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(Revised)

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1 Introduction

All markets in which production takes place are vertical. That is, inputs are transformed into outputs. Of central concern in this paper is a situation in which an input and an output both are traded on international markets. In models in which markets are perfectly competitive the size of firms becomes indeterminate, but the relationship between prices of traded inputs and outputs is important in analyzing a nation's real national income. Commercial policy may be employed by a country in order to gain advantage over other countries by obtaining better terms of trade in one or both markets. In markets which are imperfectly competitive a firm may be able on its own to affect prices. In particular, a firm may be vertically integrated and it may supply foreign markets with both inputs and outputs. Indeed, it may be in competition with rivals abroad on the output side while, at the same time, supplying them (at a profit) with the inputs which these rivals require. In the case of imperfect competition, "new trade theory" has suggested that the exercise of commercial policy may appear rather different from its form in a competitive world.

The theory of international trade has often prided itself with its use of general equilibrium analysis. However, most of classical trade theory in-

volves only two traded commodities, with each being exported by a separate country to the other. Since this implies only one traded market, the pride of technique turns into a pretty empty boast. In the case of vertically related markets studied in this paper, however, the interrelationship between markets becomes crucial, and the analysis a bit more difficult than in the standard case. Although imperfect market behavior has features that are different from those found in competitive markets, there are important similarities which stem from the relations between vertically-connected markets, and these are laid out in a core model in Section 2. In this setting, the prices of items exported by one country tend to go up and down together. By contrast, section 3 discusses the variation in which a country's two terms of trade may move in opposite directions. Section 4 pursues the analysis of the core model in a situation in which trade agreements may prevent a country from interfering in some markets, but not in others, so that a distortionary wedge can be introduced in only one of the two markets. Section 5 turns to the kind of imperfectly competitive behavior analyzed in detail in two papers by Spencer and Jones (1991, 1992) in which a vertically integrated firm is engaged in duopolistic competition with a foreign firm but has an asymmetrically strong position in producing an input required by its rival.

The role of government commercial policy in this imperfectly competitive setting is discussed in section 6, and contrasted with policy in the competitive case. Section 7 turns to some other modelling strategies concerning vertical markets which have been put forth in the literature, and Section 8 provides concluding remarks.

2 The Core Model

In discussing the issue of vertical relationships in trade it is useful to refer to a simple core model. Assume that an intermediate good or factor, z_1, is used (along with labor) to produce a final commodity, x_1. Both x_1 and z_1 are traded, with X_1 denoting exports from the home country (with negative values, i.e. imports of good 1, M_1, sometimes considered) and Z_1 exports of z_1. To avoid complications assume in this core setting that z_1 is not produced - it is available each period in a given flow amount. This fits the concept of a given and non-reproducible capital stock in the earlier literature on foreign investment [e.g.Kemp(1966)orJones(1967)] and in Section 4 more attention is paid to asymmetries between countries in supply conditions for intermediates. To round out the picture assume there is some other commodity, x_2,

produced with labor and its own specific resource or capital. This commodity is freely traded (in a competitive market - even in later sections) and serves as numeraire. Pure competition prevails but governmental commercial policy may insert tax or subsidy distortions - wedges between domestic prices of x_1 and z_1, denoted by p_1 and r_1, and world prices, p_1^* and r_1^*. Thus the production structure of the core model is of the specific-factors variety, with trade at final and intermediate good levels.

The budget constraint can be expressed either in terms of domestic prices (in which case tax or subsidy amounts get listed explicitly) or, more simply, in terms of world prices, as in (1), with the consumption bundle shown by (D_1, D_2).

$$p_1^* D_1 + D_2 = p_1^* x_1 + x_2 + r_1^* Z_1 \tag{1}$$

Of special interest are changes to equilibrium values caused by commercial policy and the consequent alteration in real national welfare, dy, defined as the domestic price-weighted sum of consumption changes:

$$dy \equiv p_1 dD_1 + dD_2 \tag{2}$$

Any changes *along* the transformation schedule linking outputs x_1 and x_2

involve only a second-order small change in the value of aggregate production at initial domestic prices, but an increase in exports of the intermediate good causes the home transformation schedule to shrink inwards. In a competitive setting such a *shift* is related to the domestic price of z_1,r_1. Thus

$$p_1 dx_1 + dx_2 = -r_1 dZ_1 \tag{3}$$

With these relationships at hand, the budget constraint (1) can be differentiated to reveal the sources of any change in aggregate real income:

$$dy = \{X_1 dp_1^* + Z_1 dr_1^*\} + \{(p_1^* - p_1)dX_1 + (r_1^* - r_1)dZ_1\} \tag{4}$$

Equation (4) is fundamental in the analysis of trade in vertically related markets. Two items are traded (plus the numeraire good 2), and for each there is a terms-of-trade effect (shown in the first bracket) and a volume-of-trade effect (shown in the second bracket). The terms-of-trade effect states that an improvement in the world price of any item exported increases real income by an amount that is proportional both to such a price rise and to the volume of exports. The volume-of-trade effect suggests that if there exists a positive gap between world and domestic prices for any exported item (tax or

subsidy inspired in this competitive case), an increase in such exports raises national income by an amount proportional both to the extent of the gap and the increase in exports. In popular parlance, "it pays to buy cheap and sell dear"; if, say, p_1^*, exceeds p_1 a unit of X_1 can be bought at home for p_1 and sold abroad for the greater amount, p_1^*. Of course in our competitive model this spread is captured by the government in the form of an export tax.

To proceed with the analysis it is important to recognize the technological and market links between the pair of prices (p_1^*, r_1^*) and trade volumes (X_1, Z_1). In general all input prices are related to commodity prices and the resource base (including the volume of intermediate goods available for production). The foreign technology thus determines the nature of the dependence of r_1^* on the price of x_1 abroad, p_1^*, and the only element in the foreign input base that is being changed, namely Z_1. Thus:

$$r_1^* = r_1^*(p_1^*, Z_1) \tag{5}$$

Differentiating,

$$dr_1^* = \frac{r_1^*}{p_1^*}\gamma_1^* dp_1^* - \frac{r_1^*}{Z_1}\delta_1^* dZ_1 \tag{6}$$

Two elasticities have been introduced. The expression γ_1^*, the relative change in the price of specific intermediates, r_1^*, compared to a given relative increase in the price of final goods abroad, p_1^*, exceeds unity in this specific-factors model.[1] The term δ_1^* is positive (if the home country exports the intermediate) and indicates the extent to which the return to Z_1 is driven down abroad as more of this input is added to a given foreign resource base.[2]

A second relationship involves market-clearing for commodities. In particular home exports, X_1, must be balanced by foreign imports, M_1^*, and these, in turn, depend upon foreign price, p_1^* (as shown by movements along a foreign offer curve for imports) and changes in Z_1 (which cause the foreign offer curve to shift):

$$X_1 = M_1^*(p_1^*, Z_1) \tag{7}$$

Thus:

$$\widehat{X_1} = -\varepsilon_1^* \widehat{p_1^*} + \frac{1}{X_1}\frac{\partial M_1^*}{\partial Z_1} dZ_1 \tag{8}$$

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[1] Details of the relationships among input and output prices in a specific-factors model can be found in Caves, Frankel and Jones (1996), supplement to Ch. 6. If p_1^* rises, the return to the mobile factor, w^*, rises but by a dampened amount: $\widehat{w^*} = \beta_1^* \widehat{p_1^*}$ with β_1^* a positive fraction. (A hat "^" over a variable denotes a relative change). Thus the competitive profit equations of change require that $\widehat{r_1^*}$ equals $\frac{(1-\beta_1^* \theta_{L1}^*)}{1-\theta_{L1}^*}$ times $\widehat{p_1^*}$, where θ_{L1}^* is labor's distributive share abroad in the first sector. The coefficient of $\widehat{p_1^*}$ is γ_1^*.

[2] In what follows I assume δ_1^* is less than unity. It equals the fraction of the foreign resource base represented by the flow from the home country (Z_1/z_1^*) times the elasticity $\{-(\partial r_1^*/\partial z_1^*) \cdot (z_1^*/r_1^*)\}$.

ε_1^* is the elasticity of foreign demand for imports along its offer curve (defined so as to be positive). The breakdown of $\partial M_1^*/\partial Z_1$ involves both changes in foreign demand for imports at constant prices, $\partial D_1^*/\partial Z_1$, and changes in foreign production, $\partial x_1^*/\partial Z_1$. The former involves just an income effect (since p_1^* is held fixed). Thus $\partial D_1^*/\partial Z_1$ equals (m_1^*/p_1^*) times $\partial y^*/\partial Z_1$, where m_1^* is the foreign marginal propensity to consume the first commodity. Assuming the foreign country is passive in the sense of not imposing trade taxes or subsidies, $\partial y^*/\partial Z_1$ reflects only a terms-of-trade effect, $-Z_1(\partial r_1^*/\partial Z_1)$, or $r_1^*\delta_1^*$. The output effect, $\partial x_1^*/\partial Z_1$, reveals that at constant prices an increase in Z_1 increases output of the first commodity, x_1^*. But by the reciprocity theorem due to Samuelson (1953), this term is related to γ_1^* since it states that

$$\frac{\partial x_1^*}{\partial Z_1} = \frac{\partial r_1^*}{\partial p_1^*}$$

Thus $\partial x_1^*/\partial Z_1 = (r_1^*/p_1^*)$ times γ_1^*. Putting these together,

$$\frac{\partial M_1^*}{\partial Z_1} = \frac{m_1^*}{p_1^*} r_1^* \delta_1^* - \frac{r_1^*}{p_1^*}\gamma_1^* \tag{9}$$

In words, an increase in flows of the intermediate good abroad at constant p_1^* serves to change foreign demand for imports since it causes r_1^* to fall and

thus to improve foreign real incomes, but also increases foreign supply. In principle the foreign offer curve can shift in either direction, but I assume the supply shift dominates so that an increase of Z_1 shifts the offer curve inwards (see footnote 2).

Assembling these various components into the general expression (4) for welfare changes at home yields (10)

$$dy = \frac{\partial y}{\partial p_1^*} dp_1^* + \frac{\partial y}{\partial Z_1} dZ_1 \qquad (10)$$

$$\text{where } \frac{\partial y}{\partial p_1^*} = X_1 \left\{ (1 + \mu^* \gamma_1^*) - \frac{(p_1^* - p_1)}{p_1^*} \varepsilon_1^* \right\}$$

$$\text{and } \frac{\partial y}{\partial Z_1} = \left[1 - \left(\frac{p_1}{p_1^*} m_1^* + m_2^* \right) \delta_1^* - \frac{(p_1^* - p_1)}{p_1^*} \gamma_1^* \right] r_1^* - r_1$$

where μ^* is the ratio of the two trade flows, $r_1^* Z_1 / p_1^* X_1$.

Consider the separate roles of the commodity terms of trade, p_1^*, and the extent of resource trade Z_1, starting from a position of initial free trade in both markets. An increase in p_1^* drives up r_1^* as well. Thus if the home country exports both the intermediate good and the final good, an export tax can be expected to improve the terms of trade in *both* markets. As (10) reveals, however, once a gap is opened up between p_1^* and p_1, there is a drag on the improvement in real income as greater values of p_1^* reduce

foreign demand along the foreign offer curve - the volume-of-trade effect. The exercise of setting $\partial y/\partial p_1^*$ in (10) equal to zero would reveal the formula for the optimal export tax. Let this ad valorem tax rate be denoted by τ, such that

$$p_1^* = (1+\tau)p_1 \tag{11}$$

Thus the optimal export tax formula is :[3]

$$\tau_{opt} = \frac{[1+\mu^*\gamma^*]}{\varepsilon^* - [1+\mu^*\gamma^*]} \tag{12}$$

Turn now to the optimal tax rate on intermediate exports, Z_1. Assume t is the ad valorem rate applied to the foreign price, r_1^*, so that

$$r_1 = (1-t)r_1^* \tag{13}$$

From (10) this implies that

$$t_{opt} = \left(\frac{p_1}{p_1^*}m_1^* + m_2^*\right)\delta_1^* + \frac{(p_1^* - p_1)}{p_1^*}\gamma_1^* \tag{14}$$

[3]It is important to note that optimal trade restriction must be sufficient to yield an equilibrium point along the foreign offer curve such that ε^* is high enough to ensure a positive denominator in (12).

Thus at the initial free trade point $t_{opt} = \delta_1^*$, which is positive, a result that parallels that for an export tax on the final good. That is, for an active home country exporting both a final good and an intermediate good used in its production, starting to restrict exports of either good from a position of free trade serves to raise real income.

How does the optimal tax distortion in each market depend on the distortion existing in the other market? Figure 1 summarizes the results. It suggests that the greater is the export tax on final commodities, the more incentive there exists to insert a tax wedge between the price of the intermediate abroad and its price at home. Rewrite (14) as (14′) to incorporate explicitly the tax rates:

$$t_{opt} = \left[\frac{1}{1+\tau} m_1^* + m_2^*\right] \delta_1^* + \frac{\tau}{1+\tau} \gamma_1^* \qquad (14')$$

The higher is τ the lower is the first expression in (14′) but the higher is the second. Comparing these effects, assuming parameters m_i^*, δ_1^* and γ_1^* remain constant, leads to:

$$\frac{dt_{opt}}{d\tau} = \frac{\gamma_1^* - m_1^* \delta_1^*}{(1+\tau)^2} \qquad (15)$$

I have assumed this term is positive since γ_1^* exceeds unity and δ_1^* is assumed

to be less than unity. That is, a restriction on intermediate exports not only serves to raise r_1^*, but by reducing production of the final good abroad (more than demand is reduced by assumption) it also leads to a positive volume-of-trade effect. This latter gets larger the greater the gap between the foreign price, p_1^*, and the home price, p_1.

By contrast, an inverse relationship exists between the optimal tax rate on final goods exports and the tax rate on the intermediate good. In equation (12) recall that μ^* indicates the ratio of revenue earned from sales of the intermediate, $r_1^* Z_1$, to that stemming from sales of the final good, $p_1^* X_1$. Assume, now, that the primary effect of an increase in the export tax on intermediates is to reduce their exports, Z_1, relative to final exports, X_1, thus reducing μ^*. From (12) this has the effect of reducing the optimal tax rate on final goods. Note that the optimal level of τ exceeds the level it would have if there were no trade in intermediates $[1/(\varepsilon^* - 1)]$, since the fact that both terms of trade move together makes raising p_1^* with a tariff more valuable the greater the value of trade in intermediates. This explains the negative relationships shown in Figure 1. Full optimization has the tax distortion shown by point E.[4]

[4]Strictly speaking the curves in Figure 1 should be relabelled as $\left\{\frac{\partial y}{\partial p_1^*} = 0\right\}$ for τ_{opt}

3 Variations on a Trading Theme: Opposed Terms of Trade

Two basic features of the core model resulted in the home country's terms of trade for final goods and for intermediates moving in the same direction. An increase in the price of the final good would, at given export levels for intermediates, result in a magnified increase in the price of those sector-specific intermediates..[5] As well, it was assumed that the home country exported both commodities. But the trading pattern might be different: The home country might import the final commodity which uses the country's exported intermediate. In such a case a price rise for imports, a deterioration in final goods terms of trade, is associated with an increase in the price of its intermediate export, an improvement in intermediate goods terms of trade.

Such a scenario may reflect the trading pattern associated with the tail end of the Vernon (1966) product cycle. Initially a country has developed a

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and $\left\{\frac{\partial y}{\partial Z_1} = 0\right\}$ for t_{opt}. Curves corresponding to $\left\{\frac{dy}{dp_1^*} = 0\right\}$ and $\left\{\frac{dy}{dZ_1} = 0\right\}$ would also intersect at $\underline{E}$ but capture more indirect effects as well. Some of these are discussed in Section 4.

[5] In Kemp (1966) and Jones (1967) investment of non-specific capital abroad took the place of the core model's export of a sector-specific intermediate good. In that Heckscher-Ohlin model it was possible that the final commodity exported by the country engaged in foreign investment was produced by labor-intensive techniques in the host country. In such a case the investor's two terms of trade move in opposite directions.

resource which is specifically used in its export commodity. Eventually it establishes production facilities abroad by sending its intermediate to a branch plant. Alternatively, it may export the intermediate in arms-length transactions to a rival final goods producer abroad. In either case home production of the final good may fall short of home demand and the home country may end up importing the commodity which uses its exported intermediate.

Another interpretation fits the scene found is many less developed countries: Exports are concentrated in a raw material whose production requires little value added at home. The country desires to expand its own production of the secondary industry whose output uses the exported raw material, but it is still at a stage where it imports the final good using this raw material.

In either of these cases it is clear from equation (10)'s expression for $\partial y/\partial p_1^*$ that the sign of $(1+\mu^*\gamma_1^*)$ is crucial in determining optimal commercial policy, where μ^* is now the negative number, $(-r_1^*Z_1/p_1^*M_1)$. The value of $(1+\mu^*\gamma_1^*)$ could still be positive if imports of the final good strongly dominate exports of the raw material. In such a case optimal policy calls for taxing imports of final good 1, despite the fact that this will drive down r_1^*, the terms of trade on material exports. Of more interest is the possibility that $(1+\mu^*\gamma_1^*)$ is negative, a result guaranteed if the value of raw material

exports is at least as great as that of final imports of good 1 (since $\gamma_1^* > 1$). Optimal policy then calls for a subsidy on imports of the final good in order to raise the foreign price of intermediates. As the expression for t_{opt} in (14) reveals, in this case of a subsidy on imports of the first commodity p_1^* once again exceeds p_1 and the case for restricting exports of the raw material gets strengthened.

4 Trade Controls Only on Intermediates

The preceding sections have discussed the case in which the home country can control prices or trade volumes both for final goods and for intermediates (or materials). However, international agreements may tie a country's hands in final goods trade. Markets for raw materials or intermediates are a different matter. Often a country maintains controls over exports of such inputs. Consider such a case. The home country can control Z_1, but there is a free trade agreement for final goods so that p_1 remains equal to foreign p_1^*. What then is the effect of a restriction on Z_1 (which forces r_1^* above r_1) on the common price of final good 1? If the home country exports at both ends of the vertical chain, are its terms of trade in these markets positively

correlated?

There is an argument for such a positive correlation in a competitive general equilibrium setting, a presumption that becomes more powerful if markets are imperfectly competitive (Section 5). Referring to equation (10) dp_1^* and dZ_1 are connected by the condition that the world market for final good 1 clears. Thus:

$$\frac{dy}{dZ_1} = \frac{\partial y_1}{\partial p_1^*}\frac{dp_1^*}{dZ_1} + \frac{\partial y}{\partial Z_1} \qquad (10')$$

Suppose the home country exports both the final good and the intermediate. If such exports are based on the home country devoting a larger share of its national income to production of good 1 than does the foreign (importing) country, there is a presumption that an increase of Z_1 will increase world output of final good 1 and thus probably eventuate in a fall in p_1^* (as well as in r_1^*).[6]

The reasoning behind this presumption is laid out in Jones (1987, 1989) and makes use of the Samuelson (1953) reciprocity theorem whereby in each country $\partial x_1/\partial z_1$ equals $\partial r_1/\partial p_1$. With free trade in goods, p_1 and p_1^* are equal, and in the initial absence of taxation on materials trade so are r_1 and

[6]The increase in Z_1 changes r_1^* and thus reallocates real incomes between countries. The assumption made here is that the resulting change in world demand for commodity 1 (if any) is outweighed by supply changes. For details see Jones (1987).

r_1^*. Therefore world output of good 1 rises with an increase in materials export if γ_1^* exceeds γ_1. A commonly-shared increase in the price of final good 1 will presumptively raise the home wage rate by more relatively than the foreign wage rate if the x_1-sector is relatively a larger share of incomes at home than abroad. If so, there is a presumption that the relative increase in return to intermediates at home, although exceeding $\widehat{p}_1$(or $\widehat{p}_1^*$), will not be as great as it is abroad. That is, the presumption is that γ_1^* exceeds γ_1, suggesting that an increase in Z_1 raises total world output of good 1 and lowers p_1^* as well as r_1^*. In equation (10′) dp_1^*/dZ_1 is negative, leading to an even greater negative value for dy/dZ_1 than for $\partial y/\partial Z_1$. The case is strong for restriction of raw materials exports.[7]

5 Firm Behavior in Imperfect Markets

In 1986 the United States levied a 35% duty on Canadian exports of cedar shakes and shingles (final goods), in an attempt to force greater Canadian

[7]With reference to Footnote 4 and Figure 1, this is an argument for a curve showing $\{dy/dZ_1 = 0\}$ to lie above the t_{opt} curve shown in Figure 1 for τ smaller than the optimum shown at E. Starting from a point on the t_{opt} curve, a slight restriction of Z_1 exports would not affect real income if p_1^* is held constant. However, if p_1^* rises following a restriction in Z_1, real incomes would rise as well, calling for a higher optimal value of $\underline{t}$ than shown by the curve in Figure 1. A similar kind of argument can be used to show that below E a curve showing $\{dy/dp_1^* = 0\}$ would have optimal γ greater than shown in Figure 1.

exports of cedar bolts and logs (raw materials). In a separate action in the 1980's, Japanese producers of DRAM semiconductors were hit by an American anti-dumping action. This encouraged a significant increase in the price of these chips to American computer firms, which were locked into duopolistic competition with Japanese firms such as Toshiba and NEC. Both these cases provided examples in which a country's exports bore a vertical relationship to each other (Canada in cedar products and Japan in computers and parts) and were faced with commercial policy instigated in the importing country. In a pair of papers Barbara Spencer and I analyzed optimal policies for firms and governments in both exporting and importing countries when final goods were produced in a duopolistic market but the production of intermediates bore strong asymmetries in the two countries.[8] Here I sketch out the basic features of this analysis and relate it to Section 2's core model.

Let a vertically integrated firm in the home country export both the final and intermediate good to the foreign country. Production technology is now more simple than in the core model. Only the intermediate good is required to produce the final good and the marginal cost of producing the intermediate good at home is constant. Further to simplify, all final

[8]See Spencer and Jones (1991, 1992) as well as an analysis in a competitive setting in Jones and Spencer (1989).

output, X_1, is shipped abroad as exports; there is no local demand for this good. The foreign country also has a firm producing the final good, with both firms engaged in Cournot fashion in deciding output. It is in producing the intermediate good that a strong asymmetry appears; abroad there is a competitive fringe of price-taking producers, with price, r_1^*, determined by the home firm, whose dominance allows it to set a value for r_1^* exceeding marginal (and average) cost, c_1. Decisions are made in stages, with the foreign firm's output decision for final goods taken as of pre-commitment by the home firm of an intermediate price, r_1^*. This price, in turn, is based on a given set of taxes or subsidies set by governments in both countries.

The key question for the vertically integrated home firm is what price to charge for the intermediate product, in full awareness that once it commits to this price Cournot competition in the final goods market determines the final good's price and each country's output share. The home firm must consider the option of charging such a prohibitive price for the intermediate that it forecloses sales in this market. The foreign firm may have its own supplies of the intermediate, but if not such a vertical foreclosure decision squeezes the foreign firm out of the final goods market. Two key elements bear upon the foreclosure decision. First of all, the foreign government may levy a tariff

on its imports of the final good from the home country, thus lowering the profit margin in this market relative to profits to be earned by supplying the intermediate.[9] This response can be illustrated in Figure 1, where τ, the export tax on final goods, now represents the profit margin in this market. As this is lowered by the imposition of the foreign tariff, the optimal "tax" on materials exports also falls. This "tax" now represents the excess of price charged to foreigners for materials, r_1^*, over the local cost, c_1. Reducing the profit margin on final goods reduces as well the incentive of the vertically integrated home firm to charge a high price for materials exports in order to gain advantage over its rival in the final goods market. It was this concern with spillovers in the final market (which in the imperfectly competitive case is referred to as the "strategic effect") that causes the optimal tax rate schedule in Figure 1 to rise from its vertical intercept at δ_1^*.

The other feature of the model that bears upon the vertical foreclosure issue is the nature of supply conditions for materials in the foreign country. Reconsider expression (4) for real income changes in a competitive market. An analogous expression holds for profit changes for a vertically integrated firm with home prices, p_1 and r_1, replaced by the home firm's (constant)

[9]Indeed one of the motives behind the 1986 American tariff on cedar shakes and shingles from Canada was to encourage more Canadian sales of raw cedar bolts and logs.

marginal costs, c_1. The more elastic is foreign supply of materials, the more will home exports, Z_1, be stimulated by a reduction in price charged, r_1^*. Thus sufficiently sensitive foreign supply will encourage home supply of materials exports.

In the competitive model the positive relationship between the terms of trade in final and intermediate goods was provided by technology - as of a given resource base a rise in the price of the final good caused the price of the specific intermediate to rise by a magnified relative amount. In the imperfectly competitive setting with Cournot duopoly in the final goods market there once again emerges this relationship between the two export prices, but for a different reason. Prices are not anchored to costs since profits can be earned, and the margin of profits varies depending on government taxes and the price charged for intermediates.

Suppose the vertically integrated home firm raises the price, r_1^*, it charges the foreign firm for materials. This shifts the foreign firm's reaction curve in Figure 2 inwards, resulting in a new Cournot equilibrium (from A to B) with reduced foreign output, increased home output, and a reduction in total world supply, which serves to increase final price, p_1^*.[10] Consider the extent

[10]The reaction loci in Figure 2 need not be linear. What is assumed, however, is that outputs are strategic substitutes - an increase in the output of one firm lowers marginal

of the rise in p_1^* if temporarily the effect of a rise in home output is ignored: The foreign firm's marginal cost schedule has shifted upwards by the increase in r_1^* and this serves to raise p_1^* along the demand curve facing the foreign firm (as of given home output). But if the marginal revenue curve is steeper than the demand curve (as I will assume), p_1^* does not rise by as much as marginal revenue (or r_1^*). As well, since p_1^* exceeds r_1^* (as a profit margin is assumed to exist), the relative increase in final goods price, $\widehat{p}_1^*$, falls short of $\widehat{r}_1^*$, as in the competitive model (for different reasons). Now take into account the fact that home output actually rises somewhat along the home reaction curve (from A to B), and the increase in p_1^* is even less.

Section 4 described the presumptive positive relationship between r_1^* and p_1^* in the "second-best" scenario in which the home country is bound by free trade in final goods but could restrict intermediate exports, Z_1, and thus raise r_1^*. The presumption rested on the argument that world output of final commodity 1 would fall in competitive markets with such a restriction on intermediate exports. In the present Cournot setting this presumption is greatly strengthened - the move from A to B in Figure 2 ensured a price rise for the final commodity.

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revenue in the other. The home reaction curve is steeper than a 45o line, so that world output at B is lower than at A.

The equilibrium position for the active home firm setting r_1^* results in profit margins in each of the two markets which may not be equal. Generally speaking, the higher is foreign supply elasticity the more attractive is a lowering of r_1^* to capture more material sales abroad, even though this entails a lower profit margin in this market than in the final goods market (a drop in r_1^* causes p_1^* to fall, but by less).

6 Government Policy: Imperfect Markets

The analysis of the core model in Section 2 suggested a strong role for an activist country engaged in trade in vertically related markets. Given that firms were assumed to be price-taking competitors, the role of commercial policy was to exercise control over markets so as to achieve better terms of trade, subject to the volume-of-trade constraint on the exercise of monopolistic power. With imperfect competition, firms no longer are passive price takers and it is natural to ask what role is left for government interference.

If all exports were of a single type and controlled by a single monopolistic firm, would the unencumbered exercise of profit maximization by such a firm yield the nation's welfare-maximizing outcome? Probably not, and this for

two basic reasons: (i) The firm's objective function (profit maximization) generally does not take account of domestic consumer interests and (ii) The firm may not be able to discriminate between local and foreign consumers and thus duplicate optimal commercial policy. Even if it could discriminate, it might not do so in the same way. For example, a discriminating monopolist may face more elastic demand for its product abroad and thus charge foreign consumers a lower price than at home. This is akin to an export subsidy rather than a national income optimum export tax.

The assumption typically made in the imperfect competition literature that no domestic consumption of the exported good takes place obviates much of these difficulties. If the firm could credibly act as a Stackelberg leader in our Cournot setting, there would then be no need for government interference and in Figure 2 a position such as S could be attained. But this may not be possible, and Section 5's discussion suggests that the strong asymmetric supply condition for materials or intermediates could allow a home vertically integrated firm to commit to a price, r_1^*, for intermediate exports, but then it has to compete in a Cournot duopoly market for the final good. The home firm does have some control over price, and can shift the foreign reaction curve by changing r_1^*. But it takes home government

commitment in the form of tax or subsidy policy to replicate the optimal Stackelberg outcome and effectively to shift the home reaction curve.

The key to optimal government policy is the comparison between profit margins in the final and intermediate markets. As demonstrated in Spencer and Jones (1991), the government will subsidize the firm's exports of final goods if the profit margin there exceeds that in materials trade, but otherwise a tax on final exports is appropriate. In the celebrated article by Brander and Spencer (1985) optimal policy called for an export subsidy (on final goods). This result, which did much to promote the analysis of strategic trade policy, seemed diametrically opposed to classical trade theory, which called for taxes on trade in order that a country improve its terms of trade. In my view these results are similar in that in each case the role of commercial policy is to see that trade is optimally *restricted.* Under perfectly competitive conditions firms have no incentive to restrict exports so that all trade restriction must be done by government taxation. By contrast, in Cournot duopoly the home firm is aware of its ability to raise price, but if it operates under the belief that foreign output is unchanged, it will "overshoot" and restrict output too much. Hence the role of government is to subsidize trade so as to encourage a bit more exports. In the case of vertically connected trade the role of

government is to encourage a switch away from final trade towards exports of the intermediate *if* the profit margin there is higher. This is obviously not the case if there were no intermediate trade, and the positive profit margin for final goods uniformly leads to subsidies on exports in that market.[11]

Section 5 discussed the role of government policy in the foreign country which is importing both final and intermediate goods. Because of the strategic connection between markets, the vertically integrated firm has charged a higher price for intermediate exports even than would a monopolist firm in that area. By diminishing the importance of the final goods market, the foreign tariff induces the vertically integrated firm to lower r_1^*, whereas a pure monopolist dealing only with intermediates would be tempted to raise export price since foreign demand for such intermediates is stimulated by the tariff's support of the local final goods sector. Much the same argument was presented for competitive markets in Jones and Spencer (1989) and, as Section 5 discussed, can be illustrated in Figure 1 by movements along the t_{opt} schedule.[12]

[11] A similar kind of argument, pointing out the possibility of a desired export tax (instead of subsidy) on final goods if there are also profits earned by intermediate exporters, is made in Bernhofen (1996 b).

[12] Lin (1994) explores the possibility that restrictions on raw material exports get tightened rather than loosened if the foreign country imposes a tariff on exports of the final good.

7 Other Facets of Vertical Markets

The international trade literature has been concerned with some other facets of markets with vertical structures. Here I briefly sketch some of the directions in which this literature has proceeded:

(i) *International Predation:* Suppose that each of two countries has a firm in the same (downstream) market (perhaps with exports to a third country), but that in one of the countries the firm is vertically integrated with a branch producing a raw material or intermediate. These firms are locked into duopolistic competition, much as in the discussion in Section 5. Bernhofen (1996a) analyses the advantages which the vertically integrated firm has over its foreign rival if predation occurs, involving losses in the downstream market. If profits are made in the materials market, these funds can be used to subsidize temporary losses by the firm at the downstream end, and thus give the vertically integrated firm an advantage in its duopolistically competitive struggle. This opens up a temporal dimension to the arguments presented in Section 5.

(ii) *Bargaining:* Karp and Sioli (1995) discuss trade between two countries, in each of which there is an upstream and a downstream firm, and instead of price-setting at the upstream (materials) end, there is bargaining.

This is like moving from non-cooperative to cooperative equilibria. Some of the novelties include a sequence in which bargaining takes place first between upstream and downstream firms in the same country and then between firms in the the two countries. Complications also appear since resale of intermediates may or may not be possible.

(iii) *Quality Differences:* The final good produced in the two countries may not be of the same quality. Chang and Kim (1989) have a setting in which a DC (developed country) is in competition with an LDC (less developed country), selling a high quality export good to third markets, whereas the LDC sells a lower quality good. The LDC is dependent upon imports of an important intermediate from the DC, which gives the DC power to affect market outcomes. Indeed, they assume that the DC can act like a Stackelberg leader [as also in Chang and Chen (1994)], as opposed to the discussion from Spencer and Jones (1991) in Section 5, where the vertically integrated firm can set conditions in the intermediate good market, but must compete in Cournot fashion in the final goods market. This difference supports the Chang and Kim conclusion that the optimal policy for the DC is one of non-intervention - there is no distortion which the government needs to offset. The LDC government, on the other hand, may find it in its interest to tax

imports of the required intermediate. In Chang and Kim (1991) the scenario is enriched by allowing the LDC to produce a substitute intermediate good. Then if the LDC uses the intermediate from the DC, it produces a medium quality good, inferior to the good produced by the DC, but of higher quality than the good produced with the home-grown intermediate. Skeath (1993) emphasizes quality differences on the input side, which in turn lead to quality differences on the output side. A model with quality differences is more amenable to the analysis of Bertrand competition, and with such competition for final goods, a tariff on inputs will drive the downstream output firm out of business. Skeath points out the relevance of the analysis to the over 60% tariff applied in the United States in 1991 on display screens (for laptop computers) supplied by Japan.

(iv) *Services and Trade:* The volume of international trade in intermediates, producer goods, raw materials, and other middle products is rising even relative to the total volume of trade. This reflects the increased *fragmentation* of the production process into separate vertical components. As modelled in Jones and Kierzkowski (1990), one element that makes this possible is the kind of increasing returns suggested long ago by Adam Smith - increased specialization and division of labor. In their model, the production

process is made up of separate *production blocks,* connected and coordinated by *service links.* As scale of productive activity expands, so does the division into production blocks, and it is primarily the costs of service links - information, communication and transportation - that have been decreasing at the international level, aiding and abetting the process whereby vertical production structures get fragmented and spread around to various countries, each of which may have a comparative advantage in a separate part of the production process. These activities may be coordinated at arms length, or production may take place under the rubric of a multinational enterprise. In the literature on the latter [see especially Helpman (1984) and Helpman and Krugman (1985)] the rationale for multinationals involves the distinction between production and headquarters services and the setting is one in which factor endowment proportions between countries may be sufficiently different that in order to maintain factor-price equalization headquarter services (presumably capital intensive) are located in the capital abundant country and some of the production activity (using only labor) is located in the labor-abundant country. This scenario is close to the earlier Kemp (1966) and Jones (1967) models in which a country uses some of its capital abroad as foreign investment and the sector-specific version of that model is the basis

for Section 2's core model. Thus there is vertical trade in which a country produces and exports a commodity using inputs (services), which are also "exported " (i.e. used) abroad (even if they do not travel).

8 Concluding Remarks

International trade in vertically related products is an important feature in world markets. For any country which trades in a final product and, as well, in an input that is used to produce that product, the relationship between the two terms of trade is crucial in determining national commercial policy or, if such trade is conducted by a vertically integrated firm, is important in deciding that firm's pricing or output strategy. The core model outlined in Section 2 revealed how technology as well as trade flows helps determine links among input and output prices. In the specific-factors framework adopted there the price of the final product and the price of the traded specific input are positively related, so that if a country exports at both ends of the vertical spectrum it has an interest in restricting trade in both items to achieve better terms of trade. The interplay between markets is more subtle, and the analysis underlying Figure 1 reveals how a higher gap between the world

price of an exported final good and the (lower) price or cost domestically of that item encourages even more restrictions on exports of an intermediate or raw material used to produce the final good.

In a purely competitive framework agents take prices as given, so that any effort to achieve better terms of trade for a country becomes the responsibility of government. In less competitive settings, much of this effort can be undertaken by private firms, but commercial policy is still required for a national optimum if the firm's objective function does not take into account interests of domestic consumers or if, as in the case of Cournot equilibria, the firm cannot credibly shift its own reaction locus. Therefore once again there is a possible use for commercial policy. Nonetheless, the basic rationale for interference - to take account of possible terms-of-trade gains subject to volume-of-trade constraints - is applicable to firms as well as countries, and this breakdown proves useful in the analysis of optimal distortions in a context in which both final goods and intermediate products are traded on world markets.

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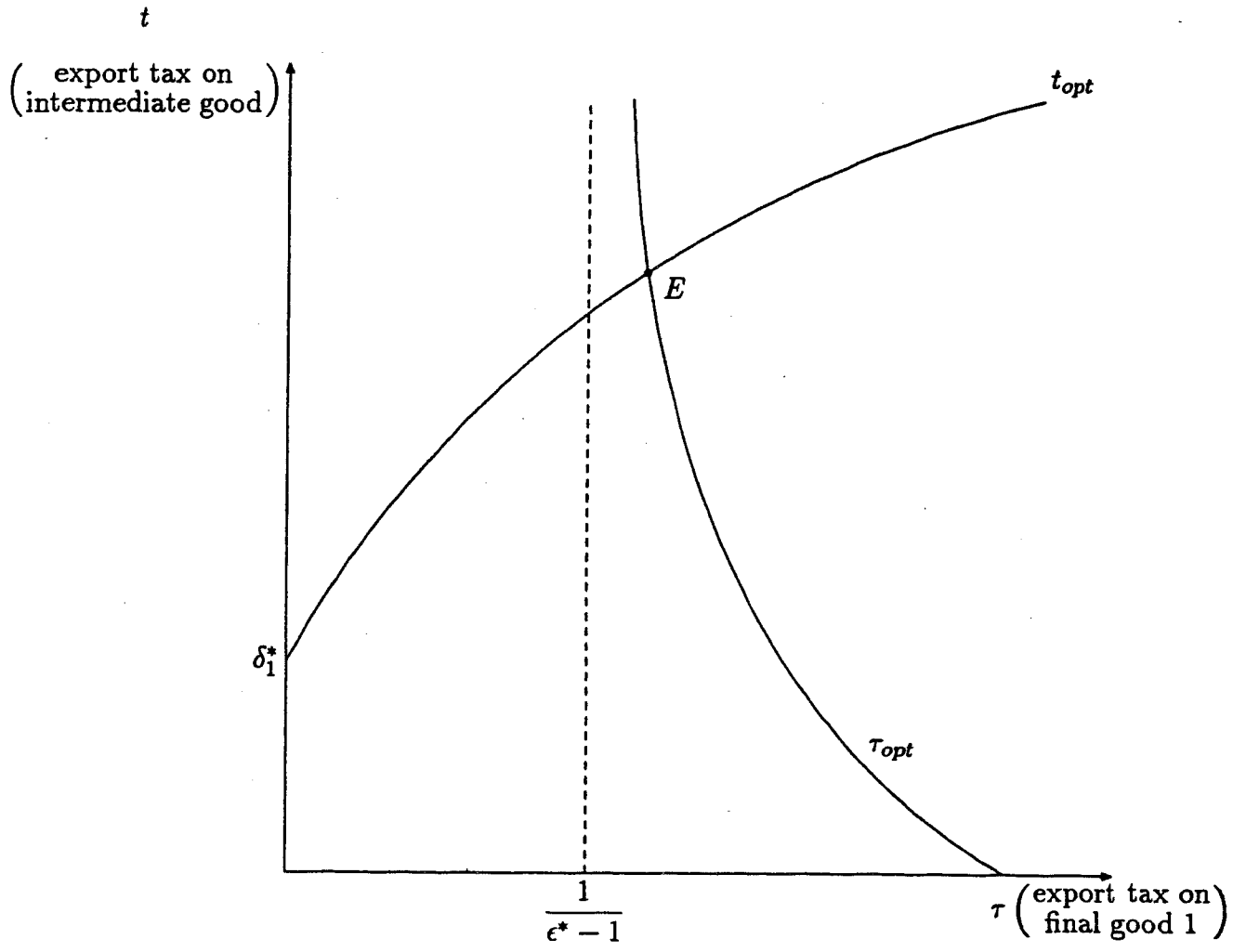
t
(export tax on intermediate good)
t_{opt}
E
δ_1^*
τ_{opt}
$\frac{1}{\epsilon^* - 1}$
τ (export tax on final good 1)

Figure 1

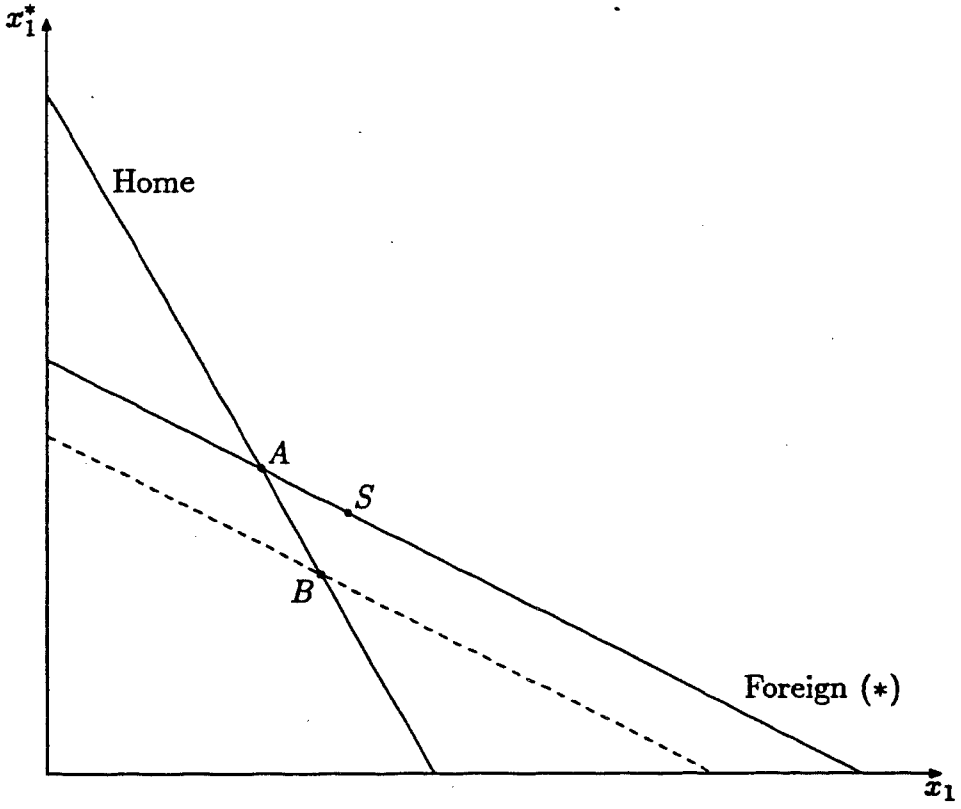

Figure 2