The Analytics of Export Promotion Policies Designed to Reduce Search Costs

Mark G. Herander*
Department of Economics
University of South Florida

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Abstract

This study examines the economic effects of export subsidy policy in an environment where exporters must expend resources to find foreign consumers. Within a sequential search model we find that export promotion policies specifically designed to lower an exporter's search costs (e.g., government-sponsored trade missions) have very different effects than non-targeted subsidies. For example, subsidies that lower search costs induce exporters to increase their price. However, this result is sensitive to model specification and may even be reversed when the analysis allows for foreign competition.

I.   Introduction

Absent full knowledge, buyers and sellers may be required to engage in a costly search process to obtain the information needed to conduct an economic transaction. Informational failures are likely to be more acute when buyers and sellers are separated by distance, culture and jurisdictional borders – conditions characterizing the relationship among buyers and sellers in an international setting. One might then expect search to be a more integral part of the activities of importers and exporters than for agents operating within national borders.

To mitigate the potential decrease in export volume that might result from costly search, governments frequently subsidize the search activity of exporters. One means is government sponsorship of trade missions and trade shows whereby domestic exporters meet, face to face, potential foreign customers and learn of possible trading opportunities. Governments also maintain overseas offices that provide basic information to foreign buyers on goods and services available from firms located within their jurisdiction. And, increasingly, governments are using electronic means to disseminate information on available export opportunities to domestic firms and to inform foreign consumers of available domestic products. The U.S. Department of Commerce, for example, lists products and services of U.S. firms on its BuyUSA.com website which non-U.S. buyers can access free of charge.

Subsidization of exporters' search costs is quite pervasive – both globally and across levels of government within nations. Ten of the twelve developed countries examined by Seringhaus and Rosson (1990) provided financial support for trade missions. Within the United States, the collective amount expended on all types of export

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promotion (search activities) is, according to Berry and Mussen (1980), comparable to the amount expended by the Department of Commerce at the federal level.[1]

Several recent studies recognize that informational barriers may force international traders to engage in costly search to find 'compatible' commercial partners located in foreign countries. Rauch and Cassella (2003) and Cassella and Rauch (2002) model a matching process where individual domestic types (e.g., producers) and foreign types (e.g., consumers) are unobservable to one another so that international pairwise matching of domestic and foreign types is random. These studies focus on the role of transnational networks – composed of a subset of domestic and foreign agents who are familiar with each other's types – in overcoming these information barriers and so facilitating exchange. Relatedly, Rauch and Trindade (2003), using a similar model, investigate how a 'technological' improvement in international matching will impact the international substitutability between foreign and domestic goods and labor forces. These studies, however, do not consider policy measures designed to reduce the search costs of international exchange.

The present study develops an analysis of the economic effects of an export subsidy specifically designed to lower the costs of search for a domestic exporting firm – henceforth, referred to as a targeted search cost subsidy (TSS). We employ a standard sequential search model where the exporter, ex ante, only knows the distribution of individual foreign consumer valuations, not the amount that any individual foreign consumer is willing to pay. The exporter engages in costly search to find a foreign consumer with a valuation (willingness to pay) greater than the price set by the firm prior

to contacting potential consumers. The costs of search are reduced by a TSS enacted by the domestic government.

The partial equilibrium framework allows an examination of the search activity of an individual firm as opposed to a random matching process among many buyers and sellers. Not only are we interested in the price and quantity effects of a TSS, but, just as significantly, how these effects compare to the well-known effects of the more familiar notion of export subsidies – those policies designed to enhance the general profitability of exporting activity.

Two sets of results emerge from the analysis. First, the price effects of a TSS differ markedly from those associated with export subsidies not directed at search activities. A TSS, by reducing the costs of search to the firm, makes the exporter more willing to accept the costs of delay (in finding a foreign consumer) that result from a higher price – forgone profits. A subsidy to overall export profits, on the other hand, increases the costs of not finding a buyer so that the exporter is more likely to decrease its price in response to nontargeted subsidies.

Second, the impact of a TSS is quite sensitive to model specification. If a firm's expenditure on search were endogenous, for example, a TSS may have no effect on price. Also, when the domestic firm competes with foreign rivals, a TSS subsidy may induce profit-reducing price competition which did not exist under free trade.

Section II examines the effects of a TSS when the domestic exporter is a monopolist. Sections III – IV attempt to generalize the monopoly case by examining the effects of export promotion policies when search expenditure is endogenous to the exporter and when search is ongoing versus the case where search terminates when a

consumer with a sufficiently high valuation is found. In Section V we compare the effects of a TSS to those of an export subsidy which is not specifically directed toward search activity. Section VI considers the effects of introducing foreign competition.

II.   Monopoly – Targeted Search Cost Subsidy (TSS)

We begin by assuming a world market characterized by a single domestic exporter. The monopoly case, because of its analytical clarity, allows us to highlight the essential aspects of the search process as well as the pricing behavior of a firm which benefits from a TSS. Moreover, since the pricing incentives facing a subsidized firm are quite similar for all types of imperfect competition, the monopoly case provides the analytical foundation for subsequent analysis.

Consider a standard infinite horizon, sequential search process whereby the domestic monopolist attempts to sell a single unit of a good to a foreign consumer. The exporter expends c per unit of (continuous) time to search for a potential customer. Search costs result from the exporter's efforts to inform foreign buyers of the availability and characteristics of its product. Expenditures on search generate a stream of foreign buyers who "arrive" according to a Poisson process at rate λ per unit of time. For analytical convenience there are no production costs. The monopolist discounts future receipts and search costs at a continuous time rate $\delta \geq 0$.

Each potential foreign buyer seeks to purchase one unit of the good and holds a valuation based on his/her preferences for the exporter's product. From the monopolist's perspective, the valuation of individual consumers is a random variable, v, described by cumulative distribution function $F(v)$ with continuous density function $f(v): E(v) < \infty$.

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We employ a 'posted price' search model developed by Arnold and Lippman (2001). The monopolist selects a price, p, prior to the 'arrival' of buyers. The first buyer with individual valuation, $v \geq p$, purchases the product paying the posted price and the search process ceases. Otherwise, search continues until the firm finds a buyer willing to pay p.[2]

The arrival of customers willing to pay p is a Poisson process with parameter $\lambda \overline{F}(p)$ where $\overline{F}(p) = 1 - F(p)$. The time until a buyer willing to pay p arrives then is an exponential random variable, τ, with parameter $\lambda \overline{F}(p) -$ a characteristic which proves useful in obtaining expressions for expected discounted revenue and costs of the exporter. Since the exporter's revenue derived from selling a single unit equals the posted price, expected discounted revenue equals $pE[e^{-\delta\tau}] = p\lambda\overline{F}(p)/(\delta + \lambda\overline{F}(p))$.[3] Expenditures on search costs, in contrast to revenue, are a continuous flow until a sale is made so that the expected discounted value of search costs required to find a buyer willing to pay p equals $cE\int_0^\tau e^{-\delta t} dt = cE(1 - e^{-\delta\tau})/\delta = c/(\delta + \lambda\overline{F}(p))$. For now, assume that search expenditure, c, is constant and so too λ.

Consider an export promotion policy which lowers search costs by s per unit of time.[4] Under such a policy the exporter's expected discounted profit equals:

$$\pi(p) = [p\lambda\overline{F}(p) - (c - s)]/(\delta + \lambda\overline{F}(p)) \tag{1}$$

The exporter sets a posted price to maximize expression (1) yielding first-order condition:

$$1 = h(p)[((c - s) + \delta p)/(\delta + \lambda\overline{F}(p))] \equiv MC(p) \tag{2}$$

where $h(p) = f(p)/\overline{F}(p) -$ the hazard rate function (for valuations). Because of the equality of price and revenue, marginal revenue associated with a price increase equals

one. The right-hand side of expression (2) represents the expected marginal costs, $MC(p)$, of finding a buyer willing to pay the higher price. Those costs include the discounted (net) expenditures on additional search plus the reduction in the present value of revenue (price) associated with delay.[5] The costs of continued search are multiplied by the hazard rate function – roughly, the probability that a randomly arriving consumer who would have been willing to purchase the product at the original price rejects the higher price – to obtain the expected marginal cost of continued search.

Second-order conditions (and stability) require expected marginal costs to be increasing with respect to price: $\text{sgn}\ \partial MC / \partial p = \text{sgn}\ \partial h / \partial p [(c-s) + \delta p] + h\delta + \lambda f(p) > 0.$ A sufficient condition for $\partial MC / \partial p > 0$ is an increasing hazard rate with respect to price (valuation). The behavior of hazard rates varies widely over distribution functions that might characterize consumer valuations. Here, we assume that $\partial h / \partial p$ is not too negative so that second-order conditions hold.[6]

To examine the effects of the search cost subsidy totally differentiate first-order condition (2) to solve for:

$$dp / ds = h(p) / [\partial h / \partial p ((c-s) + \delta p) + h\delta + \lambda f] > 0 \qquad (3)$$

The second-order condition ensures that expression (3) is positive meaning that subsidized search costs lead to an increase in the export price to foreign consumers – a result that stands in direct contrast to the standard effects of export subsidization absent search.

To understand this result consider Figure 1 which depicts expected marginal revenue and search costs of the domestic monopolist with respect to price. Marginal

search costs absent a subsidy are depicted by MC_o. Imposition of a subsidy lowers

marginal costs of search to MC_s so that marginal revenue now exceeds the costs of

additional search at the original posted price, p_o. In response, the exporter raises its

price until the marginal costs of delay associated with the higher price increase to equal

marginal revenue. With the reduction in net expenditure on search that results from the

subsidy, the exporter is now willing to accept the additional costs of delay associated

with a price increase.

It is of interest to note the role of the behavior of the hazard rate function in

determining the magnitude of the price increase. In general, the lower the value of

$\partial h / \partial p$ (or equivalently, the lower the value of $\partial MC / \partial p$) the greater the resulting price

increase. For example, should the probability that a randomly arriving consumer, who

would have otherwise purchased the product at the original price, but now rejects the

higher price decline $(\partial h / \partial p < 0)$ then the observed price increase by the exporter will be

greater (versus the case where $\partial h / \partial p > 0)$.

III.   <u>Monopoly – Endogenous Search Expenditure</u>

Suppose, instead, that the exporter's expenditure on search is endogenous and that

the "arrival" rate of foreign consumers responds to such expenditure: $\lambda = \lambda(c)$, where

$\partial \lambda / \partial c > 0$. Substituting $\lambda = \lambda(c)$ into the expected profit expression (1) and solving for

the first-order condition with respect to c, $\partial \pi / \partial c$, yields:

$$\partial \lambda / \partial c [\overline{F}(p)(\delta p + (c - s)) / (\delta + \lambda \overline{F}(p))] = 1 \tag{4}$$

The left-hand side represents the expected marginal benefit associated with an increase in

the "arrival" rate of foreign consumers induced by the increase in expenditure on search.

These benefits equal the increase in the expected present value of revenue due to the reduction in the delay of finding a foreign buyer as well as the decrease in the discounted (net) value of a given amount of expenditure on search. The right-hand side, of course, equals the (direct) marginal costs of increasing expenditure on search activity.

To determine the impact of a TSS when both price and search expenditure are endogenous combine first-order conditions (2) and (4) to obtain:

$$h(p) = (\partial\lambda/\partial c)\overline{F}(p) \tag{5}$$

The striking feature of expression (5) is the absence of the subsidy value, s, which implies that changes in the TSS have no impact on price or the level of the firm's expenditure on search.

A TSS lowers the marginal costs of a price-induced delay. However, at the same time, the TSS by reducing the direct costs of delay lowers the marginal benefits of attracting greater numbers of consumers through increased search expenditure. These two opposing effects exactly offset one another when evaluated in equilibrium.[7] Thus, the exporter has no incentive to change either its price nor expenditure on search in response to a TSS. Allowing for the endogeneity of search expenditure significantly alters previous results by eliminating the induced price effect. Of course, the exporter's expected profits still increase since it receives the subsidy payment (at the original combination of p and c).

IV.   Monopoly: Multiple Units

When the domestic firm possesses a single unit the search process terminates once the firm finds a foreign consumer willing to pay the posted price. To check on the robustness of this result suppose, instead, that the seller operates on an ongoing basis so

that after one unit of the product is sold the exporter, instantly and costlessly, produces another unit and resumes search. Here, the domestic exporter sets a posted price, to be applied to all units, prior to beginning search.

A.   Finite Number of Units

Consider the case where the domestic exporter possesses (or produces) a finite number of units, n. Define the sales period associated with an individual unit as the length of time between the point when search is initiated (or, equivalently, when the previous unit is sold) and the point when a foreign buyer accepts the posted price and purchases the unit. As before, the search process generates a stream of buyers according to a Poisson process so that the sales period is an exponential variable (τ) characterized by "lack of memory". That is, the sales period for an individual unit is independent of the sales period of the previous unit. This implies that the expected value of the sales period for all n units is identical.

The domestic exporter sets a posted price at time $t = t_0$ which maximizes the sum of the expected discounted value of profits associated with selling each of n units:

$$\Pi(n) = \pi_1 + \beta\pi_1 + ... + \beta^{n-1}\pi_1 = \pi_1(1-\beta^n)/(1-\beta) \tag{6}$$

where $\pi_1 = [p\lambda\overline{F} - (c-s)]/(\delta + \lambda\overline{F})$ represents the expected discounted value of profits associated with the first unit sold (see expression (1)) and $\beta = \lambda\overline{F}/(\delta + \lambda\overline{F})$ represents the discounted expected value of a sales period.

The intuition underlying expression (6) as well subsequent analysis on the effects of a search cost subsidy can be gleaned by examining the case where $n = 2$. Search for a foreign buyer of the first unit begins at t_0 so that the expected discounted value of first

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unit profits, π_1, is given by expression (1). Because the expected sales period for the second unit equals that of the first unit, the expected discounted value of second-unit profits, measured at the beginning of the second-unit sales period, also equals π_1. To obtain the expected discounted value of second-unit profits at t_0, π_1 must then be discounted by $\beta; \pi_2 = \beta\pi_1.$[8] The sum of expected discounted profits of units 1 and 2 equals:

$$\Pi(n=2) = \pi_1 + \pi_2 = \pi_1(1+\beta) \tag{7}$$

For $n > 2$ the recursive process continues to yield expression (6).

To determine the impact of a TSS on the posted price set at t_0 again consider the n = 2 case. The domestic exporter selects p to maximize expression (7):

$$\partial\Pi(n=2)/\partial p = (\partial\pi_1/\partial p)(1+\beta) + \pi_1(\partial\beta/\partial p) = 0 \tag{8}$$

with second-order conditions $\partial^2\Pi/\partial p^2 = \Pi(n)_{pp} < 0.$[9] Totally differentiate expression (8) to obtain:

$$dp/ds = -\Pi(n=2)_{ps}/\Pi(n=2)_{pp} > 0.^{[10]} \tag{9}$$

The explanation of this result is identical to the single unit case for the monopolist: a search cost subsidy reduces marginal search costs, at the initial price, so that the exporter now finds it profitable to accept the additional costs of delay induced by a higher price. This result generalizes to all values of $n (< \infty)$ implying that the single-unit results are robust.

B. Infinite Number of Units

Now consider the case where production continues indefinitely; $n \to \infty$. Here, expression (6) for expected discounted profits equals:

$$\lim \Pi(n \to \infty) = \pi_1 / (1 - \beta) = [p\lambda\overline{F} - (c - s)] / \delta \qquad (10)$$

Maximizing (10) with respect to p yields:

$$1 = ph(p) \qquad (11)$$

where, again, 1 represents the marginal revenue and $ph(p)$ the marginal cost associated with a price increase. A crucial difference between this and earlier results is that marginal search costs are unaffected by c, δ, λ and, crucially, s. With a finite number of units, a change in p affects the expected sales period and therefore expected search costs. With an infinite number of units, however, search continues forever, regardless of the length of a given sales period, so that the discounted value of the exporter's search costs equals $(c - s) / \delta$ regardless of p. If a randomly arriving consumer rejects $\tilde{p} > p$, but would have purchased the unit at p, then the price increase costs the exporter the full price and $ph(p)$ represents the expected value of this loss. Since a search subsidy does not impact expected marginal search costs when search is an ongoing process, such a policy will not alter the price set by the domestic exporter at the beginning of the process – in direct contrast to the finite number case.

V.   <u>Monopoly – Revenue Enhancing Export Subsidy (RES)</u>

In contrast to targeted search costs subsidies, standard export subsidy policies are designed to augment the profitability of export activity without lowering required expenditures on search. Does this difference in mechanism design between these two sets of export promotion policies yield differences in policy outcomes?

Consider a per-unit export subsidy, s', such that the net price received by the exporter, $p' = p + s'$, where p is the price posted by the domestic exporter and paid by foreign consumers. Incorporating this subsidy, henceforth referred to as a revenue-enhancing export subsidy (RES), into the single-unit search model presented above yields an expression for expected profits equal to:

$$\pi'(p) = (\lambda p' \overline{F}(p)) - c) / (\delta + \lambda \overline{F}(p)) \tag{12}$$

and first-order condition:

$$1 = h(p)[(c + \delta p') / (\delta + \lambda \overline{F})] = MC'(p) \tag{13}$$

Assuming the second-order condition holds, $\partial MC' / \partial p > 0$, the export subsidy policy lowers the posted price of the domestic firm:

$$dp / ds' = -h(p)\delta / [\partial h / \partial p (c + \delta p') + h\delta + \lambda f] < 0 \tag{14}$$

which stands in direct opposition to the effects of the TSS policy. A comparison of expressions (2) and (14) reveals the source of the difference between the two policies. A RES, by increasing p', increases the reduction in the present value of revenue associated with a delay in finding a consumer willing to pay the posted price. In other words, the monopolist forgoes more revenue with the subsidy (at a given p) when time passes without a sale. To offset this cost increase, the exporter lowers its posted price in an attempt to shorten the time needed to find a consumer willing to pay the posted price.[11]

In contrast, the TSS works by lowering required expenditures on search activities, and therefore the marginal cost of search, providing the exporter with an incentive to accept the additional costs of delay associated with a higher posted price. This difference indicates that the precise design of trade promotion policies matters in an environment where exporters incur costs searching for potential foreign consumers.

VI.   Multi-Firm Equilibrium

Allowing for multiple suppliers of the good to foreign consumers introduces the possibility of interfirm (strategic) competition into the analysis and also requires a more elaborate search process. Not only do firms search for potential buyers, but buyers must select among the multiple firms supplying the product. To incorporate the search activity of foreign consumers, we employ a sequential consumer search model whereby foreign consumers incur a fixed cost when seeking the low-priced firm.[12] The presence of consumer search costs limits the competitive effects of interfirm rivalry. Thus, the possibility remains that the monopoly effects of the TSS still hold in the presence of (potential) competition among subsidized domestic and unsubsidized foreign rivals.

To examine the impact of a TSS in an oligopolistic setting, we compare the incentives for individual firms to behave as monopolists under free trade and the TSS. Specifically, we first identify the conditions necessary for monopolistic pricing on the part of each firm under free trade. Then we introduce a TSS, maintaining all free trade conditions, and determine the likelihood that monopolistic behavior will also hold. In so doing, we demonstrate that a TSS may introduce an element of price competition that did not exist under free trade which, in turn, may significantly alter the monopoly effects of the TSS.

A.   Pre-Subsidy (Collusive-Equivalent) Equilibrium

Suppose N firms, N^d domestic and N^f foreign, produce a homogenous good and compete for foreign consumers. As before, individual firms expend c per time period to search for consumers whose valuations are independent and characterized by cumulative distribution, $F(v)$. Assume that the collective expenditure of N firms attracts

foreign consumers to this market according to a Poisson process at rate λ. When a consumer arrives in the market, he/she forms conjectures on the distribution of prices across firms, though not the price set by any individual firm, and proceeds, at zero cost, to randomly select a particular firm, firm i, to visit. The potential buyer observes price, p_i, and must decide whether to purchase the good from firm i, contact one of the remaining $N-1$ firms hoping to find a lower price or exit the market if $v < p_i$ and the expected return from contacting an additional firm is negative.

Here we describe the characteristics of a non-cooperative equilibrium that is identical to a collusive (oligopoly) solution and identify the conditions necessary to maintain that equilibrium. First, in a non-cooperative price-setting equilibrium an arrival will not contact any firms beyond firm i, the first firm selected. If the price set by the first firm contacted, $p_i > C$, the minimal expected cost to an arrival of contacting and acquiring the good from a rival firm,[13] then the arrival will reject p_i and expend resources to contact another firm. Obviously, this pricing strategy is not optimal for firm i, so that in equilibrium $p_i < C$ and individual arrivals will either purchase the good from i or exit the market, if $p_i > v$.

The probability that a randomly arriving buyer will select any individual firm equals $1/N$. Because potential buyers will, in equilibrium, contact only one firm each firm faces an expected arrival rate of λ/N. For analytical convenience, assume that each firm produces a single unit so that expected discounted firm profits equal:

$$\pi(p) = [p(\lambda/N)\overline{F}(p) - c] / (\delta + (\lambda/N)\overline{F}(p)) \tag{15}$$

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In a collusive-equivalent equilibrium (CEE), each firm behaves as a monopolist facing

arrival rate, λ/N, and sets the profit-maximizing monopoly price, $\hat{p}$.

To show that each firm will set an identical price equal to $\hat{p}$ in a CEE consider

any potential equilibrium price vector $\{p_1,...,p_N\}$. In equilibrium, all firms must be

indifferent between any equilibrium price: $\pi(p_i) = \pi(p_j)$, where $i, j = 1,..., N$. Under

the assumption that $\pi(p)$ is concave with a unique maximum, this condition can only be

met if $p_i = p_j$ at the price which maximizes (15), $\hat{p}$.

To maintain a non-cooperative CEE it is necessary that no firm holds an incentive

to deviate from the profit-maximizing price, $\hat{p}$. To formally obtain this condition,

suppose that one firm, firm j, sets price $p_j < \hat{p}$. If a potential buyer initially contacts a

firm charging $\hat{p}$, the buyer will then attempt to contact firm j if the expected return from

finding j, v_j, is greater than $v - \hat{p}$, the buyer's surplus from purchasing the good from the

initial firm:

$$v_j = v - c_b \sum_{i=1}^{N-1} i/(N-1) - p_j > v - \hat{p} \tag{16}$$

where c_b is the cost to the buyer of contacting an additional firm and $\sum_{i=1}^{N-1} i/(N-1)$ equals

the probability of locating firm j on one of $N-1$ contacts.[14] Expression (16) holds for

$p_j < \hat{p} - c_b(N/2)$, where $N/2 = \sum_{i=1}^{N-1} i/(N-1)$.

When an individual firm sets price $p_j < \hat{p} - c_b(N/2)$, its arrival rate increases

from λ/N to λ. Thus, a firm deviates from the collusive equilibrium price, $\hat{p}$, when

expected profits evaluated at $p_j, \pi(p_j; \lambda)$, exceed maximal expected profits with arrival

rate, λ/N, under the collusive equilibrium. A necessary condition for a CEE then

requires $\hat{\pi}(\hat{p}; \lambda/N) > \pi(p_j; \lambda)$.

The incentive for a firm to deviate is depicted in Figure 2 where $\pi(\lambda/N)$ and

$\pi(\lambda)$ represent the profit functions for a single firm j with arrival rates λ/N and λ,

respectively. Maximal profits with arrival rate, λ/N, obtain at price $\hat{p}$. An individual

firm's profits with arrival rate λ will exceed $\hat{\pi}(\hat{p})$ at all prices greater than p^* – the

minimal price that an individual firm is willing to set to increase its arrival rate to λ.

Thus, an individual firm j will deviate from $\hat{p}$ by setting $p_j < \hat{p} - c_b(N/2)$ if, and only if,

$p^* < \hat{p} - c_b(N/2)$. Otherwise, $\hat{\pi}(\hat{p}) > \pi(p_j; \lambda)$ and a collusive equilibrium holds. The

likelihood that a CEE holds increases with the expected cost to an arrival of locating firm

j. Since expected search costs increase as the number of firms, N, increases, we obtain

the counterintuitive result that greater potential competition may actually increase the

likelihood of monopoly pricing.[15]

B.   Export Subsidy: Collusive-Equivalent Equilibrium

Suppose that the necessary conditions for a CEE hold in free trade. Can a CEE be

sustained when the domestic government enacts a TSS payable to all N^d domestic firms?

Begin by describing the characteristics of a CEE under a TSS. As in the presubsidy CEE,

both foreign and domestic firms set a profit-maximizing monopoly price when arrivals

contact individual firms at rate λ/N. However, under the subsidy the equilibrium is no

longer symmetric. Because the TSS reduces the search costs of domestic firms only, the

profit-maximizing monopoly price of a domestic firm, $\hat{p}_s$, is greater than that of the

foreign firm, $\hat{p}$, in the CEE. Thus there are two distinct groups of foreign consumers –

buyers of the domestic product paying $\hat{p}_s$ and buyers of foreign output paying $\hat{p}$.

The higher price set by the domestic firm in a CEE under the subsidy implies that

individual firms are not required to set price as low as under free trade in order to attract

buyers of domestic output. This suggests the possibility that a CEE under the TSS is not

sustainable. The following propositions summarize the incentives for individual firms to

deviate from the CEE prices under the subsidy and thus the sustainability of the

equilibrium.

Proposition 1*: Neither individual domestic nor foreign firms will deviate from their,
respective, collusive-equivalent prices in order to attract (potential) buyers from foreign
firms.*

Since they pay $\hat{p}$ in a CEE, buyers of the foreign-produced good will search for

the low-price firm j if $p_j < \hat{p} - c_b(N/2)$ – the same incentive as in free trade. Because

foreign firms were unwilling to set p_j to increase the arrival rate to λ under free trade,

they are unwilling to do so under the subsidy since the subsidy policy does not,

otherwise, impact their profit conditions.

Domestic firms' profitability does change due to the subsidy and, as a result, so too does the minimum price that domestic firms are willing to set to attract arrivals from other firms. Define the minimal price that individual domestic firms are willing to set to increase the arrival rate to λ as p_s^*. At p_s^*, profits with arrival rate λ equal maximal monopoly profits with arrival rate, λ/N: $\pi(p_s^*;\lambda,s) = \hat{\pi}_s(\hat{p}_s;\lambda/N,s)$. Totally differentiating this equality allows us to solve for $dp_s^*/ds > 0$, so that $p_s^* > p^*$, the minimal price that the domestic firm is willing to set under free trade.[16] Thus, if domestic firm j were unwilling to set p_j in order to attract λ arrivals absent a subsidy, then it will be unwilling to deviate with a subsidy; $p_j < p^* < p_s^*$. Because the increase in profits due to the increase in arrivals at any given price decreases with increases in the subsidy rate, the relative increase in profitability from attracting more arrivals is less under the TSS than under free trade.[17]

The domestic TSS will induce neither individual domestic nor foreign firms to deviate from their respective collusive equilibrium prices in order to attract buyers from foreign firms, if no such incentive existed in free trade. We now turn to the question of whether firms hold an incentive to deviate from their collusive equilibrium prices to attract buyers from domestic firms under a TSS.

Proposition 2: *Domestic and foreign firms which have no incentive to deviate from the free-trade CEE prices may do so under the TSS in an effort to attract (potential) buyers from domestic firms.*

Here, domestic firm arrivals will search for the low price firm j, if

$p_j < \hat{p}_s - c_b(N/2)$. Since $\hat{p}_s > \hat{p}$ the price required to attract domestic arrivals is greater

than under free trade – or, equivalently, an individual firm does not have to reduce its price as much as under free trade – and price deviation becomes a possibility.

Offsetting this effect, however, is that, in general, both domestic and foreign firms have less incentive to deviate under the TSS. For $N^f > 1$, the resulting increase in new buyers due to a price deviation by a foreign firm under the subsidy, N^d, is less than the increase under free trade, $N-1$. The minimal price that a foreign firm is willing to set is lower in value, and thus deviation more likely, the lower the number of foreign firms (for a given total, N). Indeed, when N^f equals one, the minimum price that the foreign firm is willing to set to attract N^d domestic buyers is the same as under free trade. Thus, if the TSS increases the domestic monopoly price sufficiently and N^f is sufficiently small, it is possible for an individual foreign firm to deviate from its CEE price, $\hat{p}$.[18]

Although an individual domestic firm may also deviate from its collusive equilibrium price, $\hat{p}_s$, to attract (potential) buyers from its domestic rivals, it holds less incentive than an individual foreign firm. Not only is the potential increase in arrival rate for a domestic firm $(N^d - 1)$ less than for a foreign firm (N^d), but also, as in the case of price deviation to attract foreign consumers, the gain in profitability of increasing the arrival rate is less under a subsidy than under free trade. Thus, if domestic firms hold an incentive to deviate from CEE prices under the subsidy then so too will foreign firms and the CEE is not sustainable.

C.   Alternative Equilibria Under TSS

If a CEE were not sustainable, no alternative pure strategy equilibrium exists under the TSS. This is easy to illustrate for the duopoly case. Consider any potential

price vector (p_i, p_j). For any price set by firm i, firm j can set $p_j \leq p_i + c_b(N/2)$ without

losing its existing arrivals. So long as prices were less than the monopoly prices for

existing arrivals, firm i can increase profits by increasing price from p_i to $p_j + c_b(N/2)$.

Firm j responds similarly to any price set by firm i, so that no Nash equilibrium exists.

Thus, absent the necessary conditions for a CEE, only mixed strategy equilibria arise.

D.   Policy Implications of TSS in Multi-Firm Market

        Although we do not solve for mixed strategy equilibria under a TSS, the above

analysis suggests some potential distinctions between free trade and TSS equilibria that

have interesting policy implications. As demonstrated, an individual firm under a TSS

may deviate from a CEE by reducing its price, even if no such incentive exists under free

trade. Thus, there exists the possibility that under a TSS in a mixed strategy equilibrium

we may observe prices less than the levels set under free trade – in direct contrast to the

effect of a TSS on price under monopoly. And if the TSS were to result in lower prices it

would follow that the domestic exporter might experience lower profits under TSS

equilibrium than under free trade.

        It is also interesting to note that the TSS subsidy (potentially) provides an

incentive for firms to compete for the existing buyers of domestic exporters' output and

not for the buyers of the foreign firm's product. This incentive runs counter to the

objective of export subsidy policies which are designed to aid the domestic exporters'

efforts to capture buyers from foreign rivals.

VII.   Concluding Remarks

        The above analysis indicates that when domestic exporters are involved in a

search process, the design of the export subsidy policy matters. Subsidies not specifically

directed at search costs, but instead designed to benefit the overall profitability of export activity, increase, rather than decrease, the cost of "delay" – the time period required to find a buyer with a sufficiently high valuation. Here, the firm offsets the additional costs of delay – the increase in the present value of forgone revenue – by reducing price. Under a targeted search cost subsidy, however, an exporter can now justify raising its price since the associated cost of delay is mitigated by the TSS. Of course, the price effects of a TSS are sensitive to model specification, but in no case does the TSS reduce the exporter's price in the absence of foreign competition.

The introduction of foreign competition may significantly alter the effects of TSS policy. First, should consumer search costs be sufficiently high, the effects of a TSS are identical to those under a domestic monopoly: both domestic and foreign firms set a monopoly price. In this case, the TSS has no impact on a foreign firm's behavior relative to free trade as its price and profits remain equal to its free trade values. This result stands in contrast to standard analysis where, absent search, a subsidy to a firm's rival typically reduces the well-being of the non-subsidized firm.

When, instead, a TSS leads to a deviation from the monopoly price, we may observe a mixed strategy equilibrium with firms setting lower prices. However, even with this pricing outcome many of the effects of a TSS still differ from the standard effects of an export subsidy. Of particular interest is the motivation for a firm to set a lower price – to attract buyers from domestic firms only. Typically, the price effects of a subsidy to a domestic firm result in the domestic firm capturing buyers from its foreign rival. Thus, in a mixed strategy equilibrium, with nonmonopoly prices, it is uncertain how the TSS impacts firm profitability – particularly foreign firm profits.

Whether or not a collusive equivalent equilibrium holds under a TSS, the deleterious effects on a foreign firm typically associated with a subsidy provided to its domestic competitor may not hold under a TSS. The potentially benign effects of a TSS on a foreign firm suggest an absence of an incentive for the firm to exert pressure on the foreign government for protection from its domestic rival. On this score, one is struck by the minimal number of countervailing duty petitions filed by import-competing firms against this type of export promotion policy.

This analysis serves as a platform for future research on the effects of trade policy in the presence of search activity. Because of the importance of informational failures in international decision making this line of investigation merits further attention. Among the areas of interest for further work are solutions to the type of mixed strategy equilibria described above. Although beyond the scope of present analysis, such solutions would allow more precise insights on the effects of TSS on prices as well as the formation of optimal policies in the presence of search activity.

1. See Coughlin and Cartwright (1987) for a survey of state activities designed to lower the search cost of (state) exporters as well as empirical estimates of the efficacy of such policies.

2. The notion of 'arrival' does not necessarily imply that potential buyers physically travel to meet the monopolist (as in consumers arriving at a retail outlet). Perhaps a more satisfactory interpretation would be to think of the exporter contacting prospective foreign consumers, sequentially, at a rate of λ per period.

3. $E[e^{-\delta\tau}]$ equals the expected discounted time of receipt of the first valuation greater than p. The time until the arrival of a customer willing to pay p, τ, is exponentially distributed according to density function $\lambda\overline{F}e^{-(\lambda\overline{F})\tau}$. Thus,

   $E[e^{-\delta\tau}] = \lambda\overline{F}\int_0^\infty e^{-\tau(\delta+\lambda\overline{F})}d\tau$ which yields the expression for $pE[e^{-\delta\tau}]$ in the text.

4. The TSS subsidy could have been modeled as a lump sum payment to the monopolist (perhaps, made at the beginning of the search process). This would only alter the discount rate applied to search costs (versus continuous payments) and would not alter the qualitative effects of the policy.

5. The reduction in the present value of the posted price that results from delay, $\delta p/(\delta + \lambda\overline{F}(p)) = p - (p\lambda\overline{F}(p)/(\delta + \lambda\overline{F}(p)))$ where p equals present value when the good is purchased at time zero.

6. The properties of hazard rate functions vary significantly over familiar distribution functions. For example, the hazard rate function for a uniform distribution is increasing with respect to valuations. The Weibull distribution (the

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most commonly used distribution in the reliability literature) has a hazard rate

function which can be either increasing or decreasing. For a more detailed

discussion of the behavior of hazard rate functions see Arnold and Lippman

(2000).

7. The change in the expected marginal costs of a price increase with respect to s is

obtained from expression (2): $-h/(\delta + \lambda \overline{F})$. The change in the marginal benefits

of an increase in search expenditure expenditure, the left-hand side of (4), with

respect to s equals: $-(\partial \lambda / \partial c)\overline{F}/(\delta + \lambda \overline{F})$. Combining first-order conditions (2)

and (4) shows these two expressions to be identical in the profit-maximizing

equilibrium.

8. The β term is used to obtain the present (expected) value of π, one sales period

previous, since π_1 is equivalent to a one time payment at the end of the first sales

period.

9. From first-order condition (8) it is possible to demonstrate that the posted price

with two units must be less than when the firm only has one to sell. First note that

$\partial \beta / \partial p < 0$ which implies, from (8), that $\partial \pi_1 / \partial p > 0$. Since $\partial \pi_1 / \partial p = 0$ (and

$\partial^2 \pi_1 / \partial p^2 < 0$) in the single unit case, $\partial \pi_1 / \partial p > 0$ only holds at prices less than the

profit maximizing price in the single unit case. This result was demonstrated in

Arnold and Lippman (2001).

10. The expression $\Pi_{ps} = (\partial^2 \pi_1 / \partial p \partial s)(1 + \beta) + (\partial \pi_1 / \partial s)(\partial \beta / \partial p)$. Substitution of the

expressions for $(\partial^2 \pi_1 / \partial p \partial s) > 0, \partial \pi_1 / \partial s > 0$ and $\partial \beta / \partial p < 0$ into Π_{ps} yields the

result that $\Pi_{ps} > 0$.

11. Although not relevant for the present discussion, it is interesting to note that an export subsidy policy may lower the posted price, p, of the domestic firm by more than s' so that the net price received by the domestic firm, p', actually declines. A simulation, assuming a Weibull distribution of consumer valuations, is available upon request, which illustrates such an outcome.

12. The model is a version of Diamond's (1971) seminal work on the pricing effects of consumer search costs. The version presented here most closely resembles that of Arnold and Lippman (2001).

13. The cost of contacting and acquiring the good from a firm other than i is composed of consumer search costs and the actual price set by the alternative firm.

14. The probability of locating the single low-cost firm is the sum of the probabilities of finding firm j on the first through the $N-1$ possible contacts. For example, the probability of finding firm j on the second contact is the probability of not finding firm j on the first contact and finding firm j on the second contact (conditional on not finding firm j on the first contact).

15. Arnold and Lippman (2001) demonstrate that values of c_b and N exist, given specific distributions of consumer valuations, to support a CEE.

16. Totally differentiating $\pi(p_s^*;\lambda,s) = \hat{\pi}(\hat{p};\lambda/N,s)$ with respect to the subsidy rate and applying the envelope theorem ($\partial\hat{\pi}/\partial\hat{p} = 0$) yields:

    $dp_s^*/ds = (\partial\hat{\pi}/\partial s - \partial\pi/\partial s)/(\partial\pi/\partial p_s^*)$ where $\partial\hat{\pi}/\partial s, \partial\pi/\partial s, \partial\pi/\partial p_s^* > 0$ (the latter holds since $p_s^* < \hat{p}$). Also, $\partial\hat{\pi}/\partial s > \partial\pi/\partial s$ since $\partial\pi/\partial\lambda\partial s < 0$.

17.   Note that we are assuming that the arrival rate for an individual firm increases to

λ – that is, a price deviation attracts all arrivals from both foreign and domestic

firms. However, since Proposition 1 is only concerned with attracting foreign

arrivals a price deviation only increases a domestic firm's arrival rate to

$\lambda((N^f + 1)/N)$ and an individual foreign firm's arrival rate to $\lambda(N^f/N)$. Thus,

the incentive to attract only foreign arrivals is less than assumed in the analysis.

Since there is no incentive to deviate at arrival rate λ, there will be none at these

lower rates.

18.   Simulations which illustrate cases where foreign firm and domestic firm which do

not deviate from $\hat{p}$ in free trade, but do under the TSS are available from the

author. Also, it is interesting to note that an individual foreign firm may attract

domestic arrivals at prices greater than or equal to $\hat{p}$ if the subsidy raises the

domestic firm's collusive-equivalent price, $\hat{p}_s$, sufficiently.

References

1.   Arnold, Michael A. and Steven A. Lippman, "The Analytics of Search with Posted Prices," *Economic Theory*, 17, March 2001, 447-466.

2.   _____, "Elasticity of Demand for Search," *Economics Letters,* 67, June 2000, 309-314.

3.   Berry, Willard M. and William A. Mussen, "Part I – A Report," in *Export Development and Foreign Investment: The Role of States and Its Linkage to Federal Action",* Committee on International Trade Relations, Washington, D.C.: National Governors' Association, 1980.

4.   Cassella, Allesandra and James E. Rauch, "Anonymous Market and Groups Ties in International Trade," *Journal of International Economics*, 58, October 2002, 19-47.

5.   Collie, David, "Export Subsidies and Countervailing Tariffs," *Journal of International Economics*, 31, November 1991, 309-24.

6.   Coughlin, Cletus C. and Phillip A. Cartwright, "An Examination of State Export Promotion and Manufacturing Exports," *Journal of Regional Science*, 27, August 1987, 439-49.

7.   Diamond, Peter, "A Model of Price Adjustment," *Journal of Economic Theory*, 9, June 1971, 156-168.

8.   Dixit, Avinash, "Anti-Dumping and Countervailing Duties Under Oligopoly", *European Economic Review*, 32, January 1988, 55-68.

9.   Eaton, Jonathan and Gene M. Grossman, "Optimal Trade and Industrial Policy Under Oligopoly," *Quarterly Journal of Economics*, 101, May 1986: 383-406.

9. Lippman, Steven A. and John J. McCall, "The Economics of Job Search: A Survey," *Economic Inquiry*, XIV, June 1976, 155-189.

10. Qiu, Larry D., "Why Can't Countervailing Duties Deter Export Subsidization?", 39, November, 1995, 249-272.

11. Rauch, James E. and Alessandra Cassella, "Overcoming Informational Barriers to International Resource Allocation: Price and Ties," *Economic Journal*, 113, January 2003, 221-42.

12. Rauch, James J. and Vitor Trindade, "Information, International Substitutability, and Globalization," *American Economic Review*, 93, June 2003, 775-791.

13. Seringhaus, Rolf and Phillip J. Rosson, *Government Export Promotion: A Global Perspective.* London: Routledge, 1990.

FIGURE 1
Price Effects of TSS: Monopoly

Marginal Revenue,
Marginal Cost

MC_o MC_s

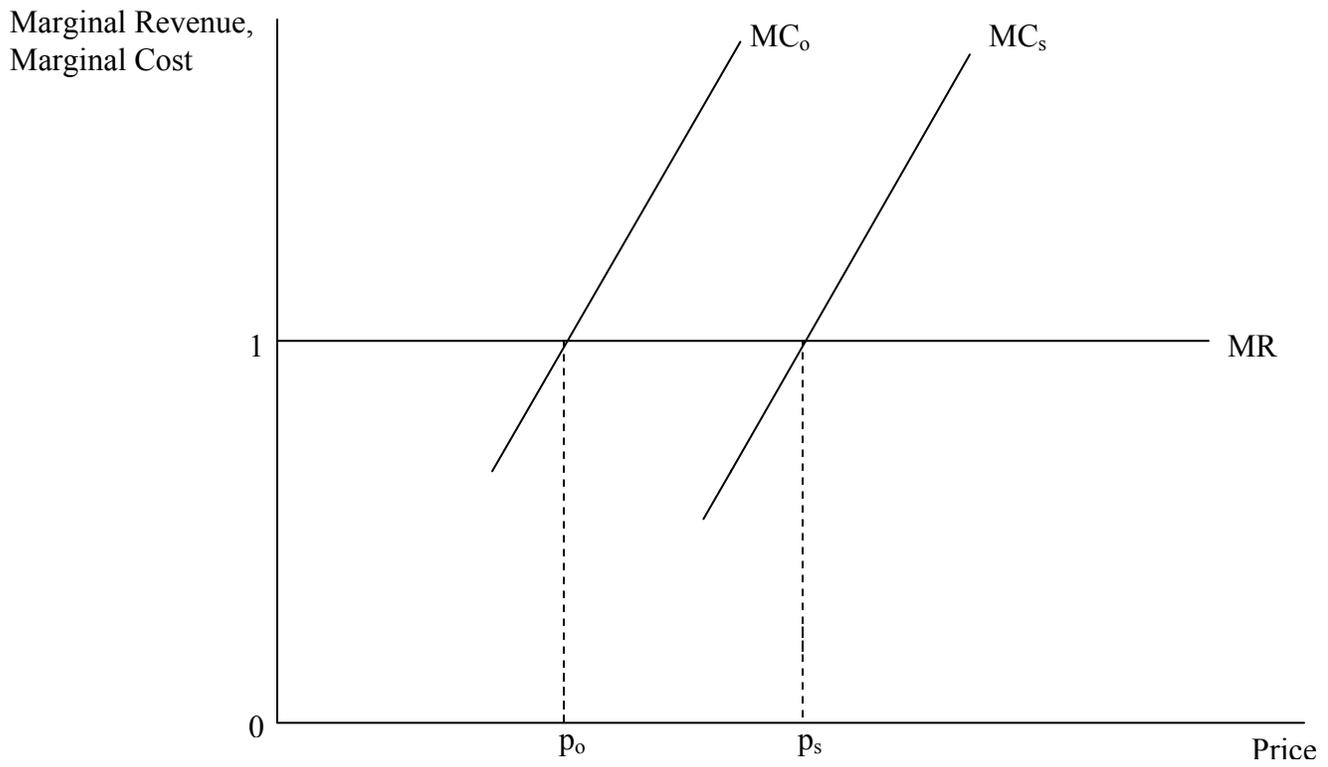1 ——————————————————————— MR

0

p_o p_s

Price

FIGURE 2

Determination of Minimal Price (p^*) that a Firm is Willing to set to Increase Arrival Rate Under Free Trade