NBER WORKING PAPER SERIES

# THE ROLE OF EXPORT SUBSIDIES WHEN PRODUCT QUALITY IS UNKNOWN

Kyle Bagwell

Robert W. Staiger

Working Paper No. 2584

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 1988

NBER Working Paper #2584
May 1988

# The Role of Export Subsidies When Product Quality Is Unknown

ABSTRACT

We explore in this paper the role of export subsidies when goods arriving from foreign countries are initially of unknown quality to domestic consumers, who learn about their quality only through consumption. If, when confronted with such goods, consumers view price as a signal of quality, a role for export subsidies can arise. In particular, we show that absent export subsidies, entry of high quality firms may be blocked by their inability to sell at prices reflecting their true quality. Export subsidies enable high quality producers to begin exporting profitably even while unable to credibly convey their high quality to consumers in the "introductory" period. Thus, in breaking the entry barrier for high quality firms, export subsidies can raise average quality in the market and a welfare-improving role for export subsidies emerges. Moreover, even when high quality firms find it possible to signal their high quality to consumers through an introductory pricing strategy, a role for government policy can arise: the signal (low introductory price) represents a transfer of surplus from foreign producers to domestic consumers which, as we show below, can be avoided with an appropriate export tax/subsidy policy.

Robert W. Staiger
Department of Economics
Stanford University
Stanford, CA 94305

Kyle Bagwell
Department of Economics
Northwestern University
Evanston, IL 60208

# I. Introduction

Recent advances in the theory of international trade have shed new light on the reasons for and effects of export subsidies. One body of literature focuses on cross-market effects of export subsidies (see, for example, Kemp, 1966, 1969: Jones, 1967; Brecher and Feenstra, 1983: Feenstra, 1986: and Itoh and Miyoto, 1987). These models share the characteristic that the subsidy-induced terms-of-trade loss in one market is offset by a terms-of-trade gain in another, raising the possibility of national benefit from a policy of export subsidization. Another body of literature, as reviewed by Brander (1986), has focused primarily on the role of export subsidies as a means to "enhance the strategic position of domestic firms engaged in competition for world markets with foreign rivals" (p. 26). This "profit-shifting" motive has been the subject of a large number of recent articles.[1/]

We explore in this paper a different motive for export subsidies, based on the notion that goods arriving from foreign countries may initially be of unknown quality to domestic consumers, who learn about their quality only through consumption. Nelson (1970) refers to goods whose quality can be known only after they have been purchased as "experience goods." Examples of such goods would typically include technologically sophisticated consumer products, consumer durables, and services that have an element of custom design. If, when confronted with such goods, consumers view price as a signal of quality, a role for export subsidies can arise.

The notion that informational asymmetries provide a rationale for trade policy has been addressed by several previous authors.[2/] Donnenfeld, Weber, and Ben-Zion (1985) examined the welfare effects of minimum quality standards on imports which are of unknown quality to domestic consumers. Mayer (1984) explored the possibility of beneficial export subsidies in the presence of initially uniformed consumers, but did so without modeling explicitly the process of consumer learning and expectations formation. A paper whose methodology is more closely related to our own is that of Grossman and Horn (1986), who explore the possibility that infant-industry protection might be welfare-improving in a market for experience goods served initially by established foreign suppliers. While theirs is a model of both adverse selection and moral hazard, (temporary) protection is shown to be welfare-worsening, as it leaves unaffected the problem of moral hazard and exacerbates the problem of adverse selection. The latter effect occurs in their model because protection simply allows lower-than-average quality firms to enter, reducing the average quality of production in the market, and hence welfare.

In contrast, our model explores a situation in which, absent export subsidies, entry of <u>high</u> quality firms may be blocked by their inability to sell at prices reflecting their true quality: export subsidies enable high quality producers to begin exporting profitably even while unable to credibly convey their high quality to consumers in the "introductory" period. Thus, in breaking the entry barrier for high quality firms, export subsidies can raise average quality in the market

and a welfare-improving role for export subsidies emerges.[3] Moreover, even when high quality firms find it possible to signal their high quality to consumers through an introductory pricing strategy, a role for government policy can arise: the signal (low introductory price) represents a transfer of surplus from foreign producers to domestic consumers which, as we show below, can be avoided with an appropriate export tax/subsidy policy.

In one respect, the role played by export subsidies in the presence of uninformed consumers bears a fundamental resemblance to the profit-shifting motive noted above: in each case, export subsidies allow firms to precommit to actions that would be incredible absent the government intervention. In another respect, however, the two policies are quite different: while profit-shifting (and terms-of-trade shifting) subsidies are beggar-thy-neighbor policies, the export subsidies explored in this paper are pareto improving. As such, the implications that emerge for an appropriate domestic policy response to export subsidies differ markedly from those of the profit-shifting and terms-of-trade shifting models.

After developing the basic model in section II, we consider the effect of export subsidies in section III. Here we establish a welfare enhancing role for export subsidies both when a high quality exporter can distinguish itself from a low quality firm through its pricing strategy and when it can not. Section IV considers several extensions of the basic model, including the introduction of a correlation between product qualities of the exporting country, and the possibility of a

policy response by the government of the importing country. Section V concludes.

## II. The Model

### Basic Assumptions

There are two countries in the model, the foreign country and the domestic country. When a distinction is necessary, foreign country variables will be denoted by an asterisk (*). We focus first on the efforts of a single foreign firm to export its product to the domestic country. For simplicity, the foreign firm is assumed not to supply consumers in the foreign country. Nor do any domestic suppliers of the good exist. In addition, we assume that there is only a single potential buyer of the firm's product in the domestic country.[4/]

The foreign firm has a two-period life. The first period of the firm's life is its "introductory" phase, while the second period corresponds to a "mature" phase. The latter phase can be thought of as capturing the discounted profits of a possibly infinite future. The firm produces a product whose quality is either "high" or "low," where the firm's quality is determined exogenously at the beginning of its life according to a commonly known probability distribution. Accordingly, we define a quality index $q$ as:

$$q = \begin{cases} H & \text{if quality is high} \\ L & \text{if quality is low} \end{cases}$$

and the probability that the good is high quality as $\delta_H \equiv \text{Prob}\ (q=H)$.

It is perhaps easiest to imagine the firm engaging in an R&D effort which may produce a high quality good (with probability $\delta_H$) or may generate a "dud."[5/] The important point is that quality is not itself a choice variable--this is a model of adverse selection, not moral hazard.

We assume that the product is an experience good: while the consumers can learn quality perfectly after purchase, the quality of the product cannot be determined by inspection (see Nelson, 1970). The domestic consumer thus does not know the quality of the foreign firm's product as its introductory phase begins. He may, however, be able to infer its quality type from observed introductory pricing behavior, a point we take up below.[6/] In each period, the consumer chooses either to buy one unit of the product or not to buy it at all. With $U(q)$ and $C(q)$ defined respectively, as the utility of consuming one unit of a good of quality $q\varepsilon\{L,H\}$ and its unit cost of production, we assume that

$$U(H) > C(H) > C(L) > U(L) = 0. \qquad (1)$$

Thus, high quality production is relatively costly, the high quality good is worth its cost, and the low quality good is not: the product either "works" or it doesn't.[7/]

We assume that each foreign government has at its disposal a non distortionary means of redistributing income among its citizens, so that policies which increase (real) national income will increase national welfare. We also assume that trade intervention is fully observed by

all players in the game. Note that we do not assume the existence of capital market imperfections: thus, the role for intervention described below does not depend on borrowing constraints of any kind.

Finally, it is convenient though inessential to abstract from aggregate uncertainty. To do this, we consider replicating the single firm-consumer set up described above, and define a market as a collection of many such firm-consumer pairs. Each pair in the market is completely isolated from every other pair in every relevant sense, and quality realizations are unrelated across firms. This allows us to interpret $\delta_H$ both as the probability that any single firm in the market will be high quality, and as the proportion of firms in the market that are high quality. Since all firm-consumer pairs are ex-ante identical, and since all firms of a quality type are identical ex-post, we will use "the firm" and "the consumer" to refer to a representative firm (possibly of type q) and a representative consumer in the market.

The Order of Moves

We ignore government policy for the moment and describe the game between the foreign firm and the domestic consumer. The introductory phase for the foreign firm starts with the realization of its quality type: once determined, the game begins. The foreign firm moves first, choosing its introductory price $P_I^*$ knowing its quality type. Next, observing $P_I^*$ but not the realization of $q$, the domestic consumer forms a belief about the quality of the foreign product and chooses whether or not to buy.

The game advances to the mature phase only if a sale was made during the introductory phase.[8/] In this case, the domestic consumer has experience with the foreign product from his introductory phase consumption, and the quality of the product is known to him. The foreign firm chooses its mature phase price $P_m^*$ aware that the domestic consumer knows the quality of its product. Finally, knowing $q$ and observing $P_m^*$, the domestic consumer chooses whether or not to make a repeat purchase of the foreign good.

The Equilibrium Concept

We now proceed to define informally a sequential equilibrium (Kreps and Wilson, 1982) for the game. A sequential equilibrium is a coupling of strategies and beliefs such that 1) every player moves optimally at every information set given his beliefs and the equilibrium strategies of other players, and 2) at every information set reached on the equilibrium path, beliefs agree with Bayes' rule.

Some further notation will prove helpful. Let $P_I^*(H)$ and $P_I^*(L)$ be the respective introductory prices of a high and low quality firm. Let $b_I(P_I^*)$ be a consumer's introductory phase belief function: $b_I(P_I^*)$ gives the probability with which the domestic consumer believes a foreign firm charging an introductory price $P_I^*$ to be high quality.

Separation is said to occur in the introductory phase if $P_I^*(H) \neq P_I^*(L)$. In this case, the consumer can infer quality exactly after seeing the introductory price. To put the point differently, when $P_I^*(H) \neq P_I^*(L)$, Bayes' rule requires $b_I(P_I^*(H)) = 1$ and $b_I(P_I^*(L)) = 0$. When $P_I^*(H) = P_I^*(L) = P_I^*$, pooling occurs in the

introductory phase. Price reveals no information in this case. Beliefs must then be such that $b_I(P_I^*)$ equals the appropriate prior on high quality. As we consider only pure strategies, any sequential equilibrium will have either separation or pooling in the introductory phase.

Notice that the sequential equilibrium concept imposes no restrictions on beliefs off the equilibrium path: that is, if $P_I^* \notin \{P_I^*(H), P_I^*(L)\}$ is announced, then $b_I(P_I^*)$ is unrestricted. (Bayes' rule can not apply to zero probability events.) The specification of disequilibrium beliefs is nevertheless important: These beliefs determine the consumer's response to a deviant price and therefore determine the firm's incentive to charge a disequilibrium price. The freedom which the sequential equilibrium concept affords in the specification of disequilibrium beliefs generally leads to a multiplicity of equilibria. However, certain belief structures are more plausible than others, and in the remainder of this section we describe a refinement of the sequential equilibrium concept which leads us to focus on particular equilibria.[9/]

To this end, consider the mature phase of the game, supposing that the domestic consumer tried the product in the introductory phase. Sequential equilibrium then requires that $P_m^*(H) = U(H)$, $P_m^*(L) > 0$, and that the consumer buy in the mature phase if and only if $q = H$. The consumer therefore gets zero utility in the (complete information) mature phase, whether $q = H$ or $L$. Realizing that his future utility is always zero, a consumer has no "experimental" incentive in the

introductory phase to try the product in order to acquire information.[10] A rational consumer therefore maximizes instantaneous expected utility in each period.

Suppose then that a price $P_I^*$ is observed in the introductory phase. The consumer buys iff his instantaneous expected utility from doing so is positive, or

$$b_I(P_I^*)\,(U(H) - P_I^*) + (1-b_I(P_I^*))(0-P_I^*) \geq 0; \tag{2}$$

that is, a purchase occurs iff

$$b_I(P_I^*)\,U(H) \geq P_I^*. \tag{3}$$

Given $U(H)$, the line plotted in Figure 1 provides beliefs about quality that would satisfy (3) with equality for $P_I^* \in [0,U(H)]$. Now suppose also that pooling occurs, so that $b_I(P_I^*) = \delta_H$. Then using (3), the consumer buys in a pooling equilibrium iff

$$P_I^* \leq \delta_H U(H). \tag{4}$$

We argue now that, if the foreign firm is in a pooling equilibrium in which it makes an introductory phase sale, then

$$\tilde{P}_I^* \equiv \delta_H U(H) \tag{5}$$

is the "most reasonable" specification for the pooling price. To see why, suppose for the moment that $p^1$ is the equilibrium pooling price where

$$p^1 = P_I^*(H) = P_I^*(L) < \tilde{P}_I^* \tag{6}$$

as illustrated in Figure 1. Then it must be that $b_I(P^1) = \delta_H$. We have the following objection to such an equilibrium. For this equilibrium to hold, it must be that

$$b_I(\tilde{P}_I^*) < \delta_H = b_I(P^1) \tag{7}$$

Otherwise, both firm types would deviate to $\tilde{P}_I^*$ and increase profits with the higher price. With $P^1 < \tilde{P}_I^*$ by assumption, (7) only makes sense if the consumer believes that the low quality firm is relatively likely to charge the deviant price $\tilde{P}_I^*$. Yet each firm type has an incentive to deviate to $\tilde{P}_I^*$ iff the consumer decides to buy at that price.

The "reasonable" belief would thus seem to be $b_I(\tilde{P}_I^*) = \delta_H$. But a pooling equilibrium at $P^1 < \tilde{P}_I^*$ can not exist when $b_I(\tilde{P}_I^*) = \delta_H$ and so a pooling equilibrium at price $P^1$ can be argued "unreasonable." A related argument suggests that equilibria in which no trade occurs (as would be the case, for example, if $P^1 > \tilde{P}_I^*$) are also "unreasonable" provided that both firm types could make positive game profits with the deviant price $\tilde{P}_I^*$. 11/

The above discussion suggests the following restrictions: 1) If $P_I^*(H) = P_I^*(L)$ and a sale occurs in the introductory phase, then the introductory pooling price must be $\tilde{P}_I^*$; and 2) If both firm types could make positive game profits at the introductory price $\tilde{P}_I^*$, then an introductory phase sale must occur. In what follows, we refer to an equilibrium as a sequential equilibrium satisfying the above restrictions.12/

We employ these restrictions because they impart a standard of plausibility and because they simplify the exposition of the ensuing analysis. We note, however, that our results are not fundamentally dependent upon the proposed restrictions.

## III. The Role of Export Subsidies

In this section, we establish three basic results. First, in the absence of export subsidies, high quality firms may be unable to find buyers in the domestic market. Incomplete information about quality can therefore act as a barrier to welfare improving exports. Moreover, this barrier emerges even though fixed costs of production and competition from incumbent producers in the domestic country are absent: the high quality firms are unsuccessful because they cannot distinguish themselves from low quality firms. Second, with no private information about firm quality but with the ability to precommit to a tax/subsidy program over the two-period life of the firm, the foreign government can increase foreign welfare by undertaking an export tax/subsidy program which supports a separating equilibrium with only high quality firms exporting. Thus, as in the rent-shifting export subsidy literature, the ability of governments to precommit where firms are unable to do so can provide a rationale for government intervention. Third, even in the absence of the ability to precommit to a two-period policy, the foreign government may be able to raise foreign welfare from its no-export level (and leave domestic welfare unchanged) with an export subsidy in the

introductory phase that supports a pooling equilibrium in which first period exports take place.

Export Barriers

We begin by asking under what conditions a high quality firm will find it impossible to export profitably to the domestic market. Theorem 1 provides the answer.

Theorem 1: In the absence of subsidies, foreign firms will be unable to export to the domestic market, regardless of quality type, if

$$[\delta_H U(H) - C(H)] + \alpha[U(H) - C(H)] < 0 \tag{8}$$

and

$$\delta_H U(H) \geq C(L). \tag{9}$$

Proof: To prove this we show that under the conditions of the theorem, a pooling equilibrium in which sales take place would lead to negative profits for a high quality firm, and that a separating equilibrium with sales also implies negative profits. Thus, the only possibility remaining is an equilibrium in which sales do not take place.

Suppose first that $P_I^*(H) = P_I^*(L) = P_I^*$ and an introductory sale occurs. Then $P_I^* = \tilde{P}_I^* \equiv \delta_H U(H)$ and, if the firm is high quality, $P_m^*(H) = U(H)$. But the first condition of the theorem then implies that the present value of game profits for a high quality firm are negative. This is contradictory.

Suppose then that $P_I^*(H) \neq P_I^*(L)$. Then the low quality firm is revealed and makes no sales. Thus, to make sales and prevent mimicry, $P_I^*(H) \leq C(L)$ is required. But according to the second condition of the theorem, this implies that $P_I^*(H) \leq \tilde{P}_I^*$ and hence, $P_I^*(H)$ also leads to negative game profits for a high quality firm. This too is contradictory.

Thus, the only possibility left is that no sales take place. Q.E.D.

To sell a new product, an investment in information diffusion must be incurred. This investment is really a low price which insures the consumer against the possibility of low quality. Separation corresponds to full insurance; pooling is a form of partial insurance. The first condition of Theorem 1 simply establishes conditions under which the cost of partially insuring the consumer in the introductory phase exceeds the future profits that come from the diffusion of product quality information. The second condition ensures that providing full insurance is no less costly.

The conditions of Theorem 1 are more likely to be satisfied the higher the discount rate in the foreign country, the lower the probability that high quality production will result from the foreign R&D effort, the smaller the social surplus associated with the high quality good, and the lower the unit cost of producing the low quality product. These conditions suggest that such informational barriers to exporting would be most likely to arise in the new-product sectors of low-income countries with no reputation for high quality production and

relatively unproven technological capabilities. In any case, when these conditions are satisfied, a role for "infant industry" export subsidies may arise. We now explore this role.

The Role of Subsidies

The notion that a government program of export subsidies can raise national welfare has been discussed in the context of oligopolistic firm interaction by Spencer and Brander (1983) and Brander and Spencer (1985). The fundamental insight of these papers is that a government may take actions which allow firms to commit to market behavior which they could not credibly pursue in its absence. In changing the nature of the strategic interaction between domestic and foreign firms, government intervention can shift rents away from the rest of the world and toward the firms of the intervening country.

Commitment plays a crucial role in the welfare effects of export subsidies in the present model as well. To isolate this role, we assume that the foreign government has no private information about firm quality in the introductory phase when setting its export subsidy program. Thus, only mature phase subsidies can be offered to firms on a quality contingent basis. Nonetheless, if the foreign government can precommit to a two-period export tax/subsidy program, then its ability to commit where the firm can not raises the possibility of welfare-enhancing export subsidies in the present model as well. The following theorem summarizes this result.

Theorem 2: If the foreign government can precommit to a two-period export tax/subsidy program, then it can increase foreign national

welfare over any no-intervention equilibrium with an export tax/subsidy program $(\bar{S}_I^*, \bar{S}_m^*)$ where the introductory phase tax is given by

$$\bar{S}_I^* = -\left(U(H) - C(L)\right) < 0 \qquad (10)$$

and the mature phase subsidy is given by

$$\bar{S}_m^* = \max\left\{0, \left(\frac{1}{\alpha}[C(H) - C(L)] - [U(H) - C(H)]\right) + \varepsilon\right\} \geq 0 \qquad (11)$$

with $\varepsilon > 0$ and where it is understood that $\bar{S}_m^*$ is to be paid in the mature phase only if the firm is observed to be high quality.

Proof: To prove Theorem 2, we first demonstrate that, under this export tax/subsidy program, a separating equilibrium will obtain. We then show that foreign welfare in a separating equilibrium under the tax/subsidy program is higher than under any equilibrium without government intervention.

Suppose first that a pooling equilibrium arises in which sales take place. Then $P_I^*(H) = P_I^*(L) = \tilde{P}_I^*$. If the firm is low quality and makes a sale, its profits in the pooling equilibrium, taking account of the introductory government tax, will be

$$\tilde{P}_I^* + \bar{S}_I^* - C(L) = -(1-\delta_H)U(H) < 0 \qquad (12)$$

This is a contradiction. Thus, in a pooling equilibrium, no sales would be made. However, a high quality firm can separate and earn positive game profits under this tax/subsidy program. In particular, with the tax $\bar{S}_I^*$ imposed by the foreign government in the introductory phase, an introductory price of $P_I^*(H) = U(H)$ will not be mimicked by a low

quality firm, since with the tax the firm receives only $C(L)$. Thus, a high quality firm can make a sale in both periods at a price $P_I^*(H) = P_m^*(H) = U(H)$, and make game profits, inclusive of mature phase subsidy payments, of

$$P_I^*(H) + \bar{S}_I^* - C(H) + \alpha[P_m^*(H) + \bar{S}_m^* - C(H)] = \alpha\,\varepsilon > 0 \qquad (13)$$

if $\bar{S}_m^*$ is strictly positive according to (11), and larger profits when (11) implies $\bar{S}_m^* = 0$. Thus, the two-period export subsidy program will force separation.

Finally, welfare in the foreign country under this program is easy to compute. Under the assumptions of the model, the export tax/subsidy payments are simply transfers between the foreign government and the foreign firm, and net out of the welfare calculations. Since no sales are made if the firm is low quality, and since the foreign country captures all the social surplus if the firm is high quality and sales occur, foreign welfare under the export subsidy program is

$$W^*(\bar{S}_I^*, \bar{S}_m^*) = \delta_H[(1+\alpha)(U(H) - C(H))]. \qquad (14)$$

Absent the program, foreign welfare will depend on whether sales take place and, if so, whether a pooling or a separating equilibrium prevails. If in the absence of intervention sales do not take place, welfare is zero, and intervention clearly increases foreign welfare since $W^*(\bar{S}_I^*, \bar{S}_m^*) > 0$. In the case of pooling with sales taking place and no intervention, we have

$$W^*_{pool}(S^*_I=0,\ S^*_m=0) = \delta_H[(\delta_H U(H) - C(H)) + \alpha(U(H) - C(H))]$$

$$+ (1-\delta_H)[\delta_H U(H) - C(L)]$$

$$= W^*(\bar{S}^*_I,\bar{S}^*_m) - (1-\delta_H)C(L)$$

$$< W^*(\bar{S}^*_I,\bar{S}^*_m)$$

Finally, in the case where sales take place in a separating equilibrium with no intervention,

$$W^*_{separate}(S^*_I = 0, S^*_m = 0) = \delta_H[(C(L) - C(H)) + \alpha(U(H) - C(H))]$$

$$= W^*(\bar{S}^*_I,\bar{S}^*_m) - \delta_H(U(H) - C(L))$$

$$< W^*(\bar{S}^*_I,\bar{S}^*_m) \qquad \text{Q.E.D.}$$

The impact of the policy outlined in Theorem 2 can be understood by examining the role of each part of the tax/subsidy program. Consider first the case in which, absent intervention, separation occurs. Here only high quality exports will occur, implying that world surplus is maximized. However, absent government intervention, the cost of the firm's signal (its low introductory price) acts to transfer social surplus from the foreign firm to domestic consumers. The government program of Theorem 2 will in this case consist only of an introductory tax on exports ($\bar{S}^*_m$ will be zero) which ensures that the firm signals its quality with its introductory price, but allows the cost of the signal to become simply a transfer from the foreign firm to the foreign government, rather than to domestic consumers.[13/] Thus, the role of the

introductory export tax is to keep the signal from becoming a transfer to foreigners. The mature phase subsidy $\bar{S}_m^*$ will be strictly positive whenever conditions are such that, absent the subsidy, a high quality firm could not make positive game profits in a separating equilibrium. Thus, the role of the mature phase subsidy $\bar{S}_m^*$ is simply to ensure positive game profits for a high quality firm in the separating equilibrium.

Theorem 2 establishes a role for export subsidies when the government is ignorant of quality but finds policy commitment over the two period life of the firm feasible. Like the rent-shifting subsidy argument, the ability of the government to precommit is crucial. Unlike the rent-shifting subsidy, the use of export subsidies outlined in Theorem 2 leads to a Pareto preferred outcome: it is not a beggar-thy-neighbor policy.[14/] However, the foreign government may find commitments of this kind infeasible. The next theorem establishes the possibility of a role for export subsidies when the government finds it impossible to precommit to a two-period program.

Theorem 3: Suppose the conditions of Theorem 1 hold and therefore that, in the absence of export subsidies, no exports will occur. Suppose further that

$$\delta_H(1+\alpha)[U(H) - C(H)] - (1-\delta_H)C(L) > 0 \qquad (15)$$

so that the social value of sales in the market is positive. Then the imposition in the introductory phase of a strictly positive export subsidy $\tilde{S}_I^*$ with

$$\tilde{S}_I^* = [(C(H) - \delta_H U(H)) - \alpha(U(H) - C(H))] + \varepsilon \qquad (16)$$

where $\varepsilon > 0$ will raise foreign welfare above the no-subsidy case.

Proof: With the conditions of Theorem 1 holding, $\tilde{S}_I^*$ will be strictly positive. Moreover, $\tilde{S}_I^*$ will support a pooling equilibrium in which sales take place and $P_I^*(H) = P_I^*(L) = \tilde{P}_I^*$. In this equilibrium, the high quality firm makes

$$(\tilde{P}_I^* - C(H) + \tilde{S}_I^*) + \alpha(U(H) - C(H)) = \varepsilon > 0 \qquad (17)$$

while the low quality firm makes

$$(\tilde{P}_I^* - C(L) + \tilde{S}_I^*) > \tilde{S}_I^* > 0. \qquad (18)$$

Finally, without the subsidy sales do not take place and foreign welfare is zero while with the subsidy, foreign welfare from market sales is

$$W^*(\tilde{S}_I^*) = \delta_H[(\delta_H U(H) - C(H)) + \alpha(U(H) - C(H))] + (1-\delta_H)[\delta_H U(H) - C(L)] \quad ($$

which reduces to the lefthand side of (15). Thus, the condition of the theorem ensures that the export subsidy will increase the welfare of the foreign country above the no-subsidy case. Q.E.D.

The nature of the government's welfare enhancing role can in this case again be interpreted as taking actions which enable the firm to

commit to behavior to which it would be unable to commit without the subsidy. In particular if, before the realization of its quality type, the firm could commit to sell its product at the introductory pooling price $\tilde{P}_I^*$ regardless of its quality realization, it would do so when the condition of Theorem 3 is met, since the condition ensures that the ex-ante profits of the firm are positive. With this commitment, the domestic consumer would buy at the pooling price $\tilde{P}_I^*$, and foreign welfare from market sales (measured by market producer surplus) would be positive. It is the firm's inability to follow through on such a commitment once quality is revealed to it -- a high quality firm would choose not to produce -- that explains the entry barrier that arises absent export subsidies under the condition of Theorem 3. And the export subsidy program, put in place by a government unaware of firm quality, simply provides a mechanism by which a commitment to introductory phase sales at the price $\tilde{P}_I^*$, regardless of quality, can be made.[15/]

## IV. Extensions

In this section we extend the basic model of section II in several directions. First we explore the role of export subsidies in the presence of several potential export goods when qualities are correlated across markets. We then relax the assumption of a passive domestic government, and consider its response to the export policies of the foreign country.

Correlated Qualities

Theorem 3 of the previous section established conditions under which, with no knowledge of product quality, the foreign government can enhance foreign welfare (and leave unaffected welfare of the domestic country) through an introductory phase export subsidy. This export subsidy program has a peculiar "fly-by-night" property that the foreign country gains are attributable to that portion of firms in the market which turn out to be of low quality. That this is the case can be seen by noting in (19) that $W^*(\tilde{S}_I^*)$ is composed of two parts: $\delta_H$ times the profits of a high quality firm, which is negative by (8), and $(1-\delta_H)$ times the profits of a low quality firm. For $W^*(\tilde{S}_I^*)$ to be positive given (8), fly-by-night firms must provide the foreign country with its welfare gain.

An interesting question is how intermarket correlation in the quality of a country's export goods might affect this fly-by-night incentive to subsidize exports. To consider the effects of quality correlation on these results, the model of section II is extended to include a second market, which we take to be an exact replica of the first market. Moreover, we assume there is now just a single firm in each market, so that $\delta_H$ is interpreted simply as the probability that a firm is high quality: this allows the quality realization in one market to alter the expected welfare consequences of sales in the other market. We refer to these markets as market 1 and market 2, respectively, and to their firms as firm 1 and firm 2.

Let $q_i$ be the event that firm i (i=1,2) has quality q. Define $\delta_H \equiv \text{Prob}(H_1)$, $\delta_{HH} \equiv \text{Prob}(H_2|H_1)$, and $\delta_{HL} \equiv \text{Prob}(H_2|L_1)$. Assume $\delta_{HH}$ and $\delta_{HL}$ are each in the open interval (0,1). As firms 1 and 2 are to be thought of as equivalent, we assume $\text{Prob}(H_2) = \text{Prob}(H_1)$. Finally, we assume that firm 1's quality is positively correlated with firm 2's quality: $\delta_{HH} > \delta_H > \delta_{HL}$. 16/ The stamp "Produced Abroad" can therefore be informative to a domestic consumer who has information about other foreign products. To explore this source of information, we assume that firm 2 can not export to market 2 until after firm 1's introductory phase in market 1.

The consumer in market 2 is "communicatively linked" to the market 1 consumer: The market 2 consumer learns about the introductory phase of play in market 1. Thus, while $\delta_H$ is the prior which initializes the market 1 game, the market 2 prior depends on the first phase of market 1 play. If firm 1's product is not tried, then the prior is derived from the belief which the market 1 consumer holds after observing $S_I^{1*}$ and $P_I^{1*}$. 17/ If instead firm 1's product is tried and found to be high (low) quality, then the market 2 prior is $\delta_{HH}$ ($\delta_{HL}$).

Intuitively, the extended model is one in which equivalent firms enter equivalent markets at different points in time. This temporal asymmetry would be irrelevant if qualities were uncorrelated. However, since correlation is present, the initial consumer experience with firm 2's product is a function of previous consumer experience with firm 1's product. If firm 1's product is known to have worked, then the market 2 consumer holds it more likely that firm 2's product works. There is

thus an informational or reputational externality between the otherwise independent firms.

Under the conditions of Theorem 3, an appropriate export subsidy was shown to be welfare improving in the absence of any quality correlation between exporting firms. The question that we now wish to ask is, given that consumer beliefs about firm 2's quality will be influenced by any experience with firm 1 exports in market 1, does there still exist a role for export subsidies in market 1? The answer is given by the following theorem.

Theorem 4: Suppose that the conditions of Theorem 3 hold for markets 1 and 2, and that quality is positively correlated across markets. Then the foreign government can raise expected foreign welfare over any equilibrium in which $S_I^{1*} = 0$ by providing an introductory export subsidy in market 1 of $S^{1*}_I = \tilde{S}^*_I$.

Proof: Under the conditions of the theorem, if the foreign government did not to subsidize exports in market 1, no market 1 exports would occur, market 2 would be unaffected by the presence of quality correlation with market 1, and a welfare enhancing export subsidy could then be provided to the market 2 firm. But an alternative policy of subsidizing market 1 exports rather than market 2 exports would yield the same producer surplus at an earlier date, and would thus welfare-dominate an export subsidy only to market 2. Moreover, the potential still remains for additional welfare gains from a subsidy to the market 2 firm. If the market 1 firm was found to be high quality, this will

augment the welfare from market 2 sales since $\delta_{HH} > \delta_{H}$. If the market 1 firm turned out to be low quality, then whether or not additional welfare gains can be had from sales in market 2 will depend on the size of $\delta_{HL}$. In any case, having subsudized exports in market 1, an export subsidy to market 2 could be offered if $\delta_{HH}$ or $\delta_{HL}$ (whichever is relevant) warrants market 2 intervention. As such, quality correlation does not undo the case for export subsidies in this model. Q.E.D.

Theorem 4 establishes that quality correlation need not diminish a country's "fly-by-night" incentive to subsidize exports. When the firms in a country are unsuccessful in the export market, and when the underlying parameters (preferences, cost functions, and $\delta_{H}$) are not expected to change in such a way as to make success in the export market more likely in the future, an export subsidy may be attractive, both because of the fly-by-night surplus captured if the firms turn out to be low quality, and because of the reputational benefits to future exporters if the firms turn out to be high quality.

Importing Government Response

Thus far the importing government has been completely passive, taking no policy actions in response to the export subsidy program abroad. An important characteristic of this export subsidy is that it is non-exploitive: the importing country is not harmed. As such, unlike profit shifting and terms-of-trade shifting subsidies, the appropriate response from the importing government may well be a note of "Thanks." However, it is possible that the importing government will be

tempted to respond with more than simply a note of thanks: once exporters have made the introductory phase investment in information dissemination, the importing country can set tariff policy to extract the mature phase rents. We return to the single-market (many firm) model of section II and explore this issue. Throughout, we assume the existence of a policy lag so that, with the foreign government moving in the introductory phase, the domestic country's only policy actions occur in the mature phase. We also assume that both governments are unable to commit to policy actions across phases, and are concerned only with the welfare of their respective citizens.

Under the assumptions of the model, the importing government's optimal tariff response, provided the mature phase has arrived, is to impose a mature phase import tariff $\tilde{\tau}_m \equiv U(H) - C(H)$ which captures all the surplus from high quality imports for domestic citizens. The announcement of any other tariff policy would not be credible since, once the mature phase arrives, $\tilde{\tau}_m$ will always be chosen. As such, when the importing government can respond freely in the mature phase, all rents from the mature phase export of high quality goods will be captured by the importing country. Now suppose that, in the absence of a mature phase rent-extracting tariff imposed by the importing country, introductory phase exports would take place at the pooling price $\tilde{P}_I^*$ with export subsidy levels set to zero. That is, suppose that

$$\tilde{P}_I^* - C(H) + \alpha(U(H) - C(H)) > 0, \quad \text{and} \quad \tilde{P}_I^* > C(L) \tag{20}$$

Suppose also that

$$\tilde{P}_I^* < C(H), \tag{21}$$

so that it is the mature phase surplus that allows the high quality firm to export at a loss in the introductory phase and still make positive game profits. Then we have the following result.

Theorem 5: Under conditions (20) and (21), the inevitability of the domestic country's mature phase rent extracting tariff $\tilde{\tau}_m$ will induce the foreign government to enter into an introductory phase export subsidy program if

$$\delta_H(\tilde{P}_I^* - C(H)) + (1-\delta_H)(\tilde{P}_I^* - C(L)) > 0 \tag{22}$$

and will preempt exports from occuring at all if

$$\delta_H(\tilde{P}_I^* - C(H)) + (1-\delta_H)(\tilde{P}_I^* - C(L)) < 0. \tag{23}$$

Proof: With $\tilde{\tau}_m$ extracting all mature phase surplus and $\tilde{P}_I^* < C(H)$, a high quality firm would suffer game losses at the pooling price $\tilde{P}_I^* < C(H)$, and thus no exports would occur absent a government subsidy. The subsidy will be forthcoming if surplus from exports is positive (condition (22)) and will not be forthcoming if surplus is negative (condition (23)). Q.E.D.

Under condition (22), Theorem 5 implies that the inevitability of future protection in response to successful imports--or in response to introductory "dumping" $(\tilde{P}_I^* < C(H))$ of high quality goods--induces an export subsidy program on the part of the exporting country: the export subsidy program arises in this case solely in response to anticipated

future import tariffs. This result reverses the causal logic behind the question of how best to respond to the export subsidy programs of other countries and suggests an escalating relationship between export subsidies and "retaliatory" tariffs. Under condition (23), the theorem implies that the inevitability of future protection preempts exports from occurring. Since the "prohibitive" tariff response would never be observed, this result suggests that observed tariff levels may yield a poor measure of the distortions associated with the ability to use them.

## V. Discussion and Conclusion

We have developed a model illustrating a role for subsidies when product quality is unknown. The model is not general, but its simplicity does enable the exploration of a new range of positive and normative issues. We now discuss briefly the robustness of our results, and outline an agenda for future research.

Incomplete information about product quality is a well known barrier to entry. This point was first made by Bain (1956), following his study of twenty industries. More recently, Schmalensee (1982), Bagwell (1985), and Farrell (1986) have established the existence of this barrier in a variety of models. Our theorem 1 would thus seem more general than the special assumptions employed.

We argue that subsidies can overcome this barrier and increase welfare. The qualitative flavor of this argument does not appear to depend on our special cost and demand functions.[18] A more interesting consideration is the possibility of many types and/or quality choices.

The model could incorporate quality choice relatively easily if the probability of successful R&D, $\delta_H$, were to be modeled as a choice variable of the firm. For example, suppose that $\delta_H$ is a function of observable inputs of resources by the exporting firm. In this case, there would exist an incentive to overinvest in R&D so as to raise $\delta_H$ and break the entry barrier. The role of export subsidies would then be to achieve the socially appropriate R&D expenditure level in the exporting country.

It is also intriguing to consider the role of subsidies when the importing country has domestic firms in the relevant industry. In such a model, the successful entry of a foreign firm can cause a loss in domestic producer surplus, and so the optimal policy for an importing country becomes more complex.

The model suggests a number of other extensions. One wonders, for example, what would happen if rational consumers were unable to observe perfectly the subsidy choices of the foreign government. Another interesting extension concerns the use of quotas and VER's. How do these policies affect the signalling game between firms and consumers? These and other related extensions would seem to be fruitful issues for future research.

## Notes

1/ See, for example, the articles in Krugman (1986a) and the literature cited therein.

2/ For an empirical exploration of the importance in developing countries of informational barriers to export, see De la Torre (1972).

3/ This result is in the spirit of the results of Greenwald and Siglitz (1986).

4/ Alternatively, there may exist many identical domestic consumers, as long as communication among them is not free. If foreign consumers were served, nothing of qualitative importance would change. Consumers in the domestic country and/or the foreign government itself might, however, be able to obtain information about the firm's success in the local market, and this could be an additional signal of quality.

5/ Throughout we ignore any cost of R&D. Consideration of such costs would alter in a straightforward way the conditions under which export barriers would arise and under which government intervention would be desireable, but would leave unaffected the qualitative nature of our results. See Ramey (1986) for a model of product quality in which the R&D process is explicitly modeled

6/ Price signals quality in Bagwell (1985), Bagwell and Riordan (1986), Farrell (1980), and Ramey (1986); advertising signals quality in Nelson (1974) and Kihlstrom and Riordan (1984); both price and advertising signal qualtiy in Milgrom and Roberts (1986).

7/ The assumption that $U(L) = 0$ is inessential for our results.

8/ This assumption simplifies the exposition of the game but is made without loss of generality.

9/ See Banks and Sobel (1985), Grossman and Perry (1986), Kreps (1984), Milgrom and Roberts (1986), and Okuno-Fujiwara and Postlewaite (1987) for more on sequential equilibrium refinements.

10/ See Grossman, Kihlstrom, and Mirman (1977) for more on experimental buying.

11/ There is a second, less formal objection to the $P^1$ equilibrium. Popular intuition holds that high prices go with high quality. But if pooling is to occur at $P^1$, then $b_I(P^1) = \delta_H$ and, for all $P \in (P^1, \tilde{P}_I^*)$, $b_I(P) < \delta_H$. It must therefore be that higher prices do not go with higher expectations about product quality. Notice, though that if pooling occurs at $\tilde{P}_I^*$, then $b_I(P_I^*)$ can be strictly increasing in $P_I^*$. If we are to have a pooling equilibrium in which the customer is supplied and higher prices go with higher beliefs about product quality, then the equilibrium pooling price must be $\tilde{P}_I^*$.

12/ Both of these restrictions are implications of the refinement suggested by Grossman and Perry (1986) as well as the refinement proposed by Okuno-Fujiwara and Postlewaite (1987).

13/ Since $\bar{S}_m^*$ is zero in this case, implementation of the policy does not require government precommitment to a second period policy.

14/ The one case in which the program of Theorem 2 will be a beggar-thy-neighbor policy is when separation would have occurred without intervention. Here the program is simply a first period export tax, and involves no export subsidy.

15/ A different interpretation, suggested to us by Dani Rodrik, is that high quality producers fail to internalize the positive externality of their sales on the profits of low quality producers. The export subsidy is then viewed as a way of internalizing this externality.

16/ Positive correlation is the natural assumption, though the statement of Theorem 4 holds for correlation of either sign.

17/ For example, if the market 1 consumer belives that he has learned nothing about the product quality from the introductory phase, either directly or indirectly, then the market 2 piror is $\delta_H$.

18/ A caveat: Bagwell and Riordan (1986) have established conditions under which a high quality firm best signals its quality with a high price. Milgrom and Roberts (1986) have constructed a different model in which a low introductory price is the best signal of high quality. These opposing predictions stem from different assumptions on the nature of consumer communication and on the extent to which price can capture all relevant quality information. For the present paper, the lesson is that our prediction of low introductory prices is not robust to all generalizations of the model.

References

Bagwell, K. (1985), "Informational Product Differentiation as a Barrier to Entry," Studies in Industry Economics, Discussion Paper No. 129, Stanford University.

Bagwell, K. and M. Riordan (1986), "Equilibrium Price Dynamics for an Experience Good," Northwestern Math Center Discussion Paper No. 705.

Bain, J. (1956), Barriers to New Competition, Cambridge: Harvard University Press.

Banks, J. and J. Sobel (1985), "Equilibrium Selection in Signaling Games," Caltech Social Science Working Paper.

Bond, E.W. and L. Samuelson (1986), "Tax Holidays as Signals," American Economic Review 76, pp. 820-826.

Brander, J.A. (1986), "Rationales for Strategic Trade and Industrial Policy," in Paul Krugman (ed.), Strategic Trade Policy and the New International Economics, pp. 23-46.

Brander, J.A., and B. Spencer (1985) "Export Subsidies and International Market Share Rivalry," Journal of International Economics.

Brecher, R.A. and R.C. Feenstra (1983), "International Trade and Capital Mobility between Diversified Economies," Journal of International Economics 14, pp. 321-339.

De la Torre, J.R. (1972) "Marketing Forces in Manufactured Exports from Developing Countries," in L.T. Wells, Jr., ed., The Product Life Cycle and International Trade (Howard Business School, Boston, MA), pp. 227-259.

Donnenfield, S., Weber, S. and U. Ben-Zion (1985), "Import Controls Under Important Information," Journal of International Economics 19, pp. 341-354.

Farrell, J. (1980), Prices as Signals of Quality, Ph.D dissertation, Brasenose College, Oxford.

Farrell, J. (1986), "Moral Hazard as an Entry Barrier," The Rand Journal of Economics, Autumn, pp. 440-449.

Feenstra, R. C. (1986), "Trade Policy with Several Goods and 'Market Linkages'," Journal of International Economics 20, pp. 249-267.

Greenwald, B.C., and J.E. Stiglitz (1986), "Externalities in Economies with Imperfect Information and Incomplete Markets," Quarterly Journal of Economics, pp. 229-264.

Grossman, G.M., and H. Horn, (1986) "Infant-Industry Protection Reconsidered: The Case of Informational Barriers to Entry," manuscript, August.

Grossman, S. and M. Perry (1986), "Perfect Sequential Equilibria," Journal of Economic Theory 39, pp. 97-119.

Grossman, S., R. Kihlstrom, and L. Mirmon (1977), "A Bayesian Approach to the Production of Information and Learning by Doing," Review of Economic Studies, 40, pp. 537-547.

Itoh, M. and K. Kiyono (1987), "Welfare-Enhancing Export Subsidies," Journal of Political Economy 95, pp. 115-137.

Jones, R. W. (1967), "International Capital Movements and the Theory of Tariffs and Trade," Quarterly Journal of Economics 81, pp. 1-38.

Kemp, M. C. (1966), "The Gain from International Trade and Investment: A Neo-Heckscher-Ohlin Approach," American Economic Review 56, pp. 788-809.

Kemp, M. C. (1969), The Pure Theory of International Trade and Investment (Prentice-Hall, Englewood Cliffs, N.J.).

Kihlstrom, R. and M. Riordan (1984), "Advertising as a Signal," Journal of Political Economy 92, pp. 427-450.

Kreps, D. (1984), "Signalling Games and Stable Equilibria," Graduate School of Business Research Paper No. 758, Stanford University.

Kreps, D. and R. Wilson (1982), "Sequential Equilibria," Econometrica 50, pp. 863-894.

Krugman, P. R. (1986a), Strategic Trade Policy and the New International Economics (MIT Press, Cambridge, Mass.).

Krugman, P. R. (1986b), "Industrial Organization and International Trade," NBER Working Paper No. 1957.

Mayer, W. (1984), "The Infant-Export Industry Argument," Canadian Journal of Economics 17, pp. 249-269.

Milgrom, P. and J. Roberts (1986), "Price and Advertising Signals of Product Quality," Journal of Political Economy 94, pp. 796-821.

Nelson, P. (1970), "Information and Consumer Behavior," Journal of Political Economy 78, pp. 311-329.

Nelson, P. (1974), "Advertising as Information," Journal of Political Economy 81, pp. 729-754.

Okuno-Fujiwara, M. and A. Postlewaite (1987), "Forward Induction and Equilibrium Refinement," University of Tokyo Working Paper 87-F-3.

Ramey, G. (1986), "Information Transfer and Investment in Product Quality," Institute for Mathematical Studies in Social Sciences (IMSSS), The Economic Series, Technical Report No. 499, Stanford University.

Schmalensee, R. (1982), "Product Differentiation Advantages of Pioneering Brands," American Economic Review 72, pp. 349-365.

Spencer, B., and J.A. Brander (1983), "International R&D Rivalry and Industrial Strategy," Review of Economic Studies 50, pp. 707-722.

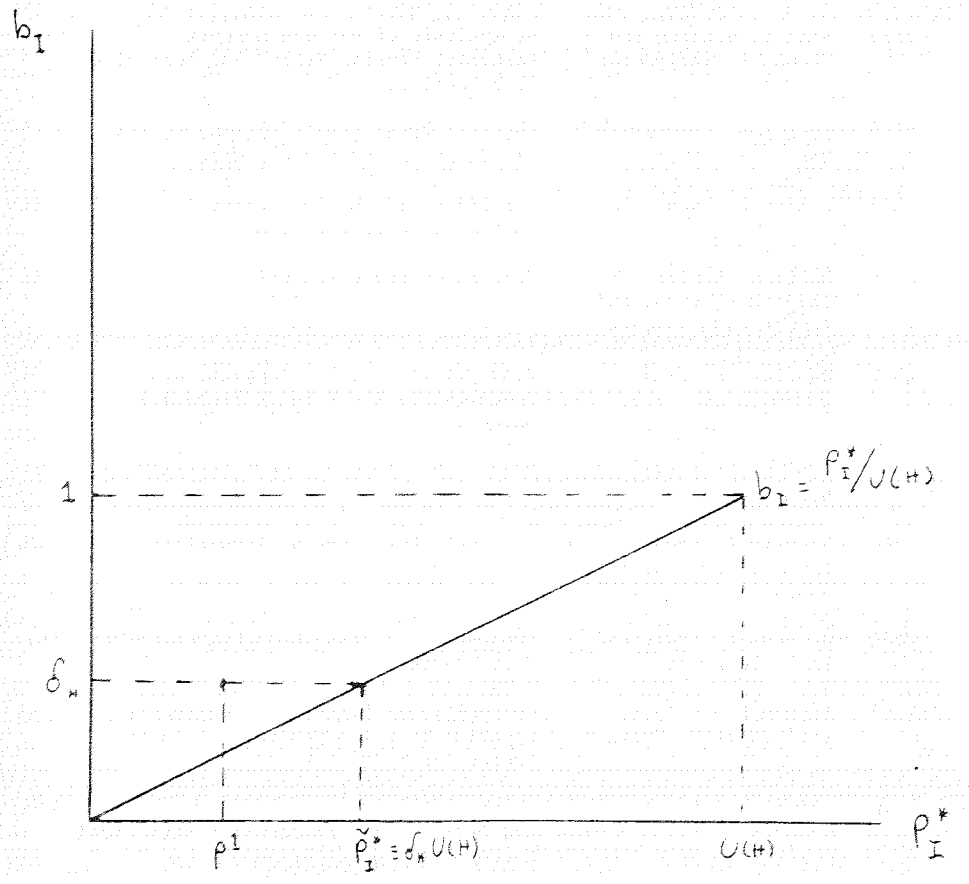


Figure 1