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TARIFFS AND CAPACITY UTILIZATION BY MONOPOLISTICALLY COMPETITIVE FIRMS*

by

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I. Introduction

Recent developments in international trade theory have placed great emphasis on the gains that might be obtained from the realization of scale economies and increased product variety made possible by trade. The influx of imports will improve the competitive environment for firms selling domestically, requiring these firms either to lower production cost or shut down and leave the industry. Trade can thus be expected to result in a rationalization of the production process by increasing output per firm and lowering average total cost.

In a policy context, the effect of trade liberalization on firm output arises importantly in evaluating the U.S.-Canada free trade area. The expectation is that tariff liberalization has the potential to increase the competitive environment in both countries, implying mutual realization of scale advantages from trade.

The theoretical treatment of the implications of a tariff for firm output, however, is inconclusive. For example, Horstmann and Markusen (1986), using a one-factor two-country Cournot model with linear demand, find that a tariff has *no* effect on output of domestic firms but *raises* firm output in the partner country. The tariff increases a foreign firm's perceived elasticity of demand, which leads to a reduction in the mark-up of price over marginal cost and increased firm output. Flam and Helpman (1987), using an n-factor two-good one-country model with monopolistically competitive firms facing constant elasticity demand schedules find that a tariff raises *industry* output but has an ambiguous effect on *firm* output. A tariff will increase the utilization rate in the monopolistically competitive sector if R&D requires highly specific resources which do not have good substitutes.

The purpose of this paper is to explore systematically the determinants of the output of a monopolistically competitive firm in response to a tariff using a two-country two-good two-factor model which incorporates and extends the results of Horstmann and Markusen and Flam and Helpman. On the production side, a corollary to the Stolper-Samuelson Theorem is used to find that the effect of a tariff on firm output depends on the factor-intensity ranking of the protected industry. On the demand side, tariffs and changes in the terms of trade affect firm output through the firm's perceived elasticity of demand. These results are then used to demonstrate that, in most cases the forces raising firm output in the home country imply falling firm output in the partner country. Consequently, mutual scale advantages from bilateral tariff elimination in the U.S.-Canada FTA are unlikely for monopolistically competitive industries. A diagrammatic technique is also developed for illustrating the general equilibrium effects of a tariff for this model.

The model is presented in section II. The effect of a tariff for firm output and terms of trade is first evaluated assuming firms face a constant elasticity demand curve in section III. The implications for allowing the firm's perceived elasticity to vary are then discussed in section IV. Conclusions follow.

II. Determinants of Output per Firm

For the purpose of evaluating the determinants of output per firm in response to a tariff, consider a simple two-good, two-factor, two-country model. Good one is homogeneous across firms and countries, produced with capital and labor using constant returns to scale technology, and sold in a perfectly competitive market. Good two is differentiated by firm. Production

requires a fixed input of capital plus variable inputs of capital and labor.[1] The variable inputs are characterized by constant returns to scale but the fixed input requirement gives rise to a downward sloping average total cost curve (ATC). Firms in industry 2 set price as a profit-maximizing mark-up over marginal cost, where the mark-up is inversely related to the firm's perceived elasticity of demand. However, free entry is assumed so that price is equal to average total cost.

There are three determinants of firm output in industry 2 in this model. On the demand side, changes in the tariff and changes in the terms of trade will affect each firm's perceived elasticity of demand. On the production side, the factor intensity ranking of the two industries plays a key role in determining firm output consistent with factor market equilibrium.

Turning first to the production side of the economy, the price in industry 2 must be consistent with profit maximization, which implies that

$$MC_2 = P_2\left[1 - \frac{1}{\eta}\right] \tag{1}$$

where

$$MC_2 = w\, a_{L2} + r\, a_{K2}$$

is marginal cost in industry 2, w is the return to labor, r is the return to capital, $a_{ij}(w,r)$ is the variable unit input requirement of factor i in industry j, and $\eta>1$ is a representative firm's perceived elasticity of demand in industry 2. For the sake of brevity, country subscripts have been

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[1]The assumption that capital is the only fixed factor is not essential for the following results. It is sufficient for our purposes here that the production function simply be nonhomothetic. That is, the fixed factor proportions be different from the variable factor proportions.

suppressed. Proportionately differentiating equation (1), using the definition of marginal cost, yields

$$\hat{P}_2 = \theta_{L2}\, M\, \hat{w} + \theta^{V}_{K2}\, M\, \hat{r} + \frac{\hat{\eta}}{1-\eta} \qquad (1')$$

where θ_{ij} is factor i's share of total cost in industry j, θ^{V}_{K2} is variable capital's share of total cost in industry 2, $M=P_2/MC_2$ is the mark-up of price over marginal cost, and the circumflex indicates proportionate change.

Price in both sectors must also be consistent with the zero-profit condition which requires that price equal average total cost for all firms. That is

$$P_1 = w\, a_{L1} + r\, a_{K1} \qquad (2)$$

$$P_2 = w\, a_{L2} + r\, a_{K2} + \frac{F\, r}{q_2} \qquad (3)$$

where F is the fixed capital input requirement in industry 2, and q_2 is *firm* output in industry 2. Proportionate differentiation of equations (2) and (3) yields

$$\hat{P}_1 = \theta_{L1}\, \hat{w} + \theta_{K1}\, \hat{r} \qquad (2')$$

and

$$\hat{P}_2 = \theta_{L2}\, \hat{w} + \theta_{K2}\, \hat{r} - \theta^{F}_{K2}\, \hat{q}_2 \qquad (3')$$

where θ^{F}_{K2} is *fixed* capital's share of total cost in industry 2.

Equations (1'), (2'), and (3') can be solved simultaneously for the proportionate changes in w, r, and q_2 which satisfy the zero-profit and maximum-profit conditions in terms of prices and the firm's perceived elasticity of demand:

$$\hat{w} - \hat{r} = -\frac{\hat{P}_2 - \hat{P}_1}{M\, \theta_V} - \frac{\hat{\eta}}{M\, (\eta-1)\, \theta_V} \qquad (4)$$

$$\hat{q}_2 = \frac{\theta_{L2}\ (\hat{P}_2 - \hat{P}_1)}{\Theta_V} + \frac{\Theta\ \hat{\eta}}{\theta^F_{K2}\ M\ (\eta\text{-}1)\ \Theta_V} \tag{5}$$

where $\Theta_V = \theta_{L1}\ \theta^V_{K2} - \theta_{K1}\ \theta_{L2}$ and $\Theta = \theta_{L1}\ \theta_{K2} - \theta_{K1}\ \theta_{L2}$.

Equation (4) is simply a restatement of the Stolper-Samuelson Theorem. A rise in the relative price of good 2 requires a fall in w/r if industry 2 is the capital intensive industry, ranked according to variable inputs. That is, if Θ_V is positive.

The implications of an increase in P_2 for firm output in industry 2 depends on the factor intensity ranking of each industry, as well. An increase in P_2 requires an equal proportionate increase in ATC_2, but no change in ATC_1, in order to satisfy the zero-profits conditions in both sectors. An increase in P_2 must also be accompanied by an equal proportionate increase in MC_2 in order to satisfy the profit-maximization condition, as long as the firm's perceived elasticity of demand is unchanged. That is

$\hat{ATC}_2 = \hat{MC}_2 = \hat{P}_2$ and $\hat{ATC}_1 = \hat{P}_1 = 0$.

What changes in w, r, and q_2 will satisfy all three conditions? By the Stolper-Samuelson Theorem, a fall in w/r will increase both ATC_2 and MC_2 relative to ATC_1 if industry 2 is capital intensive. However, a fall in w/r alone will not satisfy both the zero-profits and maximum-profits conditions for industry 2. For, as w/r falls, ATC_2 rises faster than MC_2. This follows from the fact that the fixed capital input requirement in industry 2 implies that capital's share of total cost is greater than capital's share of variable cost. Therefore, an increase in firm output in industry 2, which reduces ATC_2, is also required.

If, on the other hand, industry 2 is the labor intensive industry, then

w/r must rise. However, in this case, an increase in w/r will cause MC_2 to rise faster than ATC_2 since labor's share of marginal cost is greater than labor's share of total cost in industry 2. Therefore, a fall in firm output in industry 2, which raises ATC_2, is required.

The implications for an increase in the firm's perceived elasticity of demand for firm output, holding prices fixed, is more definitive, as can be seen from the second term on the right hand side of equation (5). An increase in η will increase q_2 as long as industry 2's factor intensity ranking according to its variable inputs corresponds to the factor intensity ranking according to its total inputs. That is, as long as $\theta_v > 0 \iff \theta > 0$.

The larger the firm's perceived elasticity of demand the smaller the gap between ATC_2 and MC_2 necessary to satisfy the profit-maximization condition. If P_1 and P_2 are unchanged, MC_1 and ATC_2 must also remain fixed to satisfy the zero-profit condition. Therefore, the mark-up over marginal cost in industry 2 must be reduced entirely by raising MC_2. That is

$$\hat{ATC}_2 = \hat{MC}_1 = \hat{P}_2 = \hat{P}_1 = 0 \quad \text{and} \quad \hat{MC}_2 > 0.$$

This is accomplished by increasing the return to the factor used intensively in industry 2. However, if w/r is changed so that MC_1 is held constant while MC_2 is increasing, then ATC_2 must also be rising. Consequently, firm output in industry 2 must also be rising to hold $\hat{ATC}_2$ equal to zero.

It is interesting to note, however, that if industry 2 is capital intensive based on total inputs, so that θ is positive, but industry 2 is the labor intensive industry based on variable inputs, so that θ_v is negative, then an increase in the firm's perceived elasticity of demand will lower firm output. This case emerges if industry 2 requires a lot of fixed capital but very little variable capital.

As before, an increase in η requires a smaller gap between MC_2 and ATC_2. However, if P_2 is held constant then ATC_2 cannot change. Therefore, the adjustment must occur by increasing MC_2. This requires an increase in w/r since industry 2 is labor intensive in its variable inputs. The increase in w/r, though, will lower ATC_2 since industry 2 is capital intensive overall. Thus, firm output must fall to raise ATC_2 to its original level.

The production side is completed by adding the factors markets. Labor market equilibrium is given by equation (6) and capital market equilibrium by equation (7)

$$a_{L1}\, Q_1 + a_{L2}\, q_2\, n_2 = L \tag{6}$$

$$a_{K1}\, Q_1 + a_{K2}\, q_2\, n_2 + n_2\, F = K \tag{7}$$

where Q_1 is output by industry 1, n_2 is the number of firms in industry 2, L is the economy's endowment of labor, and K is the economy's endowment of capital. Proportionate differentiation of (6) and (7) gives

$$\lambda_{L1}\, \hat{Q}_1 + \lambda_{L2}\, (\hat{q}_2 + \hat{n}_2) = \delta_L\, (\hat{w} - \hat{r}) \tag{6'}$$

and

$$\lambda_{K1}\, \hat{Q}_1 + \lambda^V_{K2}\, (\hat{q}_2 + \hat{n}_2) + \lambda^F_{K2}\, \hat{n}_2 = -\, \delta_K\, (\hat{w} - \hat{r}) \tag{7'}$$

where $\delta_L = \lambda_{L1}\, \theta_{K1}\, \bar{\sigma}_1 + \lambda_{L2}\, \theta^V_{K2}\, \bar{\sigma}_2$, $\quad \delta_K = \lambda_{K1}\, \theta_{L1}\, \bar{\sigma}_1 + \lambda^V_{K2}\, \theta_{L2}\, M\, \bar{\sigma}_2$,
λ_{ji} is the fraction of the endowment of factor j employed in industry i, and $\bar{\sigma}_i$ is the elasticity of substitution between capital and labor in industry i.

Solving (6') and (7') simultaneously, using (4) and (5), we can find output in industry 1 and the number of firms in industry 2 to be

$$\hat{Q}_1 = -\frac{1}{\lambda\,\theta_V\,M}\,[\Delta_2 + \theta_{L2}\,\lambda_{L2}\,\lambda^F_{K2}\,M]\,(\hat{P}_2 - \hat{P}_1) - \frac{1}{\lambda\,\theta_V\,M}\left[\Delta_2 + \frac{\lambda_{L2}\,\lambda^F_{K2}\,\theta}{\theta^F_{K2}}\right]\frac{\hat{\eta}}{\eta-1} \qquad (8)$$

and

$$\hat{n}_2 = \frac{1}{\lambda\,\theta_V\,M}\,[\Delta_1 - \lambda_V\,\theta_{L2}\,M]\,(\hat{P}_2 - \hat{P}_1) + \frac{1}{\lambda\,\theta_V\,M}\left[\Delta_1 - \frac{\lambda_V\,\theta}{\theta^F_{K2}}\right]\frac{\hat{\eta}}{\eta-1} \qquad (9)$$

where $\lambda = \lambda_{K2}\,\lambda_{L1} - \lambda_{K1}\,\lambda_{L2}$, $\lambda_V = \lambda_{L1}\,\lambda^V_{K2} - \lambda_{K1}\,\lambda_{L2}$, and $\Delta_i = \delta_L\,\lambda_{Ki} + \delta_K\,\lambda_{Li}$.

Output in industry 2 can be found by combining equations (5) and (9) to obtain

$$\hat{Q}_2 = \hat{q}_2 + \hat{n}_2 = \frac{1}{\theta_V\lambda M}\,[\Delta_1 + M\theta_{L2}\lambda^F_{K2}\lambda_{L1}](\hat{P}_2 - \hat{P}_1) + \frac{1}{M\lambda\theta_V\theta^F_{K2}}\,[\Delta_1\theta^F_{K2} + \theta\lambda^F_{K2}\lambda_{L1}]\,\frac{\hat{\eta}}{\eta-1}. \qquad (10)$$

It is clear from equations (8) and (10) that an increase in P_2 relative to P_1 will increase production in industry 2 and reduce production in industry 1 as long as the factor intensity ranking based on total inputs agrees with the factor intensity ranking based on variable inputs. However, if industry 2 is capital intensive overall ($\lambda > 0$) but labor intensive based on variable inputs ($\theta_V < 0$) then an increase in the relative price of good 2 will lower industry 2 output and raise industry 1 output.

To see this point, recall that an increase in P_2 in the mixed intensity case requires that w/r rise and q_2 fall. If industry 2 is labor intensive according to its variable input requirements, the increase in w/r and the fall in q_2 will generate an excess supply of labor and an excess demand for capital. By the Rybczynski Theorem, output of the overall capital intensive industry must fall and output of the overall labor intensive industry must rise. Therefore, if industry 2 is capital intensive ranked according to total

inputs, then industry 1 must expand and industry 2 must contract.

These results are summarized in Table 1. A +(-) entry indicates a non-negative(positive) response of an endogenous variable to a change in relative price or elasticity of demand necessary to maintain production-side equilibrium. Results are presented for each of the three possible factor intensity rankings.

On the demand side, we adopt the Dixit-Stiglitz-Spence form of the utility function (Dixit and Stiglitz (1977) and Spence (1976)) of a representative individual

$$U = D_1^{\alpha} D_2^{1-\alpha} \tag{11}$$

where D_1 is consumption of good 1 and D_2 is a CES aggregate of the varieties of good 2. Due to the symmetry of the CES function, domestic demand for a representative domestic firm is

$$D_{2H} = \frac{E_2 P_{2H}^{-\sigma}}{n_{2H} P_{2H}^{1-\sigma} + n_{2F} [P_{2F}(1+t)]^{1-\sigma}} \tag{12a}$$

where E_2 is domestic expenditure on good 2, P_{2H} is the price of the domestic variety of good 2, P_{2F} is the price of the imported variety, n_{2H} is the number of domestic firms in industry 2, n_{2F} is the number of foreign firms in industry 2, t is the ad valorem tariff imposed by the home country on imports of good 2, and $\sigma>1$ is the elasticity of substitution among the varieties of good 2. Similarly, the demand for good 2 produced by a representative foreign firm is

$$D_{2F} = \frac{E_2 [P_{2F}(1+t)]^{-\sigma}}{n_{2H} P_{2H}^{1-\sigma} + n_{2F} [P_{2F}(1+t)]^{1-\sigma}} \tag{12b}$$

The general equilibrium effect of a tariff on the utilization rate for the case in which firms accurately calculate the elasticity of demand for

their product is complex. Equilibrium will, therefore, first be illustrated for the case in which each firm behaves as if its demand curve has constant elasticity. The implications of variable elasticity of demand will be discussed subsequently.

III. General Equilibrium with Constant Perceived Elasticity of Demand

General equilibrium for the case in which industry 2 is capital intensive and the firm's perceived elasticity of demand is constant is depicted in Figure 1, where P_{2F} has been chosen as the numeraire. The first quadrant determines equilibrium firm output and price for a representative domestic producer in industry 2. $q_{2H}(P_{2H};P_1)$ is the set of combinations of firm output and price in industry 2 which satisfy the supply side conditions in the home country: profit maximization, zero profits, and factor market equilibrium. q_{2H} is increasing in P_{2H} and decreasing in P_1, as can be seen from the first column of Table 1. Total demand (domestic plus exports) for a representative domestic firm in industry 2 is given by $D^*_{2H}(P_{2H};t)$, which is decreasing in P_{2H} but increasing in the tariff, t.

All combinations of P_{2H} and P_1 which maintain equilibrium for a representative domestic firm in industry 2 are depicted in quadrant IV by $E_2(t)$. An increase in P_1 to P_1' will reduce q_{2H} consistent with supply side equilibrium, shifting q_{2H} in quadrant I down. A change in P_1 will have no effect on demand for good 2 since the upper level of the utility function is Cobb-Douglas. Therefore, P_{2H} must rise to restore equilibrium, implying that E_2 is positively sloped.

The market for good 1 is depicted in quadrant III of Figure 1. Total demand for good 1, $D^*_1(P_1)$, is decreasing in P_1. Total supply of good 1,

$Q_1^*(P_1;P_{2H})$, is increasing in P_1 and decreasing in P_{2H} according to Table 1.

All combinations of P_{2H} and P_1 which maintain equilibrium in the market for good 1 are given in quadrant IV by E_1. An increase in P_{2H} to P'_{2H} relative to P_1 will reduce domestic production of Q_1, requiring an increase in P_1 to restore equilibrium in the market for good 1. This implies that E_1 is positively sloped, as well.

Consider, now a tariff increase by the home country. A tariff increase from t to t' will have no effect on the q_{2H} schedule in quadrant I, but will increase demand for a representative domestic firm. An increase in P_{2H} is required to restore equilibrium, implying a rightward shift in E_2. The tariff has no direct effect on the market for good 1 since the firm's perceived elasticity of demand is held constant and the upper level of the utility function is Cobb-Douglas. Therefore, the tariff increase by the home country shifts equilibrium in quadrant IV from A to B, increasing P_1 and P_{2H} relative to P_{2F}.

What are the implications of the tariff for capacity utilization? The increase in P_1/P_{2F} will lower firm output in the foreign country, according to Table 1, thus lowering the utilization rate.

It is also possible to determine that firm output in the home country will increase. Recall that the shift in equilibrium from A to B in quadrant IV of Figure 1 corresponds to a rightward shift of Q_1^* in quadrant III. The adjustment in the market for good 1 from a to b involves a fall in demand for good 1 since P_1 is rising, an increase in foreign production of good 1 since P_1/P_{2F} is rising, and therefore a fall in domestic production of good 1. Domestic production of good 1 will fall if and only if P_{2H}/P_1 rises, according to Table 1. Hence, q_{2H} must also rise.

The change in relative prices also constitutes an improvement in the terms of trade for the home country for all patterns of trade. The increase in P_{2H}/P_{2F} implies an improvement in the terms of trade within industry 2 for the home country. The increase in P_{2H}/P_1 is an improvement in the terms of trade if the home country is a net exporter of good 2 and an importer of good 1 and the decline in P_{2F}/P_1 is an improvement in the terms of trade if the home country is a net importer of good 2 and an exporter of good 1.

The effect of a tariff on the capacity utilization rate in industry 2 is reversed if industry 2 is labor intensive ranked according to total and variable factors. A tariff increase in the home country will lower firm output in the home country while raising firm output in the foreign country. This case is depicted in Figure 2.

The labor intensive case differs from the capital intensive case in that an increase in P_2/P_1 will lower firm output while raising total output in industry 2, as can be seen from the third column in Table 1. Consequently, q_{2H} is decreasing in P_{2H} and therefore negatively sloped in quadrant I. An increase in P_1 will raise q_{2H}, requiring a fall in P_{2H} to restore equilibrium. Therefore, E_2 in quadrant IV, is negatively sloped as well.[2]

The market for good 1 is diagrammed identically to the capital intensive case, however the interpretation is slightly different. An increase in P_{2H} will now reduce industry 1 output in the home country, increase industry 2 output in the home country, but reduce firm output in industry 2.

An increase in the home country tariff from t to t' increases total demand for a representative firm in industry 2 in quadrant I, requiring an

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[2]If q_{2H} is steeper than D^*_{2H}, then E_2 will be positively sloped. In this case the tariff will reverse our results if E_2 is steeper than E_1. Therefore, the usual regularity assumptions are adopted.

increase in P_{2H} to restore equilibrium in the market for good 2. This corresponds to a rightward shift in E_2 in quadrant IV.

As in the capital intensive case, P_1/P_{2F}, P_{2H}/P_{2F}, and P_{2H}/P_1 all increase as a result of the tariff, implying an improvement in the terms of trade for the home country. However, according to Table 1, this change in relative prices implies that the utilization rate in the home country is now falling while the utilization rate in the foreign country is rising.

The case in which industry 2 is capital intensive based on total inputs but labor intensive based on variable inputs is the only one in which a tariff lowers firm output in both countries. The mixed factor intensity case is diagrammed in Figure 3. Here, the distinguishing feature is that an increase in P_2/P_1 will lower both firm and industry output sector 2 and raise industry 1 output. Consequently, the market for industry 2 is diagrammed as in the labor intensive case, but now the supply of industry 1 is decreasing in P_1. Moreover, an increase in P_{2H} will also increase industry 1 output. Therefore, Q_1^* in quadrant III is negatively sloped, as is E_1 in quadrant IV.

A tariff increase in the home country from t to t', will shift E_2 to the right. In the new equilibrium P_1/P_{2F} falls, P_{2H}/P_{2F} rises, and P_1/P_{2H} falls. According to Table 1, the rise in the price of good 2 relative to the price of good 1 in both countries implies that firm output in industry 2 must be falling in both countries. Therefore, this is the only case in which tariff liberalization will allow for the mutual realization of economies of scale. Note also that the increase in the price of good 2 implies that total output of industry 2 is *contracting* and industry 1 is *expanding* in the home country.

The terms-of-trade implications of the tariff are ambiguous. As before, the home country's terms of trade within industry 2 improve. If the home

country is also a net exporter of good 2 and an importer of good 1 then the decline in P_1/P_{2H} also constitutes an improvement in the home country's terms of trade. However, if the home country is a net importer of good 2 and an exporter of good 1 then the decline in P_1/P_{2F} implies a deterioration in the inter-industry terms of trade.

IV. General Equilibrium with Variable Elasticity of Demand

Results presented above will be confounded by changes in the firm's perceived elasticity of demand. The elasticity of demand facing a representative domestic firm for sales in the domestic market can be calculated from the demand system to be

$$\eta_H = \sigma + \frac{(1-\sigma)\ P_{2H}^{1-\sigma}}{n_{2H}\ P_{2H}^{1-\sigma} + n_{2F}\ [P_{2F}(1+t)]^{1-\sigma}} \tag{13a}$$

and the elasticity of demand facing a representative foreign firm for sales to the domestic market is

$$\eta_F = \sigma + \frac{(1-\sigma)\ [P_{2F}(1+t)]^{1-\sigma}}{n_{2H}\ P_{2H}^{1-\sigma} + n_{2F}[P_{2F}(1+t)]^{1-\sigma}}. \tag{13b}$$

Similar equations apply for firms selling in the foreign market. The elasticity of demand for home country sales to the foreign market and foreign sales to the foreign market can be found by setting t=0 in equations (13a) and (13b), respectively.

Note that a representative domestic firm's perceived elasticity of demand for both national markets, $\eta_H^*(P_{2H}, P_{2F}, t)$, is increasing in P_{2H}, decreasing in

P_{2F}, and decreasing in t.[3] An increase in the landed price of imports reduces the competition perceived by home country suppliers in the domestic market and an increase in the price of foreign goods in the foreign market reduces the competition perceived by home country suppliers for their exports. These price and tariff changes have the opposite effect on the foreign supplier. The perceived elasticity of demand for a representative foreign firm, $\eta_F^*(P_{2H}, P_{2F}, t)$, is decreasing in the price of the home good, increasing the price of the foreign good, and increasing in t.

Under the conditions described below, the relative price effects of a tariff discussed in section III will carry over to the variable elasticity of demand case. General equilibrium for the case in which industry 2 is capital intensive and firms accurately perceive the elasticity of demand as variable is depicted in Figure 4, where P_{2F} has again been chosen as the numeraire. The first quadrant determines equilibrium firm output and price for a representative domestic producer in industry 2. $q_{2H}(P_{2H}; P_1, t)$ is the set of combinations of firm output and price in industry 2 which satisfy the supply side conditions in the home country: profit maximization, zero profits, and factor market equilibrium. q_{2H} is increasing in P_{2H} for two reasons. First, as can be seen from Table 1, the direct effect of an increase in P_{2H} is positive. Second, an increase in P_{2H} will raise a domestic firm's perceived elasticity of demand, which in turn will raise firm output.

Total demand for a representative domestic firm in industry 2 is given by

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[3]Here we have not taken into account the change in the number of firms on the firm's perceived elasticity of demand. An increase in t, a fall in P_{2H}, or an increase in P_{2F} will all raise η_H^*, raising the number of firms at home, while lowering η_F^*, lowering the number of foreign firms. As a result, the total number of competitors is unlikely to change, leaving the firm's perceived elasticity of demand unaffected. Therefore, this channel is ignored.

D^*_{2H} and is decreasing in P_{2H}. According to equation (12a), P_{2H} will reduce D^*_{2H} both directly and by changing the number of domestic firms. An increase in P_{2H} will increase the number of domestic firms necessary for supply side equilibrium, which will lower the market share of each individual firm.[4] (In addition, an increase in P_{2H} raises the domestic producer's demand elasticity thereby raising the number of domestic firms, while lowering the foreign producer's demand elasticity thereby lowering the number of foreign firms. On balance, the market share of an individual domestic firm is unlikely to be altered importantly through the elasticity channel, and so is ignored here and in future occurrences.)

All combinations of P_{2H} and P_1 which maintain equilibrium for a representative domestic firm in industry 2 are depicted in quadrant IV by $E_2(t)$. According to Table 1, an increase in P_1 to P_1' will reduce q_{2H}, shifting q_{2H} in quadrant I down. An increase in P_1 will also raise the demand for good 2 by reducing the number of domestic and foreign firms.[5] Therefore, an increase in P_1 requires an increase in P_{2H} in order to maintain equilibrium in the market for a representative variety of good 2, so that E_2 is positively sloped.

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[4]As can be seen from Table 1, it is unclear how a change in P_{2H} will affect the number of domestic firms. As discussed in the text, the increase in P_{2H} requires a fall in w/r and an increase in q_{2H} to satisfy the zero-profit and maximum-profit conditions. The fall in w/r will create an excess demand for labor. According to the Rybczynski theorem, a shift in resources toward production of the capital intensive good (good 2) is required. However, the increase in q_{2H} has an ambiguous impact on the factor markets. If $a_{K2}/a_{L2}>K/L$ then the increase in q_{2H} creates a relative excess demand for capital, requiring a shift in resources away from the production of the capital intensive good (good 2). If the elasticity of substitution between capital and labor is large enough (specifically, if $\tilde{\sigma}_2>M$) then the factor-price effect will dominate and the number of firms in industry 2 will rise.

[5]See footnote 4.

A tariff increase by the home country on imports of good 2 from t to t' will affect E_2 first by lowering the domestic firm's perceived elasticity of demand, thereby lowering firm output. On the demand side, a tariff will shift demand toward domestic firms so that P_{2H} must rise.[6] Thus, a tariff increase will shift E_2 to the right.

Equilibrium in the market for good 1 is depicted in quadrant III of Figure 4. Total demand for good 1, D_1^*, is decreasing in P_1. Demand for good 1 is independent of other prices and the tariff since the upper level of the utility function has been chosen to be Cobb-Douglas. Total supply of good 1, $Q_1^*(P_1;P_{2H})$, is increasing in P_1.

All combinations of P_{2H} and P_1 which maintain equilibrium in the market for good 1 are depicted in quadrant IV by E_1. P_{2H} has two effects on the supply of good 1. From Table 1, the direct effect of an increase in P_{2H} reduces Q_1. An increase in P_{2H} will also raise the perceived elasticity of demand for domestic firms in industry 2 but lower the perceived elasticity of demand for foreign firms in industry 2. Thus, output by industry 1 at home will tend to fall while output by industry 1 in the foreign country will rise. Here, we will assume that, overall, industry output falls when P_{2H} rises, requiring an increase in P_1 to maintain equilibrium in the market for good 1. Therefore, E_1 is positively sloped, as well. E_1 has been drawn more steeply than E_2 in Figure 4. However, this choice makes no difference for the following analysis.

A change in the tariff will have an ambiguous effect on the supply of

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[6]The tariff will also lower a domestic firm's perceived elasticity of demand, lowering the number of domestic firms, but raise the perceived elasticity of demand for foreign firms, raising the number of foreign firms. These two effects have an ambiguous impact on the total number of firms and therefore an ambiguous impact on the market share of an individual firm.

good 1. The tariff lowers the perceived elasticity of demand of domestic firms raising industry 1 output, but raises the perceived elasticity of foreign firms, lowering output of good 1. We will assume here that the increase in output in the home country will be balanced by a fall in output in the foreign country, so that Q_1^* is not affected by the tariff. Therefore, the position of E_1 in quadrant IV is not affected by the tariff.

Overall, the tariff imposed by the home country will shift equilibrium in quadrant IV from point A to point B. It is immediately apparent that P_1/P_{2F} and P_{2H}/P_{2F} will rise. It can also be determined from quadrant III that P_{2H}/P_1 will also rise.[7]

The labor intensive case is analyzed in Figure 5. This case differs from the capital-intensive case only with respect to the shape of q_{2H} in the first quadrant. This schedule may be positively or negatively sloped. According to Table 1, an increase in P_{2H} will lower firm output if industry 2 is relatively labor intensive. However, an increase in P_{2H} will also raise the domestic firm's perceived elasticity of demand, increasing firm output. Consequently, E_2 could be positively or negatively sloped. This distinction, however, makes no difference for the determination of equilibrium prices. A tariff increase will shift E_2 to the right in either case.

It is clear from quadrant IV of Figure 5 that the tariff will again increase P_1/P_{2F}, P_{2H}/P_{2F}, and P_{2H}/P_1. The tariff and terms-of-trade effects will have the same impact on firm output as for the capital-intensive case.

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[7]Recall that the movement from A to B in quadrant IV corresponds to the right-ward shift of Q_1^* in quadrant III. The adjustment in the market for good 1 involved a fall in industry 1 output in the home country as the result of an increase in P_{2H}/P_1, a fall in demand for good 1 as the result of an increase in P_1, and an increase in industry 1 output in the foreign country as the result of an increase in P_1.

However, the change in domestic relative prices will not. The increase in P_1/P_{2F} will raise firm output in the foreign country, while the increase in P_{2H}/P_1 will lower firm output in the home country.

There are three channels through which these relative price changes affect firm output: the *domestic relative price* effect, the *tariff* effect, and the *terms of trade* effect. Results for each factor intensity ranking are summarized in Table 2. In each case the change in relative prices and the direction of each of the three effects on firm output in industry 2 are reported.

Consider first the capital intensive case. If the firm is perceiving a constant elasticity of demand, the increase in P_{2H}/P_1 will increase both industry output and firm output in industry 2, while lowering industry 1 output in the home country. On the other hand, for the foreign country, the increase in P_1/P_{2F} will lower industry and firm output in industry 2 and increase industry 1 output. Thus, the tariff leads to rationalization in the home country but de-rationalization in the foreign country.

However, this will not necessarily be the case if the firm's perceived elasticity of demand also changes. The tariff effect raises the price of imports relative to the home good in the home country market which lowers the domestic firm's perceived elasticity of demand. The tariff, then, reduces the market power of foreign producers in the home country market, and thus has an *anti-competitive* effect on domestic producers, causing firm output to fall.

The tariff has the opposite effect on foreign producers. An increase in the home country's tariff raises the elasticity of demand for imports in the home country as perceived by foreign exporters. Thus, the tariff has a *pro-competitive* effect on foreign suppliers, increasing output per firm.

Changes in the terms of trade work against the tariff effect on the firm's perceived elasticity of demand. The increase in P_{2H}/P_{2F} raises the elasticity of demand for domestic firms on their exports but lowers the elasticity of demand for foreign firms on their sales in their own market. Therefore, the terms-of-trade effect of the tariff will stimulate rationalization in the home country but lead to a fall in output per firm in the partner country.

In the labor intensive case the change in relative prices is identical to that of the capital intensive case. As a result, the terms of trade and the tariff effects have the same implications for firm output as previously. However, the domestic relative price effect works to reduce domestic firm output and increase foreign firm output.

V. Conclusions

This paper has explored theoretically the general equilibrium determinants of firm output in a monopolistically competitive industry and has found that the capacity utilization rate depends on relative domestic prices, the terms of trade, tariffs, and the factor-intensity ranking of industries. On the production side, a corollary of the Stolper-Samuelson Theorem was used to determine that an increase in the price of the monopolistically competitive good, relative to other goods in the economy, will raise the utilization rate if the monopolistically competitive industry is capital intensive ranked according to its variable factor inputs, but lower the utilization rate if labor intensive ranked according to its variable factor inputs. A tariff will generally raise the relative price of the monopolistically competitive good in the home country relative to the competitive good, while having the opposite

effect on the partner. Therefore, firm output will rise(fall) in the home country and fall(rise) in the partner country if the monopolistically competitive industry is unambiguously capital(labor) intensive.

Firm output falls in both countries as a result of the tariff only if the monopolistically competitive industry is labor intensive when ranked according to its variable inputs but capital intensive ranked according to total inputs. In this case, the relative price of the monopolistically competitive good rises in both countries and firm output falls. This case is also marked by the fact that output of the protected industry declines, while output of the unprotected industry expands.

On the demand side, a tariff, which raises the landed price of imports in the home country, is anti-competitive for domestic firms and pro-competitive for foreign firms, altering each firm's perceived elasticity of demand. As a result, firm output will fall in the home country and rise in the foreign country if and only if an industry's factor intensity ranking based on variable inputs agrees with the factor intensity ranking based on total inputs. On the other hand, the tariff will improve the intra-industry terms of trade for the home country, thus raising the landed price of imports in the foreign country as well. Therefore, the terms-of-trade effect works against the tariff effect in determining firm output.

The likely rationalization effects of the U.S.-Canada FTA can be considered in light of the theoretical results presented here. On the demand side, Canada's relatively deep tariff reductions will be pro-competitive for Canadian firms and anti-competitive for U.S. firms, stimulating rationalization in Canada but not the United States. Tariff reductions by the United States on Canadian exports, however will be anti-competitive for

Canadian firms, lowering firm output. Canada's terms of trade are also likely to deteriorate, further lowering firm output in Canada. On the production side, changes in the price of capital will play a role in determining the utilization rate. If the return to capital rises, then firm output is likely to rise as well.

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TABLE 1

EFFECT OF RELATIVE PRICE AND ELASTICITY ON
RESOURCE ALLOCATION AND FACTOR PRICES

	Industry 2 K Intensive $\theta > 0$ $\theta_v > 0$		Industry 2 L Intensive $\theta < 0$ $\theta_v < 0$		Industry 2 K Intensive Total L Intensive Variable $\theta > 0$ $\theta_v < 0$	
	P_2/P_1	η	P_2/P_1	η	P_2/P_1	η
w/r	-	-	+	+	+	+
n_2	?	?	+	?	-	-
q_2	+	+	-	+	-	-
Q_2	+	+	+	?	-	-
Q_1	-	-	-	?	+	+

TABLE 2

CHANGE IN RELATIVE PRICE AND FIRM OUTPUT IN INDUSTRY 2
DUE TO A TARIFF INCREASE BY THE HOME COUNTRY ON IMPORTS OF GOOD 2

	Industry 2 K Intensive	Industry 2 L Intensive	Industry 2* K Intensive Total L Intensive Variable
Relative Prices:			
P_{2H}/P_{2F}	+	+	+
P_{2H}/P_1	+	+	+
P_{2F}/P_1	-	-	+
Firm Output: Home (q_{2H})			
Domestic Price Effect	+	-	-
Terms of Trade Effect	+	+	-
Tariff Effect	-	-	+
Firm Output: Foreign (q_{2F})			
Domestic Price Effect	-	+	-
Terms of Trade Effect	-	-	+
Tariff Effect	+	+	-

*The change in relative prices and the domestic price effect are determined under the assumption that firm's behave as if the demand schedule has constant price elasticity.

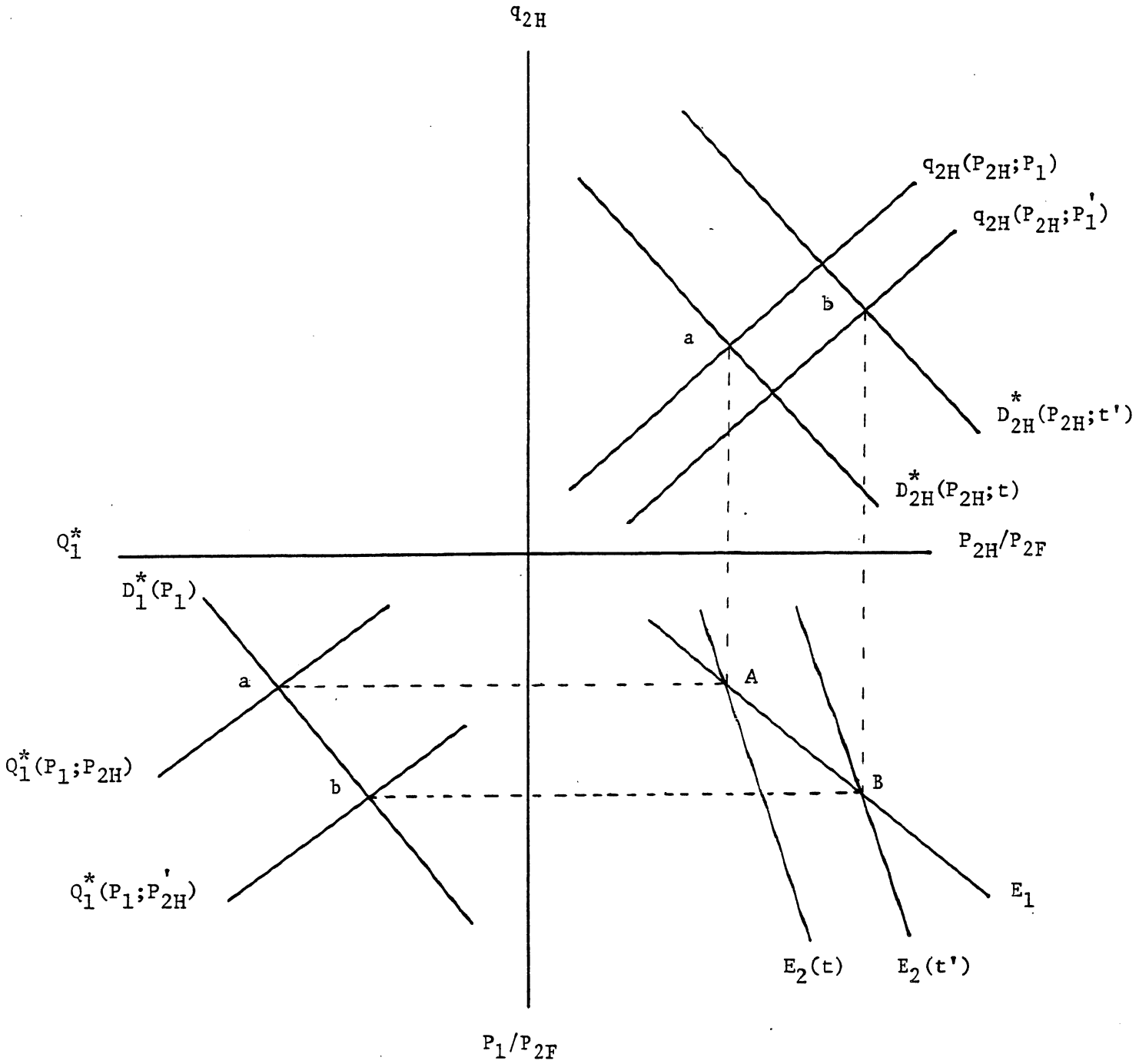
q_{2H}
$q_{2H}(P_{2H};P_1)$
$q_{2H}(P_{2H};P_1')$
b
a
$D^*_{2H}(P_{2H};t')$
$D^*_{2H}(P_{2H};t)$
Q_1^*
P_{2H}/P_{2F}
$D_1^*(P_1)$
a
A
$Q_1^*(P_1;P_{2H})$
b
B
$Q_1^*(P_1;P_{2H}')$
E_1
$E_2(t)$
$E_2(t')$
P_1/P_{2F}

Figure 1

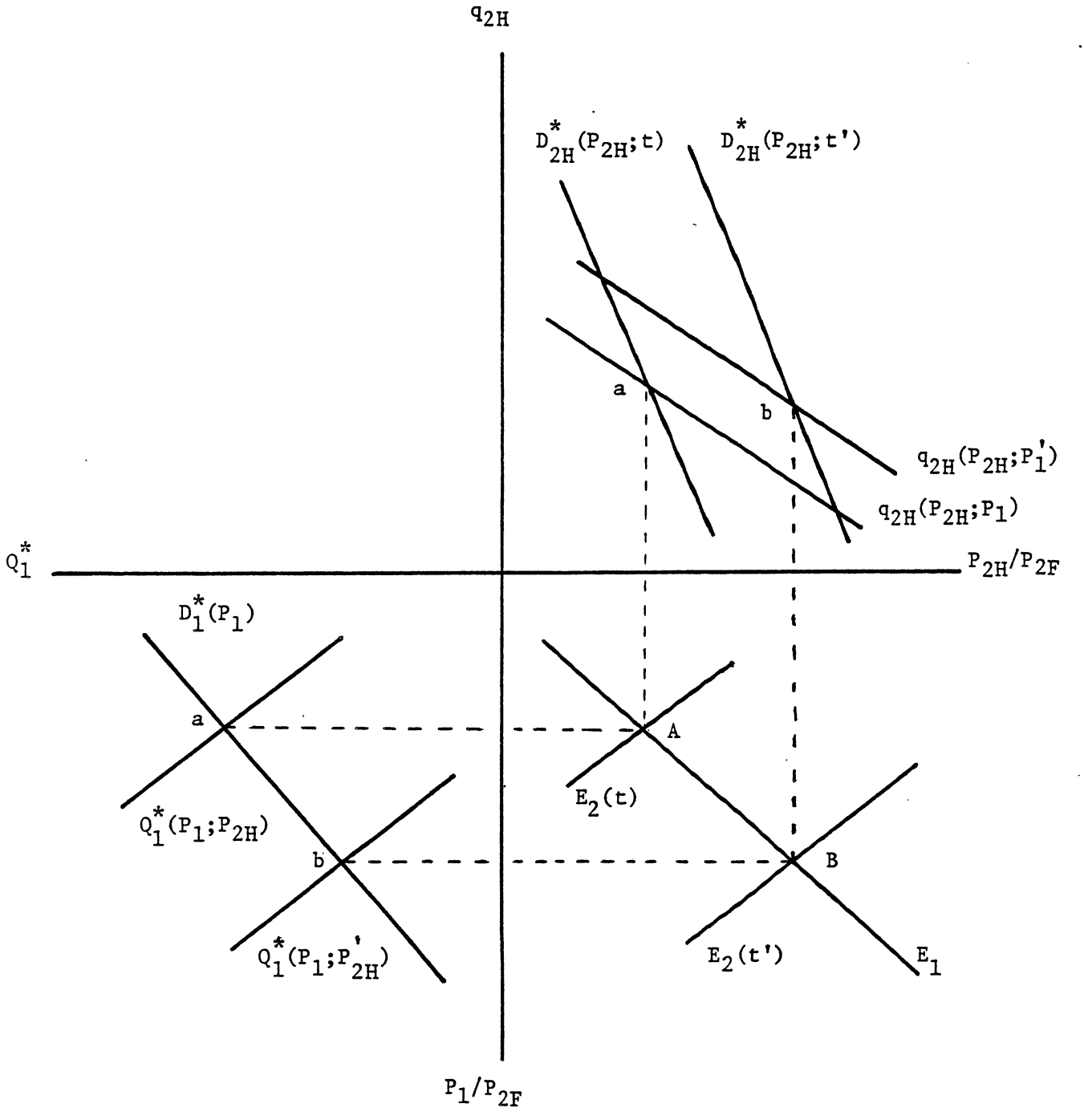
q_{2H}
$D^*_{2H}(P_{2H};t)$
$D^*_{2H}(P_{2H};t')$
a
b
$q_{2H}(P_{2H};P_1')$
$q_{2H}(P_{2H};P_1)$
Q_1^*
P_{2H}/P_{2F}
$D_1^*(P_1)$
a
A
$E_2(t)$
$Q_1^*(P_1;P_{2H})$
b
B
$Q_1^*(P_1;P'_{2H})$
$E_2(t')$
E_1
P_1/P_{2F}

Figure 2

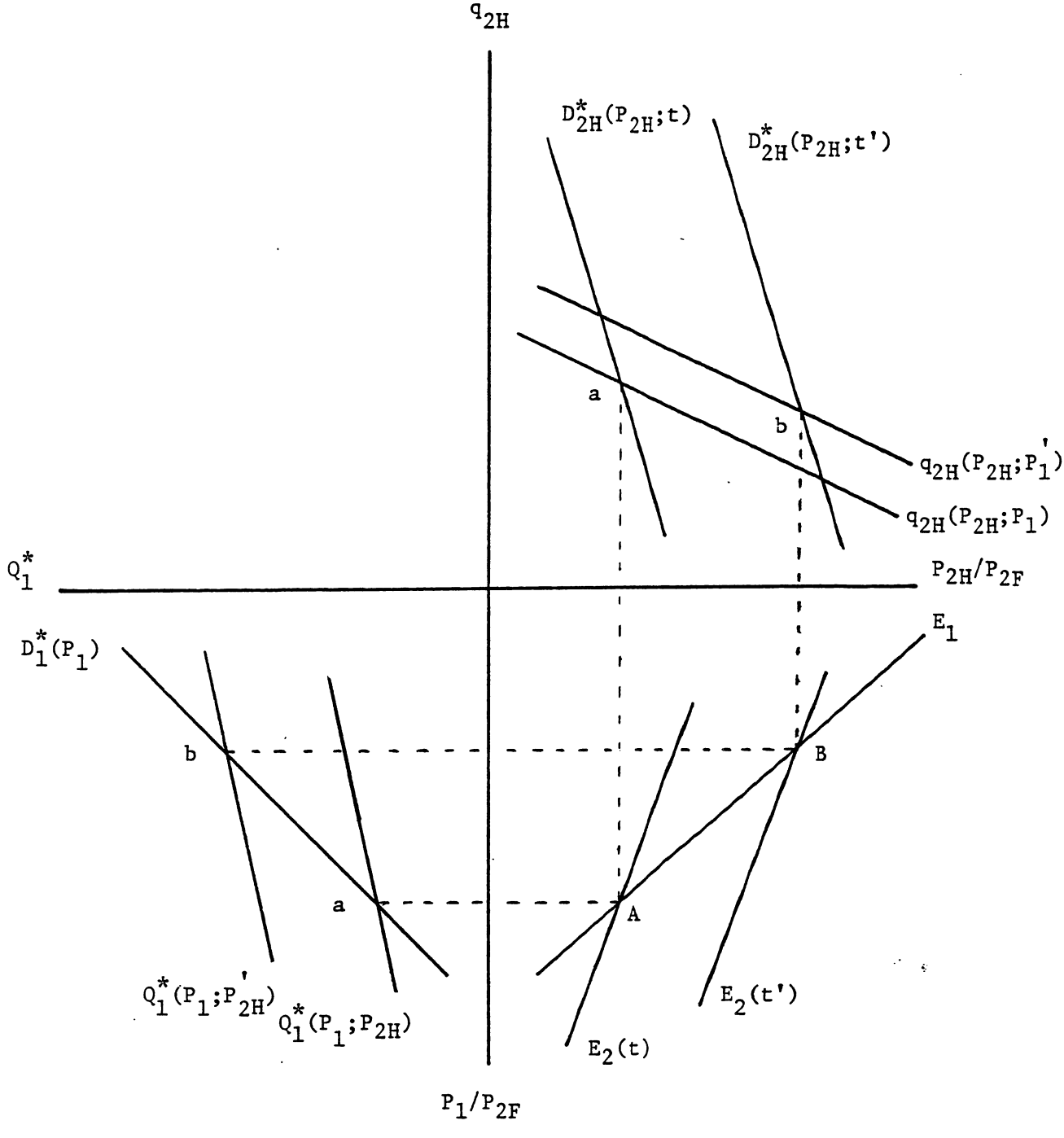
q_{2H}
$D^*_{2H}(P_{2H};t)$
$D^*_{2H}(P_{2H};t')$
a
b
$q_{2H}(P_{2H};P_1')$
$q_{2H}(P_{2H};P_1)$
Q_1^*
P_{2H}/P_{2F}
E_1
$D_1^*(P_1)$
b
B
a
A
$Q_1^*(P_1;P_{2H}')$
$Q_1^*(P_1;P_{2H})$
$E_2(t')$
$E_2(t)$
P_1/P_{2F}

Figure 3

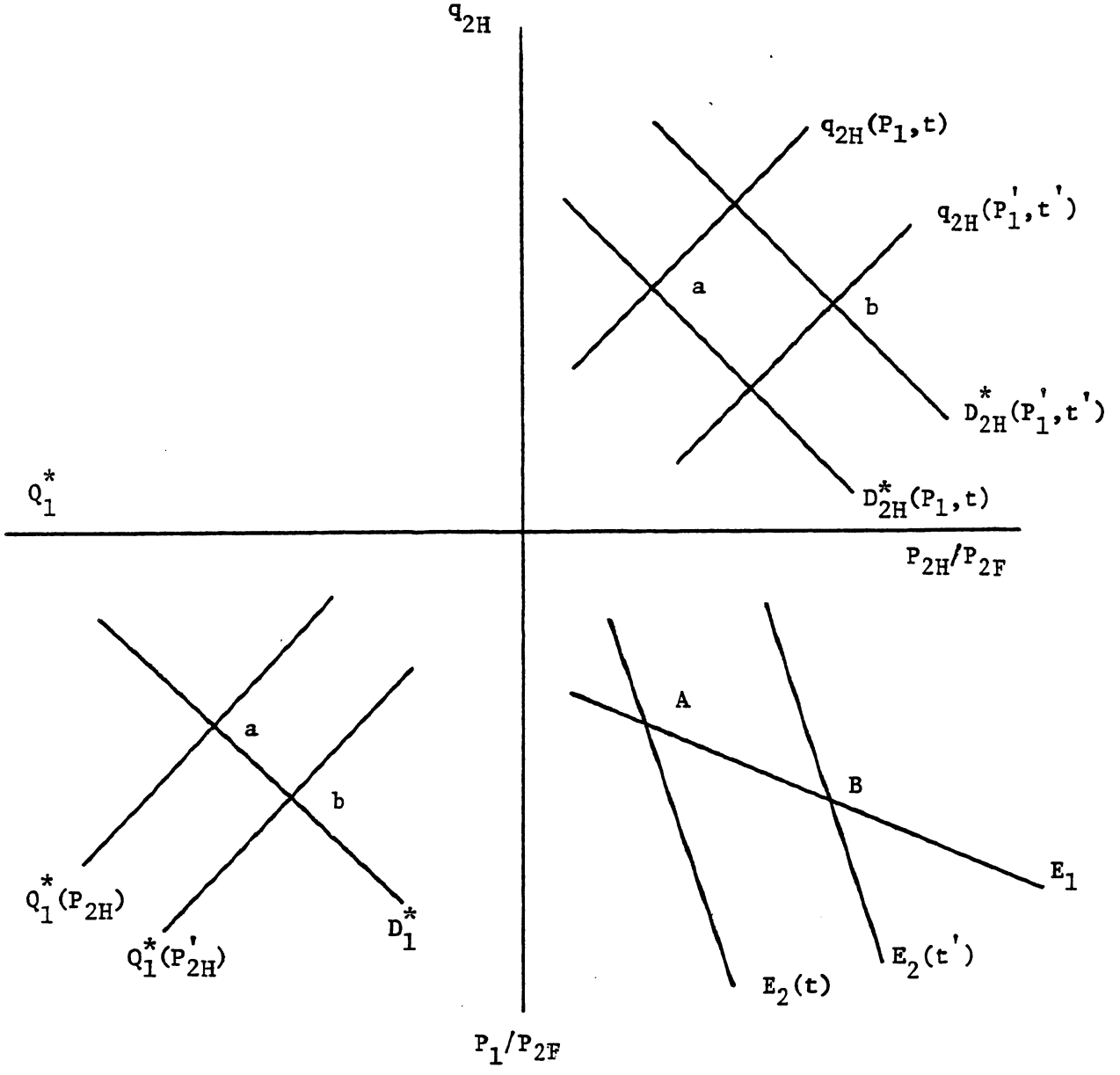
q_{2H}
$q_{2H}(P_1,t)$
$q_{2H}(P_1',t')$
a
b
$D^*_{2H}(P_1',t')$
$D^*_{2H}(P_1,t)$
Q_1^*
P_{2H}/P_{2F}
a
b
$Q_1^*(P_{2H})$
$Q_1^*(P_{2H}')$
D_1^*
A
B
E_1
$E_2(t')$
$E_2(t)$
P_1/P_{2F}

Figure 4

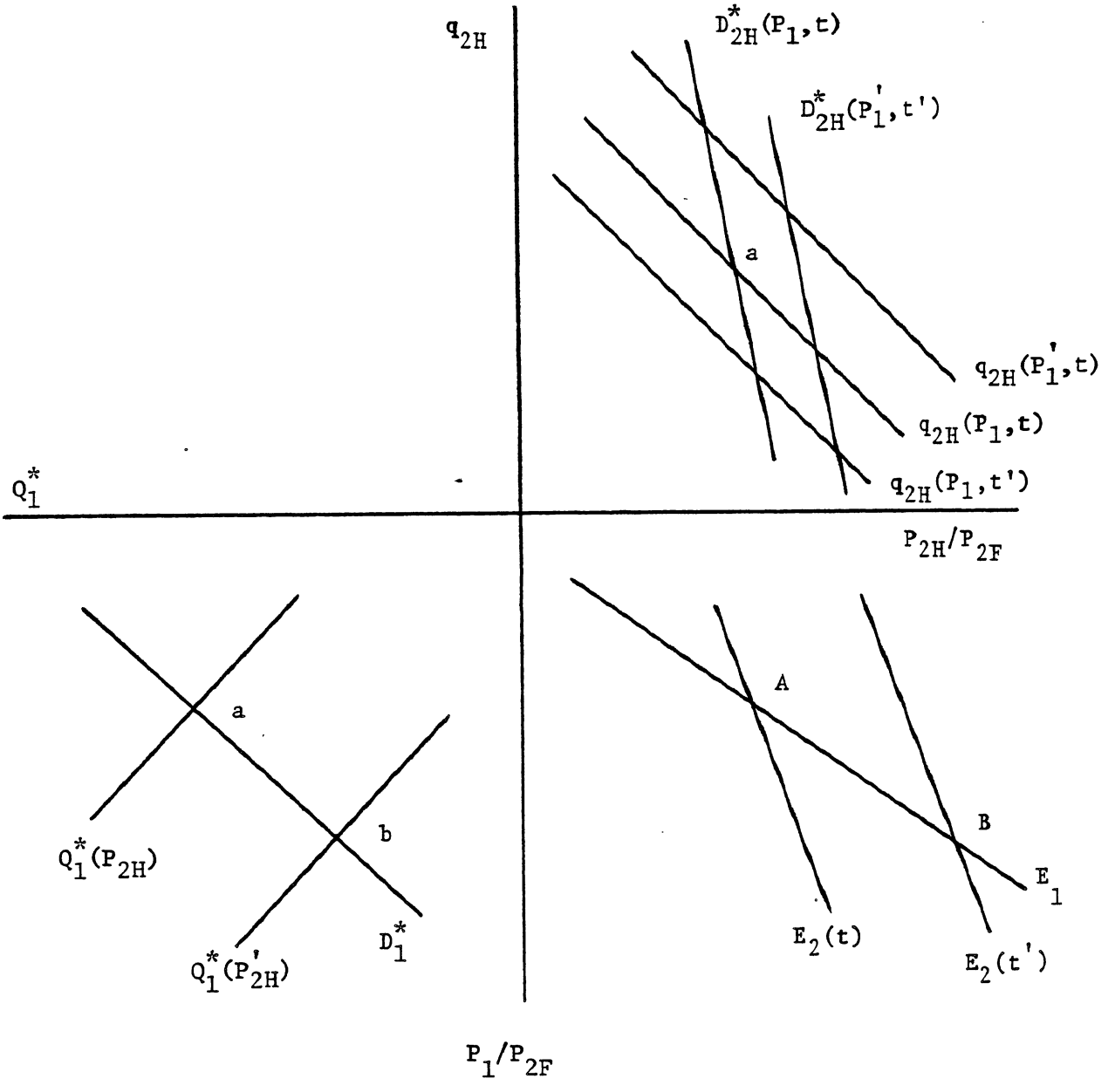
q_{2H}
$D^*_{2H}(P_1,t)$
$D^*_{2H}(P_1',t')$
a
$q_{2H}(P_1',t)$
$q_{2H}(P_1,t)$
$q_{2H}(P_1,t')$
Q_1^*
P_{2H}/P_{2F}
a
b
$Q_1^*(P_{2H})$
$Q_1^*(P_{2H}')$
D_1^*
A
B
E_1
$E_2(t)$
$E_2(t')$
P_1/P_{2F}

Figure 5