

We also examine the impact of self-enforcing agreements between the foreign monopolist and the domestic industry which take the form of a promise by the former to limit its exports in exchange for a promise by the latter not to file a suit. This kind of arrangement between firms is likely to arise in repeated play as a way to economize on filing costs. We find that such arrangements tend to reduce the range of soft foreign demand states over which domestic dumping suits will be filed and to increase the foreign capacity choice, hence raising foreign export volume over ranges of soft and strong foreign demand. These arrangements also allow the foreign monopolist to 'insulate' the foreign market from its efforts to avoid antidumping suits, thereby resulting in higher prices for foreign consumers. Such arrangements do not, however, change our basic finding that competitive domestic firms will file against a foreign monopolist, if at all, only in periods of sufficiently soft demand.

The remainder of the paper is devoted to making these points. The model in the absence of antidumping law is presented in section 2. After providing a brief description of the salient features of U.S. antidumping law in section 3, section 4 introduces antidumping law into the domestic country and explores its impact on equilibrium behavior. Section 5 provides some illustrative model solutions. Section 6 concludes.

2. The model in the absence of antidumping law

2.1. Basic assumptions

Our goal is to set out the simplest model that captures the essence of the environment within which antidumping law was intended to operate. The key ingredients of such an environment are (i) a cartelized and heavily protected foreign market, (ii) stochastic foreign demand which periodically leaves the foreign cartel with excessive capacity for supplying the foreign market, and (iii) a competitive and relatively open domestic market to serve as the 'dumping ground' for excess capacity. As Viner (1966, p. 51) notes, cartelization and heavy protection are necessary to check price competition in the foreign market, the former from producers within the foreign market and the latter from producers in other markets. Add to this the interaction of stochastic foreign demand with relatively inflexible production capacity, and the incentive to dump during periods of slack foreign demand emerges 'in order to maintain full production without reducing domestic prices' [Viner (1966, p. 115)]. Finally, a competitive and open domestic market provides a natural outlet for this periodic excess capacity.

[3]A similar observation is made in Hillman and Katz (1986).

To capture the central features of foreign and domestic markets as outlined above, we consider an infinitely repeated game for a single industry in which production and sales take place in a domestic and foreign market.[4] In the domestic market, demand, D, is a deterministic linear function of price, P, and given by $D=\alpha-P$. Demand in the foreign market is stochastic and given by $D^*=\alpha^*-P^*$, with D^* denoting foreign demand and P^* denoting foreign price, and with α^* an i.i.d. random variable whose distribution function $F(\alpha^*)$ has full support on the interval $[\underline{\alpha}^*, \bar{\alpha}^*]$, with $\bar{\alpha}^*>\underline{\alpha}^*>0$.[5] Since we wish to examine the use of antidumping law by competitive domestic firms against collusive foreign exporters, we take as given the existence of an asymmetry in market structure between the domestic and foreign industries. That is, we assume that there are many potential firms that operate under conditions of free entry in the domestic market, while in the foreign market there is a single monopolist. All domestic firms share a common linear homogeneous domestic technology which exhibits constant long-run (before capacity is installed) marginal costs and constant short-run (after capacity is installed) marginal costs up to capacity. The foreign firm possesses a foreign technology which also exhibits constant long-run marginal costs and constant short-run marginal costs up to capacity. Finally, the foreign market is taken to be segmented from the domestic market by prohibitively high import barriers. Thus, while domestic firms cannot sell in the (segmented) foreign market, the foreign firm does have access to the domestic market. Without loss of generality, we set all state-invariant domestic trade impediments to zero. For now we also assume that no antidumping law exists in the domestic country, so that foreign access to the domestic market is unimpeded.

At the beginning of any period, before the period's state of demand is revealed, the foreign firm must build capacity facing per-unit capacity costs r^*, with K^* denoting its capacity choice.[6] Once capacity is set, the period's foreign demand realization is revealed. The foreign firm sets its price P^* for the (segmented) foreign market and makes deliveries (subject to capacity constraints) at a short-run marginal cost of C^*. We set C^* to zero for simplicity. The sales of the foreign firm in the foreign market are then given by $q^*(\alpha^*; K^*, P^*)\equiv\min[K^*, D^*(\alpha^*; P^*)]$.

[4]Infinite repetition becomes important only when we consider self-enforcing agreements in section 4.

[5]For simplicity, and since it is not an essential element of the environment we wish to capture, we abstract from uncertainty in domestic demand. The introduction of domestic demand uncertainty does not present a problem provided that it is resolved each period before the capacity choices of domestic firms are made. If domestic capacity choices were to be made before the resolution of domestic demand uncertainty, some demand realizations would lead to mixed strategy pricing, a complication we wish to avoid. See Staiger and Wolak (1990b) for a treatment of mixed strategies in capacity-constrained price games under demand uncertainty.

[6]Alternatively, the foreign monopolist could set capacity once and for all at the beginning of the initial period, without changing the nature of any of the results.

With K^* and P^* chosen, the foreign firm has implicitly determined its export capacity, $x^*(\alpha^*; K^*, P^*) \equiv K^* - q^*(\alpha^*; K^*, P^*)$. Observing foreign export capacity for the period, domestic firms make entry decisions and choose capacity for sales in the domestic market facing per-unit capacity costs r, with domestic industry capacity denoted by K. Finally, with their capacity decisions made, domestic firms face short-run marginal costs of C (up to capacity). We set C to zero for simplicity. We also assume that domestic long-run marginal cost lies between foreign long-run and short-run marginal cost, which, with $C = C^* = 0$, implies

$$r^* > r > 0. \tag{1}$$

As will become clear shortly, this assumption ensures that the domestic market is viewed by the foreign monopolist as a 'dumping ground' for its 'excess' capacity.[7] Finally, with foreign export capacity and domestic production capacity set, domestic and foreign firms simultaneously set prices and make deliveries (up to capacity) in the domestic market. In modeling the capacity-constrained price game, we follow Kreps and Scheinkman (1983) and adopt the (efficient) rationing rule that consumers buy first from the cheapest supplier and income effects are absent.

Thus, we model the foreign monopolist as setting capacity in the face of foreign demand uncertainty, and then choosing its price for foreign market sales once demand uncertainty is resolved. Competitive domestic firms then take the foreign export capacity (implied by the residual foreign capacity after foreign sales are made) as given when choosing domestic production capacity and, once their capacity decisions are made, set prices simultaneously with the foreign exporter for sales in the domestic market.

Note that our timing assumptions amount to the requirement that the foreign monopolist behaves as a Stackelberg leader in its capacity choice for sales in the domestic market. This 'first mover' advantage of the foreign monopolist in the domestic market can be motivated by the dominant market position of the foreign monopolist relative to firms in the domestic 'competitive fringe'. In fact, such a timing assumption is in agreement with Viner's (1966) description of the German cartels to which U.S. antidumping law was in large part a response. A commitment to export volume, $x^*(\alpha^*; K^*, P^*)$, is implied by the dual commitment to maintain 'full production' (up to capacity K^*) and 'stable and profitable' own-market prices, P^*,

[7]In particular, building foreign capacity for the sole purpose of selling in the domestic market is not profitable. Thus, sales to the domestic market by the foreign firm is not an end in itself. This is consistent with Viner's (1966) observation concerning the dumping activity which gave rise to early antidumping legislation in the United States: 'The export dumping of the German Kartells had as its predominant objective the maintenance at the same time of full production and stable and profitable domestic prices. The development of export trade was only a secondary consideration' (pp. 59–60).

which Viner describes (pp. 59–60). Of course, other timing assumptions are also plausible. However, the nature of our results is unlikely to be sensitive to plausible variations in the order of moves.[8]

We close this subsection by fixing foreign export capacity x^* and solving the remaining stages of the game. We will assume throughout that domestic demand is not 'too' inelastic at $P=r\equiv\bar{P}$ in the sense that

$$\bar{\eta}\geqq\bar{s}^*(x^*), \tag{2}$$

where $\bar{\eta}$ is the absolute value of the elasticity of domestic demand evaluated at $\bar{P}$ and $\bar{s}^*(x^*)\equiv x^*/D(\bar{P})$ is the domestic market share of the foreign monopolist at $\bar{P}$.[9] We also assume that the domestic market is 'large' relative to foreign export capacity in the weak sense that

$$D(\bar{P})>x^* \tag{3}$$

for x^* in the relevant range. The exact relevance of (2) and (3) will become clear shortly.

Fixing x^* in the range given by (3), suppose that domestic entry yields a domestic capacity $\hat{K}(x^*)$ given by

$$\hat{K}(x^*)\equiv D(\bar{P})-x^*. \tag{4}$$

$\hat{K}(x^*)$ is strictly positive by (3), and is simply the residual domestic demand (net of foreign exports) at domestic price $\bar{P}$. In the final stage of the game, the foreign firm and the many domestic firms then play a capacity-constrained, price-setting game in the domestic market.

We now establish that, given $\hat{K}(x^*)$ and x^*, all foreign and domestic firms will name $\bar{P}$ in equilibrium. Note from (4) that, by naming $\bar{P}$, each firm can sell its entire (domestic market) capacity. Thus, no firm has an incentive to shave its price below $\bar{P}$. Neither would any firm wish to unilaterally raise its

[8]For example, the most plausible alternative would have the foreign monopolist and domestic competitors choosing capacity for the domestic market simultaneously. Thus, the foreign firm would first set its (overall) capacity, then the foreign demand state would be revealed, and finally the allocation of foreign capacity to foreign and domestic sales would be chosen simultaneously with the capacity decisions of domestic firms. In this case pure strategy equilibria will continue to exist, periods of slack foreign demand will still result in increased dumping activity, and our basic results concerning the use and effect of antidumping law are preserved.

[9]We have written (2) under the assumption that the domestic market share of individual domestic firms is smaller than that of the foreign monopolist. While it is most natural to think of the domestic 'competitive fringe' as composed of a large number of small firms, our linear technology assumption leaves the size of individual domestic firms indeterminate. If any domestic firm did have a larger domestic market share than the foreign monopolist, condition (2) would simply be rewritten with the domestic market share of the largest domestic firm replacing that of the foreign monopolist.

price above $\bar{P}$ since, by (2), any firm that unilaterally raises its price and sells less will reduce its revenue but not its costs (short-run marginal costs are zero).[10] Finally, for any $P \neq \bar{P}$ it is readily established that a unilateral move toward $\bar{P}$ will raise profits. Thus, for any x^* satisfying (3), domestic entry yielding $\hat{K}(x^*)$ will have all firms naming $\bar{P}$ and selling their entire capacity. Moreover, since domestic firms sell all capacity at a price equal to (long-run) unit cost, the equilibrium zero profit condition required by free domestic entry is satisfied at $\hat{K}(x^*)$, so that $\hat{K}(x^*)$ represents an equilibrium domestic capacity choice in the penultimate stage of the game.

In the appendix we rule out the existence of any additional equilibrium domestic capacity choices. We are thus left with $\hat{K}(x^*)$ as the unique equilibrium domestic capacity choice given x^*, and $\bar{P}$ as the equilibrium domestic price. Finally, note from (1) that the equilibrium domestic price $\bar{P}$ is larger than short-run marginal costs for foreign exports but is not sufficient to cover their long-run marginal costs. Hence, from the perspective of the foreign firm, the domestic market represents a 'dumping ground', that is, a location where 'excess' capacity can be sold at a constant price $\bar{P}$ which covers short-run but not long-run marginal costs. With this established, we now turn to an analysis of foreign firm decisions in detail, and return our focus to the domestic firms with the introduction of domestic antidumping law in the next section.

2.2. *The foreign monopoly problem*

Above, we characterized equilibrium behavior in the domestic market as a function of foreign export capacity x^*. To complete the description of equilibrium in the absence of antidumping law, we now consider the problem faced by the foreign monopolist, i.e. the determination of foreign export capacity x^*. Facing uncertain foreign demand, the foreign monopolist must first choose capacity K^*. Once K^* is in place, the foreign demand uncertainty is resolved, and the foreign monopolist must then set P^* for foreign market sales up to capacity, with any excess capacity, x^*, to be sold on the domestic market at the domestic market price of $\bar{P}$.

To find choices of K^* and P^* that maximize expected profits of the foreign firm, we note that, for any K^*, the realization of α^* will either be such that the foreign capacity constraint binds in the foreign market at a price that is strictly above the unconstrained foreign monopoly price, or it does not bind. In the former case the foreign profit-maximizing price, as a function of α^* and K^*, is given trivially by $P^*(\alpha^*; K^*) = (\alpha^* - K^*)$. In the latter case it is

[10]Nothing would change if short-run marginal costs were strictly positive, provided that condition (2) were strengthened accordingly.

easily shown to be given by $P^*(\alpha^*)=(\alpha^*+\bar{P})/2$, provided only that $P^*(\alpha^*)>\bar{P}$, an assumption we maintain for all α^*.

With this we can now write foreign market sales, $q^*(\alpha^*; K^*)$, as $q^*(\alpha^*; K^*)\equiv\min[K^*, D^*(\alpha^*; P^*(\alpha^*))]$ and exports to the domestic market, $x^*(\alpha^*; K^*)$, as $x^*(\alpha^*; K^*)=K^*-q^*(\alpha^*; K^*)$. Finally, expected monopoly profits as a function of K^* are given by

$$\mathrm{E}\pi^*(K^*)=\int_{\alpha^*}^{\bar{\alpha}^*}\{P^*(\alpha^*; q^*(\alpha^*; K^*))\cdot q^*(\alpha^*; K^*) + \bar{P}\cdot x^*(\alpha^*; K^*)\}\,\mathrm{d}F(\alpha^*)-r^*K^*. \tag{5}$$

Before considering the choice of K^* that maximizes $\mathrm{E}\pi^*(K^*)$, note that $D^*(\alpha^*; P^*(\alpha^*))$ is monotonically increasing in α^*. Thus, for any non-negative K^* there exists an $\alpha_1^*(K^*)$ at which foreign capacity becomes binding for foreign market monopoly sales so that

$$q^*(\alpha^*; K^*)=\begin{cases} K^*, & \text{for } \alpha^*\geqq\alpha_1^*(K^*), \\ D^*(\alpha^*; P^*(\alpha^*)), & \text{for } \alpha^*<\alpha_1^*(K^*). \end{cases}$$

Explicit calculation yields $\alpha_1^*(K^*)\equiv 2K^*+\bar{P}$. Thus, $1-F(\alpha_1^*(K^*))$ is the ex ante probability that K^* will bind in the foreign market. Clearly it is optimal to choose K^* such that $1-F(\alpha_1^*(K^*))>0$ since, as established above, sales on the domestic market cover short-run but not long-run marginal costs for the foreign monopolist. Thus, $\alpha_1^*(K^*)<\bar{\alpha}^*$ in the relevant range of K^*, and (5) can be rewritten as

$$\mathrm{E}\,\pi^*(K^*)=\int_{\alpha_1^*(K^*)}^{\bar{\alpha}^*} P^*(\alpha^*;K^*)\cdot K^*\,\mathrm{d}F(\alpha^*) + \int_{\alpha^*}^{\alpha_1^*(K^*)}\{P^*(\alpha^*)\cdot D^*(\alpha^*; P^*(\alpha^*)) + \bar{P}\cdot x^*(\alpha^*; K^*)\}\,\mathrm{d}F(\alpha^*)-r^*K^*. \tag{6}$$

The first- and second-order conditions of (6) are then given by

$$\begin{aligned} &\mathrm{E}\,\pi^*_{K^*}(K^*)=\int_{\alpha_1^*(K^*)}^{\bar{\alpha}^*}(\alpha^*-2K^*)\,\mathrm{d}F(\alpha^*)+F(\alpha_1^*(K^*))\cdot\bar{P}-r^*=0, \\ &\mathrm{E}\,\pi^*_{K^*K^*}(K^*)=-2[1-F(\alpha_1^*(K^*))]<0. \end{aligned} \tag{7}$$

Thus, with second-order conditions globally met, expressions (7) implicitly

determine the unique foreign capacity choice K_0^*, and through $x^*(\alpha^*; K^*)$, the foreign export supply to the domestic market as a function of α^*.

We conclude this section with a summary of equilibrium industry behavior in the absence of antidumping law. In periods of high foreign demand, $\alpha^* > \alpha_1^*(K_0^*)$, the foreign monopolist sells its entire capacity on the foreign market at the market-clearing price, while domestic production expands to satisfy the entire domestic market at a price equal to domestic unit cost. In periods of sufficiently low foreign demand, $\alpha^* < \alpha_1^*(K_0^*)$, the foreign monopolist sells its unconstrained short-run monopoly quantity, $D^*(\alpha^*; P^*(\alpha^*))$, in the foreign market and exports its excess capacity to the (lower price) domestic market, while domestic production contracts to accommodate the import surge and maintain domestic price equal to domestic unit cost. Despite a number of simplifications, this model paints a picture of dumping behavior in the absence of antidumping law which accords well with the pricing behavior that antidumping law was largely designed to remedy. As such, it should provide a reasonable framework within which to study the use of antidumping law as it was originally intended.

3. U.S. antidumping law

Before introducing antidumping law into the formal model, we provide a brief discussion of current U.S. antidumping law. While antidumping law in the United States has a long and complex legislative history, we abstract from much of this and focus here on three features of current U.S. law that are important for our results.

The first concerns the legal definition of dumping, which must be clarified in order to determine whether and when dumping occurs in the model (absent domestic antidumping law). Foreign dumping is defined in the Trade and Tariff Act of 1984 as pricing at 'less than fair value' in the domestic market. The crucial issue is how 'fair value' is measured. Under 'normal circumstances', fair value would be measured by prevailing prices in the foreign market. Hence, evidence of price discrimination across international markets is sufficient (though not necessary) under U.S. law to establish that dumping has occurred. With this view of its legal definition under current U.S. law, it is clear from the analysis of the previous section that dumping by the foreign monopolist occurs in the domestic market whenever the foreign monopolist exports, i.e. whenever $\alpha^* < \alpha_1^*(K^*)$, since the foreign firm makes sales in the domestic market at a price $\bar{P}$ which is below that prevailing in the foreign market, $P^*(\alpha^*)$.

The second aspect of U.S. antidumping law important for our purposes concerns the conditions under which dumping activity is 'actionable', i.e. the conditions under which a dumping finding will lead to the imposition of antidumping duties. According to U.S. law, a determination must first be

made that 'material injury' or the 'threat of material injury' due to imports is present in the petitioning industry before antidumping duties can be imposed as a remedy for dumping activity. Whether measured by a loss of market share or output, injury to the domestic industry will be associated with the dumping that occurs in this model. Moreover, the threat of injury due to imports – as measured by domestic profit losses – is present in the petitioning industry since, with domestic capacity decisions for the period made by the time of filing, domestic profits are decreasing in imports and will thus fall unless duties are forthcoming. Hence, the dumping that occurs in the model will be actionable.[11]

The final aspect of U.S. antidumping law that is relevant for our modeling purposes concerns the nature of antidumping duties and the period over which they are imposed. While the final determination of an antidumping suit may easily take 6 months to a year from the initial filing date, antidumping duties reflecting the 'dumping margin' can be applied retroactively to potentially all foreign shipments subsequent to the date the antidumping petition was filed.[12] This leads to a natural specification of the antidumping remedy as a duty equal to the dumping margin and applied to all foreign imports during the period in which a successful suit is filed. However, it is important to point out that U.S. law provides for the imposition of antidumping duties on domestic importers rather than on foreign exporters. Moreover, exporters are allowed to reimburse importers for dumping duties only on imports that were purchased and exported before specified dates in an ongoing antidumping proceeding.[13] In practice the result is, not surprisingly, a reduction in the ability of the foreign exporter to find willing importers on goods against which a dumping order is outstanding [see Dale (1980, p. 86)]. In the homogeneous good model we consider here, the foreign exporter will find *no* willing importers for goods with

[11]Of course, the 'material' standard must be met in the injury determination as well, which in this case boils down to a requirement that α^* lie sufficiently below $\alpha_1^*(K^*)$. Since this plays no essential role in our analysis, we ignore it. A related point concerns whether the dumping that occurs in this model would be viewed as so-called 'technical dumping' under the law and thus 'inactionable'. Technical dumping refers to a situation in which foreign exporters dump only to 'meet the price' of domestic competition. While this description fits our model, it is only the prompt exit of domestic firms in periods of low foreign demand that stabilizes the domestic price in the presence of foreign dumping, and it is only the mitigated exit in anticipation of filing that leaves the price unaffected when filing occurs and dumping duties are imposed. Thus, it is unlikely that the dumping activity we have characterized in the model would be viewed as 'technical' in nature. For a brief discussion of the notion of technical dumping and one case in which it was used, see Dale (1980, p. 58).

[12]A finding that there are 'massive' imports of the relevant product over a 'relatively short period' allows dumping duties to be applied retroactively 90 days prior to the preliminary dumping determination.

[13]Specifically, reimbursement of dumping duties is only allowed when the goods in question were purchased prior to a notice of withholding of appraisement and were exported prior to a determination of sales at less than fair value [Dale (1980, p. 105, note 42)].

nonreimbursable duties. Thus, past some critical (within-period) point in time, the foreign monopolist will be precluded from exporting to the domestic market when an antidumping proceeding is ongoing. To capture this effect simply, we assume that no goods can be successfully exported by the foreign monopolist when faced with an ongoing suit.[14]

4. The impact of domestic antidumping law

With the above discussion of U.S. antidumping law in mind, we turn now to an evaluation of the impact of antidumping law in the model of the previous sections. We begin under the assumption that the foreign monopolist and domestic firms behave noncooperatively.

4.1. Antidumping suits in the absence of agreements

We assume that the timing of the game is unchanged from the previous sections except that domestic firms now have an option to file, at a cost $F>0$ per unit of domestic capacity, an antidumping suit against the foreign monopolist after domestic firm capacity (entry) is determined but prior to the final price-setting stage of the game.[15] We abstract from free-rider issues by assuming the presence of a domestic 'industry association'.

Consider first the filing decision of domestic firms, still taking foreign export capacity x^* as given. Domestic firms must in any period weigh the industry costs of filing, FK, against the benefits of the antidumping suit which take the form of increased domestic industry revenues. With foreign export capacity and domestic production capacities for the period already set at the time the decision to file must be made, the impact of filing on domestic industry profits is given by

$$\Delta\pi(x^*, K, F) \equiv [P(K) - F - P(K + x^*)]K = (x^* - F) \cdot K. \tag{8}$$

The domestic industry will file if and only if $\Delta\pi(x^*, K, F) \geqq 0$; that is, if and only if incurring the filing cost F and filing an antidumping petition raises domestic profits for the period (by blocking imports), given that domestic

[14]While we model the 'rationing' aspect of antidumping law in an extreme and ad hoc manner, our results are not sensitive to reasonable alternative specifications. For example, nothing would change if exports were limited to an amount $\bar{x}>0$ under a suit, or if instead a fraction $\lambda>1$ of foreign export capacity $x^*(\alpha^*)$ could be successfully exported under a suit. The important property is that the discrepancy between export capacity and actual exports under the suit increase with export capacity.

[15]The assumption that filing costs are constant per unit of domestic capacity is made to assure that as domestic industry capacity gets small, the costs of filing a suit do not become prohibitively high. One way to interpret the assumption is that filing a convincing suit against the foreign monopolist becomes less costly as the volume of dumped imports increases, i.e. as domestic capacity falls.

production capacity is, at the time of the decision to file, fixed. Using (8), this amounts to the condition that $x^* \geqq F \equiv \hat{x}^*$. Thus, antidumping suits will be filed against the foreign monopolist in any period for which foreign export capacity is sufficiently large.

Of course, domestic capacity decisions anticipate fully the incentives to file an antidumping suit once capacities are set, and free domestic entry (and rational expectations) requires in equilibrium that domestic profits in each period are zero. Thus, domestic capacity as a function of foreign export capacity $\hat{K}(x^*)$ is given, in the presence of domestic antidumping law, by

$$\hat{K}(x^*) = \begin{cases} D(\bar{P}) - x^*, & \text{for } x^* < \hat{x}^*, \\ D(\bar{P} + F), & \text{for } x^* \geqq \hat{x}^*. \end{cases} \tag{9}$$

Using (4) and (9) it follows that, conditional on foreign export capacity x^*, the equilibrium filing of antidumping suits serves to support a larger domestic industrial capacity in times of high foreign export capacity ($x^* \geqq \hat{x}^*$) than would exist absent domestic antidumping law. That is, the domestic industry rents associated with filing an antidumping petition when foreign export capacity is high are dissipated by the diminished exit of domestic resources. The domestic production capacity that remains is consistent with zero profits when a suit is filed, and would result in negative profits if in fact no suit were filed and no duties imposed.

Finally, with equilibrium behavior in the domestic market in the presence of antidumping law now characterized as a function of foreign export capacity, we turn to equilibrium determination of foreign export capacity in the presence of domestic antidumping law. We first define expected foreign revenues in the presence of domestic antidumping law. For $\alpha^* \in [\alpha_1^*(K^*), \bar{\alpha}^*]$, there are no exports to the domestic market, so foreign revenues for α^* in this range are $R^*(\alpha^*; K^*) = P^*(\alpha^*; K^*) \cdot K^*$. Next we denote $\alpha_2^*(K^*)$ as the value of α^* at which exports reach the critical level $\hat{x}^*$, defined implicitly by $x^*(\alpha_2^*; K^*) = \hat{x}^*$. Explicit calculation yields $\alpha_2^*(K^*) \equiv 2(K^* - \hat{x}^*) + \bar{P}$. Then for $\alpha^* \in (\alpha_2^*(K^*), \alpha_1^*(K^*))$, we have $\hat{x}^* > x^*(\alpha^*; K^*) > 0$, so that excess foreign capacity is exported to the domestic market, but not in sufficient quantities to trigger the filing of a domestic antidumping suit. Thus, for α^* in this range, $R^*(\alpha^*; K^*) = P^*(\alpha^*) \cdot D^*(\alpha^*; P^*(\alpha^*)) + \bar{P} \cdot x^*(\alpha^*; K^*)$.

For α^* below $\alpha_2^*(K^*)$, domestic firms will file an antidumping suit and the foreign monopolist will be precluded from exporting to the domestic market in that period unless it chooses to lower the foreign price below $P^*(\alpha^*)$ to keep $x^*(\alpha^*; K^*) = \hat{x}^*$, in which case no antidumping suit will be filed. We denote the associated foreign price under the suit-acceptance strategy by $\dot{P}^*(\alpha^*)$ and under the suit-avoidance strategy by $\hat{P}^*(\alpha^*; K^*)$ and note that $\dot{P}^*(\alpha^*) = \alpha^*/2$, while $\hat{P}^*(\alpha^*; K^*) = \hat{x}^* + P^*(\alpha^*; K^*)$.

Defining $\alpha_3^*(K^*) \equiv 2(K^* - \hat{x}^*) - 2\sqrt{\bar{P}\hat{x}^*}$, it is readily established that, for $\alpha^* \in [\alpha_3^*(K^*), \alpha_2^*(K^*)]$, the suit-avoidance price $\hat{P}^*(\alpha^*; K^*)$ is chosen and foreign revenues are $R^*(\alpha^*; K^*) = \hat{P}^*(\alpha^*; K^*) \cdot D^*(\alpha^*; \hat{P}^*(\alpha^*; K^*)) + \bar{P}\hat{x}^*$. For $\alpha^* \in [\underline{\alpha}^*, \alpha_3^*(K^*)]$, the foreign monopolist sets $\dot{P}^*(\alpha^*)$, the domestic industry files a suit, and foreign revenues are $R^*(\alpha^*; K^*) = \dot{P}^*(\alpha^*) \cdot D^*(\alpha^*; \dot{P}^*(\alpha^*))$. Collecting expressions, we can now define foreign monopoly revenues as

$$R^*(\alpha^*; K^*) = \begin{cases} P^*(\alpha^*; K^*) \cdot K^*, & \text{for } \alpha \in [\alpha_1^*(K^*), \bar{\alpha}^*], \\ P^*(\alpha^*) \cdot D^*(\alpha^*; P^*(\alpha^*)) + \bar{P} \cdot x^*(\alpha^*; K^*), & \text{for } \alpha \in [\alpha_2^*(K^*), \alpha_1^*(K^*)], \\ \hat{P}^*(\alpha^*; K^*) \cdot D^*(\alpha^*; \hat{P}^*(\alpha^*; K^*)) + \bar{P} \cdot \hat{x}^*, & \text{for } \alpha \in [\alpha_3^*(K^*), \alpha_2^*(K^*)], \\ \dot{P}(\alpha^*) \cdot D^*(\alpha^*; \dot{P}(\alpha^*)), & \text{for } \alpha \in [\underline{\alpha}^*, \alpha_3^*(K^*)], \end{cases}$$

and expected foreign monopoly profits as

$$\mathrm{E}\,\pi^*(K^*) = \int_{\alpha^*}^{\bar{\alpha}^*} R^*(\alpha^*; K^*)\,\mathrm{d}F(\alpha^*) - r^*K^*. \tag{10}$$

The first- and second-order conditions of (10) are given by

$$\mathrm{E}\,\pi_{K^*}^*(K^*) = \int_{\alpha_1^*(K^*)}^{\bar{\alpha}^*} (\alpha^* - 2K^*)\,\mathrm{d}F(\alpha^*) + \int_{\alpha_3^*(K^*)}^{\alpha_2^*(K^*)} (\alpha^* - \bar{P} - 2(K^* - \hat{x}^*))\,\mathrm{d}F(\alpha^*)$$

$$+ [F(\alpha_1^*(K^*)) - F(\alpha_3^*(K^*))]\bar{P} - r^* = 0, \tag{11}$$

$$\mathrm{E}\,\pi_{K^*K^*}^*(K^*) = -2\{[1 - F(\alpha_1^*(K^*))] + [F(\alpha_2^*(K^*)) - F(\alpha_4^*(K^*))]$$

$$+ [F(\alpha_4^*(K^*)) - F(\alpha_3^*(K^*))]$$

$$- [\alpha_4^*(K^*) - \alpha_3^*(K^*)] f(\alpha_3^*(K^*))\} < 0,$$

where $\alpha_4^*(K^*) \equiv 2(K^* - \hat{x}^*)$.

Expression (11) implicitly defines the expected profit-maximizing foreign capacity choice in the presence of domestic antidumping law, K_1^*, provided that the second-order condition is met. The second-order condition holds if the distribution of demand shocks satisfies

$$[F(\alpha_4^*(K^*)) - F(\alpha_3^*(K^*))] > [\alpha_4^*(K^*) - \alpha_3^*(K^*)] f(\alpha_3^*(K^*)), \tag{12}$$

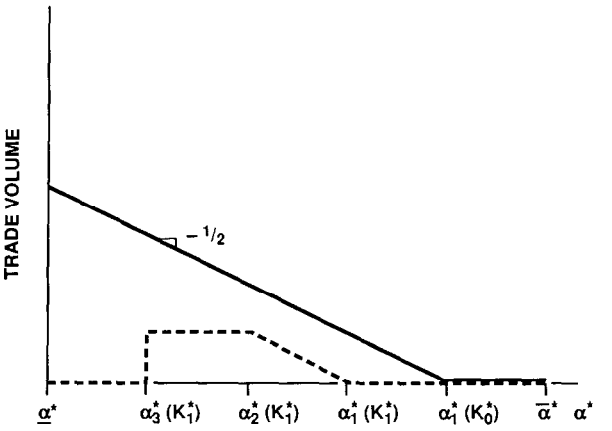

Fig. 1

an assumption we maintain throughout.[16]

Finally, to compare the foreign capacity choice in the presence of domestic antidumping law to that in its absence, we evaluate the first-order condition for the foreign monopolist's problem in the absence of domestic antidumping law at the optimal foreign capacity choice in the presence of the law K_1^*. Using (7) and (11), $\mathrm{E}\,\pi_{K^*}^*(K^* = K_1^*)$ reduces to

$$\mathrm{E}\,\pi_{K^*}^*(K^* = K_1^*) = -\int_{\alpha_3^*(K_1^*)}^{\alpha_2^*(K_1^*)} (\alpha^* - \bar{P} - \alpha_4^*(K_1^*))\,\mathrm{d}F(\alpha^*) + F(\alpha_3^*(K_1^*))\cdot\bar{P},$$

which, using the definitions of $\alpha_2^*(K^*)$, $\alpha_4^*(K^*)$ and $\alpha_3^*(K^*)$, is strictly positive. Thus, $K_1^* < K_0^*$; the introduction of domestic antidumping law leads the foreign monopolist to scale back its capacity choice.

We conclude that the presence of antidumping law has an impact on the volume of foreign exports even when suits are not filed; foreign export volume is strictly lower in the presence of domestic antidumping law than in its absence for all $\alpha^* \in [\underline{\alpha}^*, \alpha_1^*(K_0^*)]$. Nevertheless, the actual filing of suits and the imposition of duties occurs only in low foreign demand states, $\alpha^* \in [\underline{\alpha}^*, \alpha_3^*(K_1^*)]$, and is associated with large foreign excess capacity.

This is summarized in fig. 1, where foreign export volume is plotted against realizations of α^*. The solid line represents foreign export volume in the absence of domestic antidumping law. For $\alpha^* \in [\alpha_1^*(K_0^*), \bar{\alpha}^*]$, foreign

[16]This condition will be met, for example, by any symmetric unimodal distribution, provided that in equilibrium the foreign monopolist sets capacity K_1^* at a level at which it does not *expect* to dump more than $\hat{x}^*$ on the foreign market, i.e. will only dump more than $\hat{x}^*$ if the realization of α^* is below its expected value.

demand is sufficiently strong to eliminate excess foreign capacity completely, and foreign exports are zero. For $\alpha^* \in [\underline{\alpha}^*, \alpha_1^*(K_0^*))$, trade volume rises monotonically as α^* falls. The dashed line represents foreign export volume in the presence of domestic antidumping law. With the law's introduction, foreign capacity falls, $K_1^* < K_0^*$, and thus so too does $\alpha_1^*(K^*)$. Since for $\alpha^* \in [\alpha_1^*(K_1^*), \bar{\alpha}^*]$ the strength of foreign demand is sufficient to eliminate exports, trade volume has been reduced as a result of the existence of the law over the range $\alpha^* \in [\alpha_1^*(K_1^*), \alpha_1^*(K_0^*))$ as depicted by the dashed line in fig. 1, even though no suits are filed nor duties levied for α^* in this range. The same is true over the range $\alpha^* \in [\alpha_2^*(K_1^*), \alpha_1^*(K_1^*))$, where trade volume is now rising as α^* falls at the same rate as without the law. For $\alpha^* \in [\alpha_3^*(K_1^*), \alpha_2^*(K_1^*))$, trade volume is flat in the presence of domestic antidumping law, as the foreign monopolist adjusts its foreign price below the unconstrained foreign monopoly price to maintain exports at a level just below that which would trigger a suit by domestic firms. Finally, for $\alpha^* \in [\underline{\alpha}^*, \alpha_3^*(K_1^*))$ dumping suits are actually filed, duties are levied, and exports are precluded.

4.2. *Self-enforcing agreements*

Thus far we have maintained the assumption that domestic firms correctly infer that the foreign monopolist will attempt to export to the domestic market its entire export capacity in any period. Within this setting we have shown that the existence of domestic antidumping law will reduce exports over a wide range of foreign demand realizations, even though antidumping suits will be filed and duties levied only in periods of sufficiently soft foreign demand. A natural question, however, is why suits should be filed at all, since the equilibrium that results is clearly Pareto-dominated by an equilibrium without filing.

We now explore the extent to which self-enforcing agreements between the foreign monopolist and the domestic industry alter the circumstances under which antidumping suits will be filed and ask how trade volume will be affected by the possibility of such arrangements. We consider the most-cooperative equilibrium that is sustainable by the threat to forever revert to the noncooperative play characterized in the previous subsection if any player is observed to cheat on the agreement. The agreement takes the form of a promise from the foreign firm to limit exports as a function of α^* in exchange for a promise from the domestic industry not to file in that period. The most-cooperative agreement puts this kind of arrangement in place over the widest sustainable range of α^*'s.[17]

[17]Our focus on the most-cooperative equilibrium sustainable by the threat of infinite Nash reversion can be justified on the grounds that communication among foreign and domestic firms is protected from U.S. antitrust proceedings under the Noerr–Pennington Doctrine [see Prusa (1988)]. Thus, coordination on the most-cooperative equilibrium could occur the first time a suit was filed.

In any self-enforcing arrangement of this type between the foreign monopolist and domestic firms, each party to the agreement must in each period find that cooperating and preserving the agreement into the future is preferable to taking the one-time gain from defection and thereafter playing noncooperatively. But the free-entry conditions in the domestic industry ensure that, in equilibrium, domestic firms make zero profits in the future whether the future involves cooperative or noncooperative play.[18] Thus, in order for domestic firms to cooperate, i.e. not file antidumping suits, they must be given no one-time gain from defecting from the agreement and filing a suit. Thus, the domestic incentive constraint requires that foreign exports be limited to an amount no greater than $\hat{x}^*$ in any period for which the agreement is in force.

It is clear that there is nothing to gain from such an agreement for $\alpha^* \in [\alpha_2^*(K^*), \bar{\alpha}^*)$, since the foreign monopolist's unconstrained exports are less than $\hat{x}^*$ in this range of α^*'s. Moreover, even when the agreement to restrict exports to $\hat{x}^*$ is binding, the foreign monopolist would choose to sell its entire remaining capacity, $K^* - \hat{x}^*$, on the foreign market provided that $\alpha^* \in [\alpha_4^*(K^*), \alpha_2^*(K^*)]$, since marginal revenue on the foreign market evaluated at $K - \hat{x}^*$ is $[\alpha^* - 2(K^* - \hat{x}^*)]$, which is strictly positive for $\alpha^* \in (\alpha_4^*(K^*), \alpha_2^*(K^*)]$ and zero at $\alpha_4^*(K^*)$. Thus, for $\alpha^* \in [\alpha_4^*(K^*), \alpha_2^*(K^*)]$, the foreign monopolist will set the foreign price at $\hat{P}^*(\alpha^*; K^*)$ as long as its exports are limited to $\hat{x}^*$, even if it is not constrained to sell $K^* - \hat{x}^*$ in the foreign market.

The potential benefit to the foreign monopolist from striking such an agreement comes from α^* in the range given by $\alpha^* \in [\underline{\alpha}^*, \alpha_4^*(K^*)]$. For α^* in this range, the foreign monopolist would ideally export $\hat{x}^*$ at a domestic price $\bar{P}$ and set its unconstrained foreign monopoly price in the foreign market, $\dot{P}^*(\alpha^*)$, agreeing not to export the remaining capacity, $x^*(\alpha^*; K^*, \dot{P}^*(\alpha^*)) - \hat{x}^*$. The question is: Over what range of α^*'s can this kind of arrangement be sustained?

For $\alpha^* \in [\underline{\alpha}^*, \alpha_4^*(K^*)]$, the foreign monopolist's one-time gain from defection, i.e. exporting its entire export capacity $x^*(\alpha^*; K^*, \dot{P}^*(\alpha^*))$ at a price (just below) $\bar{P}$ rather than the agreed upon $\hat{x}^*$, is given by

$$\Omega^*(\alpha^*; K^*, \dot{P}^*(\alpha^*)) \equiv \bar{P} \cdot [x^*(\alpha^*; K^*, \dot{P}^*(\alpha^*)) - \hat{x}^*] = (1/2)[\alpha_4^*(K^*) - \alpha^*] \cdot \bar{P}. \quad (13)$$

[18]This being the case, a natural question is: Why is cooperation pursued at all by domestic firms? The answer is that, while domestic entry and exit drives 'long-run' equilibrium profits to zero, cooperation is nonetheless profitable to domestic firms in the 'short run', that is, after domestic capacity is set for the period. Hence, domestic entry will anticipate the incentive to cooperate once capacity is set, and will ensure that domestic firms earn zero profits under cooperation, and that they would make losses absent cooperation. For an analogous line of reasoning, see Brander and Spencer (1985). Note also that this reasoning does not apply to collusion over price in this model, since domestic firms would always defect from any P above $\bar{P}$.

From (13), the foreign monopolist's temptation to cheat on the arrangement is falling monotonically in α^*. But under our assumption that the realizations of α^* are independent over time, the present discounted value to the foreign monopolist of future cooperation, which we denote by $\omega^*(\cdot)$, is independent of the current realization of α^*. This implies that, if cooperation at $\dot{P}^*(\alpha^*)$ is unsustainable over some range of α^*'s, it will be for low α^*'s that no sustainable agreement exists at this foreign price. Fixing the value of $\omega^*(\cdot)$ for the moment and assuming that agreements at $\dot{P}^*(\alpha^*)$ are not sustainable over all $\alpha^* \in [\underline{\alpha}^*, \bar{\alpha}^*]$, we define $\alpha_5^*(K^*, \omega^*)$, the value of α^* below which agreements involving $\dot{P}^*(\alpha^*)$ cannot be sustained, by $\Omega^*(\alpha_5^*; K^*, \dot{P}^*(\alpha_5^*)) = \omega^*$. Explicit calculation yields $\alpha_5^*(K^*, \omega^*) \equiv \alpha_4^*(K^*) - 2\omega^*/\bar{P}$.

For $\alpha^* \in [\underline{\alpha}^*, \alpha_5^*(K^*, \omega^*)]$, agreements at $\dot{P}^*(\alpha^*)$ are not sustainable. However, this does not mean that cooperation need break down for α^* in this range. The foreign monopolist can pursue a cooperative suit-avoidance strategy by lowering its foreign price below $\dot{P}^*(\alpha^*)$ as α^* drops below $\alpha_5^*(K^*, \omega^*)$, thereby reducing its excess capacity and preventing the foreign incentive constraint from being violated. For $\alpha^* \in [\underline{\alpha}^*, \alpha_5^*(K^*, \omega^*)]$, the highest foreign price $\check{P}^*(\alpha^*; K^*, \omega^*)$ that keeps the agreement at α^* intact is defined implicitly by $\Omega^*(\alpha^*; K^*, \check{P}^*) = \omega^*$. Explicit calculation yields $\check{P}^*(\alpha^*; K^*, \omega^*) = \hat{P}^*(\alpha^*; K^*) + \omega^*/\bar{P}$. For any α^* below $\alpha_5^*(K^*, \omega^*)$, the foreign monopolist must choose between cooperative revenues under the suit avoidance price, $\check{P}(\alpha^*; K^*, \omega^*)$, given by

$$R^*(\alpha^*; K^*, \omega^*) = \check{P}(\alpha^*; K^*, \omega^*) \cdot D^*(\alpha^*; \check{P}(\alpha^*; K^*, \omega^*)) + \bar{P}\hat{x}^*,$$

and those under the alternative strategy of setting the foreign monopoly price, $\dot{P}^*(\alpha^*)$, and facing a dumping suit, which are given by $R^*(\alpha^*) = \dot{P}^*(\alpha^*) \cdot D^*(\alpha^*; \dot{P}^*(\alpha^*))$. To determine the range over which each of these prices will be implemented, we define $\alpha_6^*(K^*, \omega^*) \equiv \alpha_5^*(K^*, \omega^*) - 2\sqrt{\bar{P}\hat{x}^*}$ and note that $\alpha_6^*(K^*, \omega^*) > \underline{\alpha}^*$ if and only if $\omega^* < \bar{P}[K^* - \hat{x}^* - \underline{\alpha}^*/2 - \sqrt{\bar{P}\hat{x}^*}] \equiv \bar{\omega}^*(K^*)$. Then it is readily shown that, for $\omega^* < \bar{\omega}^*(K^*)$, cooperation is sustained with a price $\check{P}^*(\alpha^*; K^*, \omega^*)$ over the range $\alpha^* \in [\alpha_6^*(K^*, \omega^*), \alpha_5^*(K^*, \omega^*)]$, while the foreign monopolist chooses the foreign monopoly price, $\dot{P}^*(\alpha^*)$, and faces dumping suits over $\alpha^* \in [\underline{\alpha}^*, \alpha_6^*(K^*, \omega^*))$.

Summarizing for a given foreign capacity level, agreements of a self-enforcing nature which stipulate that some foreign capacity remain unused will affect equilibrium behavior over the range $\alpha^* \in [\alpha_6^*(K^*, \omega^*), \alpha_4^*(K^*)]$. For $\alpha^* \in [\alpha_5^*(K^*, \omega^*), \alpha_4^*(K^*)]$, such arrangements permit the foreign monopolist to continue to pursue a suit-avoidance strategy (limit exports to $\hat{x}^*$) without distorting foreign prices from the monopoly level; the monopolist operates with unused capacity, with the commitment not to use it being the focus of the agreement. For $\alpha^* \in [\alpha_6^*(K^*, \omega^*), \alpha_5^*(K^*, \omega^*)]$, the foreign monopolist

reduces the foreign market price to maintain its unused capacity at a level that is incentive compatible, but continues to avoid antidumping suits by holding exports to $\hat{x}^*$. Finally, for $\alpha^* \in [\underline{\alpha}^*, \alpha_6^*(K^*, \omega^*)]$ no agreement is sustainable and antidumping suits are filed, while for $\alpha^* \in [\alpha_4^*(K^*), \bar{\alpha}^*]$ there is no role for unused capacity and hence agreements are not relevant.

Still treating ω^* as a parameter for the moment and assuming that $\omega^* < \bar{\omega}^*(K^*)$, we can now write down expected foreign monopoly profits under cooperation as

$$\mathrm{E}\,\pi^{*c}(K^*; \omega^*) = \int_{\underline{\alpha}^*}^{\bar{\alpha}^*} R^*(\alpha^*; K^*, \omega^*)\,\mathrm{d}F(\alpha^*) - r^*K^*. \tag{14}$$

The first- and second-order conditions of (14) are given by

$$\begin{aligned}\mathrm{E}\,\pi^{*c}_{K^*}(K^*; \omega^*) = &\int_{\alpha_1^*(K^*)}^{\bar{\alpha}^*} (\alpha^* - 2K^*)\,\mathrm{d}F(\alpha^*) + \int_{\alpha_4^*(K^*)}^{\alpha_2^*(K^*)} (\alpha^* - \bar{P} - \alpha_4^*(K^*))\,\mathrm{d}F(\alpha^*) \\ &+ \int_{\alpha_6^*(K^*, \omega^*)}^{\alpha_5^*(K^*, \omega^*)} (\alpha^* - \bar{P} - \alpha_5^*(K^*, \omega^*))\,\mathrm{d}F(\alpha^*) \\ &+ [F(\alpha_1^*(K^*)) - F(\alpha_4^*(K^*)) + F(\alpha_5^*(K^*, \omega^*)) \\ &- F(\alpha_6^*(K^*, \omega^*))]\bar{P} - r^* = 0\end{aligned} \tag{15}$$

and

$$\begin{aligned}\mathrm{E}\,\pi^{*c}_{K^*K^*}(K^*, \omega^*) = &-2\{[1 - F(\alpha_1^*(K^*))] + [F(\alpha_2^*(K^*)) - F(\alpha_4^*(K^*))] \\ &+ [F(\alpha_5^*(K^*, \omega^*)) - F(\alpha_6^*(K^*, \omega^*))] \\ &- [\alpha_5^*(K^*, \omega^*) - \alpha_6^*(K^*, \omega^*)] f(\alpha_6^*(K^*, \omega^*))\} < 0.\end{aligned}$$

Expressions (15) implicitly define the foreign capacity choice as a function of ω^* in the most-cooperative equilibrium, $K_2^*(\omega^*)$, provided second-order conditions are met. Analogous to (12), the second-order condition holds if the distribution of demand shocks satisfies

$$\begin{aligned}&[F(\alpha_5^*(K^*, \omega^*)) - F(\alpha_6^*(K^*, \omega^*))] \\ &\quad > [\alpha_5^*(K^*, \omega^*) - \alpha_6^*(K^*, \omega^*)] f(\alpha_6^*(K^*, \omega^*)).\end{aligned} \tag{16}$$

When $\omega^* = 0$, so that no cooperation is sustainable, (16) collapses to (12).

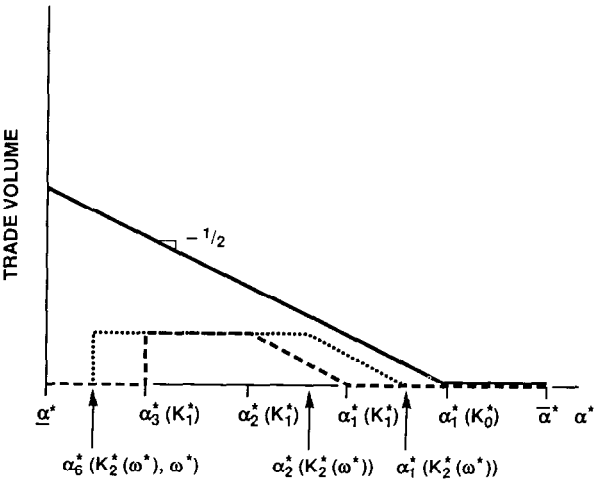

Fig. 2

More generally, (16) is simply the analogue to (12) for all $\omega^* \geqq 0$. As before, we maintain the assumption that (16) holds throughout the analysis.

Using (11) and (15), and the fact that $\alpha_5^*(K^*, \omega^*=0)=\alpha_4^*(K^*)$ and $\alpha_6^*(K^*, \omega^*=0)=\alpha_3^*(K^*)$, it is straightforward to show that $K_2^*(\omega^*=0)=K_1^*$. Moreover, with $\mathrm{E}\,\pi^{*c}_{K^*K^*}(K^*, \omega^*)<0$, the effect of an increase in ω^* on $K_2^*(\omega^*)$ has the same sign as $\mathrm{E}\,\pi^{*c}_{K^*\omega^*}(K^*, \omega^*)$, which is given by

$$\mathrm{E}\,\pi^{*c}_{K^*\omega^*}(K^*, \omega^*)=\frac{2}{\bar{P}}\{[F(\alpha_5^*(K^*, \omega^*))-F(\alpha_6^*(K^*, \omega^*))]$$

$$-[\alpha_5^*(K^*, \omega^*)-\alpha_6^*(K^*, \omega^*)]f(\alpha_6^*(K^*, \omega^*))\}.$$

By (16), this is positive. Thus, for $\omega^*>0$, we have $K_0^*>K_2^*(\omega^*)>K_1^*$.

Fig. 2 illustrates the effect of self-enforcing agreements on equilibrium trade volume by comparing export volume in the absence of antidumping law (solid line) to that in its presence without agreements (dashed line) and with agreements (dotted line). As depicted, the direct impact of such agreements is to raise trade volume from zero to $\hat{x}^*$ over the range $\alpha^* \in [\alpha_6^*(K_2^*(\omega^*), \omega^*), \alpha_3^*(K_1^*)]$ since antidumping suits are avoided over this region as a result of the arrangement. However, there is also an indirect effect of the agreements that works through the impact on foreign capacity choice, and this raises trade volume over the range $\alpha^* \in [\alpha_2^*(K_1^*), \alpha_1^*(K_2^*(\omega^*))]$. Also, note that, as in the absence of agreements, any dumping suits that occur will be associated with the lowest range of α^*'s.

Finally, we have treated ω^* as a parameter when in fact it is a function of the degree of cooperation. Thus, we must solve for a fixed point. Defining the present discounted value to the foreign monopolist of maintaining the agreement, as a function of ω^*, as

$$\omega_1^*(\omega^*)=\frac{\delta}{1-\delta}\{\mathrm{E}\pi^*(K_2^*(\omega^*);\omega^*)-\mathrm{E}\,\pi^*(K_1^*)\} \tag{17}$$

with δ the foreign discount factor, it is readily shown that: (i) $\omega_1^*(\omega^*=0)=0$, (ii) $\omega_1^{*\prime}(\omega^*=0)>1$ provided that $\bar{P}$ is sufficiently small relative to δ, and (iii) $\omega_1^{*\prime\prime}(\omega^*)<0$, provided condition (16) holds.

By (i), one fixed point exists with $\omega^*=0$, representing continual play of the noncooperative (no agreements) game. Moreover, under conditions (i), (ii) and (iii), a unique strictly positive fixed point $\omega_2^*>0$ exists with self-enforcing agreements put in place over some range of α^*'s. If δ is not too large, then $\omega_2^*<\bar{\omega}^*(K_2^*(\omega_2^*))$ and cooperation cannot be sustained over the entire range of α^*'s, so that suits will be filed in states of sufficiently soft foreign demand.

5. Illustrative model solutions

To provide some assessment of the quantitative impact of antidumping law, we selected parameter values satisfying all of our restrictions and computed the resulting equilibrium magnitudes under the three environments: no antidumping law, antidumping law without agreements, and antidumping law with agreements. We specify α^* as being drawn from a four-parameter beta distribution $B(p, q, \underline{\alpha}^*, \bar{\alpha}^*)$, where p and q determine the shape of the distribution and $\underline{\alpha}^*$ and $\bar{\alpha}^*$ are the lower and upper bounds on its support. Johnson and Kotz (1970) provide a complete discussion of how the values of p and q affect the shape of the beta distribution.

Table 1 lists the three model solutions for each of two sets of parameter values. For each solution we present the equilibrium foreign capacity choice, the expected dumping margin, the dumping frequency, the filing frequency, and the expected trade volume.[19] Three general conclusions emerge from the simulation results reported in the table, as well as from the many other simulations we ran but do not report. First, the introduction of antidumping law leads to a dramatic reduction in the expected trade volume despite the fact that dumping suits are rarely filed. This is true whether or not agreements are possible. This observation leads to the second point: the effects of antidumping law on trade volume are largely indirect, and stem

[19]The expected dumping margin is defined as $[\mathrm{E}_{\alpha^*}(P^*(\alpha^*))-\bar{P}]/\bar{P}$ conditional on the event that the foreign firm exports (possibly unsuccessfully), where $P^*(\alpha^*)$ is the foreign price as a function of α^* and $\mathrm{E}_{\alpha^*}(\cdot)$ is the expectation operator with respect to the distribution of α^*.

Table 1
Simulation results.

	Foreign capacity	Exp. dumping margin	Dumping freq.	Filing freq.	Exp. trade vol.
Simulation A[a]					
NDL	0.1967	62.6%	47.8%	–	0.0342
DLWOA	0.1646	27.2	35.8	0.978%	0.0017
DLWA	0.1650	27.7	35.9	0.001	0.0018
Simulation B[b]					
NDL	0.2196	111.2%	37.1%	–	0.0200
DLWOA	0.2017	77.6	29.8	0.884%	0.0013
DLWA	0.2019	78.1	29.9	0.103	0.0014

[a]Parameter values: $\underline{\alpha}^* = 0.21$; $\bar{\alpha}^* = 1.0$; $r = 0.20$; $r^* = 0.28$; $\delta = 0.996$; $p = 2$; $q = 2$; $F = 0.005$

[b]Parameter values: $\underline{\alpha}^* = 0.30$; $\bar{\alpha}^* = 1.0$; $r = 0.15$; $r^* = 0.25$; $\delta = 0.995$; $p = 2$; $q = 2$; $F = 0.005$.

Note: NDL = No dumping law; DLWOA = Dumping law without agreements; DLWA = Dumping law with agreements.

primarily from (i) the smaller foreign capacity choice, which reflects the increase in the cost of holding 'excess' capacity with the introduction of antidumping law, and (ii) the reallocation of foreign capacity away from exports in order to avoid antidumping suits. It is this suit-avoidance behavior that also helps account for the drop in the expected dumping margin with the introduction of antidumping law absent agreements. When agreements are not possible, this reallocation is accomplished by reducing the foreign market price to increase foreign market sales, and the lower foreign market price results in a lower dumping margin in the domestic market. Also contributing to the lower dumping margin is the optimally lower foreign market price that emerges in periods when suits are filed and the domestic market is foreclosed. The final point concerns the impact of agreements. As expected, agreements reduce the filing frequency, but they leave the expected trade volume largely unaffected. Their main effect is to permit the foreign monopolist to partially insulate the foreign market from its efforts to avoid antidumping suits; by allowing the foreign monopolist to hold unused capacity, such agreements allow exports to be restricted without the need to reduce the foreign market price in the process. Thus, these agreements raise the price to foreign consumers, as reflected in the higher dumping margins.

6. Conclusion

We have explored the impact of domestic antidumping law in an

environment where competitive firms face dumping from a foreign monopoly during periods of low foreign demand. We find that the availability of antidumping law in the domestic industry will serve to diminish the dumping activity of the foreign monopolist generally, whether or not a suit is filed in the period. We have also examined the possibility of tacit 'suit-avoidance' arrangements between the foreign monopolist and domestic industry. We find that such arrangements tend to reduce the range of foreign demand realizations over which antidumping suits are filed, and to increase the volume of foreign exports over a range of low foreign demand states directly because fewer suits are filed. Moreover, such arrangements will indirectly increase trade volume over a range of high foreign demand states because of the larger foreign capacity that results. By allowing the foreign monopolist to hold unused capacity in equilibrium, such agreements permit it to avoid antidumping suits without reducing its foreign market price in the process. Finally, if antidumping suits are filed by the domestic industry in the presence of such agreements, it will still be in periods for which foreign demand is sufficiently soft.

Appendix

In this appendix we ask whether there are additional domestic capacity choices other than $\hat{K}(x^*)$ which could yield zero domestic profits and thus also constitute equilibrium domestic entry behavior given foreign export capacity x^*. We can rule out any $K < \hat{K}(x^*)$ as a candidate equilibrium directly, since this would lead to positive domestic firm profits. This is seen by noting that, for $K < \hat{K}(x^*)$, $P(K + x^*) > P(\hat{K}(x^*) + x^*) \equiv \bar{P}$ so that any domestic firm naming $P(K + x^*)$ is guaranteed strictly positive profits.

To rule out $K > \hat{K}(x^*)$, we first observe that any pure strategy equilibria with $K > \hat{K}(x^*)$ and $P > 0$ must have all capacity being sold so that, with $K > \hat{K}(x^*)$, $P(K + x^*) < \bar{P}$ and domestic firm profits would be negative. However, we must also show that any mixed strategy equilibria that do exist with $K > \hat{K}(x^*)$ yield negative expected profits for domestic firms; then $K > \hat{K}(x^*)$ can be ruled out in equilibrium as well. To show this, we suppose to the contrary that a mixed strategy equilibrium exists with $K > \hat{K}(x^*)$ and domestic firms making non-negative profits. Then the lowest price played in equilibrium by any domestic firm must be no lower than $\bar{P}$, the break-even price for a domestic firm that sells its entire capacity. Thus, equilibrium expected revenues for the foreign monopolist must be no less than $\bar{P}x^*$ (and this must be true at every price named in its equilibrium strategy), because the foreign monopolist could always name $\bar{P}$ (or $\bar{P} - \varepsilon$ if domestic firms play $\bar{P}$ with positive probability) and sell its entire export capacity x^*. But this implies that the foreign monopolist would not name a price higher than $\bar{P}$ if at that price it would be undercut by all other firms with certainty. This is

because in naming such a price (say P^*), the foreign monopolist would obtain revenues of $P^*[D(P^*)-K] < P^*[D(P^*)-\hat{K}(x^*)] < \bar{P}[D(\bar{P})-\hat{K}(x^*)] = \bar{P}x^*$, where the inequalities follow from $P^* > \bar{P}$, $K > \hat{K}(x^*)$, and (2). Similar reasoning establishes the same result for domestic firms. Thus, since no firm is willing to play a price that all others will undercut with certainty, the highest price played in equilibrium must be played with positive probability by more than one firm. But this cannot be, since a slight reduction in this price would lead to strictly greater revenues (by selling strictly more with positive probability at a negligibly lower price). Thus, a mixed strategy equilibrium with $K > \hat{K}(x^*)$ and non-negative domestic profits cannot exist.

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