NBER WORKING PAPER SERIES

RENT-SHIFTING EXPORT SUBSIDIES WITH AN IMPORTED INTERMEDIATE PRODUCT

Jota Ishikawa
Barbara J. Spencer

Working Paper 5458

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
February 1996

We would like to thank Amy Glass for helpful comments. Financial support was gratefully received by Jota Ishikawa from the Kajima Foundation and the Government of Canada Awards and by Barbara Spencer from C.I.B.S. at the University of British Columbia. This paper is part of NBER's research program in International Trade and Investment. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper 5458
February 1996

RENT-SHIFTING EXPORT SUBSIDIES WITH AN IMPORTED INTERMEDIATE PRODUCT

ABSTRACT

This paper argues that export subsidies aimed at shifting rents from foreign to domestic producers of a final good may also serve to shift rents to foreign firms supplying an intermediate good, weakening the incentive for the subsidy. By contrast, assuming Cournot competition for both the final and intermediate goods, this second layer of rent-shifting between final and intermediate good firms can strengthen the argument for an export subsidy if intermediate good firms are domestic. The domestic welfare implications of alternative rent-shifting policies (a production subsidy and an import tariff) at the intermediate good stage are also considered.

Jota Ishikawa
Department of Economics
Hitotsubashi University
Kunitachi, Tokyo 186
JAPAN

Barbara J. Spencer
Faculty of Commerce
University of British Columbia
2053 Main Mall
Vancouver, B.C. V6T 1Z2
CANADA
and NBER

Rent-Shifting Export Subsidies with an Imported Intermediate Product

1. Introduction

Export subsidies, such as attractive terms of credit for export sales[1], have often been promoted on the basis that they might allow domestic exporters to gain market share and presumably profit at the expense of foreign rivals. Indeed, the Brander and Spencer (1985) model of strategic-trade policy has shown that there are conditions under which such a subsidy might actually give rise to a net domestic benefit. However, given the importance of world trade in intermediate products, firms producing manufactured goods for export would also commonly import parts or components from foreign suppliers. This suggests that if the foreign suppliers are oligopolistic, they could share in some of the rents resulting from, say, a domestic subsidy to final-good exports, opening the question as to the ultimate recipients of the rents shifted by strategic trade policies. For example, Samsung Electronics Inc. is a major exporter of electronic products from Korea, but it also imports significant components such as flat panel displays (for computers), glass bulbs and electronic guns (for televisions), and magnetrons (for microwave ovens) from Japanese firms such as Toshiba Corp. and Sharp Corp[2]. If Korea chose to provide tax or financing incentives to promote electronics exports, would the rents go to Korean firms such as Samsung or would they be further shifted so as to mostly benefit the Japanese parts suppliers?

---

[1] Low interest loans to finance exports and tax incentive systems such as deductions for export earnings and accelerated depreciation for exporting firms are common forms of export subsidies.

[2] Other examples include LG Electronics Inc. which imports compressors for air conditions from Matsushita Electric Industrial Co. Ltd of Japan. Also, Hyundai Motor Company, a major Korean exporter of autos, has used Mitsubishi Motors Corp of Japan to supply engines.

This paper explores this issue by considering an export subsidy applied to a final-good in a setting in which at one extreme, imperfectly competitive domestic firms produce all of an intermediate-good used by domestic final-good producers and at the other extreme, all of the intermediate-good is imported. So as to clarify the additional effects arising from the intermediate-good market, we assume, as in the original Brander and Spencer (1985) model, that final-good producers in both the domestic and foreign countries act as Cournot competitors and that all the final product is exported to a third market. Cournot competition is also assumed in the intermediate-good market[3], with some attention given to the special case of domestic or foreign monopoly. Our main model involves import of the intermediate good, but some consideration is also given to the possibility that a subsidy boosting final-good exports could impact on domestic profits from intermediate-good sales to foreign final-good producers. In addition, the paper develops some welfare comparisons of the export subsidy with other rent-shifting policy instruments, namely a production subsidy and an import tariff applied at the intermediate-good stage.

Since Eaton and Grossman (1986), it is well known that the nature of rent-shifting policy is sensitive to whether outputs are strategic substitutes or complements and that this is affected by the form of competition. Although our analysis is limited to the Cournot case, we allow for general demand conditions in which outputs can be either strategic substitutes or complements. Hence, considering the final-product market alone, the point made by Eaton and Grossman (1986) that the domestic country would gain from an export tax as opposed to an export subsidy in the strategic complements case applies in our

---

[3] Cournot competition in both intermediate and final good markets is a familiar framework in the antitrust literature [see Tirole (1988)]. Other trade papers adopting this framework (but addressing different issues) include Spencer and Raubitschek (1996), Ishikawa and Lee (1995) and Ishikawa (1995).

model. Also, since there are no restrictions on the numbers of final and intermediate good producers, effects arising from the relative numbers of domestic and foreign firms are incorporated[4].

With the addition of an intermediate-good market, optimal strategic trade policy involves consideration of three kinds of rent-shifting; between foreign and domestic final-good producers, between foreign and domestic intermediate-good producers and between final-good producers and intermediate-good producers. As the paper shows, even if all the intermediate-good producers are domestic, rent-shifting between final-good and intermediate-good producers affects the conditions under which an export subsidy raises domestic welfare. For example, suppose a domestic monopolist supplies the intermediate good. Taking into account the profit shifted to the monopolist and the cost to taxpayers, a subsidy to exports is called for if and only if the profits of domestic final-good producers would rise. By contrast, under perfect competition in intermediate-good supply, the profits of final-good producers would need to rise by more than the subsidy payment. Having a domestic monopolist provide the intermediate good broadens the conditions for a positive export subsidy under some demand conditions (e.g. linear demand). However, if demand is linear, a foreign monopoly supplying the intermediate product would capture sufficient of the rents generated by an export subsidy that such a policy is never worthwhile from a domestic viewpoint.

An important assumption is that the markets for the intermediate product in the foreign and domestic countries are segmented. Thus final-good producers in each country can face different prices for the intermediate-good, even in the absence of trade restrictions. However, for much of the paper, the

---

[4] Having more than one domestic final-good producer gives rise to a 'terms of trade' effect favoring an export tax (see Eaton and Grossman (1986) and Krishna and Thursby (1991)).

presentation is simplified by assuming that the price paid by foreign final-good producers is an exogenously given constant (perhaps because these firms are vertically integrated[5]). This provides a better focus on main effects, but also, when we later relax this assumption to allow the foreign as well as the domestic price to be endogenously determined in separate Cournot markets, there is surprisingly little impact on results. All of the above mentioned results carry over to this broader setting. In the linear demand case, the results are identical since the foreign price of the intermediate good is actually unaffected by domestic trade policy.

Although the analysis of "strategic trade policy" has had extensive development in the last decade[6], so far relatively little attention has been given to the implications of trade in intermediate goods for strategic trade policy. Some exceptions are Spencer and Jones (1991, 1992), Rodrik and Yoon (1989) and Ishikawa and Lee (1995). These papers analyze various trade policies in the context of vertically related markets with particular attention to the effects of vertical integration[7]. Chang and Kim (1989) and Chang and Chen (1994) also consider trade policies in vertically related markets, but in the context of a rather different model focusing on quality differentiation.

The rest of the paper is organized as follows. Section 2 describes the

---

[5]A similar assumption was made by Spencer and Raubitschek (1996), who suggest a number of other possibilities. The intermediate good could be produced by a competitive industry in the foreign country and exported to the domestic country through a government mandated export cartel. The foreign intermediate-good suppliers could be constrained by regulation as to the price charged within the country, but not as to the price charged for export.

[6] See Brander (1995) for details.

[7] Of these papers, only Spencer and Jones (1991) considers export subsidies, but the setting differs because the subsidized firm is vertically integrated and does not import the intermediate product.

basic model of vertically related markets characterized by Cournot oligopolies. Section 3 sets out the equilibrium conditions in the markets for the final and intermediate goods. Section 4 then develops the domestic welfare effects of subsidy to final-good exports, examining the implications of the source of intermediate goods, whether foreign or domestic, for the sign of the optimal subsidy (negative for a tax). In Sections 2, 3 and 4, the price of the intermediate-good paid by foreign firms is exogenously given. This assumption is relaxed in Section 5 so as to incorporate the endogenous determination of intermediate-good prices in both countries as well as the possibility that domestic firms export the intermediate-good for use by foreign final-good producers. Section 6 then develops the domestic welfare effects of a production subsidy and import tariff directly applied to the intermediate-good. Finally, Section 7 provides concluding remarks.

2. Model Structure

As illustrated by Figure 1 below, we consider two vertically related activities in two countries, country D (for domestic) and country F (for foreign). In the upstream stage, a homogeneous intermediate good is produced, while, in the downstream stage, a homogeneous final good is produced. Typical domestic and foreign final-good producers are referred to as firm d (d for domestic) and f (f for foreign) respectively and typical domestic and foreign intermediate-good producers as firms h (h for home) and m (m for imports), respectively. There are n^i firms of type i for i = d,f,h, and m respectively.

Firms d and f in countries D and F respectively export all of the final product to a third country Cournot market (shown by the solid arrows to the oval shaped field at the bottom of Fig. 1). The solid arrows within Country D and from country F to country D illustrate our main model in which country D potentially both produces and imports the intermediate good. The domestic price, denoted r^D, of the intermediate good is then determined by Cournot competition between firms h and m within the domestic market. In this simplified model, final-good producers in country F obtain all their supplies of the intermediate good from within their own country at an exogenously given price, denoted r^F. However, we later relax the model (see Section 5) to allow r^F as well as r^D to be determined endogenously. As illustrated by the dashed (in addition to the solid) arrows in Fig. 1, the same group of identical firms h or m then provide the intermediate good to firms d and f in both countries.

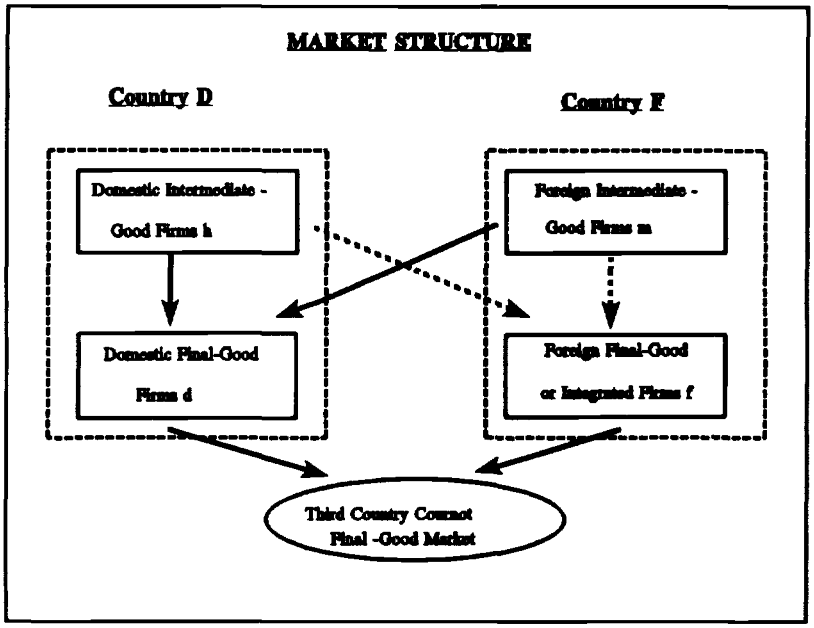

Fig. 1

The subgame perfect equilibrium of the model incorporates three stages of decision. In stage 0, the domestic government commits to the values of its trade policy instruments. In stage 1, firms h and m commit to the quantities of the intermediate good supplied to country D on the basis of a Cournot-Nash equilibrium. When r^F is made endogenous, there are segmented Cournot markets in each country. Each firm h or m then commits to the quantities it will supply to each country taking the quantities supplied by other firms to each country as given. In stage 2, final-good producers d and f set their exports on the basis of

Cournot competition taking the prices r^D and r^F of the intermediate good as given. The price r^D is simply the market-clearing price at which demand by domestic final-good producers equals supply. If r^F is allowed to be endogenous, it equates the foreign demand for the intermediate good to the supply.

3. Equilibrium in the Markets for the Final and Intermediate Goods

We first set out the conditions determining the Cournot-Nash equilibrium in the final-good market, before developing the Cournot-Nash equilibrium in the intermediate-good market.

Firms d and f produce outputs y^d and y^f respectively of the final good giving rise to aggregate output $Y \equiv Y^d + Y^f$ where $Y^d \equiv n^d y^d$ represents total domestic output and $Y^f \equiv n^f y^f$ represents total foreign output. The price, denoted p, of the final product is given by the inverse demand function $p = p(Y)$ where $p'(Y) < 0$. As in the previous literature in the area, the analysis is simplified by assuming that the final-good is produced using fixed proportions of the intermediate good and another factor, labor. By an appropriate choice of units, there is no loss of generality in assuming that just one unit of the intermediate good is required for each unit of the final product. Labor is supplied to the industry in each country at a constant wage, with unit wage costs given by w^D in country D and w^F in country F.

Letting $\rho \equiv r^D - s^d$ where s^d denotes a specific subsidy applied to firm d's exports, it follows that the profits of firms d and f are respectively given by

$$\pi^d = [p-(\rho+w^D)]y^d \text{ for } \rho \equiv r^D - s^d \text{ and } \pi^f = [p-(r^F+w^F)]y^f. \qquad (1)$$

Since each firm maximizes profit taking the outputs of rivals as given, the outputs of firms d and f respectively satisfy the first order conditions:

$$\partial\pi^d/\partial y^d = p+y^d p'-(\rho+w^D) = 0,\ \partial\pi^f/\partial y^f = p+y^f p'-(r^F+w^F) = 0. \qquad (2)$$

The following second order and stability conditions are assumed to hold globally[8]: i.e.

$$2p'+y^ip'' < 0,\ \gamma^i \equiv n^i+1-\sigma^iE > 0\ (i=d,f)\ \text{and}\ \psi \equiv N+1-E > 0, \quad (3)$$

where $\sigma^i \equiv Y^i/Y$ (the share of firms i in the final-good market), $E \equiv -Yp''/p'$ (the elasticity of the slope of the inverse demand curve of the final good), and $N \equiv n^d+n^f$ (the total number of final-good firms).

The first order conditions (2) define the Cournot equilibrium output levels $y^d(\rho)$ and $y^f(\rho)$ for firms d and f respectively as functions of the component $\rho \equiv r^D-s^d$ of domestic marginal cost (r^F is omitted until it becomes variable in Section 5 and w^D, w^F are omitted since they are constants). Now, using subscripts to denote partial derivatives, from (A.3) (equations numbered as (A.) are all in the Appendix) we obtain

$$y^d_\rho(\rho) = \gamma^f/p'\psi < 0 \ \textit{and}\ y^f_\rho(\rho) = -(n^d/n^f)(n^f-\sigma^fE)/p'\psi \quad (4)$$

where $\gamma^f > 0$ and $\psi > 0$ from (3). As (4) shows, an increase in ρ (due to an increase in the price r^D or a reduction in the export subsidy s^d holding r^D fixed) always reduces the output of firm d. However, since $n^f-\sigma^fE = n^f(p'+y^fp'')/p'$, the output of firm f rises if and only if it views the final outputs as strategic substitutes (i.e. iff $p'+y^fp'' < 0$). The total output of the final product, given by $Y(\rho) \equiv Y^d + Y^f$ where $Y^i = Y^i(\rho) \equiv n^iy^i(\rho)$ for i = d,f, always falls since, using (4),

$$Y_\rho(\rho) = n^d/p'\psi < 0. \quad (5)$$

Whether domestic firms d gain from a reduction in marginal costs (due to an export subsidy) proves to be important for some of the subsequent results. As originally shown by Seade (1985), a reduction in the marginal cost faced by

[8]These conditions are more commonly expressed as: $(n^d+1)p'+Y^dp'' < 0$, $(n^f+1)p'+Y^fp'' < 0$ and $(N+1)p'+Yp'' < 0$. The first two conditions are used to sign the comparative statics and the last is needed for uniqueness and stability of equilibrium (see Seade (1980) and (1985)).

all firms in a Cournot industry could cause *profit over-shifting* in the sense that overall industry profits fall. Spencer and Raubitschek (1996) have extended this analysis to consider profit over-shifting when there are outside or foreign firms for whom costs remain constant. Following their approach, we first define $\beta \equiv -p'(Y_\rho - y^d_\rho)$, measuring the effect of a change in ρ on the price of the final product through changes in the outputs of all other firms, but one's own. The term β is positive if a reduction in ρ would cause the aggregate output of other firms to fall (raising price and profit), and negative otherwise. Letting $\alpha \equiv \gamma^f - n^d$ and using (4) and (5), we then obtain

$$\beta \equiv -p'(Y_\rho - y^d_\rho) = \alpha/\psi \text{ where } \alpha \equiv \gamma^f - n^d = n^f + 1 - \sigma^f E - n^d. \qquad (6)$$

Hence from (1), using (2) and (4), the effect of ρ on firm d's profit is given by

$$d\pi^d/d\rho = -y^d + y^d p'(Y_\rho - y^d_\rho) = -y^d(\rho)(1+\beta) \qquad (7)$$

where, using (3) and (6), $1+\beta = (\psi+\alpha)/\psi = [2(1+n^f) - E(1+\sigma^f)]/\psi$.

As can be seen from (7), an increase in marginal cost reduces the profits of firms d (ruling out profit over-shifting) if and only if $1+\beta > 0$. Since $p'' \leq 0$ implies $E \leq 0$ and hence $1+\beta > 0$, profits are always reduced if the inverse demand curve for the final good is concave or linear. More generally, $E < 2$ is sufficient to rule out profit over-shifting but even greater convexity in the inverse demand curve can be accommodated if $n^f > 0$[9].

Now considering the intermediate-good market, firms h and m produce outputs x^h and x^m respectively of the intermediate good for sale in country D. Aggregate supplies in country D are given by $X^D \equiv X^h + X^m$ where $X^h \equiv n^h x^h$ represents total domestic production and $X^m \equiv n^m x^m$ represents total foreign production. In setting output in stage 1, the firms h and m fully anticipate the derived demand $Y^d(\rho)$ for the intermediate good arising from the second stage Cournot equilibrium for the final good. Equating demand with supply (i.e. $Y^d(\rho)$

---

[9] See Spencer and Raubitschek (1996).

$= X^D$) and taking the inverse defines $\rho = \rho(X^D)$, which from $\rho = r^D - s^d$ is the inverse demand curve $r^D = \rho(X^D) + s^d$ for the intermediate good. The inverse demand curve has first and second derivatives

$$\rho'(X^D) = 1/Y^d_\rho < 0 \textit{ and } \rho''(X^D) = -Y^d_{\rho\rho}/(Y^d_\rho)^3. \qquad (8)$$

Marginal production costs are assumed constant at a level c^h for firm h and c^m for firm m. Letting s^h represent a specific subsidy applied to domestic production of the intermediate good and t^m a specific tariff imposed on domestic imports of the intermediate good and using $r^D = \rho(X^D) + s^d$, it follows that the profits of firms h and m are respectively given by

$$\pi^h = [r^D-(c^h-s^h)]x^h = [\rho(X^D)-\upsilon^h)]x^h \text{ and}$$
$$\pi^m = [r^D-(c^m+t^m)]x^m = [\rho(X^D)-\upsilon^m]x^m \qquad (9)$$

where $\upsilon^h \equiv c^h-s^h-s^d$ and $\upsilon^m \equiv c^m+t^m-s^d$ are constants. Cournot competition in intermediate-good production then gives rise to the following first order conditions: from (9),

$$\partial\pi^k/\partial x^k = \rho(X^D) + x^k\rho'(X^D) - \upsilon^k = 0 \ (k = h,m). \qquad (10)$$

Letting $E^u \equiv -X^D\rho''/\rho'$ represent the elasticity of the slope of the inverse demand curve of the intermediate good where u stands for up-stream, then, analogously to the market for the final good, the following second order and stability conditions are assumed to hold globally: i.e. for $k = h,m$

$$2\rho'+x^k\rho'' < 0,\ \gamma^{uk} \equiv n^k+1-\sigma^{uk}E^u > 0 \textit{ and } \psi^u \equiv N^u+1-E^u > 0, \quad (11)$$

where $\sigma^{uk} \equiv X^k/X^D$ (the share of firms $k = h,m$ in the domestic intermediate-good market) and $N^u \equiv n^h+n^m$ (the total number of intermediate-good firms).

4. A Subsidy to Final-Good Exports

This section develops the domestic welfare effects of the subsidy s^d applied to final-good exports by country D with particular attention given to the shifting of profits to intermediate-good producers, both domestic and foreign. When foreign firms m supply the intermediate good, the natural interpretation is that these firms are located in the foreign country. However, under some circumstances, it may be possible to interpret firms m as being foreign-owned plants located in the domestic country through foreign direct investment. This interpretation would require that none of the profit going to firm m is captured back through domestic taxes or rents going to domestic workers. A similar point would apply to the location of domestic firms h.

Considering first the effects of s^d on the firm-level outputs x^h and x^m of the intermediate good, it is shown in (A.6) that

$$dx^h/ds^d = -[1 + n^m\delta^u E^u/X^D]/\rho'\psi^u \text{ and } dx^m/ds^d = -[1 - n^h\delta^u E^u/X^D]/\rho'\psi^u \quad (12)$$

for $\delta^u \equiv x^h - x^m$. As (12) shows, if demand is linear (i.e. if $E^u = 0$)[10] or if the intermediate-good suppliers are identical (which holds if they are all domestic, all foreign or if $\delta^u = x^h - x^m = 0$) then firm-level outputs x^h and x^m both increase. However with asymmetric costs and non-linear demand, x^h or x^m may fall. Nevertheless the export subsidy always raises the total supply $X^D \equiv n^h x^h + n^m x^m$ of the intermediate good in country D and, since $Y^d = X^D$, domestic exports of the final product must also rise:

$$dX^D/ds^d = dY^d/ds^d = -N^u/\rho'\psi^u > 0. \quad (13)$$

As for the effect of the export subsidy on the price of the intermediate product and the domestic marginal cost of final-good production, from $r^D = \rho(X^D) + s^d$, using (13) and $\psi^u \equiv N^u + 1 - E^u > 0$, we obtain

$$dr^D/ds^d = \rho'(dX^D/ds^d) + 1 = (1-E^u)/\psi^u \text{ and}$$

$$d\rho/ds^d = dr^D/ds^d - 1 = -N^u/\psi^u < 0. \quad (14)$$

Proposition 1 follows immediately from (14).

__*Proposition 1*__: *An increase in the subsidy s^d applied to final-good exports raises the price r^D of the intermediate good (respectively lowers the price) if and only if $E^u < 1$ (resp. $E^u > 1$). Nevertheless, $\rho = r^D - s^d$ always falls, causing an*

---

[10] Spencer and Raubitschek (1996) derive the relationship between $E^u \equiv -X^D\rho''/\rho'$ and $E \equiv -Yp''/p'$ for general demand. If $p'' = 0$, then $\rho'' = -Y^d_{\rho\rho}/(Y^d_\rho)^3 = 0$, which implies $E^u = E = 0$.

overall reduction in the marginal cost faced by domestic firms d.

As stated in Proposition 1, if $E^u < 1$ which holds if demand for the intermediate good is not too convex (including linear and concave demand), an increase the subsidy s^d is partially offset by an increase in the price r^D of the intermediate good. Thus part of the gain from the subsidy is shifted from firms d in the final-good sector to firms h and m in the intermediate-good sector. By contrast, if $E^u > 1$, the export subsidy decreases the price r^D, magnifying the effect of the subsidy in lowering marginal cost. Using (7) and (14), we can express $d\pi^d/ds^d$ in the form:

$$d\pi^d/ds^d = (d\pi^d/d\rho)(d\rho/ds^d) = y^d(1+\beta)N^u/\psi^u. \quad (15)$$

As can be seen from (15), firm d's profit rises if and only if $1+\beta > 0$, which is just the condition required to rule out profit over-shifting from a reduction in marginal cost. The following expression for the effect of s^d on firm d's profit also proves useful: from (1) and (2)

$$d\pi^d/ds^d = y^d p'[(dY^f/ds^d)+(n^d-1)(dy^d/ds^d)] - y^d(d\rho/ds^d). \quad (16)$$

Now considering the effect of the subsidy s^d on the profits of intermediate-good firms h and m, it follows from (9), imposing the first order conditions (10) and then using (12) and (13) that

$$d\pi^h/ds^d = x^h + x^h\rho'((dX^D/ds^d)-(dx^h/ds^d))] = x^h[2-E^u+n^m\delta^u E^u/X^D]/\psi^u \text{ and}$$
$$d\pi^m/ds^d = x^m[2-E^u-n^h\delta^u E^u/X^D]/\psi^u. \quad (17)$$

If the firms h and m are identical (i.e. if $\delta^u = x^h-x^m = 0$), then (17) reveals that intermediate-good profits rise in response to the subsidy if and only if $E^u < 2$. This condition holds for a monopoly supplier since, with $N^u = 1$, $\psi^u = 2-E^u > 0$ from (11). Since the subsidy s^d shifts out the inverse demand curve $r^D = \rho(X^D) + s^d$ by an additive constant, it has the same effect as would an equal reduction in the marginal costs c^h and c^m (see (9)). Hence the condition $E^u < 2$ is related to the result by Seade (1985) that profits are not over-shifted for (identical) final-good producers if and only if $E < 2$. Although s^d lowers the price r^D of the intermediate good when $E^u > 1$ (recall Proposition 1), intermediate-good profits nevertheless rise because of higher output.

Even if international cost differences cause firms h and m to be very asymmetric in size, the subsidy raises the profit of every intermediate-good firm if demand is linear (from (17) with $E^u = 0$). However, if demand is non-linear, it is possible that the higher cost firms lose from the subsidy even if $E^u < 2$. In summary, with respect to the effects of s^d on profits, the following proposition is established.

__Proposition 2__: An increase in the subsidy s^d increases the profits of

(i) domestic final-good producers if and only if $1+\beta > 0$.

(ii) domestic and foreign intermediate-good producers (a) if and only if $E^u < 2$ provided $\delta \equiv x^h - x^m = 0$ or (b) if demand is linear.

Turning to the overall welfare implications, country D's welfare, denoted W^D, is just the total domestic profit earned from final and intermediate good production, less the cost of the subsidy:

$$W^D = n^d\pi^d + n^h\pi^h - s^dY^d - s^hX^h + t^mX^m. \tag{18}$$

(The subsidy s^h and the tariff t^m are included in (18) for completeness). From (18), assuming $d^2W^D/(ds^d)^2 < 0$, the optimal rent-shifting export subsidy, denoted $\hat{s}^d$ (with $s^h = t^m = 0$) satisfies

$$dW^D/ds^d = n^d(d\pi^d/ds^d) + n^h(d\pi^h/ds^d) - Y^d - \hat{s}^d(dY^d/ds^d) = 0. \tag{19}$$

Rearranging (19) using (14) and (16), $\hat{s}^d$ can usefully be expressed as

$$\hat{s}^d = Y^d p'\left[\frac{dY^f/ds^d}{dY^d/ds^d} + \frac{(n^d-1)}{n^d}\right] + \frac{Y^d\Omega}{dY^d/ds^d} \tag{20}$$

where $\Omega \equiv [n^h d\pi^h/ds^d - Y^d(dr^D/ds^d)]/Y^d$. The expression in square brackets in (20) captures the standard 'strategic' and 'terms of trade' effects of an export subsidy arising from the final-goods market in a form very similar to an expression derived by Krishna and Thursby (1991, equation (A.8)). The last term of (20) arises because of the existence of the Cournot market for the intermediate good.

Some brief explanation of the 'strategic' and 'terms of trade' effects seems warranted. The first term of (20) represents the strategic effect of the subsidy on the output of the foreign firms f. Since $dY^f/ds^d = Y^f_\rho(d\rho/ds^d)$, if firms f view outputs as strategic substitutes then $Y^f_\rho > 0$ from (4) ensuring that their output falls in response to the subsidy (i.e. $dY^f/ds^d < 0$). This tends to make $\hat{s}^d > 0$ and is the source of the Brander and Spencer (1985) argument for an export subsidy. However as pointed out by Eaton and Grossman (1986), if firms f view outputs as strategic complements, then, $dY^f/ds^d > 0$ favoring an export tax. The 'terms of trade' effect arising when there is more than one domestic firm is reflected in the second term of (20). Since domestic firms take no account of the effect of their exports on the exports of other domestic firms, each firm d expands exports beyond the level that maximizes total domestic profits taking foreign output as given. This expansion lowers the export price, worsening the terms of trade. Correction of this distortion alone would require an export tax.

Combining the 'strategic' and 'terms of trade' effects as given by the first two terms of (20), it is instructive to express $\hat{s}^d$ in the form[11]

$$\hat{s}^d = Y^d[-\beta(d\rho/ds^d) + \Omega]/(dY^d/ds^d) \qquad (21)$$

where from (6), $\beta \equiv -p'(Y_\rho - y^d_\rho) = -p'(Y^f_\rho + (n^d-1)y^d_\rho)$. In the absence of an intermediate-good market, then $\Omega = 0$ and (21) shows that $\beta > 0$ is necessary and sufficient for $\hat{s}^d > 0$. If a reduction in ρ would cause the aggregate output of other firms to fall (i.e. if $\beta > 0$), a subsidy is called for since the Cournot domestic firms (taking the output of other firms as given) would undersupply the market from the viewpoint of joint profit maximization. Recalling that $\alpha \equiv \beta\psi$ from (6) and $\psi > 0$ from (3), if $\Omega = 0$ it also follows that $\hat{s}^d > 0$ if and only if $\alpha > 0$. Since, from (6), α can be expressed as $\alpha = n^f(p' + y^f p'')/p' + 1 - n^d$,

---

[11] This follows since
$p'[(dY^f/ds^d) + (n^d-1)(dy^d/ds^d)] = p'(Y^f_\rho + (n^d-1)y^d_\rho)(d\rho/ds^d) = -\beta(d\rho/ds^d)$.

we obtain the familiar result that $\hat{s}^d$ can be positive only if foreign firms view outputs as strategic substitutes (i.e. only if $p' + y^f p'' < 0$). An additional requirement is that the number of domestic firms be sufficiently small to prevent the 'terms of trade effect' from dominating. For example, if demand were linear, we require $\alpha = n^f + 1 - n^d > 0$.

With respect to the additional effects caused by the intermediate-good market, as can be seen from (20) or (21), all else equal, having Ω positive makes it more likely that the optimal export policy is a subsidy (i.e $\hat{s}^d > 0$). From (20), (14) and (17), Ω can be expressed as[12]:

$$\Omega \equiv [n^h(d\pi^h/ds^d) - Y^d(dr^D/ds^d)]/Y^d = -[\sigma^{uh}\rho'(dx^h/ds^d) + \sigma^{um}(dr^D/ds^d)]. \quad (22)$$

Not surprisingly, (22) shows that if the export subsidy raises the profits of domestic intermediate good producers, this tends to make Ω positive. However, this effect is at least partially offset to the extent that profit is shifted from final-good to intermediate-good producers through an increase in the domestic price r^D of the intermediate good (rather than purely through an increase in quantity). As we know from Proposition 1, the price r^D is increased if demand is not too convex (i.e. if $E^u < 1$). When the intermediate-good industry is 100% domestic (i.e. when $\sigma^{uh} = 1$ and $n^m = 0$), it follows from (22) using (12) that the effect of s^d in raising the profits of domestic intermediate-good producers always dominates making $\Omega = -\rho'(dx^h/ds^d) = 1/\psi^u > 0$. By contrast, if the intermediate-good is entirely foreign, then $\Omega = -(dr^D/ds^d)$ is negative whenever r^D is increased. However, it is possible that $dr^D/ds^d < 0$, making Ω positive even in the 100% foreign case.

This brings us to one of the central questions of this paper, namely the effect of having a foreign rather than a domestic intermediate-good industry on the domestic incentive to subsidize final-good exports for rent-shifting purposes.

---

[12] Follows since $\Omega = (X^h/Y^d)[1 + \rho'((dX^D/ds^d) - (dx^h/ds^d)) - (d\rho/ds^d + 1)] - (X^m/Y^d)(dr^D/ds^d)$.

Proposition 3 addresses this issue by supposing that a foreign firm replaces a domestic firm holding the total number of intermediate-good firms fixed. So as to focus purely on the issue of the ultimate recipient of the profits, we abstract from efficiency effects by assuming that intermediate-good firms h and m have identical costs. In the absence of efficiency effects, a change in the ownership of these firms has no effect on prices or outputs, greatly simplifying the analysis.

Proposition 3: Assume $\delta^x \equiv x^h - x^m = 0$ and $N^x = n^h + n^m$ is fixed. An increase in the proportion of foreign relative to domestic suppliers of the intermediate product reduces the incentive to subsidize final-good exports if and only if the subsidy shifts profits to intermediate-good producers.

Proof: Holding N^x fixed, $dn^h = -dn^m$, but with $\delta^x = 0$, all other variables are unchanged ensuring that Y^d, r^D, $d\pi^d/ds^d$ and $d\pi^h/ds^d$ are unaffected. From (19), this implies $d^2W/ds^d dn^m = -d\pi^h/ds^d$ evaluated at $\hat{s}^d$. Hence $\hat{s}^d$ is reduced iff $d\pi^h/ds^d > 0$. Since $d\pi^h/ds^d = d\pi^m/ds^d$, the result follows. QED

As Proposition 3 has shown, if some of the profits gained from a subsidy to final-good exports are shifted to intermediate-good producers, a reduction in the proportion of domestic intermediate-good producers must lower the domestic incentive for the subsidy. Thus, Proposition 3 confirms the intuitively plausible idea that having profits leak to foreign intermediate-good producers reduces any domestic gain from an export subsidy.

The next question is the effect of the presence of a Cournot intermediate-good industry, whether domestic or foreign, on the conditions determining the sign of the export subsidy used for rent-shifting purposes. For better comparison with the standard analysis incorporating only the final product, we first consider the case in which the intermediate-good industry is purely domestic.

Purely Domestic Intermediate-Good Industry

Supposing that the intermediate good firms are all domestic (i.e. $N^u = n^h$), using $\Omega = 1/\psi^u$ (from (22) using (12)) and $d\rho/ds^d = -N^u/\psi^u$ in (21) and then using $dY^d/ds^d = Y^d_\rho(-n^h/\psi^u)$, we obtain

$$\hat{s}^d = Y^d[\beta N^u + 1]/\psi^u(dY^d/ds^d) = -[Y^d\beta + x^h]/Y^d_\rho, \text{ for } N^u = n^h, \quad (23)$$

where $\beta = \alpha/\psi$. Recalling that in the absence of an intermediate good market, $\hat{s}^d > 0$ if and only if $\alpha \equiv n^f+1-\sigma^f E-n^d > 0$, Proposition 4 concerns the corresponding conditions arising when a purely domestic Cournot industry supplies the intermediate good.

__*Proposition 4*__*: Suppose the Cournot industry supplying the intermediate good is purely domestic.*

(i) $\alpha = n^f+1-\sigma^f E-n^d > 0$ *is sufficient but not necessary for* $\hat{s}^d > 0$.

(ii) (a) A necessary condition for $\hat{s}^d > 0$ *is* $d\pi^d/ds^d > 0$ *(i.e. that the profits of firms d not be over-shifted, which holds iff* $1+\beta > 0$*). (b) If* $n^h = 1$ *(domestic monopoly), then* $\hat{s}^d > 0$ *iff* $d\pi^d/ds^d > 0$.

(iii) If demand is linear, then (a) $\hat{s}^d > 0$ *iff* $(n^f+1)(n^h+1) - n^d(n^h-1) > 0$ *or (b)* $\hat{s}^d > 0$ *if* $n^h = 1$.

Proof: (i) From (23), $\hat{s}^d > 0$ if $\beta = \alpha/\psi > 0$, but $\beta > 0$ is not required. (ii) From (23) with $N^u = n^h$, $\hat{s}^d = Y^d[(1+\beta)n^h - (n^h-1)]/\psi^u(dY^d/ds^d)$ so (a) and (b) follow from (15). (iii) If $p'' = 0$, (a) and (b) follow since $\hat{s}^d = Y^d[(n^f+1)(n^h+1) - n^d(n^h-1)]/\psi^u(dY^d/ds^d)(N+1)$ from (23) with $\beta = (n^f+1-n^d)/(N+1)$. QED

Proposition 4(i) shows that when the intermediate-good industry is domestic, the export subsidy $\hat{s}^d$ can be positive even if $\alpha < 0$. However, from Proposition 4(ii)(a), it is necessary that $1+\beta = 1+\alpha/\psi > 0$, which is the condition ruling out profit over-shifting for firms d. In the special case in which the domestic firm h is a monopolist, Proposition 4(ii)(b) demonstrates that the only requirement for $\hat{s}^d > 0$ is that it increase the profits of domestic final-good firms. The cost of the subsidy payment is not relevant because by adjusting the quantity supplied, the monopolist is able to capture added profits just equal to the increase in the subsidy payment for a given quantity $x^h = Y^d$ of exports[13]. Since the profits of final-good firms d rise when demand is linear, $\hat{s}^d$ is positive in the linear case with a domestic monopolist (see Proposition 4(iii)). This last result is worth emphasising because it does not depend on the relative numbers of domestic and foreign final-good firms.

As set out in Proposition 5, it is now possible under some limited conditions for an export subsidy to raise domestic welfare even if final-good outputs are strategic complements. If $n^d \geq 2$ in this strategic complements case, then Spencer and Raubitschek (1996) have shown that profit is over-shifted, which from Proposition 4(ii), rules out $\hat{s}^d > 0$. However if $n^d = 1$ (which favors $\hat{s}^d > 0$ because there is no terms of trade effect) then it follows from (A.11) that $\hat{s}^d > 0$ iff

$$2p' + y^d p'' < -(n^h+1)n^f(p' + y^f p''). \tag{24}$$

Since $2p' + y^d p'' < 0$ from the second order conditions, (24) could hold even if $p' + y^f p'' > 0$. This is more likely if $n^h = n^f = 1$, since then the right hand side of (24) is less negative. Also, as reflected by Proposition 5, it is helpful if countries D and F have similar costs making y^d not very different from y^f.

<u>***Proposition 5***</u>*: Assume $N^u = n^h$ and $n^d = 1$. Sufficient conditions for $\hat{s}^d > 0$ and final goods to be strategic complements are:*

(i) $1 \leq y^d/y^f < 2$ and $n^f/\sigma^f < E < n^f/\sigma^f + \tau$ OR (ii) $n^f/(n^f+1) < y^d/y^f \leq 1$ and $1/\sigma^d < E < n^f/\sigma^f + \tau$ OR (iii) $y^d/y^f = 1$, $n^f = n^h = 1$ and $2 < E < 7/3$ where $\tau \equiv (2-y^d/y^f)/[n^f(n^h+1) + y^d/y^f] > 0$.

<u>Proof</u>: Since final goods are strategic complements iff $n^i - \sigma^i E < 0$, using $\psi = n^d + n^f + 1 - E > 0$, we have $\sigma^i/n^i = Y/y^i = n^i + n^j y^j/y^i < E < n^i + n^j + 1$ for $i \neq j$ and $i,j = d,f$. These inequalities hold only if $y^j/y^i < (n^j+1)/n^j$ which implies

[13] If $n^h = N^u = 1$, then from (17), $d\pi^h/ds^d = x^h = Y^d$ and from (19), $\hat{s}^d = n^d(d\pi^d/ds^d)/(dY^d/ds^d)$.

$n^f/(n^f+1) < y^d/y^f < 2$ for $n^d = 1$. For $N^u = n^h$ and $n^d = 1$, from (A.11), $\hat{s}^d > 0$ iff $E < [n^f(n^h+1) + 2]/[\sigma^f(n^h+1)+\sigma^d]$ and using $n^f\sigma^d/\sigma^f = y^d/y^f$ for $n^d = 1$, we obtain

$$\hat{s}^d > 0 \text{ iff } E < (n^f/\sigma^f)[n^f(n^h+1)+2]/[n^f(n^h+1) + y^d/y^f] = n^f/\sigma^f + \tau,$$

where $y^d/y^f < 2$ implies $\tau \equiv (2-y^d/y^f)/[n^f(n^h+1) + y^d/y^f] > 0$. Conditions (i) are sufficient since if $1 \leq y^d/y^f < 2$ and $n^f/\sigma^f = n^f+y^d/y^f < E$ then $1/\sigma^d = 1 + n^f y^f/y^d < E$ (i.e. outputs are all strategic complements) and $\hat{s}^d > 0$ since $E < n^f/\sigma^f + \tau$. Similarly conditions (ii) are sufficient since if $n^f/(n^f+1) < y^d/y^f \leq 1$ and $1/\sigma^d < E$, then $n^f/\sigma^f < E$. Conditions (iii) follow by setting $y^d/y^f = 1$ and $n^f = n^h = 1$ in conditions (i) or (ii). QED

The above analysis is not sufficient to determine whether Cournot competition at the intermediate-good stage has increased (or reduced) the incentive for an export subsidy relative to having the intermediate-good produced by a perfectly competitive constant cost industry. This is because imperfect competition at the intermediate-good stage serves to raise the price r^D above marginal cost reducing the magnitude of final-good exports[14]. Denoting the competitive 'base case' with a superscript zero, then $\rho^0 \equiv c^h - s^d$ and setting $\Omega = 0$ and $d\rho/ds^d = -1$ in (21), the optimal export subsidy $\hat{s}^{d0}$ satisfies

$$\hat{s}^{d0} = -Y^d(\rho^0)\beta^0/Y^d_\rho(\rho^0), \qquad (25)$$

which is positive if and only if $\alpha^0 \equiv \beta^0/\psi = n^f+1-\sigma^{f0}E^0-n^d > 0$. Comparing (25) with (23), $\hat{s}^d$ is similar in form to s^{d0} except that it has an additional positive term, namely, $-x^h/Y^d_\rho$, which reflects the effect of an export subsidy in shifting profits to the intermediate good suppliers. However, ambiguity is created because the higher price charged for the intermediate product under imperfect competition makes $Y^d(\rho) < Y^d(\rho^0)$ for any given subsidy level, reducing the magnitude of $\hat{s}^d$ and raising the foreign share $\sigma^f \equiv Y^f/Y$ of the

---

[14] See Neary (1994) for analysis of the effect of the level of marginal cost on the export subsidy.

market for the final good so as to affect the value of α relative to α^0.

The general condition under which the introduction of a domestic Cournot industry producing the intermediate good would increase the range of cases in which the export subsidy is positive, is set out in Proposition 6. This condition is always satisfied when demand is linear.

__Proposition 6__: Suppose $N^m = n^h$ and $n^m = 0$. The presence of Cournot competition (in contrast to perfect competition) in intermediate-good supply increases the range of cases in which $\hat{s}^d > 0$ if and only if

$$N + 1 - E + n^h(\sigma^{f0}E^0 - \sigma^f E) > 0.$$

This holds if demand is linear.

<u>Proof</u>: From (23), $\hat{s}^d > 0$ iff $n^f + 1 - n^d > [-(N+1-E) + \sigma^f E n^h]/n^h$ and from (25), $\hat{s}^{d0} > 0$ iff $n^f + 1 - n^d > \sigma^{f0}E^0$. Hence $\hat{s}^d > 0$ under a broader range of conditions iff $[-(N+1-E) + \sigma^f E n^h]/n^h < \sigma^{f0}E^0$. QED

Foreign Intermediate-good Producers

Turning to a consideration of the other extreme in which the producers of the intermediate good are entirely foreign, it follows from (22) and (14) that $\Omega = -(dr^D/ds^d) = -(1-E^u)/\psi^u$ when $\sigma^{uh} = 0$. From (21) using (14), the optimal export subsidy then satisfies

$$\begin{aligned} \hat{s}^d &= Y^d[\beta N^u - \psi^u(dr^D/ds^d)]/\psi^u(dY^d/ds^d) \\ &= Y^d[\beta N^u + 1 - (2-E^u)]/\psi^u(dY^d/ds^d) \qquad (26) \end{aligned}$$

for $N^u = n^m$. Although $\alpha \equiv \beta\psi > 0$ is sufficient for $\hat{s}^d > 0$ when the suppliers are all domestic (see Proposition 4(i)), since dr^D/ds^d is positive under a wide range of demand conditions including linear demand (see Proposition 1), the first expression of (26) reveals that this is not the case when all suppliers are foreign. Extending this analysis to allow for both foreign and domestic intermediate-good firms, Proposition 7(i) (see below) shows that in a linear demand setting, $\alpha = n^f + 1 - n^d > 0$ is sufficient for $\hat{s}^d > 0$ if and only if domestic suppliers control at least half the intermediate-good market.

Now considering the case in which a foreign monopolist supplies the intermediate good (i.e. $N^u = n^m = 1$), Proposition 7(ii) shows that when demand is linear, domestic final-good exports should be taxed. Thus, comparing with Proposition 4(iii)(b), a shift from a domestic to a foreign monopoly in intermediate-good supply causes the rent-shifting export policy to switch from a subsidy to a tax. More generally, a comparison of the last expression of (26) with (23) reveals that having all foreign rather than all domestic firms supply the intermediate good reduces the incentive to subsidize final-good exports if and only if $2\text{-}E^u > 0$. Since, from Proposition 2(ii), $2\text{-}E^u > 0$ is necessary and sufficient for s^d to raise the profits of identical intermediate-good suppliers, this is just the condition (see Proposition 3) under which a greater foreign presence in intermediate-good supply lowers the incentive to subsidise exports.

__Proposition 7__: Suppose $p'' = 0$.

(i) If $\alpha = n^f+1-n^d > 0$ and $\sigma^{uh} \geq 1/2$ then $\hat{s}^d > 0$.

(ii) If $N^u = n^m = 1$, then $\hat{s}^d < 0$.

<u>Proof</u>: (i) From (21) and (14), $\hat{s}^d = Y^d[\beta N^u + \psi^u\Omega]/\psi^u(dY^d/ds^d)$. If $p'' = 0$ then $\beta = \alpha/(N+1)$ and $\Omega = (2\sigma^{uh}-1)/\psi^u$ (from (22), (12), (14) and $\sigma^{um} = 1-\sigma^{uh}$) and the result follows since,

$$\hat{s}^d = Y^d[\alpha N^u + (2\sigma^{uh}-1)(N+1)]/(N+1)\psi^u(dY^d/ds^d). \qquad (27)$$

(ii) From (27) with $N^u = n^m = 1$ and $\sigma^{uh} = 0$, we obtain

$\hat{s}^d = -2n^dY^d/(N+1)\psi^u(dY^d/ds^d) < 0$. QED

5. <u>Endogenous Foreign Price r^F</u>

In this section, the foreign price r^F of the intermediate good is made endogenous by assuming that firms f in country F as well as firms d in country D purchase the intermediate good from the same group of suppliers.

Writing $y^d = y^d(\rho,r^F)$ and $y^f = y^f(\rho,r^F)$ to represent the final-good outputs of firms d and f respectively (from the first order conditions (2)), it follows, analogously to (4) that

$$y^f_{r'} = \gamma^d/p'\psi < 0 \text{ and } y^d_{r'} = -(n^f/n^d)(n^d-\sigma^d E)/p'\psi. \qquad (28)$$

Next, equating demand with supply of the intermediate good in the (segmented) domestic and foreign markets, i.e. setting $Y^d(\rho,r^F) = X^D$ and $Y^f(\rho,r^F) = X^F$ and solving simultaneously, defines the inverse demand curves $r^D = \phi^D(X^D,X^F) + s^d$ and $r^F = \phi^F(X^D,X^F)$ in the domestic and foreign markets respectively. As shown in (A.12), ϕ^D and ϕ^F have partial derivatives:

$$\phi^D_D = p'\gamma^d/n^d < 0, \ \ \phi^F_F = p'\gamma^f/n^f < 0,$$
$$\phi^D_F = p'+y^d p'' \text{ and } \phi^F_D = p'+y^f p''. \qquad (29)$$

As might be expected, (29) implies that an increase in any one country's supply of the intermediate good always reduces price in that country and that the price in the other country also falls if final-good outputs are strategic substitutes, but rises if they are strategic complements.

To simplify the analysis, intermediate-good producers are assumed to be identical, either all domestic, all foreign or both foreign and domestic, but with identical costs. Using the superscripts D and F to distinguish the destinations of the intermediate good, a typical intermediate-good producer k, where k = h if domestic and k = m if foreign, incurs marginal costs c^{kD} and c^{kF} in supplying quantities x^{kD} and x^{kF} of the intermediate good to countries D and F respectively. If firm k is foreign (i.e. k = m), then c^{mD} might exceed c^{mF} because of transport costs from country F to D, and vice-versa if k = h. Thus taking account of sales in both markets, firm k's profit is given by

$$\pi^k = [\phi^D(X^D,X^F)+s^d-c^{kD}]x^{kD} + [\phi^F(X^F,X^D) - c^{kF}]x^{kF} \quad \text{for } k = h,m. \quad (30)$$

Assuming Cournot behavior with respect to each market, each firm k sets the quantities x^{kD} and x^{kF} to maximize profit taking the respective quantities supplied by the other firms as given. Hence, from (30), x^{kD} and x^{kF} for the N^u identical firms satisfy the first order conditions:

$$\partial\pi^k/\partial x^{kD} \equiv \pi^k_D = \phi^D + x^{kD}\phi^D_D + x^{kF}\phi^F_D - c^{kD} + s^d = 0 \textit{ and}$$
$$\partial\pi^k/\partial x^{kF} \equiv \pi^k_F = \phi^F + x^{kD}\phi^D_F + x^{kF}\phi^F_F - c^{kF} = 0. \qquad (31)$$

The second order conditions are also assumed to be satisfied: i.e.

$$\pi^k_{DD} < 0,\ \pi^k_{FF} < 0 \textit{ and } \pi^k_{DD}\pi^k_{FF} - (\pi^k_{DF})^2 > 0 \quad (32)$$

where $\pi^k_{ii} = 2\phi^i_i + x^{ki}\phi^i_{ii} + x^{kj}\phi^j_{ii}$ and $\pi^k_{DF} = \phi^D_F + \phi^F_D + x^{kD}\phi^D_{FD} + x^{kF}\phi^F_{FD}$ for $i \neq j$ and $i,j = D,F$. In addition, we impose the stability conditions[15]:

$$A^k_{DD} < 0,\ A^k_{FF} < 0 \textit{ and } H^u \equiv A^k_{DD}A^k_{FF} - A^k_{DF}A^k_{FD} > 0 \quad (33)$$

where $A^k_{ii} \equiv (N^u+1)\phi^i_i + X^i\phi^i_{ii} + X^j\phi^j_{ii}$ and $A^k_{ij} \equiv N^u\phi^i_j + \phi^j_i + X^i\phi^i_{ij} + X^j\phi^j_{ij}$ for $i \neq j$ and $i,j = D,F$.

As can be seen from (31), the quantity of the intermediate good destined for any one country is determined taking account of its effect on both the prices r^D and r^F. Thus, although the markets for the intermediate good are segmented in the sense that the prices r^D and r^F can differ, they are nevertheless connected through the decisions of the intermediate-good firms as to how much to supply. The effect of the subsidy s^d on the quantities supplied is found by totally differentiating (31) for the N^u firms, then using (33), $Y^d = X^D = N^u x^{kD}$ and $Y^f = X^F = N^u x^{kF}$ to obtain

$$dY^d/ds^d = dX^D/ds^d = -N^u A^k_{FF}/H^u > 0 \textit{ and}$$
$$dY^f/ds^d = dX^F/ds^d = N^u A^k_{FD}/H^u. \quad (34)$$

As (34) shows, an increase in s^d always causes more of the intermediate good to be supplied to the domestic market and hence domestic final-good exports must rise. Also foreign final-good exports fall if $A^k_{FD} < 0$ (each firm k then reduces its output x^{kF} destined for country F) and rise if $A^k_{FD} > 0$.

Turning to the welfare analysis, the first point to make is that the domestic welfare function (18), the first order condition (19) for the choice of $\hat{s}^d$ and the overall expression (20) for $\hat{s}^d$ are unchanged from the previous analysis. Since our central proposition, Proposition 3, follows directly from

---

[15] Note that $A^k_{DF} = \pi^k_{DF} + (N^u-1)\pi^k_{DF*}$, where $\pi^k_{DF*} \equiv \phi^D_F + x^{kD}\phi^D_{DF} + x^{kF}\phi^F_{DF}$ is not equal to A^k_{FD} since $A^k_{FD} = \pi^k_{DF} + (N^u-1)\pi^k_{FD*}$, where $\pi^k_{FD*} = \phi^F_D + x^{kD}\phi^D_{DF} + x^{kF}\phi^F_{DF}$.

(19), this has the implication that Proposition 3 extends to this expanded model. Taking the case in which there are both foreign and domestic intermediate-good producers with identical costs, it follows that allowing r^F as well as r^D to be determined endogenously, an increase in the foreign ownership of the intermediate-good industry reduces the incentive to subsidize final-good exports if and only if intermediate-good producers would benefit from the subsidy.

However, the conditions under which intermediate-good producers gain from the subsidy now depend on changes in r^F as well as changes in $\rho \equiv r^D\text{-}s^d$ and on profits earned in the foreign as well as the domestic market: i.e. from (A.20), for k = h,m

$$d\pi^k/ds^d = x^{kD} + (N^u\text{-}1)[x^{kD}(d\rho/ds^d) + x^{kF}(dr^F/ds^d)]/N^u. \qquad (35)$$

As (35) shows, if $N^u > 1$ (i.e. there is more than one firm k), then the foreign market and changes in r^F matter for $d\pi^k/ds^d$. If r^F falls, this tends to make an increase in s^d less profitable for the firms k and vice versa if r^F rises. Hence, if the intermediate-good firms are domestic (i.e. if k = h), then in considering the rent-shifting policy s^d, the domestic country would need to take into account any gains or losses that firms h would experience in supplying foreign as well as domestic final-good producers.

By contrast, only the domestic market matters for $d\pi^k/ds^d$ if firm k is a monopoly. In this case (35) implies $d\pi^k/ds^d = x^{kD}$, which (from (17)) is the same expression as obtained with r^F exogenous. Moreover, if the monopoly is domestic (i.e. if k = h), then, using (19) and (35), $\hat{s}^d$ reduces to the form:

$$\hat{s}^d = n^d(d\pi^d/ds^d)/(dY^d/ds^d). \qquad (36)$$

As can be seen from (36), $\hat{s}^d$ is positive if and only if $d\pi^d/ds^d > 0$. This extends Proposition 4(ii) to this more general case with r^F endogenous. However, the conditions under which $d\pi^d/ds^d > 0$ are affected by changes in r^F. From (1) and (7), we obtain

$$d\pi^d/ds^d = -y^d(1+\beta)(d\rho/ds^d) + (\partial\pi^d/\partial r^F)(dr^F/ds^d), \qquad (37)$$

where, from (1), (2), (28), and $2n^d\text{-}\sigma^d E = n^d(2p'+y^dp'')/p' > 0$, it can be shown that

$$\partial\pi^d/\partial r^F = y^d p'[Y^f_{r'} + (n^d-1)y^d_{r'}] \\ = y^d n^f(2n^d - \sigma^d E)/n^d\psi > 0. \tag{38}$$

Comparing (37) with (15), $d\pi^d/ds^d$ has an additional term which is positive if r^F rises and negative if r^F falls. Further results require the derivation of the effects of the subsidy on r^F and $\rho \equiv r^D - s^d$.

The domestic export subsidy s^d has an effect on r^F given by (see (A.17))

$$dr^F/ds^d = N^u\{[p'/n^f + 2\phi^F_D]\delta p'' + (p'/n^f)[X^F\phi^F_{FD} + X^D\phi^D_{DF}]\}/H^u. \tag{39}$$

where $\delta \equiv y^d - y^f$, $\phi^F_{FD} = p''(n^f+1)/n^f + y^f p'''$ and $\phi^D_{DF} = p''(n^d+1)/n^d + y^d p'''$ from (A.14). Supposing that p'''/p'' is small, then ϕ^F_{FD} and ϕ^D_{DF} have the same sign as p''. Proposition 8 follows.

Proposition 8:

(i) If $p'' = 0$, then $dr^F/ds^d = 0$.

(ii) If $p'' < 0$ with p'''/p'' small and $\delta \equiv y^d - y^f \geq 0$ then $dr^F/ds^d > 0$.

Proof: (i) If $p'' = 0$, then (39) vanishes. (ii) If $p'' < 0$ with p'''/p'' small, then, from (29) and (A.14), $\phi^i_j < 0$ and $\phi^i_{ij} < 0$ for $i,j = D,F$. From (39), this implies $dr^F/ds^d > 0$ for $\delta > 0$. QED

Apart from its implications for the welfare effects of the subsidy s^d (discussed later), Proposition 8 is also interesting because it shows that the active involvement of the same suppliers of the intermediate good in both countries can significantly change the reaction of r^F to an export subsidy. For example, suppose that there are two firms, one domestic and one foreign, each with a monopoly in their own country. Then with $p'' = 0$, the domestic export subsidy would cause foreign final-good output to fall, reducing foreign demand for the intermediate good which would reduce r^F. As a consequence the domestic export subsidy would be less effective in raising exports. By contrast, from Proposition 8(i), if $p'' = 0$ then the quantity of the intermediate-good sold in country F is sufficiently reduced[16] that r^F remains constant.

With respect to the effect of the s^d on $\rho \equiv r^D - s^d$, (A.18) shows

$$d\rho/ds^d = -N^u\{(p'/n^d)A^k_{FF} + \phi^D_F(A^k_{FF}-A^k_{FD})\}/H^u. \qquad (40)$$

where, $A^k_{FF}-A^k_{FD} = p'(n^k+1)/n^f - 2p''\delta$ for $\delta \equiv y^d-y^f$ from (A.34). If $A^k_{FF}-A^k_{FD} < 0$ and $\phi^D_F < 0$ (i.e. if the direct effect A^k_{FF} dominates the cross effect A^k_{FD}[17] and final outputs are strategic substitutes), then $d\rho/ds^d < 0$ from (40), showing that firms d receiving the subsidy actually experience a net reduction in marginal cost. In particular, if demand is linear, then (40) implies (see (A.19)) that

$$d\rho/ds^d = -N^u/(N^u+1) < 0 \textit{ and } dr^D/ds^d = d\rho/ds^d+1 = 1/(N^u+1) > 0. \quad (41)$$

Since r^F is unchanged when demand is linear, it is not surprising that expressions (41) are identical to those obtained with r^F set exogenously (see (14) with $E^u = 0$ and $\psi^u = N^u+1$).

The overall effect of having r^F endogenous on $\hat{s}^d$ is best seen by expressing the optimal subsidy in the following form: from (19) using (37) and (22), we obtain

$$\hat{s}^d = \{Y^d[-\beta(d\rho/ds^d) + \Omega] + n^d(\partial\pi^d/\partial r^F)(dr^F/ds^d)\}/(dY^d/ds^d), \qquad (42)$$

where Ω is given by (22). A comparison of (42) with (21) reveals that (42) is similar in form to (21), but has an additional term involving dr^F/ds^d. Since $\partial\pi^d/\partial r^F > 0$ from (38), this term is positive tending to raise $\hat{s}^d$ if $dr^F/ds^d > 0$ and negative if $dr^F/ds^d < 0$. The outcome is particularly simple if $dr^F/ds^d = 0$ as occurs with linear demand (see Proposition 8(i)). In this case, setting dr^F/ds^d

---

[16] If $p'' = 0$ then $A^k_{FD} < 0$ from (33) and (29), which implies $dX^F/ds^d < 0$ from (34).

[17] If marginal costs differ significantly across countries so as to make $p''\delta$ large and negative, it is possible $A^k_{FF}-A^k_{FD} > 0$. This need not violate the stability conditions (33) provided $A^k_{DD} - A^k_{DF} = p'(n^k+1)/n^d + 2p''\delta$ is sufficiently negative.

$= 0$ and using (41), it can be shown that (42) reduces to (21). Hence, we have the rather remarkable implication that all the previous results concerning the sign of $\hat{s}^d$ when demand is linear, including Proposition 4(iii), Proposition 6 for $p'' = 0$ and Proposition 7 parts (i) and (ii), also apply when r^F is set endogenously.

5. Domestic Policy toward the intermediate-good

For this section concerning the effects of a tariff t^m applied to imports of the intermediate product and a subsidy s^h to domestic production of the intermediate product, we simplify the analysis by returning to the model in which r^F is exogenously given.

The first point to make is that if s^h is combined with an equal subsidy to imports of the intermediate good, i.e. $s^h = -t^m$, then, since $\upsilon^h = c^h - s^h$ and $\upsilon^m = c^m + t^m$ at $s^d = 0$, the first order conditions (10) determining the levels of output of firms h and m are identical to those that would be obtained from an export subsidy s^d alone set at the same level $s^d = s^h = -t^m$. Since replacing the export subsidy s^d with the policy combination $s^h = -t^m$ at the level s^d also has no effect on the marginal costs and output levels of final-good producers, Proposition 9 follows.

__*Proposition 9*__*: If domestic production and imports of the intermediate good are jointly subsidized at the same level, i.e. if $s^h = -t^m$, this gives rise to the same output and welfare effects as an equal subsidy to final-good exports.*

The following corollary is immediate from this proposition.

__*Corollary 1*__*:*

(i) If all the intermediate good is imported, an import subsidy to the intermediate good and an export subsidy to the final good set at the same levels are equivalent.

(ii) If all the intermediate good is domestic, a production subsidy to the intermediate good and an export subsidy to the final good set at the same levels are equivalent.

Although the policy combination of $s^h = -t^m$ has the same effect on output, profit and domestic welfare as an export subsidy alone set at the same level, it is *not* optimal to combine t^m and s^h so as to mimic an export subsidy. Letting s^{h*} and t^{m*} represent the jointly optimal policies, Proposition 10 follows.

<u>***Proposition 10:***</u> *Suppose $\pi^h > 0$ and $\pi^m > 0$. The policy combination of the subsidy s^{h*} to domestic intermediate-good production and the tariff t^{m*} on intermediate-good imports raises domestic welfare by more than the export subsidy $\hat{s}^d$ alone. The optimal policy combination always requires $s^{h*} > -t^{m*}$.*

<u>Proof</u>: From (A.29), the jointly optimal values of s^h and t^m are respectively

$$s^{h*} = -[Y^d\beta + x^h + x^m\sigma^{um}E^u]/Y^d_\rho \text{, and } t^{m*} = [Y^d\beta - x^m(1-\sigma^{um}E^u)]/Y^d_\rho. \qquad (43)$$

where $s^{h*}+t^{m*} = -(x^m+x^h)/Y^d_\rho > 0$ from (A.28). Hence it is *not* the case that $s^{h*} = -t^{m*}$. QED

Not surprisingly Proposition 10 shows that the optimal policy combination involves a higher subsidy (or lower tax) on domestic production of the intermediate good than on imports. Insight into the conditions determining the signs of the joint policies is obtained by relating t^{m*} and s^{h*} to the export subsidy $\hat{s}^d$. Supposing firms h and m have identical costs (i.e. $\delta^u = 0$), (A.32) and (A.33) imply that

$$s^{h*} = \hat{s}^d - n^m(x^h+x^m)/N^uY^d_\rho \text{, } \textit{and } t^{m*} = -\hat{s}^d - n^h(x^m+x^h)/N^uY^d_\rho. \qquad (44)$$

It then follows from (44) that $s^{h*} > \hat{s}^d > -t^{m*}$. Hence if $\delta^u = 0$ and $\hat{s}^d$, used as a sole policy, happens to be zero, then the optimal policy combination involves a strictly positive subsidy s^{h*} and a strictly positive tariff t^{m*}. However if $\hat{s}^d$ is positive, it is possible that $t^{m*} < 0$, which would imply that imports should be subsidized. Even if such import promotion directly shift profits to foreign intermediate-good producers, nevertheless the domestic country can gain if the policy reduces the marginal costs of domestic final-good producers so as to promote final-good exports. The motive for an import subsidy presented here differs fundamentally from the motive for subsidizing imports produced by a foreign monopoly in Brander and Spencer (1984). In their case, the imported good was a direct consumption good and had no effect on exports. Moreover, a subsidy was called for only in situations when the import price would be over-shifted, falling by more than the amount of the subsidy, so the gain to domestic consumers exceeded the cost of subsidy.

Finally, it is instructive to analyze the effects on domestic welfare of a domestic production subsidy to the intermediate-good alone[18]. Denoting the optimal value of this subsidy used as a sole policy by $\hat{s}^h$, (A.34) shows that

$$\hat{s}^h = X^h\rho'\left[\frac{(dX^m/ds^h)}{(dX^h/ds^h)} + \frac{n^h-1}{n^h}\right] + \frac{n^d(d\pi^d/ds^h)}{(dX^h/ds^h)} \quad . \tag{45}$$

Analogously to (20) for the export subsidy $\hat{s}^d$, the first and second terms (in square brackets) of (45) respectively represent the 'strategic effect' and the 'terms of trade effect' of the production subsidy. The (negative) 'terms of trade effect' here refers to the reduction in the price of the intermediate good arising from the over expansion of domestic output for a given level of imports when there is more than one domestic intermediate-good producer. The third term of (45) reflects the effect of domestic profits earned in the final-good market.

Letting $\alpha^u \equiv \gamma^{um}\text{-}n^h = n^m+1\text{-}\sigma^{um}E^u\text{-}n^h$, (45) reduces to (see (A.35))

$$\hat{s}^h = -[x^h\alpha^u + Y^d(1+\beta)]/\gamma^{um}Y^d_{\rho}, \tag{46}$$

where $\gamma^{um} > 0$ from (11). Proposition 11 follows.

<u>Proposition 11</u>: *Suppose the subsidy s^h to domestic intermediate-good production is imposed as a sole policy. If $1+\beta > 0$, then $\alpha^u \equiv n^m+1\text{-}\sigma^{um}E^u\text{-}n^h > 0$ is sufficient for the optimal subsidy $\hat{s}^h$ to be strictly positive. If $1+\beta = 0$, then $\alpha^u > 0$ is necessary and sufficient for $\hat{s}^h > 0$.*

---

[18] Also, from (A.25b) and (A.24) with $s^h = 0$, the optimal tariff alone is $\hat{t}^m = -[n^h(d\pi^h/dt^m) + X^m - Y^d(1+\beta)(dr^D/dt^m)]/(dX^D/dt^m)$. The effect of t^m in raising π^h and tariff revenue tends to make $t^m > 0$, but it is possible $t^m < 0$ since t^m raises r^D, causing π^d to fall if $1+\beta > 0$.

Proposition 11 can be understood from the fact that these are two profit-shifting games involved, one with respect to the foreign producers of the final product and the other with respect to foreign exporters of the intermediate good to the domestic country. If $1+\beta = 0$, since the price of the intermediate good has no effect on final-good profits (see Proposition 2), s^h only affects domestic welfare through profit-shifting in the intermediate-good market. The requirement $\alpha^u \equiv n^m+1-\sigma^{um}E^u-n^h > 0$ is then fully analogous to the requirement $\alpha^0 = n^f+1-\sigma^{f0}E^0-n^d > 0$ for the export subsidy s^{d0} to be positive in the base case with perfect competition in intermediate-good supply. However if $1+\beta > 0$ then the conditions under which a subsidy to intermediate-good production raises domestic welfare become less stringent since the subsidy also shifts profits to domestic final-good producers.

7. Concluding Remarks

This paper makes the point that strategic trade policies aimed at shifting rents from foreign to domestic producers of a final good may also serve to shift rents to foreign firms supplying an intermediate good to the domestic economy. This occurs because the profits gained by domestic final-good producers are potentially further shifted to intermediate-good producers through endogenous changes in the price and quantity demanded of the intermediate good. Particular attention is given to the effects of a specific subsidy applied to final-good exports, but a production subsidy and import tariff applied at the intermediate-good stage are also considered.

In considering the subsidy to final-good exports, a main result is to show that if intermediate-good producers would gain from such a subsidy (which holds under broad conditions ruling out profit over-shifting), the purchase of the intermediate good from foreign rather than (equally efficient) domestic producers indeed weakens the domestic incentive to subsidize exports. This provides a new argument undermining the use of export subsidies for rent-shifting purposes. What is perhaps more surprising is the contrasting result that when the intermediate-good industry is purely domestic, having an additional layer of Cournot competition at the intermediate product stage can increase the range of cases in which subsidization of final-good exports would increases domestic welfare. In particular, the optimal rent-shifting subsidy might be positive even if final goods are strategic complements. Although our main results are obtained with an exogenous foreign price for the intermediate-good, on relaxing this assumption we find, rather surprisingly, that most of the results would carry over in a more general model with r^F endogenous.

With respect to policies directly applied to the intermediate product, we show that a combination of a domestic production subsidy and an import subsidy of the same amount is equivalent to an equal subsidy applied to final-product exports. However, higher domestic welfare can be obtained under the optimal combination of the two policies applied at the intermediate-good stage than under the optimal export subsidy alone.

It is possible to relax the assumption that the intermediate good and labor are used in fixed proportion in producing the final good. Although the full analysis is beyond the scope of this paper, the following is worth mentioning. Suppose that wage rates are constant (because of, say, the existence of another good produced with constant marginal costs by labor alone). Then, if an export subsidy raises the price of the intermediate good, substitution of labor for the intermediate good would reduce the extent that profits are shifted to foreign intermediate-good suppliers. Since imperfect competition at the intermediate-good stage would obviously distort factor proportions in final-good production away from the intermediate product, the desirability of policies that increase the distortion (e.g. a tariff applied to intermediate-good imports) would be reduced relative to policies directly applied to final-good exports.

As a final remark, we would like to make it clear that this paper in no way advocates the use of strategic trade policy. The paper helps to provide insight as to some of the conditions under which governments might be motivated to use rent-shifting policies, but the hope is that such understanding will aid in designing international agreements in which mutual gains are achieved through cooperation rather than through beggar thy neighbor policies.

Appendix

1. Comparative Static Effects of s^d, t^m and s^h on Output

Effect of $\rho \equiv r^D - s^d$ on Final-Good Output: Taking the total differential of the first order conditions (2): we obtain

$$[(n^d+1)p' + Y^d p'']dy^d + n^f(p' + y^d p'')dy^f = -d\rho \qquad (A.1)$$

$$n^d(p' + y^f p'')dy^d + [(n^f+1)p' + Y^f p'']dy^f = 0. \qquad (A.2)$$

Solving (A.1) and (A.2) using Cramer's rule and using $Y^f p'' = -p'\sigma^f E$, the effect of an increase in $\rho \equiv r^D - s^d$ on final-good output (shown as (4) of the text) is given by

$$y^d_\rho(\rho) = \gamma^f/p'\psi < 0 \textit{ and } y^f_\rho(\rho) = -(n^d/n^f)(n^f - \sigma^f E)/p'\psi, \qquad (A.3)$$

where $\gamma^f \equiv n^f + 1 - \sigma^f E > 0$ and $\psi \equiv N + 1 - E > 0$ from (3).

Effects of s^d, s^h and t^m on Intermediate-Good Output: Taking the total differential of the first order conditions (10), we obtain:

$$[(n^h+1)\rho' + X^h \rho'']dx^h + n^m(\rho' + x^h \rho'')dx^m = -ds^h - ds^d \qquad (A.4)$$

$$n^h(\rho' + x^m \rho'')dx^h + [(n^m+1)\rho' + X^m \rho'']dx^m = dt^m - ds^d. \qquad (A.5)$$

Using Cramer's rule to solve (A.4) and (A.5) and noting $E^u \equiv -X^D \rho''/\rho'$, $\delta \equiv x^h - x^m$ and $\psi^u \equiv N^u + 1 - E^u$, we obtain (12) of the text:

$$dx^h/ds^d = -[1 + n^m \delta E^u/X^D]/\rho'\psi^u \text{ and } dx^m/ds^d = -[1 - n^h \delta E^u/X^D]/\rho'\psi^u. \qquad (A.6)$$

Similarly, using $X^k = N^u x^k$ for $k=h,m$ and $n^m(\rho' + x^m \rho'') = \rho'(n^m - \sigma^{um} E^u)$,

$$dX^h/ds^h = -n^h \gamma^{um}/\rho'\psi^u > 0, \quad dX^m/ds^h = n^h(n^m - \sigma^{um} E^u)/\rho'\psi^u, \qquad (A.7)$$

$$dX^m/dt^m = n^m \gamma^{uh}/\rho'\psi^u < 0 \textit{ and } dX^h/dt^m = -n^m(n^h - \sigma^{uh} E^u)/\rho'\psi^u, \qquad (A.8)$$

for $\gamma^{uk} \equiv n^k + 1 - \sigma^{uk} E^u > 0$ from (11). Also, from (A.6), (A.7) and (A.8),

$$dX^D/ds^d = -N^u/\rho'\psi^u > 0,\ dX^D/ds^h = -n^h/\rho'\psi^u > 0 \textit{ and}$$
$$dX^D/dt^m = n^m/\rho'\psi^u < 0. \tag{A.9}$$

2. <u>STRATEGIC COMPLEMENTS AND $\hat{s}^d > 0$</u>: Final goods are strategic complements iff $n^i\text{-}\sigma^i E = n^i(p'+y^i p'')/p' < 0$ for $i = d,f$. Since $\beta = \alpha/\psi$, assuming $N^u = n^h$, (23) implies $\hat{s}^d > 0$ iff $\alpha n^h + \psi > 0$ and since $\psi = \alpha+2n^d\text{-}\sigma^d E$, we obtain $\hat{s}^d > 0$ iff

$$\alpha(n^h+1) + 2n^d\text{-}\sigma^d E = (n^f\text{-}\sigma^f E)(n^h+1) + n^d\text{-}\sigma^d E + [1\text{-}(n^d\text{-}1)n^h] > 0. \tag{A.10}$$

If $n^d \geq 2$ then $1\text{-}(n^d\text{-}1)n^h \leq 0$ and (A.10) implies $\hat{s}^d < 0$ for $n^i\text{-}\sigma^i E < 0$. Hence for $\hat{s}^d > 0$ in the strategic complements case we require $n^d = 1$. Setting $n^d = 1$, we have from (A.10) that $\hat{s}^d > 0$ iff

$$(n^f\text{-}\sigma^f E)(n^h+1)+2\text{-}\sigma^d E = (n^h+1)n^f(p'+y^f p'')/p' + (2p'+y^d p'')/p' > 0 \tag{A.11}$$

3. <u>ENDOGENOUS FOREIGN PRICE r^F</u>: Totally differentiating $Y^d(\rho,r^F) = X^D$ and $Y^f(\rho,r^F) = X^F$ and using (28), $\rho = \phi^D(X^D,X^F)$ and $r^F = \phi^F(X^F,X^D)$ have partial derivatives:

$$\begin{aligned} \phi^D_D &= Y^f_{r^F}/J = p'\gamma^d/n^d < 0, & \phi^F_F &= Y^d_\rho/J = p'\gamma^f/n^f < 0, \\ \phi^D_F &= -Y^d_{r^F}/J = p'+y^d p'', & \phi^F_D &= -Y^f_\rho/J = p'+y^f p'', \end{aligned} \tag{A.12}$$

for $J = Y^d_\rho Y^f_{r^F} - Y^d_{r^F} Y^f_\rho = n^d n^f/(p')^2 \upsilon$. It then follows from (A.12) that

$$\phi^F_F - \phi^F_D = p'/n^f,\ \phi^D_D - \phi^D_F = p'/n^d \text{ and } \phi^F_D - \phi^D_F = -\delta p'' \tag{A.13}$$

for $\delta \equiv y^d\text{-}y^f$. Also, from (A.13), we obtain

$$\phi^F_{FF} = \phi^F_{DF} + p''/n^f \text{ and } \phi^D_{FF} = \phi^D_{DF} - p''/n^d \tag{A.14}$$

where $\phi^F_{DF} = p''(n^f+1)/n^f + y^f p'''$ and $\phi^D_{DF} = p''(n^d+1)/n^d + y^d p'''$.

In addition, from (A.13), (A.14) and the stability conditions (33),

$$A^k_{FF} - A^k_{FD} = (N^u+1)p'/n^f - 2\delta p'' \text{ for } \delta \equiv y^d - y^F. \tag{A.15}$$

where $A^k_{ii} = (N^u+1)\phi^i_i + X^i\phi^i_{ii} + X^j\phi^j_{ii} < 0$ and $A^k_{ij} \equiv N^u\phi^i_j + \phi^j_i + X^i\phi^i_{ij} + X^j\phi^j_{ij}$ for $i \neq j$ and $i,j = D,F$.

Derivation of dr^F/ds^d and $d\rho/ds^d$: Since $dr^F/ds^d = \phi^F_F(dX^F/ds^d) + \phi^F_D(dX^D/ds^d) = N^u[\phi^F_F A^k_{FD} - \phi^F_D A^k_{FF}]/H^u$ (using (34)), it follows using (A.13) that

$$dr^F/ds^d = N^u\{(p'/n^f)A^k_{FD} - \phi^F_D(A^k_{FF}\text{-}A^k_{FD})\}/H^u. \tag{A.16}$$

Hence, using (A.15) and $\phi^D{}_F = \phi^F{}_D + \delta p''$ from (A.13) in (A.16), we obtain (39) of the text:

$$dr^F/ds^d = N^u\{[p'/n^f + 2\phi^F{}_D]\delta p'' + (p'/n^f)[X^F\phi^F{}_{FD} + X^D\phi^D{}_{DF}]\}/H^u. \quad (A.17)$$

Similarly, since $d\rho/ds^d = \phi^D{}_D(dX^D/ds^d) + \phi^D{}_F(dX^F/ds^d) = -N^u(\phi^D{}_D A^k{}_{FF} - \phi^D{}_F A^k{}_{FD})/H^u$ (from (34)), we obtain (40) of the text:

$$d\rho/ds^d = -N^u\{(p'/n^d)A^k{}_{FF} + \phi^D{}_F(A^k{}_{FF}-A^k{}_{FD})\}/H^u. \quad (A.18)$$

If $p'' = 0$, then $A^k{}_{FF} = (N^u+1)\phi^F{}_F = (N^u+1)p'(n^f+1)/n^f$ and $H^u = (N^u+1)^2(p')^2(N+1)/n^d n^f$ (from (33)) so (A.18) implies

$$d\rho/ds^d = -N^u/(N^u+1) < 0 \textit{ and}$$

$$dr^D/ds^d = d\rho/ds^d + 1 = 1/(N^u+1) > 0. \quad (A.19)$$

From (30), (31) and $(N^u-1)[\phi^D{}_D(dx^{kD}/ds^d)+\phi^D{}_F(dx^{kF}/ds^d)] = (N^u-1)(d\rho/ds^d)/N^u$, the effect of s^d on profits π^k as in (35) is

$$d\pi^k/ds^d = x^{kD} + (N^u-1)[x^{kD}(d\rho/ds^d) + x^{kF}(dr^F/ds^d)]/N^u \quad (A.20)$$

4. THE OPTIMAL PRODUCTION SUBSIDY s^{h*} AND TARIFF t^{m*}:

Effects of s^h and t^m on Profits: From (9) using (10) and (A.7), the effect of s^h on firm h's profit is

$$d\pi^h/ds^h = x^h\{1+\rho'[(dX^m/ds^h) + (n^h-1)(dx^h/ds^h)]\} = x^h(1+\beta^u), \quad (A.21)$$

where $\beta^u \equiv \alpha^u/\psi^u$ for $\alpha^u \equiv n^m+1-\sigma^{um}E^u-n^h$. Also, noting that $d\pi^h/dt^m = x^h\rho'[(dX^D/dt^m)-(dx^h/dt^m)]$ and $2n^k-\sigma^{uk}E^u = n^k(2\rho'+x^k\rho'')/\rho' > 0$ for $k = h,m$ from (11), we have

$$d\pi^h/dt^m = n^m x^h(2n^h-\sigma^{uh}E^u)/n^h\psi^u > 0. \quad (A.22)$$

Similarly, the effects of s^h and t^m on the profit of a foreign firm m are given by

$$d\pi^m/ds^h = -n^h x^m(2n^m-\sigma^{um}E^u)/n^m\psi^u < 0 \textit{ and } d\pi^m/dt^m = -x^m(1+\beta^u). \quad (A.23)$$

Finally, it follows from (7) and $r^D = \rho(X^D)-s^d$ that

$$d\pi^d/ds^h = -y^d(1+\beta)(dr^D/ds^h) \text{ and } d\pi^d/dt^m = -y^d(1+\beta)(dr^D/dt^m), \quad (A.24)$$

for $dr^D/ds^h = \rho'(dX^D/ds^h) = -n^h/\psi^u < 0$ and $dr^D/dt^m = n^m/\psi^u > 0$ from (A.9).

Effects of s^h and t^m on Welfare: Setting $s^d = 0$ in W^D as given by (18), s^{h*} and t^{m*} satisfy $dW^D/ds^h = 0$ and $dW^D/dt^m = 0$ where

$$dW^D/ds^h = n^d(d\pi^d/ds^h)+n^h(d\pi^h/ds^h)-X^h-s^h(dX^h/ds^h)+t^m(dX^m/ds^h) \textit{ and} \quad \text{(A.25a)}$$

$$dW^D/dt^m = n^d(d\pi^d/dt^m)+n^h(d\pi^h/dt^m)+X^m+t^m(dX^m/dt^m)-s^h(dX^h/dt^m). \quad \text{(A.25b)}$$

From (A.7), (A.8), (A.21), (A.22) and (A.24), expressions (A.25a&b) become

$$dW^D/ds^h = (n^h/\psi^u)\{Y^d(1+\beta) + x^h\alpha^u + (s^h+t^m)(n^m-\sigma^{um}E^u)/\rho' + s^h/\rho'\} \textit{ and}$$

$$dW^D/dt^m = (n^m/\psi^u)\{-Y^d(1+\beta) + x^h(2n^h-\sigma^{uh}E^u)$$

$$+ x^m\psi^u + (s^h+t^m)(n^h-\sigma^{uh}E^u)/\rho' + t^m/\rho'\}. \quad \text{(A.26)}$$

From (A.26) using $2n^h-\sigma^{uh}E^u = \psi^u - \alpha^u$, it follows that

$$s^{h*} = -\rho'[Y^d(1+\beta) + x^h\alpha^u] - (s^{h*}+t^{m*})(n^m-\sigma^{um}E^u) \textit{ and}$$

$$t^{m*} = -\rho'[-Y^d(1+\beta) + (x^h+x^m)\psi^u - x^h\alpha^u] - (s^{h*}+t^{m*})(n^h-\sigma^{uh}E^u), \quad \text{(A.27)}$$

which, summing the two expressions, implies,

$$s^{h*}+t^{m*} = -\rho'(x^h+x^m) > 0. \quad \text{(A.28)}$$

Substituting (A.28) back into (A.27) and using $\alpha^u \equiv (n^m-\sigma^{um}E^u)+1-n^h$, $\psi^u = n^m+n^h+1-E^u$ and $\rho' = 1/Y^d_\rho$, we then obtain (43) of the text:

$$s^{h*} = -[Y^d\beta + x^h + x^m\sigma^{um}E^u]/Y^d_\rho \textit{ and } t^{m*} = [Y^d\beta - x^m(1-\sigma^{um}E^u)]/Y^d_\rho. \quad \text{(A.29)}$$

Relationship Between $\hat{s}^d$ and the Joint Policies s^{h*} and t^{m*}: From (A.29), (21) and $\sigma^{um} = X^m/X^D$,

$$\hat{s}^{h*} = \hat{s}^d - [(x^h + X^m x^m E^u/X^D)N^u - Y^d\Omega\psi^u]/N^uY^d_\rho \quad \text{(A.30)}$$

Using $\sigma^{um} = 1 - \sigma^{uh}$, $\sigma^{uh} = X^h/X^D$ and $X^D = Y^d$ in $\Omega \equiv [\sigma^{uh}(1+n^m\delta E^u/X^D) - \sigma^{um}(1-E^u)]/\psi^u$ from (22), we obtain $Y^d\Omega = \{X^h-X^m+(E^u/X^D)[X^mY^d+n^hn^mx^h\delta]\}/\psi^u$, which, using (A.30), implies

$$s^{h*} = \hat{s}^d - \{n^m(x^h+x^m) - (E^u/X^D)[X^mX^h + n^hn^mx^h\delta - X^mx^mn^h]\}/N^uY^d_\rho. \quad \text{(A.31)}$$

Since $[X^mX^h + n^hn^mx^h\delta - X^mx^mn^h] = n^hn^m[x^h\delta + x^m\delta]$, (A.31) reduces to

$$s^{h*} = \hat{s}^d - n^m(x^h+x^m)[1 - n^h\delta E^u/X^D]/N^uY^d_\rho. \quad \text{(A.32)}$$

Also from (A.32) using $t^{m*} = - s^{h*} - (x^h+x^m)/Y^d_\rho$ from (A.28), it follows that

$$t^{m*} = -\hat{s}^d - n^h(x^m+x^h)[1 + n^m\delta E^u/X^D]/N^uY^d_\rho \quad \text{(A.33)}$$

A Production Subsidy $\hat{s}^h$ to the Intermediate Good Alone: Setting $t^m = 0$ in (A.25a) and using the first expression of (A.21), $\hat{s}^h$ is given by

$$\hat{s}^h = X^h\rho'[\frac{(dX^m/ds^h)}{(dX^h/ds^h)} + \frac{n^h-1}{n^h}] + \frac{n^d(d\pi^d/ds^h)}{(dX^h/ds^h)}, \quad \text{(A.34)}$$

which is (45) of the text. Next, using (A.7), (A.24), $dr^D/ds^h = -n^h/\psi^u$ and $\rho' = 1/Y^d_\rho$, in (A.34), we obtain

$$\hat{s}^h = [X^h\beta^u - Y^d(1+\beta)(dr^D/ds^h)]/(dX^h/ds^h)$$

$$= -[x^h\alpha^u + Y^d(1+\beta)]/\gamma^{um}Y^d_\rho, \qquad \text{(A.35)}$$

where $\gamma^{um} \equiv n^m+1-\sigma^{um}E^u > 0$.

References

Brander, J. A., 1995, Strategic trade policy, in: G. Grossman and K. Rogoff eds., Handbook of International Economics 3, (North-Holland, Amsterdam), 1395-1455.

Brander, J. A. and B. J. Spencer, 1984, Trade Warfare: Tariffs and Cartels, Journal of International Economics 16, 227-242

Brander, J. A. and B. J. Spencer, 1985, Export subsidies and international market share rivalry, Journal of International Economics 18, 83-100.

Chang, W. W. and J. Kim, 1989, Quality-differentiated products and optimal trade policy, Keio Economic Studies 26, 1-17.

Chang, W. W. and F. Chen, 1994, Vertically related markets: Export rivalry between DC and LDC firms, Review of International Economics 2, 131-142.

Eaton, J. and G. M. Grossman, 1986, Optimal trade and industrial policy under oligopoly, Quarterly Journal of Economics 101, 383-406.

Ishikawa, J., 1995, Expanding the purchase of a foreign intermediate good: An analysis of VIEs and content protection under oligopoly, mimeo.

Ishikawa, J. and K. Lee, 1995, Backfiring tariffs in vertically related markets, International Business, Trade and Finance Working Paper No. 95-021, Faculty of Commerce and Business Administration, University of British Columbia (revised October 1995).

Krishna, K. and M. Thursby, 1991, Optimal policies with strategic distortions, Journal of International Economics 31, 291-308.

Neary, J.P., 1994, Cost asymmetries in international subsidy games: Should governments help winners or losers?, Journal of International Economics 32, 197-218.

Rodrik, D. and C. Yoon, 1989, Strategic trade policy when domestic firms compete against vertically integrated rivals, NBER Working Paper No. 2919

Seade, J., 1980, The stability of cournot revisited, Journal of Economic Theory 23, 15-27.

Seade, J., 1985, Profitable cost increases and the shifting of taxation: equilibrium responses of markets in oligopoly, Warwick University manuscript.

Spencer, B. J. and R. W. Jones, 1991, Vertical foreclosure and international trade policy, Review of Economic Studies 58, 153-170.

Spencer, B. J. and R. W. Jones, 1992, Trade and protection in vertically related markets, Journal of International Economics 32, 31-55.

Spencer, B.J. and R. S. Raubitschek, 1996, High-cost domestic joint ventures and international competition: Do domestic firms gain?, International Economic Review, Vol 37, No 2, May forthcoming.