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RAW MATERIALS, PROCESSING ACTIVITIES AND PROTECTIONISM

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In classical treatments of commercial policy any nation which imposes tariffs or quotas on trade with another in an attempt to improve national welfare faces the real danger of foreign retaliation. Two-way trade links between nations provide each with the opportunity to have an adverse effect on the market for the other's exports. But the recent revival of protectionist sentiment in the United States has raised the question as to whether there is some means of retaliation that the trading partner can target toward the industry promoting the protection. A case in point is the Canadian reaction exhibited in 1986 when the United States, claiming injury to local producers in the Northwest, levied a 35% duty on Canadian exports of cedar shakes and shingles (destined, primarily, for the California housing market). Canada retaliated with import restrictions on books and some computer software products. Such a reaction could hardly be expected to have an influence on shake and shingle producers in Washington and Oregon, and these Canadian retaliatory gestures were soon rescinded.

Although special interests in one country might in some instances remain fairly immune to retaliation from the injured government abroad, in other cases the special interest group can be directly threatened. One such instance is that of intra-industry trade; producers might face competition in their own markets from foreign firms while, at the same time, competing for a share in the foreign market. The case we wish to discuss in this paper is different in that it involves the industry clamoring for protection from foreign competition in the final goods market also relying on imports of raw materials from the same source. This example of trade in vertically related industries indeed fits the outlines of the shake and shingle case. Canada - which in this instance effectively means the Province of British Columbia - has a decided advantage in obtaining the raw material and was in a position to tighten up even further than initially on its exports of cedar bolts and logs in retaliation for the American duty on the processed good - cedar shakes and shingles.

In the present paper we develop a competitive, general equilibrium model of an economy which exports both a raw material and the output of a sector which processes that raw material. Although it is not our intention to model directly any particular industry setting, some aspects of the model fit the shakes and shingles industry quite well. In particular, the asymmetry we build into the model as to the difficulty of obtaining raw materials at home and abroad seems to mirror the relatively limited local supplies of raw cedar bolts and logs available to American producers. As well, the importance to Canadians of American consumption of final shakes and shingles is captured by the assumption that all production of the processed good at home is destined for export. As a further asymmetry, we assume that initially the country exporting both raw and processed goods has imposed export controls on the raw material but not on the final good.

We begin by exploring the two kinds of links connecting the raw material producing sector and the processing sector. These two sectors compete with each other, as well as with the rest of the economy, for the nation's available supply of labor. This kind of connection, whereby an increase in activity in one sector draws labor away from others and thus exerts upward pressure in the labor market, is a hallmark of competitive general equilibrium modelling strategy and serves the purpose of linking competitive costs (and prices) among sectors.[1] A different link is provided by the complementarity requirement that the raw material is used as an input in the processing sector. This technological requirement is, in our model, quite rigid - one unit of the raw material is required per unit output of processed goods. However, the existence of international trade in the raw material serves to loosen this link for both exporting and importing countries.

Although economic agents are presumed to behave competitively, we assume the government in the home country is aware of the connection between its targeted export allowance for raw materials and the foreign market in the final processed good. Indeed, we assume that export controls (which for convenience take the form of an ad valorem tax on raw material exports) are set at a level which optimizes the home country's national income, subject to its decision not to interfere directly in the final goods market. (Perhaps a tax on the exports of the processed sector would prove to be politically infeasible, whereas an export tax on the raw material forms part of a long-standing policy of encouraging secondary industry. Once again the position of the lumber industry in British Columbia is suggestive). We then examine two aspects of the situation which could emerge if special interests in the importing country can promote a tariff on imports of the final product. First, what is the optimal response in the exporting country? Its market position in the raw materials sector provides it with the opportunity to retaliate with stricter controls on raw exports, but is such a policy of retaliation optimal? Perhaps surprisingly, it is possible to argue that the exporting country's best interests may be served by allowing more exports, at a lower price. Secondly, what is the impact of the tariff on prices in each of the vertically related export markets? Might it be the case that the tariff ends up inflicting little harm, or actually proving of benefit to the exporting nation? We conclude the paper with a brief discussion of the variety of interesting questions such a setting poses for the political economy of protectionism.

1. A Model of Processing Activities

We begin by presenting a small-scale competitive general equilibrium model for the home country, assumed to be an exporter of a raw material $\underline{x}$ which is used as an input into the processing sector producing $\underline{y}$. The home country exports both $\underline{x}$ and $\underline{y}$ and imports a third commodity, $\underline{z}$, also produced at home under competitive conditions. It is convenient to think of $\underline{x}$ and $\underline{z}$ as comprising the primary tier of the economy[2] in that production in each sector is assumed to require inputs of labor and, as well, factors V_x and V_z, specific to each sector with available quantities fixed throughout the analysis. By contrast, the processing sector, $\underline{y}$, is footloose - it requires inputs of labor and internationally-traded raw material $\underline{x}$.

The processing sector and the primary tier of the economy vie with each other for the economy's fixed overall supply of labor. Input requirements in the processing sector are assumed to be rigid: one unit of raw-material x is used to make a single unit of processed y. With labor the only other input into y-production, it is convenient to assume that exactly one unit of labor is required to produce a unit of y as well. Any prescribed given level of y-production implies that the primary tier has available for its own use (L-y) units of labor as well as specific factors V_x and V_y. Therefore outputs of x and z can be portrayed by the bowed-out transformation schedule shown in Figure 1, drawn as of a fixed level of y-output. Throughout we let commodity z play the role of numeraire so that $p_z \equiv 1$.

A unique feature of specific-factors models is the dependence of outputs (of x and z) only on own price relative to the wage rate(w); any labor supply changes (or price changes in other sectors) influence a sector's output only via their effect on the wage rate. Let e_x represent the supply elasticity in the sector producing raw material x and p_x the price of the raw material.[3] Letting a "^" represent the relative change in a variable (e.g. $\hat{x}$ is dx/x),

$$(1) \qquad \hat{x} = e_x(\hat{p}_x - \hat{w})$$

With z chosen as numeraire, the wage rate is directly linked to the price of x, the other commodity produced in the primary tier. In addition, if prices of x and z are kept fixed, any expansion in the level of output in the processing sector serves to syphon labor out of the primary tier and to put upward pressure on the wage rate. These two influences on the wage are represented by β_x (a positive fraction) and E (positive) in equation (2).[4]

$$\hat{w} = \beta_x \hat{p}_x + E\hat{y} \tag{2}$$

Substitution of (2) into (1) yields equation (3) as the connection between outputs of raw materials, final processing output, and the price of raw materials:[5]

$$\hat{x} = \beta_z e_x \hat{p}_x - e_x E\hat{y} \tag{3}$$

Expression (3) reveals that at fixed price for x (and z) an expansion of output in the processing sector would, in its requirements of extra labor, force a reduction in each sector of the primary tier. As we now demonstrate, this competitive stance between the processing sector and each of the sectors in the primary tier is also evident if p_y is kept constant instead of p_x. With labor and raw material output the only inputs necessary in the processing sector, the competitive profit equations of change are shown by equation (4), where θ_{Ly}, the distributive labor share in producing y, is w/p_y and θ_{xy} is p_x/p_y:

$$\hat{p}_y = \theta_{Ly}\hat{w} + \theta_{xy}\hat{p}_x \tag{4}$$

Of course by (2) the wage change is itself dependent on the price change in the x-sector and the volume of y-production. Substitution leads to:

$$\hat{p}_y = \theta_{Ly}E\hat{y} + \rho_x\hat{p}_x \tag{5}$$

$$\text{where } \rho_x \equiv \beta_x\theta_{Ly} + \theta_{xy}$$

The coefficient of $\hat{p}_x$ is a positive fraction, which exceeds the direct effect of raw-materials price on the cost of producing processed-y (given by θ_{xy}) since it includes the indirect effect of the induced wage increase.

The final step required to show that y and x are inversely related at a constant price for processed y involves substituting (5) into equation (3). This simplifies as equation (6):

$$\hat{x} = \frac{\beta_z e_x}{\rho_x}\hat{p}_y - \frac{e_x E}{\rho_x}\hat{y}. \tag{6}$$

Figure 1 illustrates a transformation schedule for the primary tier as of a given allocation of labor to the processing sector, y. As y expands, this transformation schedule shifts in. Two expansion (or contraction) paths are shown, corresponding to output changes with a constant price for raw materials, on the one hand, and a constant price for processed-y, on the other. The $\bar{p}_y$ locus is flatter since an expansion of y puts upward pressure on the wage rate and thus depresses the price of x if p_y is kept constant. These characteristics are shown by the negative signs and the relative sizes of the coefficients of $\hat{y}$ in equations (3) and (6).

For a given price of y, the inverse connection between output in the sector supplying raw materials for the processing sector and output of the processing sector itself, which is based on the two sectors competing for labor, is also illustrated in Figure 2. In that diagram the negatively sloped $\bar{p}_y$ curve is portrayed as bowed out. This, in part, reflects the assumption we now make that as the raw materials sector expands, the elasticity of supply, e_x, gets smaller as more and more labor is combined with a fixed amount of the specific factor.

The possibility of trading in raw materials frees outputs x and y from the necessity of moving together as per their 1 for 1 input-output requirements. If the home country had not been allowed to trade in raw materials, x and y outputs would have to lie along a 45° ray from the origin in Figure 2. The pair of 45° sloped lines drawn in Figure 2 each depict a given level of exports of x, X_x. The movement from A to B illustrates that an increase of exports of raw materials from the home country at constant prices of final processed y is met both by an increase in local raw materials production and a decrease in activity in the processing sector. By contrast, an increase in the price of y (with price fixed in the numeraire z-industry) with no change allowed in trade volume for raw materials would cause x and y production both to expand, e.g. from A to C in Figure 2.

To pursue the algebraic details of these relationships, let μ represent the fraction of total home x production that is sent abroad as exports. In terms of relative changes,

(7) $$\hat{x} = (1-\mu)\hat{y} + \mu\hat{X}_x.$$

Substituting this expression for $\hat{x}$ into equation (6) we obtain equation (8), showing explicitly the dependence of final processing activity, y, on its own price and the volume of trade in raw materials:

(8) $$\hat{y} = e_y \cdot \hat{p}_y - \frac{\mu}{(1-\mu)} \cdot \frac{1}{(\epsilon + 1)} \hat{X}_x$$

$$\text{where } e_y \equiv \frac{\beta_z}{E} \cdot \left[\frac{\epsilon}{\epsilon + 1}\right]$$

$$\text{and } \epsilon \equiv \left[\frac{e_x}{(1-\mu)}\right] \cdot \frac{E}{\rho_x}$$

For a given volume of trade in raw materials, Figure 3 shows a transformation schedule between final consumer goods, y and z. The term, e_y, is the elasticity of supply of final processed y along such a schedule. It can be viewed as the product of two terms. The first of these, $\left[\frac{\beta_z}{E}\right]$, refers to the transfer of labor from the z-sector to the y-sector as p_y rises if x-production could be kept constant. (Set $\hat{x} = 0$ in equation (6).) With y taking all the labor released by z in that circumstance, the value of $\left[\frac{\beta_z}{E}\right]$ would reflect primarily the elasticity of labor's marginal product schedule in the z-sector. But this term overestimates the possible expansion in y-production, since it does not recognize that with exports of raw materials held constant along the curve, any increase in y-production must be accompanied by a labor flow into raw materials so that they can expand unit-for-unit. This explains the second term, the fraction $[\frac{\epsilon}{\epsilon + 1}]$, which tends to be closer to unity the easier it is to extract and produce raw materials, i.e. the higher is e_x. (Note that the slope of the $\bar{P}_y$ schedule in Figure 2 is $-1/\epsilon$.)

Equation (8) also confirms that an increase in raw-materials exports at a constant price of final y must be associated with a reduction in the output of the final processed good, which, as shown in Figures 1 and 2, allows both outputs in the primary tier to expand. Alternatively viewed in the framework of the standard 2x2 model, the Rybczynski-like $\bar{P}_y$ locus in Figure 3 reveals that an increase in the availability of raw material-x (i.e. a decrease in X_x for the home country) expands the sector using x intensively (or at all) as an input, at the expense of the other sector.

2. Asymmetries Abroad and the Market for the Processed Good

The situation in the raw-material importing country is portrayed in Figure 4. The volume of x-imports at $\underline{A}^*$ reflects x-exports from the home country at $\underline{A}$ in Figure 2. The foreign $\bar{P}_y^*$ schedule is assumed to be steeper, to capture our assumption that foreign raw-material supply elasticity, e_x^*, is small compared with e_x at home. Letting μ^* denote the fraction of foreign processing output, y^*, supplied with imports of x, equation (7^*) matches that of (7) for the home country:

$$(7^*) \qquad \hat{y}^* = (1 - \mu^*)\hat{x}^* + \mu^*\hat{X}_x.$$

Changes in the foreign output level, $\hat{y}^*$, are thus connected to $\hat{p}_y^*$ and $\hat{X}_x$ by:

$$(8^*) \qquad \hat{y}^* = e_y^* \hat{p}_y^* + \frac{\mu^*}{(\epsilon^* + 1)} \hat{X}_x$$

$$\text{where } e_y^* \equiv \frac{\beta_z^*}{E^*} \cdot \left(\frac{\epsilon^*}{\epsilon^* + 1}\right)$$

$$\text{and } \epsilon^* \equiv \left[(1 - \mu^*)e_x^*\right] \cdot \frac{E^*}{\rho_x^*}$$

With these relationships in hand it is possible to analyze how an increase in home exports of raw materials affects the (world) market for the processed good. Before the foreign country levies any tariff, this is a free market so that p_y equals p_y^*. At given p_y the effect on world supply of an increase in X_x is shown by:

$$(9) \qquad \frac{\partial(y + y^*)}{\partial X_x} = \frac{(\epsilon - \epsilon^*)}{(\epsilon + 1)(\epsilon^* + 1)}$$

The basic supply-side asymmetry built into our model is that $\underline{\epsilon}$ exceeds $\underline{\epsilon}^*$ -- both because raw-materials supply elasticity e_x exceeds e_x^* and because the home country exports $\underline{x}$ (i.e. μ and μ^* are fractions). Therefore if the home country expands its exports of raw materials, world output of processed $\underline{y}$ (and world output of $\underline{x}$) will be enlarged. In a stable competitive market this eventuates in a price fall. For the analysis of optimal commercial policy at home, phrasing the argument in the reverse direction is appealing: a contraction of raw materials exports expands production of processed-y at home, but contracts production abroad to a greater extent. The consequence is a rise in the world price of y, which is viewed in beneficial terms at home since processed-y is also exported.

This connection between the volume of exports of raw material and the price of final y abroad that clears the market is formally stated in equation (10):

$$\hat{p}_y^* = -\omega \hat{X}_x, \tag{10}$$

$$\text{where } \omega \equiv \frac{\mu}{(1-\mu)(\eta_y^* + e_y)} \frac{(\epsilon - \epsilon^*)}{(\epsilon + 1)(\epsilon^* + 1)}$$

The terms η_y^* and e_y denote, respectively, the elasticity of demand for imports of y abroad (defined so as to be positive) and the elasticity of export supply at home (picking up only the supply term since home demand for y has been assumed away). An awareness on the part of the home government of this connection between supplies of the raw material and the foreign market in the processed good underlies its strategy in selecting the optimal degree of trade in raw materials. We turn now to this welfare issue.

3. Optimal Strategy for Raw Materials Exports

Given our assumption that the only initial interference in markets is the home country's control over raw materials exports, it is possible to develop an expression showing how home welfare is affected by changes in X_x.[6] With welfare directly dependent upon the consumption bundle, (D_y, D_z), evaluated at domestic prices, the change in welfare at home is given by (11):[7]

$$dW = p_y dD_y + dD_z \tag{11}$$

To anticipate our subsequent analysis in which the foreign country levies a tariff on its imports of processed y, let p_y^* denote the price faced abroad by consumers and producers, and $p_y^*(1 - v^*)$ the price received by home exporters of the processed good. v^* represents the foreign tariff rate.[8] The home country receives price p_x^* for its exports of raw materials, although an export tax at rate t raises this price above that received directly by home producers. (Thus $p_x^* = (1 + t)p_x$.) Balanced trade requires that :

$$p_x^* X_x + p_y^*(1 - v^*)X_y = (D_z - z), \tag{12}$$

where X_y denotes home exports of commodity y, and imports of z reflect the excess of demand over local production. Differentiate the trade constraint totally and use expression (11) for the change in welfare to obtain:

$$dW = X_x dp_x^* + X_y d\left[p_y^*(1 - v^*)\right] + p_x^* dX_x + \left\{p_y dy + dz\right\}.$$

The last term in brackets is zero for small movements along the transformation curve between y and z shown in Figure 3, while if exports of raw materials go up by one unit this expression becomes negative, equal in absolute value to the domestic competitive price of raw materials. With this in mind, the expression for the change in welfare can be written as in (13):

$$\text{(13)} \qquad dW = \left\{X_x dp_x^* + X_y d\left[p_y^*(1 - v^*)\right]\right\} + (p_x^* - p_x)dX_x.$$

Expression (13) points out how an improvement in the price received for either type of export raises home welfare by an amount proportional to the volume of export sales (and the price rise). In addition, the last term in (13) reveals that if an export tax has been levied on raw materials so that foreign price, p_x^*, exceeds home cost of production, p_x, welfare is reduced by any cut-back in raw materials exports. Optimal strategy depends upon the connections between export supply and the two terms of trade. We have already shown, in equation (10), how control over raw exports can influence the foreign price of y. We turn, now, to investigate how control over the quantity of raw materials exports affects directly the foreign price of raw materials for any given foreign price of processed y.

The change in foreign production of raw materials, $\hat{x}^*$, is related to $\hat{p}_x^*$ and $\hat{y}^*$ by the foreign version of equation (3). Furthermore, $\hat{x}^*$ is related to $\hat{X}_x$ and $\hat{y}^*$ by equation (7^*). Bringing these two results together allows us to solve for $\hat{y}^*$ in terms of $\hat{X}_x$ and $\hat{p}_x^*$. Substitute this solution for $\hat{y}^*$ into the foreign version of equation (5), the competitive profit equation of change for processed y^* abroad. The result is equation (14), providing the sought-for link connecting $\hat{p}_x^*$ to $\hat{X}_x$ and $\hat{p}_y^*$:

$$(14) \qquad \hat{p}_x^* = \frac{1}{\tilde{\rho}_x^*}\hat{p}_y^* - \delta^*\hat{X}_x$$

$$\text{where } \tilde{\rho}_x^* \equiv \frac{\rho_x^* + [(1-\mu^*)e_x^*]E^*}{1 + [(1-\mu^*)e_x^*]E^*}$$

$$\text{and } \delta^* \equiv \frac{\theta_{Ly}^* E^* \mu^*}{\rho_x^* + [(1-\mu^*)e_x^*]E^*}.$$

The relationships captured by equation (14) are easy to interpret. For a given level of raw-material exports it suggests that any increase in final p_y^* entails a magnified increase in raw-material p_x^*. The reasoning: an increase in p_y^* at constant X_x serves to raise y^* along the foreign transformation curve (the foreign version of Figure 3), and x^* must increase unit-for-unit to provide the needed raw materials. But x^* will rise only if $\hat{p}_x^*$ exceeds $\hat{w}^*$. Since these two input price changes straddle $\hat{p}_y^*$, the result is obtained. $\tilde{\rho}_x^*$ in (14) is a fraction, closer to unity than is ρ_x^*. Turning to the effect of restricting sales of raw materials to the foreign country, we note that such restrictions can be expected to raise their price. For given price of processed $\underline{y}^*$, a reduction in X_x (like the move from $\underline{B}^*$ to $\underline{A}^*$ in Figure 4) requires an increase in local raw materials production. Such an increase requires p_x^* to rise relative to the foreign wage and, since $\hat{p}_x^*$ and $\hat{w}^*$ straddle $\hat{p}_y^*$, which is assumed to be zero, p_x^* must rise. The coefficient δ^* shows how much a one percent cut back in raw-materials exports will raise p_x^*.

The key relationships abroad are provided by equations (14) and (10), and it is instructive to insert them in turn into welfare expression (13). Since our object is to analyze optimal home strategy as of a given tariff policy abroad, we simplify by assuming initial free trade, allowing us to set v^* equal to zero.[9] First we rewrite (13) in "hat" notation, introducing explicitly the export tax rate, t, and the term, ζ, which represents the ratio of export sales in the two markets. Thus:

$$(15) \qquad dW = p_x^* X_x \left\{ \left(\hat{p}_x^* + \frac{1}{\zeta}\hat{p}_y^*\right) + \left[\frac{t}{1 + t}\right]\hat{X}_x \right\}$$

$$\text{where } \zeta \equiv \frac{p_x^* X_x}{p_y^* X_y}$$

Substitute expression (14) for $\hat{p}_y^*$ to obtain:

$$(16) \qquad dW = p_x^* X_x \left\{ \left[\frac{1}{\tilde{\rho}_x^*} + \frac{1}{\zeta}\right]\hat{p}_y^* + \left[\left(\frac{t}{1 + t}\right) - \delta^*\right]\hat{X}_x \right\}$$

This reveals that even if the effect on final price p_y^* is ignored, the home country has an interest in restricting exports of raw materials, since this serves to raise their foreign price. Equation (16) also suggests how any increase in final processed p_y^* implies linked terms-of-trade gains for the home country since p_x^* would also be raised.

Finally, recognition of the effect which restriction of raw materials exports has on price in the final y^*-market (equation (10)) leads to expression (17):

(17) $$dW = p_x^* X_x \left\{ \left[\frac{t}{1 + t}\right] - \left[\delta^* + \omega\left[\frac{1}{\zeta} + \frac{1}{\tilde{\rho}_x^*}\right]\right]\right\}\hat{X}_x.$$

A comparison of (17) with (16) shows how optimal strategy that takes into account the effect of raw-materials exports on the final market price of processed $\underline{y}^*$ abroad will prove to be more restrictive than if such an effect were ignored. The optimal export tax rate is found by setting $dW = 0$ so that the price spread for raw materials between the two markets is given by:

(18) $$\left[\frac{t}{1 + t}\right] = \delta^* + \omega\left[\frac{1}{\zeta} + \frac{1}{\tilde{\rho}_x^*}\right].$$

The term δ^* reflects the directly beneficial effect on raw-materials price of a policy of restriction. The second term shows the added benefit which restriction entails since it raises the price of final good, p_y^*, as well which, of course, also produces a further improvement in p_x^*. In Spencer and Jones (1988b) it is shown that a private firm which exports good $\underline{y}$ and also supplies its rival foreign firm with raw materials will charge a higher price for these raw materials than would a private raw-material monopolist unaffected by the strategic link between these vertically related markets. Here it is the government which sets tax rates in awareness of the relation between markets when all agents behave competitively.

4. Optimal Response to a Foreign Tariff on Processed Exports

The optimal export tax wedge separating foreign and home prices for raw materials is provided by the formula in (18). If the foreign country levies a tariff on home exports of processed-y, the formula remains an appropriate guide to optimal home policy concerning raw materials exports, assuming the home country thinks that no action of its own can affect the foreign tariff rate. Although the formula remains intact, values of the parameters involved need not stay constant.

The foreign tariff has the principal effect of cutting down on home exports of the processed good, thus encouraging the foreign y^*-producing sector and, with it, foreign demand for imports of raw materials. Of the terms making up δ^*, the tariff has a primary effect in raising μ^*, a measure of the dependence of foreign y^*-producers on the home market for supplies of raw materials. That is, we argue that δ^* might be higher with a foreign tariff than with free trade. If so, expression (16) suggests that optimal strategy for a government which <u>ignores</u> the repercussions caused by changes in the final goods market would be to tighten its controls on the raw materials market and widen the premium which foreigners must pay for X_x. However, formula (18) includes the strategic effect of restricting X_x on the final goods market. The shift in the relative importance of the raw materials export trade, away from exports of protected final processed-good <u>y</u>, is reflected in an increase in the ζ term in (18). That is, with export sales in the final goods market curtailed by the tariff, there is less rationale for the strategic further restriction on raw materials exports in order to get a better price for sales of processed <u>y</u>.

Although this line of reasoning suggests that the extra ingredient provided by the second term in (18) to the export tax wedge is diminished, an increase in δ^* leaves in doubt the net reaction of home authorities to the tariff hike. In a companion piece (Spencer and Jones, 1988b) we show how, in a model characterized by duopolistic competition between home and foreign producers of final processed-y in a setting in which the home firm has a cost advantage in supplying raw materials to its foreign rival, the home private reaction to a tariff can be signed if demand for the final product is linear. A tariff would indeed induce a home exporter of the raw material to raise price if the secondary market is ignored -- this is analogous to a tariff-induced increase in the size of δ^* in formula (18). However, the lessened importance of the final market weakens the strategic desirability of even more restrictive sales of raw materials so much that optimal policy for a home producer dealing jointly in the raw material and final goods market is to lower the price of raw materials.

In the initial free trade situation the home country's optimal strategy includes imposing a "tight grip" on exports of raw materials since this will not only help maintain their price in foreign markets, but will also limit world production of the processed good and thus raise its price as well. Although this extra channel of trade allows the home country the opportunity to retaliate against the tariff by further restrictions in the raw materials market, our argument demonstrates that optimal policy may well call for a "relaxation of the tight grip" in response. The underlying rationale, whether in the case of private response in imperfectly competitive markets or government response via an export tax in competitive markets, resides in the lessened importance of export sales in the final goods protected market compared with sales in the unprotected raw materials market. This shift in trade weights for vertically-related exports works systematically to weaken the strategic importance of manipulating the raw-materials market to influence the market for the final processed good.

5. The Effect of the Foreign Tariff on Home Welfare

The foreign tariff affects both markets in which the home country is engaged in exports, although it directly interferes only in the market for the processed good. We have assumed that the home country selects an optimal value for its allowed exports of raw materials. This optimum point will, as we have seen, be affected by the tariff. The question we now raise concerns the impact of the tariff on welfare at home as of the initial value of X_x; any alterations in X_x subsequent to the tariff are deliberately taken in order to improve welfare from this level. Must the foreign tariff hurt the home country?

To proceed, reconsider the expression for the change in welfare shown in equation (13). The term $p_y^*(1 - v^*)$ is the price received by the home country for its sales of y abroad after the tariff has been paid. The imposition of the tariff creates a wedge between p_y^*, the price faced by consumers and producers abroad, and p_y, the price faced by producers at home, so that:

$$(19) \qquad \hat{p}_y = \hat{p}^*_y - \frac{dv^*}{(1 - v^*)}.$$

Keep X_x constant in (13) to get the impact effect of the tariff on welfare; the result is shown in (20):

$$(20) \qquad dW|_{\bar{X}_x} = p^*_x X_x \left\{ \frac{1}{\zeta} \hat{p}_y + \left[\frac{\hat{p}^*_x}{\hat{p}^*_y} \right] \cdot \hat{p}^*_y \right\}.$$

This form of the expression highlights the connection between foreign prices of processed y^* and raw-material x^* even at a given level of trade. The magnified response of p^*_x to p^*_y is shown by the inverse of $\tilde{\rho}^*_x$ in (14). Substitution reveals:

$$(21) \qquad dW|_{\bar{X}_x} = p^*_x X_x \left\{ \frac{1}{\zeta} \hat{p}_y + \frac{1}{\tilde{\rho}^*_x} \cdot \hat{p}^*_y \right\}.$$

All that remains is to solve for the impact of the tariff set on final y-goods on the price in each national market separately. With X_x assumed constant, foreign import demand, M^*_y, depends only upon foreign price, p^*_y; similarly, the home supply of exports, X_y, depends only on domestic p_y. (Recall that we are assuming that all local production is destined for the foreign market, which, inter alia, allows us to neglect the income effect of the tariff on home demand.) Assigning positive values η^*_y and e_y to foreign and home trade elasticities, market-clearing for processed goods implies that:

$$(22) \qquad -\eta^{*}_{y}\hat{p}^{*}_{y} = e_{y}\hat{p}_{y}.$$

Combining this with the tariff connection between home and foreign prices shown in (19) yields separate solutions:

$$(23) \qquad \hat{p}^{*}_{y} = \frac{e_{y}}{(\eta^{*}_{y} + e_{y})} \frac{dv^{*}}{(1 - v^{*})}$$

$$(24) \qquad \hat{p}_{y} = \frac{-\eta^{*}_{y}}{(\eta^{*}_{y} + e_{y})} \frac{dv^{*}}{(1 - v^{*})}$$

Figure 5 illustrates a possible outcome of the tariff when home export supply elasticity shows a high value relative to foreign import demand elasticity. (This could reflect an underlying assumed e^{*}_{x} much smaller than e_{x}.) The tariff would raise foreign p^{*}_{y} from A to B and lower domestic p_{y} from A to C. With income effects on demand assumed away, no Metzler (or Lerner) tariff paradox emerges. Price goes up in the protected market and falls in the exporting country.

These price changes can be substituted into (21) to give (25) as the final expression for the impact effect of a foreign tariff on home welfare:

$$(25) \qquad \frac{\partial W}{\partial v^{*}} = p^{*}_{x}X_{x}\left\{\frac{\eta^{*}_{y}}{(\eta^{*}_{y} + e_{y})}\left(-\frac{1}{\zeta}\right) + \frac{e_{y}}{(\eta^{*}_{y} + e_{y})}\left[\frac{1}{\tilde{\rho}^{*}_{x}}\right]\right\}$$

As written in this expression the change in home welfare depends on a weighted average of two terms: The $(-\frac{1}{\zeta})$ term expresses the fall in welfare of a given drop in price received by the home country for processed-y; the $\left[\frac{1}{\tilde{\rho}_x^*}\right]$ term shows the gain in welfare stemming from the effect of a given rise in foreign p_y^* since this translates into a magnified relative rise in the price received by home raw-materials exporters. The weights on these two terms represent the split of the tariff wedge into the fall in home p_y (which is the home country's final goods terms of trade) and the rise in p_y^* (which improves the home country's raw-materials terms of trade).

The biased outcome shown by Figure 5, wherein the foreign price rises relatively much compared with the fall in prices received by final goods exporters at home could well result in a home welfare improvement as a consequence of the tariff. At home producers of the processed good are hurt, but by less than suggested by the tariff rate. Home raw materials producers benefit by the price rise for their product. These producers could be expected to object if, instead of being allowed to export more, their exports were cut back by a home country retaliation in response to the tariff imposed on final goods.

6. Concluding Remarks: The Political Economy of Protectionism

We have put forth a simple general equilibrium model of an economy engaged in two vertically-related competitive export activities. One of these involves the production of raw materials used as an input into a footloose processing sector producing final goods. Exports from the latter have been hit by a foreign tariff. We have assumed that the home government's response to the tariff is conditioned both by its taking the foreign action as given and by initially having pursued an optimal policy concerning the volume of exports of the raw material. This policy, whose instrument we have assumed to be an export tax on sales abroad of raw materials, is supposed to be sufficiently sophisticated that the connection between restrictions on raw materials exports and the consequence for prices abroad of the final processed commodity is understood and taken into account. In these circumstances the optimal home reaction to the foreign tariff might prove not to be retaliatory. That is, being in a position to retaliate does not guarantee that retaliation is in a region's self-interest.

A number of interesting questions concerning the political economy of protectionism have been put aside in our framework. Perhaps most obviously, if the home country had not originally been optimally restricting its raw materials trade, would retaliation be a more likely response to the foreign tariff? Given the market conditions assumed in our model, some degree of export restriction for primary goods is in the national interest for any given rate of foreign duty, and the imposition of the original duty abroad may awaken the home country to its potential ability to affect prices by active commercial policies. If so, it could well respond by imposing restrictions of its own. The case of Canadian exports of raw cedar bolts and logs, which has suggested some of the features built into our model, provides an example in which restrictions on raw exports initially did exist. However, these were prompted not by a desire to obtain better terms of trade abroad, but by a long-standing concern to promote processing activities within British Columbia.[10]

The original tariff imposed by the foreign country was (we have assumed) levied upon instigation of a particular industry or region abroad. Similarly, the consequences of the tariff might be felt especially strongly in the home economy by a particular industry or region. It might be the case that real incomes in such a region could (as we have argued) be hurt by a policy of retaliation, but that nonetheless such a retaliatory response is deemed optimal at the national level. A crude argument would, say, compare the loss in real income which would accompany retaliation with the gain in terms of future actions (or some notion of self-esteem) from being seen to respond actively to counter the foreign measure. The point is that such a source of gain could be shared by the afflicted region as well, but if this is weighed against the loss of real income <u>per capita in the affected region</u>, provincial support for retaliation could be withheld although pursued at the national level (where loss of income <u>per capita</u> is smaller).[11]

Neglected in this analysis is the use by one country of commercial policy to affect the tariff or tax policies pursued by the other. Such a game-theory setting suggests, for example, that home retaliation to the foreign tariff is a strategy adopted to force the foreign country to back down and remove its tariff. But now the notion of credibility is raised. Should the foreign country respond to such pressure if it knows that it is in the home country's best interests not to retaliate if the tariff is kept in place?[12] Alternatively, the original tariff imposed by the foreign country might itself be viewed as a strategy to force the home country to follow a less restrictive materials-export policy.

All these questions need to be raised once it is acknowledged that national commercial policy can be strongly influenced by the concerns of special industries and regions. But an analysis in such a setting would have to incorporate the more narrowly-focussed questions we have attempted to address in this paper, dealing with optimal strategy and response in one country in the face of given restrictive policies imposed abroad when export markets encompass both raw materials and processed goods. When a country faces a tariff on its exports of final goods, this market tends to shrink concurrently with a stimulus to its sales of raw materials abroad to supply foreign producers protected by the tariff. Such a shift in market weights is crucial in understanding why a country might relax its controls on exports of raw materials in response to the tariff. Awareness of the connection between prices in the two export markets serves to encourage restrictions on material exports; a reduced importance of final goods markets lessens the benefit of extra restrictions on sales abroad of raw materials.

Footnotes

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[1]To the extent that the Canadian sector producing final shakes and shingles is quite small relative to other sectors, a more direct modelling strategy allows prices of raw materials and final processed output to be set in an imperfectly competitive setting with prices not driven by average costs. This alternative is analysed in a companion piece, Spencer and Jones (1988b). In our competitive setting, even if the industry is relatively small within Canada (and the comparable sector small in the United States), Canadian exports can supply a large share of the American market. In this case prices of both raw materials and the final processed output can be affected by commercial policy and the succeeding analysis is relevant despite the fact that wage disturbances in either country may be slight.

[2]In the language of Sanyal and Jones (1982), this could be labelled the Input Tier, although the structure of trade flows here is somewhat different.

[3]As detailed in the standard model, e_x is linked to the elasticity of the marginal product of labor schedule in producing raw materials. Thus $e_x = \theta_{LX}\gamma_{LX}$, where θ_{LX} is labor's distributive value share in the raw-materials sector and γ_{LX} is the elasticity of the marginal product of labor schedule. (See Caves and Jones, 1985, pp. 505-509).

[4]To fill in details, the general expression for the change in the wage rate in specific factors models (see Jones, 1971) in which the labor supply varies as well as prices is:

$$\hat{w} = \beta_x\hat{p}_x + \beta_z\hat{p}_z - \frac{1}{\gamma}\hat{L}_{(x+z)},$$

where γ is the economy's overall elasticity of demand for labor, the weighted average $\lambda'_{Lx}\gamma_{Lx} + \lambda'_{Lz}\gamma_{Lz}$. (The weights, λ'_{Lx} and λ'_{Lz}, represent the quantities of labor used in x and z respectively, as a fraction of the labor force used in the primary tier, $L_{(x+z)}$.) β_j is the fraction $\frac{\lambda'_{Lj}\gamma_{Lj}}{\gamma}$, and β_x and β_z add to unity. Since $\hat{L}_{(x+z)}$ equals $-\frac{L_y}{L_{(x+z)}} \cdot \hat{L}_y$, and $\hat{L}_y$ equals $\hat{y}$, the term E in equation (2) reduces to $\left\{\frac{L_y}{L_{(x+z)}}\right\} \cdot \frac{1}{\gamma}$. Finally, recall that z is chosen as numeraire so that $\hat{p}_z \equiv 0$.

[5]The term $(\beta_z e_x)$ can be thought of as a "general equilibrium" elasticity of supply of x, reflecting movements along the transformation schedule in the primary tier (fixed for a given value of y). It incorporates the effect of the price change on the wage rate. Note, for example, that if z production is

very small, the term approaches zero since any price rise for x forces the wage rate up almost as much, allowing little leeway for movement down labor's marginal product curve in the x-sector.

[6]The following treatment follows the lines of analysis set out in Jones (1967) and Jones (1979) for optimal strategy when a country trades in commodities and also a factor (capital) used as an input in one or both commodities.

[7]Although we have simplified our previous reasoning by assuming that home consumption of y is negligible, here we develop welfare expressions in a more general framework in which both final goods are consumed at home.

[8]For convenience this tariff rate is expressed as a fraction of the foreign price, p_y^*.

[9]We assume here that the home country provides raw material exports when the foreign country allows unrestricted imports of final goods. The possibility that the home country might foreclose the raw material market is considered in Spencer and Jones (1988a). As shown there, a sufficiently high foreign tariff encourages home supplies.

[10]One of the interesting aspects of this particular case is that provisions affecting shipments of raw lumber products to any destination outside the Province of British Columbia have been left up to the Province itself, whereas typically commercial policy is exercised at the Federal level.

[11] In the shakes and shingles case the Federal response led to tightening of the embargo on raw materials exports, although the support from Victoria, especially in the face of complaints from raw producers in the Province, seems to have been more qualified.

[12] Our remarks about the shakes and shingles case in the Canadian setting suggest the following possibility: Retaliation might not be a credible policy for the Province to pursue on its own (via its control over log supplies) but, if undertaken at the Federal level, where the per capita income gains or losses are smaller, such a policy might be taken more seriously abroad.

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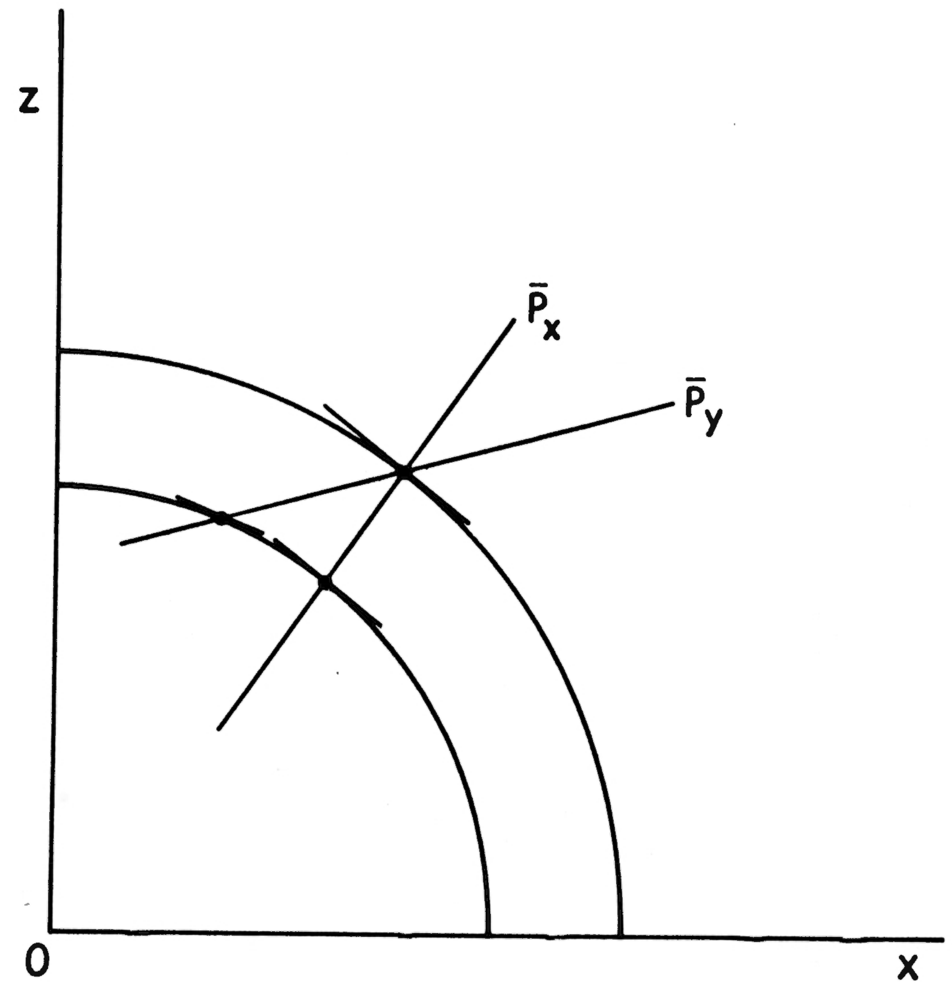

Figure 1. The Transformation Schedule in the Primary Tier.

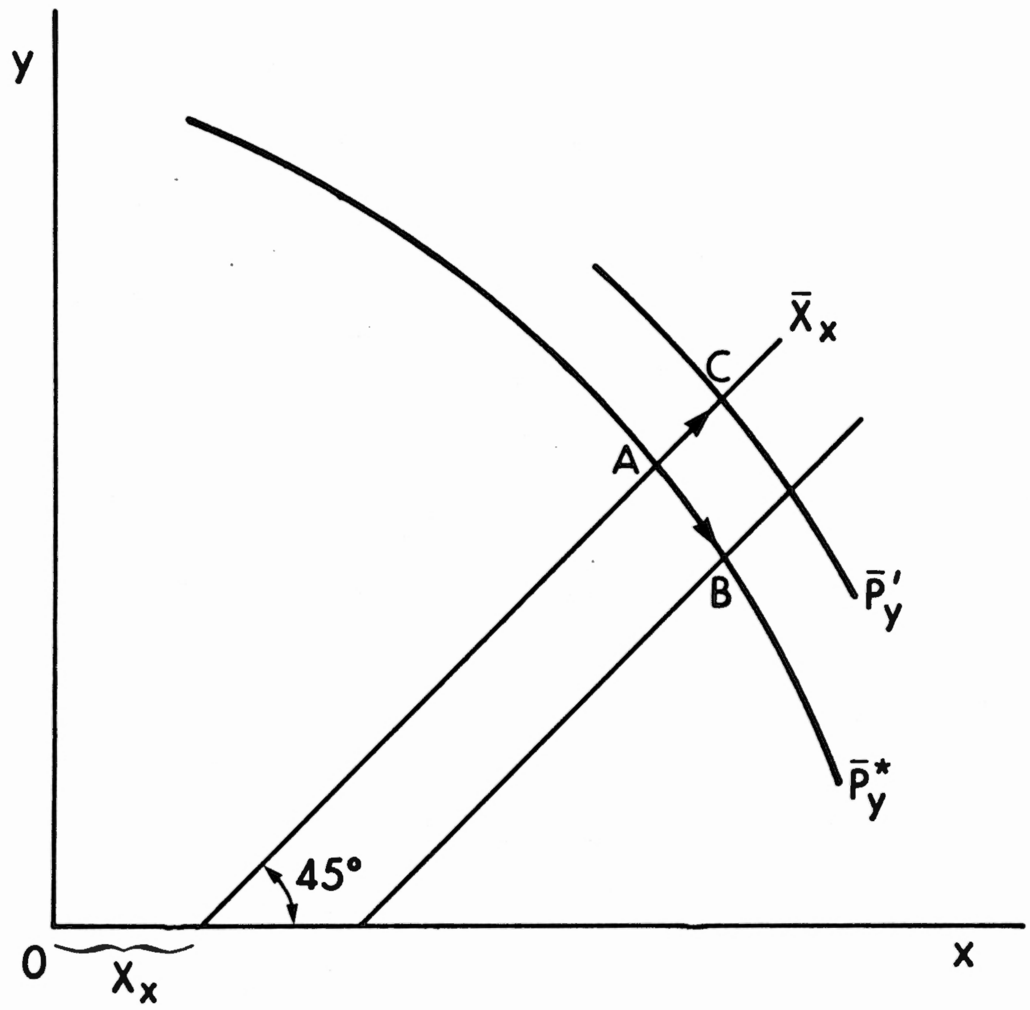

Figure 2. Relations Between Raw Material and Processing Sectors

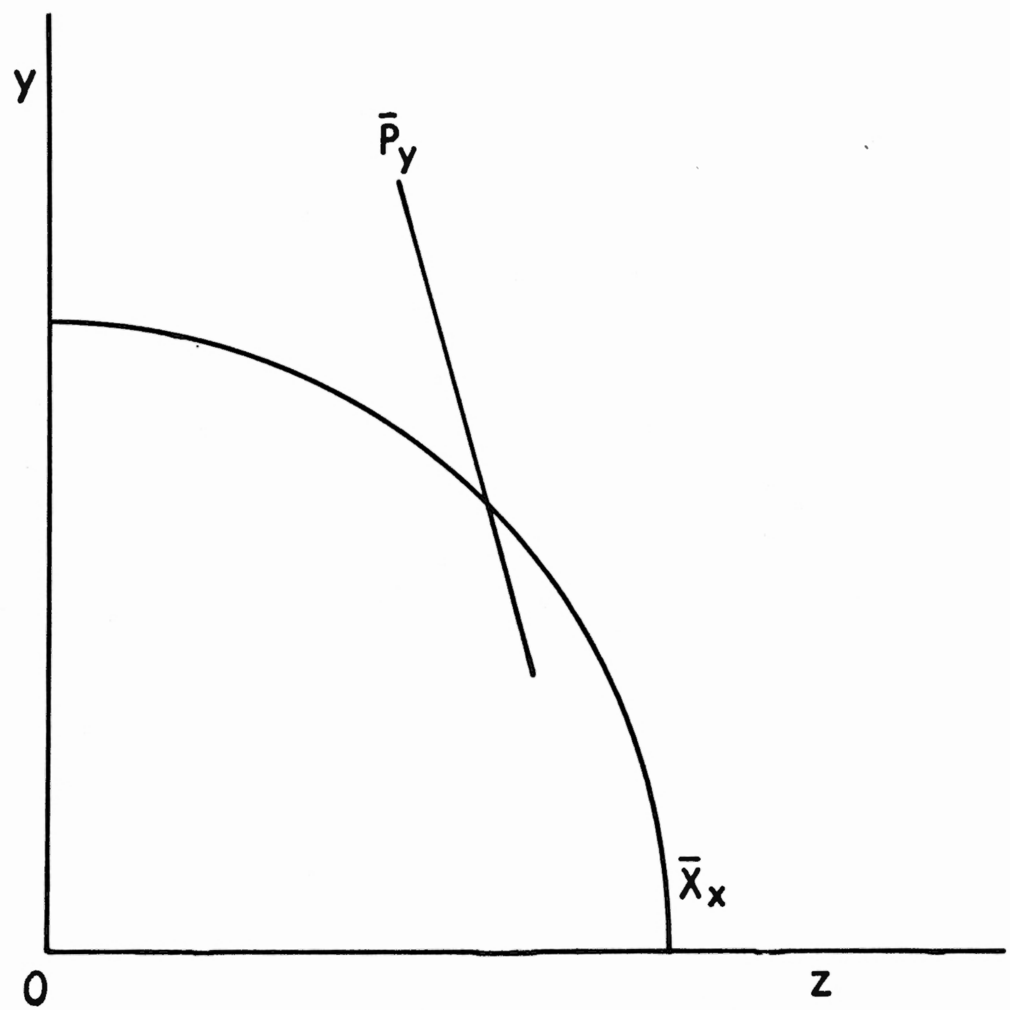

Figure 3. The Transformation Schedule for Final Consumption Goods

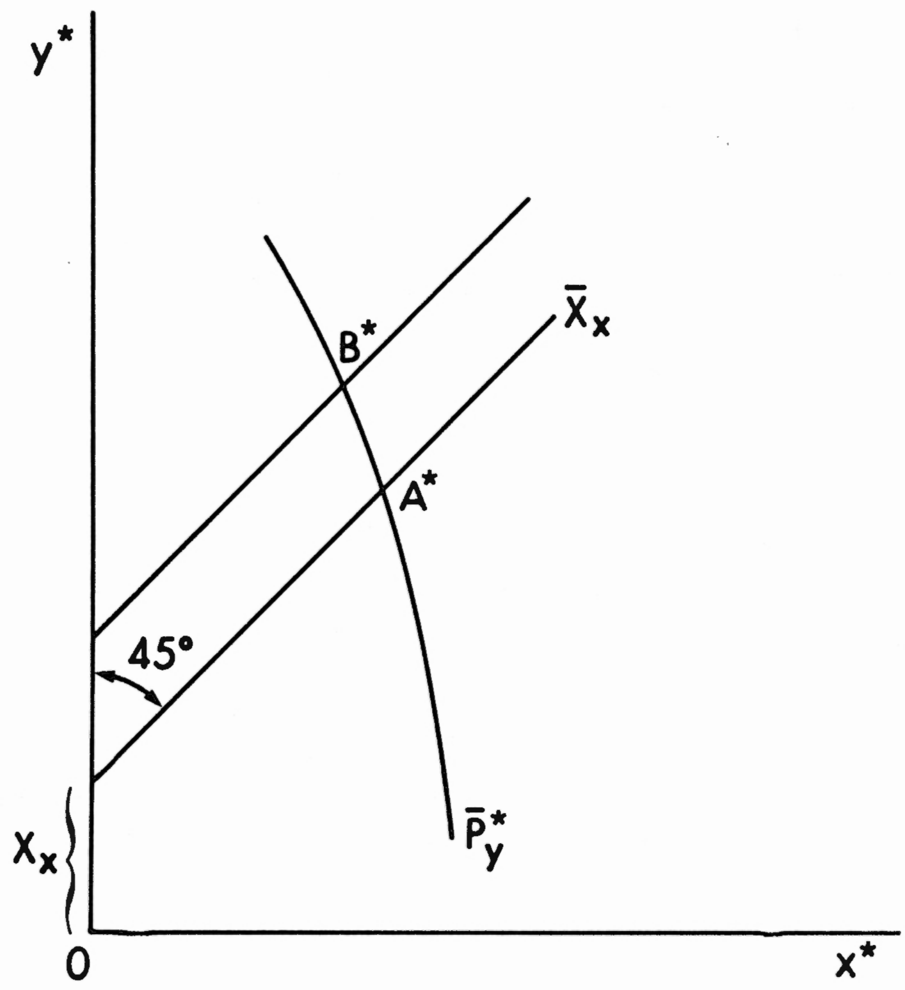

Figure 4. Raw Materials and Processed Goods Abroad

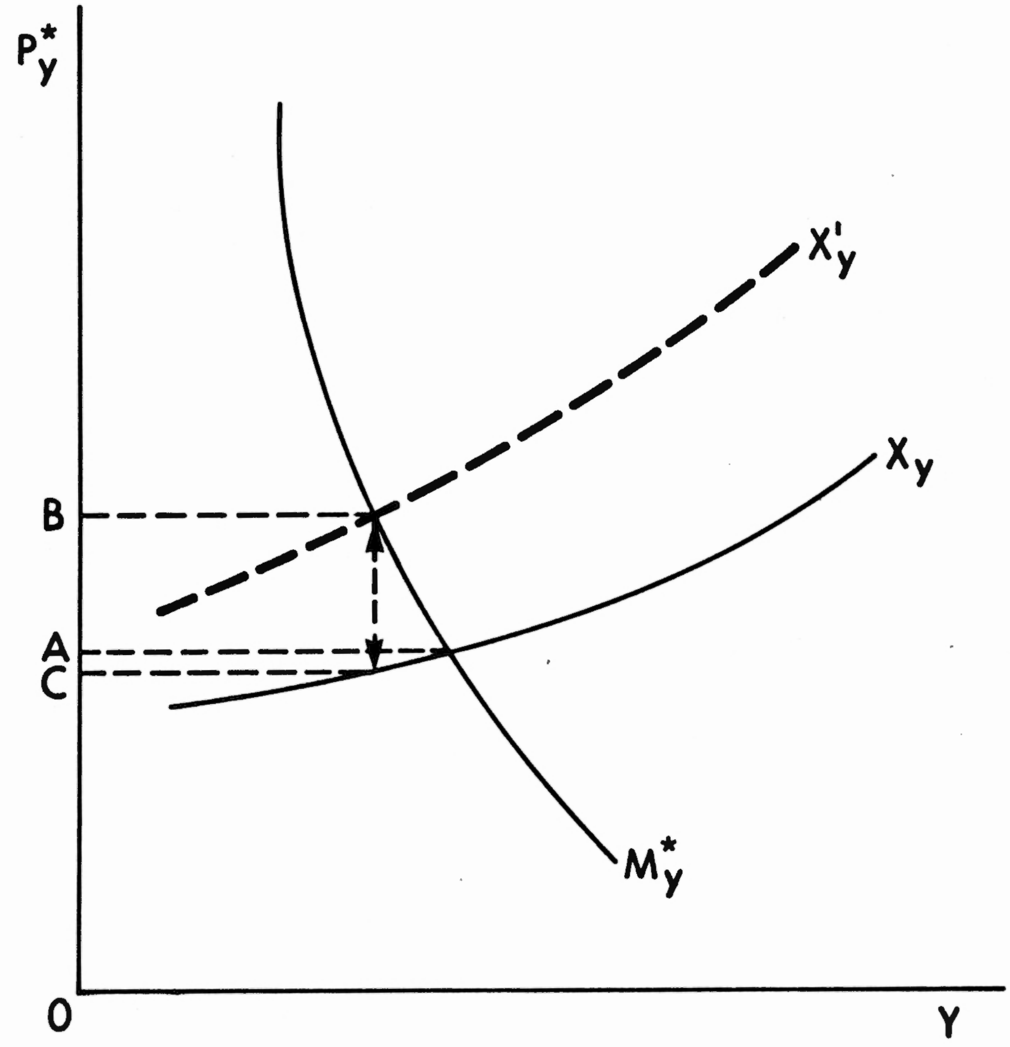

Figure 5. A Foreign Tariff on Processed-Y

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