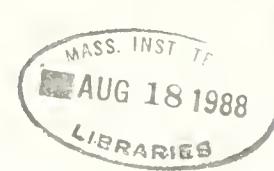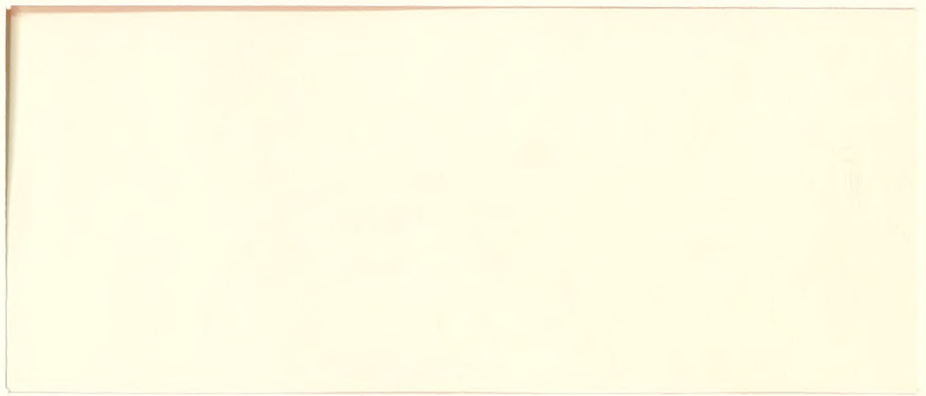WORKING PAPER
ALFRED P. SLOAN SCHOOL OF MANAGEMENT

TARIFFS VS. QUOTAS WITH IMPLICIT COLLUSION

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Working Paper #2004-88
Revised April 1988

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        We consider an infinite horizon setting in which
domestic and foreign firms achieve collusive outcomes by
threatening to punish deviators.  We show that in this
setting the standard results of Bhagwhati can be reversed
in that quotas promote competition while tariffs do not.

# I Introduction

As noted by Deardorff (1986) and others, tariffs have been gradually replaced by nontariff barriers such as quotas. He points out that the apparent preference of governments for these nontariff barriers is surprising given that in standard economic models tariffs are Pareto superior to quotas. In particular in static models with imperfect competition (Bhagwati (1965), Krishna (1985)), tariffs strictly dominate quotas since the latter tend to reduce competition in the domestic market. In this paper we show that this finding can be reversed when dynamic models of imperfect competition are considered. The imposition of an import quota by one country can reduce the price in the country that imposes the quota.

This somewhat paradoxical result emerges from a model of implicit collusion. In such a setting the firms in an industry sustain collusive prices by the threat that more competitive pricing will ensue if any firm deviates. In models of this type it is well known that the more powerful the threat, the more collusion that can be sustained.

Whether tariffs make collusion more difficult to sustain or not depends on the severity of the punishments that the firms can reasonably be expected to inflict on their cheating rivals. The maximal punishments of the style developed by Abreu (1986) involve an outcome in which the domestic firm earns zero profits[1]. This is because even with a very large tariff, the foreign firm can, if it is willing to tolerate the ensuing losses, charge a price so low that it makes it impossible for the domestic firm to earn profits at home. As a result, tariffs do not affect the ability of the duopoly to maintain monopolistic outcomes.

Contrast this with a quota.  There the maximum punishment the foreign firm can inflict on the domestic firm is to sell its entire quota.  This generally still yields positive profits for the domestic firm.  Thus since the domestic firm faces a lower punishment, it has a larger incentive to deviate from the monopolistic outcome.

In this case of maximal punishments, therefore, our results have the opposite implication of those of Bhagwati (1965).  In his classic paper he showed that a single domestic producer who faced a competitive foreign market would act more competitively with a tariff than with a quota.  When we consider a single domestic producer and a single foreign producer, the opposite result emerges.

In the next section we develop a simple model in which these ideas are presented.  Section III concludes.


## II Quotas vs. Tariffs with Price Competition

There are two countries, domestic and foreign.  We consider an oligopolistic industry with one domestic and one foreign firm. Alternatively a domestic and a foreign oligopoly can be envisaged where each oligopoly has enough instruments to enforce perfect collusion among its members.  Thus, we imagine a market such as that for cars or bicycles in the US were relatively few sellers foreign or domestic operate.  We assume that the domestic firm makes no sales abroad.  Marginal cost for domestic delivery is constant and equal to c for both firms.  The markets are segmented[2] so that consumers can only buy the good in their own country.  Finally, the goods sold by the two firms are viewed as perfect substitutes in the domestic market.  Demand is given by:

$$P = a - bQ \qquad\qquad (1)$$

where P is the industry price and Q is the sum of the amounts sold by the domestic and foreign firms.

Price is the strategic variable. If one firm quotes a price lower than the other, it supplies the entire market. If the two firms quote the same price any possible market division is feasible and market shares are also implicitly agreed upon.

We start by analyzing equilibrium under free trade. This equilibrium is the standard duopoly equilibrium in a repeated setting.[3] We assume that the firms try to sustain the monopoly price $(a+c)/2$ and that they each serve half the market.[4] Then, if neither firm deviates, each earns $(a-c)^2/4b$ per period. A deviating firm undercuts the price slightly and captures the entire market so that it earns twice this amount. However, after a deviation the firms are assumed to revert forever to the noncooperative equilibrium for the corresponding one-period game which has a price equal to the marginal cost c. So, each firm will be deterred from deviating as long as:

$$(a-c)^2/4b \leq \delta(a-c)^2/4b(1-\delta)$$

where the RHS of this equation represents the future profits that are given up by cheating and $\delta$ is the rate at which future profits are discounted. As long as $\delta$ equals at least 1/2, the monopoly price is sustainable.

We now consider the effect of a quota equal to $\epsilon(a-c)/b$ so that permissible imports are scaled by total sales under perfect competition. A quota where $\epsilon$ is 1 would allow the foreign firm to supply the amount demanded at a price equal to marginal cost.

Notice as an aside that any quota which is binding at the original equilibrium, i.e. which reduces the amount imported, raises

the standard measures of domestic welfare. This is so because, even if the price remains at (a+c)/2, the domestic firm having higher sales, now earns higher profits. Domestic welfare is only increased further if the price actually falls[5]. Since the national identity of firms is a slippery concept, however, we focus mainly on the competition-enhancing affects of quotas.

We begin studying the equilibrium with quotas by analyzing the punishments for deviating from the implicitly collusive understanding. We start by assuming, partly for simplicity, that firms revert to the one shot Nash equilibrium if any firm deviates from the collusive understanding. We later argue that, for quotas, the use of maximal punishments as in Abreu (1986) would not affect the conclusion that quotas enhance competition.

The static one-shot game to which firms revert when they are punishing each other has no pure strategy equilibrium. Kreps and Scheinkman (1983) present a mixed strategy equilibrium which Osborne and Pitchik (1986) show to be the unique equilibrium. The salient features of this equilibrium are:

(i) The highest price charged by both firms is [a+c-$\epsilon$(a-c)]/2.

(ii) The lowest price charged is

$$\sigma = (a+c)/2 - (a-c)(2\epsilon-\epsilon^2)^{1/2}/2 \qquad (2)$$

and it is charged by both firms with probability zero

(iii) In equilibrium, the domestic firm has expected profits of $(a-c)^2(1-\epsilon)^2/4b$ per period while those of the foreign firm equal $\epsilon(\sigma-c)(a-c)/b$.

Notice that this static equilibrium has the features of the differentiated products model of Krishna (1986). A higher quota (a higher $\epsilon$) lowers both the highest and lowest price charged. Kreps

and Scheinkman (1984) show that the entire distribution of prices is stochastically dominated by that with a lower quota.

At this equilibrium the domestic firm earns a present value of $(a-c)^2(1-\epsilon)^2/4b(1-\delta)$. What must be noted is that the domestic firm can never earn less than this present discounted value of profits at any equilibrum; even the one involving maximal punishments. The reason for this is that the domestic firm can guarantee for itself that it will earn $(a-c)^2(1-\epsilon)^2/4b$ per period by posting a price equal to $[a+c-\epsilon(a-c)]/2b$. This limit on the punishability of the domestic firm is what gives quotas their ability to break the monopoly price.

With the value of the punishments in hand we now turn to the analysis of the repeated game. The price preferred by the domestic firm continues to be $(a+c)/2$ while the foreign firm, which is subject to a quota, naturally prefers a higher price. Yet we concentrate on the question of whether the duopoly can sustain the "monopoly" price of $(a+c)/2$. We do this because higher prices are more difficult to sustain and we wish to ascertain whether a quota lowers equilibrium prices from their free trade level of $(a+c)/2$.

The incentives to deviate depend on the amount the foreign firm is expected to sell at this price. We assume it is supposed to sell $\mu(a-c)/b$ $(0<\mu<1)$ in the collusive arrangement. Then, by going along with the collusive arrangement, its profits are $\mu(a-c)^2/2b$. Instead, if it deviates by undercutting the price slightly, it sells either total demand or its entire quota at a price essentially identical to $(a+c)/2$. We analyze separately the case in which $\epsilon\leq1/2$ so that it sells its entire quota, and the case in which $\epsilon>1/2$, so that it sells $(a-c)/2b$.

Consider first the former case. By deviating, the foreign firm

earns $\epsilon(a-c)^2/2b$. It will thus choose to deviate unless:

$$(\epsilon - \mu)/2 \leq \delta[\mu - \epsilon + \epsilon(2\epsilon - \epsilon^2)^{1/2}]/2(1-\delta)$$

or:

$$\mu \geq \epsilon - \delta\epsilon(2\epsilon - \epsilon^2)^{1/2}. \tag{3}$$

Note that for small $\epsilon$, $\mu$ must essentially equal $\epsilon$. The foreign firm knows that the price will roughly equal $(a+c)/2$ whether it goes along or is being punished[6]. Thus it deviates unless it is allowed to sell essentially its entire capacity.

Now consider the domestic firm. If it goes along it sells $(a-c)(1/2 - \mu)/b$ at the monopoly price of $(a+c)/2$, while if it cheats it can sell $(a-c)/2b$ at that price. On the other hand it earns only $(a-c)^2(1-\epsilon)^2/4b$ per period after cheating. Thus the domestic firm is deterred from price-undercutting if:

$$\mu \leq \delta\epsilon - \delta\epsilon^2/2. \tag{4}$$

Equation (4), which is valid also when punishments are maximal, shows that $\mu$ must be relatively small if the domestic firm is to be deterred from cheating since higher levels of $\mu$ make cheating more attractive without increasing its cost to the firm.

If (3) and (4) contradict one another the monopoly price is not sustainable. This occurs when:

$$\epsilon\{ 1 - \delta - \delta[(2\epsilon - \epsilon^2)^{1/2} - \epsilon/2]\} \leq 0. \tag{5}$$

For $\epsilon$ small enough we can neglect the term in square brackets and the condition is clearly violated. When $\epsilon$ is small enough we saw that the foreign firm must be allowed to sell essentially its entire quota. But the domestic firm always requires that $\mu$ be smaller than $\delta\epsilon$ which is strictly smaller than $\epsilon$.[7]

For $\epsilon$ between 0 and 1 the term in brackets is positive. The term in square brackets is increasing in $\epsilon$ until $\epsilon$ reaches .553. Yet this analysis is only relevant for $\epsilon$ up to 1/2. For this

8

maximal applicable $\epsilon$, $\delta$ must exceed about .62 for (5) to be satisfied.

Now consider the case in which $\epsilon$ exceeds 1/2 so that when the foreign firm cheats it earns $(a-c)^2/4b$. Then the foreign firm will cheat unless:

$$\mu \geq (1-\delta)/2 + \delta\epsilon - \delta\epsilon(2\epsilon - \epsilon^2)^{1/2}. \tag{6}$$

which must now be satisfied together with (4) for monopolization to be feasible. Combining the two equations:

$$(1-\delta)/2 \leq \delta\epsilon(2\epsilon - \epsilon^2)^{1/2} - \delta\epsilon^2/2. \tag{7}$$

For $\epsilon$ equal one, that is when the foreign firm can sell the entire quantity demanded at the competitive price, (7) requires that $\delta$ exceed 1/2 as it did under free trade. Since the RHS of (7) is strictly increasing in $\epsilon$, the level of $\delta/(1-\delta)$ (and thus of $\delta$) required to make (7) hold, falls strictly when $\epsilon$ rises.

To summarize, more restrictive quotas (starting at a quota which allows the foreign firm to sell the entire amount demanded at the competitive price) monotonically reduce the ability to monopolize the market. Note that, for a given $\delta$, the quota that gives the minimum price in the domestic market is strictly smaller than the one which satisfies (5) (or (7)) with equality. When these equations hold with equality, monopoly is just sustainable. For lower values of $\epsilon$, the price falls. However, if the quota is reduced significantly more, the price starts rising again as the prices charged even in the one-shot game rise. For $\epsilon$ equal to zero, the monopoly price is reestablished.

It must be pointed out again that the increased competition brought about by quotas is not sensitive to the use of one-shot Nash punishments. For instance even if deviations by the foreign firm lead this firm to earn zero profits from then on (which for low $\epsilon$ is

a much harsher punishment than the maximal punishment) the foreign firm will require that $\mu$ equal at least $(1-\delta)\epsilon$ so as to refrain from deviating. This is inconsistent with (5) for any positive $\epsilon$ with $\delta$ equal to 1/2.

We now briefly consider tariffs. A tariff simply raises the costs of the foreign firm relative to those of the domestic firm. The repeated game in which the two firms have different costs has been analyzed by Bernheim and Whinston (1986), who consider optimal punishments in the style of Abreu (1986). Then, both the domestic and foreign firms still earn zero profits when they are being punished. So, the incentives to deviate from the price (a+c)/2 do not change as a result of the tariff. Moreover, Bernheim and Whinston (1986) show that the equilibrium that involves the highest profits for the duopoly as a whole now has a price higher than (a+c)/2. This occurs because the profit maximizing price from the point of view of the foreign firm is now higher. So a tariff has the potential for increasing the domestic price above the monopoly price.

Thus, in the case of maximal punishments the classic results of Bhagwati (1965) about competition between a foreign and a domestic firm, are precisely reversed. A quota, because it makes it impossible for the domestic firm to be punished effectively, makes it difficult to collude, while a tariff has no such consequence. This raises the intriguing possibility that this is the reason governments seem to prefer quantitative restrictions to tariffs[8].

However, it must be pointed out that the robustness of the monopoly outcome with respect to a tariff is sensitive to the use of maximal punishments. If instead, reversions to the Bertrand outcome are used, a tariff which raises the foreign firm's costs barely

below the monopoly price of (a+c)/2 makes the monopoly price
unsustainable. The reason for this is that to maintain this price
the domestic firm must give a sizeable fraction of the market $(1-\delta)$
to the foreign firm. Thus if the foreign firm's costs are near
(a+c)/2 the domestic firm will actually earn more during the period
of punishment (when it charges a price barely below the foreign
firm's costs) than when it goes along with the monopoly price.

There is another contrast between tariffs and quotas which does
not depend on maximal punishments and which makes certain quotas
more attractive from a policy viewpoint. Consider quotas which
allow imports to equal their free trade level. Under perfect
competition such quotas would be equivalent to a tariff of zero and
irrelevant. In our setting, these quotas, which set $\epsilon$ equal to 1/4,
make the monopoly price less sustainable and are thus attractive.
Tariffs of zero could not achieve this result. Positive tariffs
could also not be relied on in the presence of maximal punishments.
With reversions to Bertrand competition positive tariffs could lead
to the same price as our "free trade" quota. Yet, such tariffs
represent a policy whose attractiveness is less robust to model
specification since they would be unattractive under perfect
competition.

## III. Conclusions

Our simple model demonstrates that the standard conclusion
that, with imperfect competition, tariffs are superior to quotas is
very sensitive to the form of imperfect competition. Our model
differs from the classic treatment mainly in allowing the actions of
firms to depend on the history of their industry and yet it reverses

the conclusions.  Whether such dependence on history is relevant is of course an empirical question.  The evidence of Porter , Bresnahan, and Rotemberg and Saloner is at least consistent with the existence of this dependence.  Some further evidence consistent with the model presented here is presented in Feenstra (1985).  He shows that the "voluntary export restraint" established in April 1981 on japanese automobiles shipped to the US led to reductions in quality adjusted real prices of both japanese and american automobiles.

One natural question to ask is whether our conclusions are robust or whether they depend critically on the simplifying assumptions we have made.  This issue is explored at length in our working paper (Rotemberg and Saloner 1986b).  One question we pose is whether our results are sensitive to our assumption that the domestic firm sells only at home.  We show that, on the contrary, when it can sell in both countries the imposition of a quota can increase competition not only at home but also abroad.

A second issue which we explore is the sensitivity of the results to the use of price as the strategic variable.  When quantity is the strategic variable, and punishments take the form of reversion to the single period Nash equilibrium in quantities, punishments are milder and are relatively unaffected by quotas.  For this case we show that only very restrictive (i.e. very small) quotas raise competition; larger quotas actually enhance collusion. These results paralell Davidson's (1984) analysis of tariffs.  When quantity is the strategic variable small tariffs enhance collusion and very restrictive (i.e. very large) tariffs promote competition.

12

FOOTNOTES

1    This is proven by Mookerjee and Ray (1986) and Bernheim and Whinston (1986)

2    See Helpman (1982).

3    For the specific demand and cost functions used here it is presented, for instance, in Rotemberg and Saloner (1986).

4    The first of these assumptions is not restrictive since, with constant demand, if the firms can sustain any collusive outcome, they can also sustain the monopoly outcome.  The second assumption is the division of the spoils that makes it easiest to collude.

5    The ability of tariffs to shift rents from foreign to domestic firms is considered in a static model by Brander and Spencer (1985).

6    This result does not depend on the use of one-shot Nash punishments and can be derived also with maximal punishments.  The reason for this is that, as mentioned above, the domestic firm can be sure to earn at least $(a-c)^2(1-\epsilon)^2/4b(1-\delta)$ at any equilibrum.  To make the foreign firm earn less than it does at the one-shot Nash equilibrium for at least one period it must charge a price v which is below $\sigma$.  It must then be compensated in later periods for taking this loss.  To obtain a lower bound on this price v we assume that, after taking this loss, the domestic firm earns the entire monopoly profits $(a-c)^2/4b$.  Then v must equal at least $(a+c)/2 - [(a-c)/b]\{\epsilon/2 + [\delta(2\epsilon-\epsilon^2)/(1-\delta)]^{1/2}\}$ so that, to first order the foreign firm earns $\epsilon(a+c)/2$ even when it is being punished.

7    Footnote 7 establishes that for $\epsilon$ small, $\mu$ must be essentially equal to $\epsilon$ for the foreign firm not to cheat even with maximal punishments.  Since (5) is valid in this case as well, monopoly is unsustainable for small $\epsilon$ even with maximal punishments.

8    For evidence on this fact and some alternative explanations see Deardorff (1986).

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