MULTINATIONALS AND TRANSFER PRICING

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I. Introduction

In this paper the 'transfer price' is defined as the price that applies to intra-firm trade in tangible goods between affiliates of a multinational enterprise (MNE). Because the affiliates are related, the transfer price is an internal price to the MNE, serving to allocate profits between exporting and importing firms. In the absence of tariffs or corporate profit tax differentials constraining the MNE, Hirshleifer (1956) proved that the efficient or shadow transfer price should be marginal cost of the selling division. If a perfectly competitive outside market exists and there are no costs of transacting in this market, the MNE should set the shadow transfer price equal to market price. The shadow price is efficient in the sense that it induces a resource allocation between the divisions of the MNE that maximizes global MNE profits. Hirshleifer (1957) proved that this shadow transfer price is also the decentralized or arm's-length transfer price that would be chosen if the individual divisions of the MNE were run as profit centres and were required to maximize their separate profits.

However, when the MNE is constrained by tariffs and corporate profit tax differentials, the transfer price that maximizes global profits net of taxes and tariffs — the external or profit-maximizing price — in general differs from the Hirshleifer shadow/decentralized transfer price. This was first proved in seminal papers by Horst (1971) and Copithorne (1971). Motivated by these two articles, a growing literature has developed over the past twelve years which models MNE behaviour when transfer prices are constrained by tax and tariff authorities. These partial equilibrium microeconomic models assume the MNE chooses transfer prices and resource levels so as to maximize global profits net of taxes and tariffs. The articles model either horizontally integrated trade in secondary processed goods (following Horst) or vertically integrated trade in primary processed goods (following Copithorne). The research to date has determined profit-maximizing transfer prices and resource allocation decisions for given corporate profit tax, tariff and exchange rates. The comparative static effects of changes in these rates, and optimal commercial policies for intra-firm trade, have also been investigated. The first task we undertake in this paper is to review and synthesize the transfer pricing literature based on Horst (1971) and Copithorne (1971).

The second purpose of our paper is to develop a model that encompasses and extends the Horst-Copithorne literature. The major extensions we develop are:

(1) horizontally and vertically integrated trade are simultaneously modelled;
(2) the implications of setting the profit-maximizing transfer price above, below or equal to the shadow transfer price for the comparative static effects of changes in corporate tax, tariff and exchange rates are determined;
(3) the welfare effects of tariffs on intra-firm trade are examined; and
(4) the efficiency of transfer price manipulation in response to tariffs and corporate profits tax differentials is addressed; i.e. we determine which transfer price, Hirshleifer shadow/decentralized or Horst/Copithorne profit-maximizing, generates an allocation of resources closest to that generated by the MNE in the absence of tax and tariff constraints.

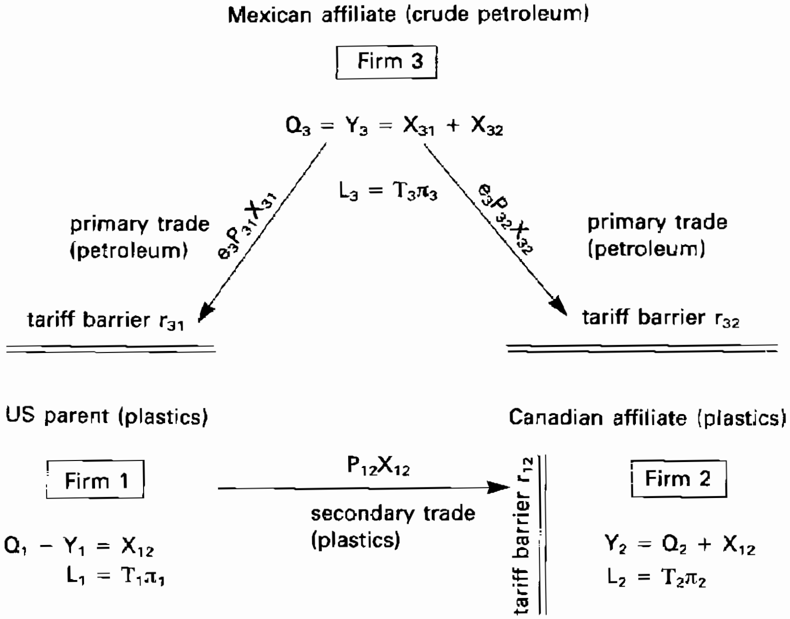
Lastly, section IV concludes the paper by briefly outlining possible directions for future transfer pricing research.

To facilitate comparison among the various transfer pricing models, we use one set of symbols and the same general assumptions throughout the paper. We assume firm 1 is the parent firm located in the home country, country 1, and firms 2 and 3 are subsidiaries located in host countries 2 and 3, respectively. Firm 3 produces a primary product for sale to the two secondary firms, 1 and 2, which process the primary good into a final product for sale in their local markets. The secondary firms are assumed to face downward-sloping demand curves and the MNE can price discriminate between these markets. Firms 1 and 2 can also engage in intra-firm trade where, for simplicity, we assume exports flow from firm 1 to firm 2. Exports from firm 3 to firms 1 and 2, therefore, involve vertically integrated trade while trade between firms 1 and 2 is horizontally integrated. We assume one unit of primary output is required per unit of final output. The following symbols and assumptions are used throughout (where $i, j = 1, 2, 3$ and $i \neq j$):

Q_i = volume of output produced by firm i;
Y_i = volume of domestic sales by firm i;
X_{ij} = volume of exports from firm i to firm j;
P_{ij} = the profit-maximizing transfer price firm i charges firm j per unit of X_{ij};
λ = the shadow transfer price per unit of X_{ij};
C_i = total cost of producing Q_i where $C_i = C_i(Q_i)$, $\partial C_i/\partial Q_i = MC_i > 0$, $\partial^2 C_i/\partial Q_i^2 = MC_i' \gtreqless 0$;
R_i = total revenue from sales of Y_i where $R_i = R_i(Y_i)$, $\partial R_i/\partial Y_i = MR_i$, $R_i/Y_i = P_i$, $\partial^2 R_i/\partial Y_i^2 = MR_i' < 0$; and $\varepsilon_i = \partial Y_i/Y_i \cdot P_i/\partial P_i$;
r_{ij} = *ad valorem* tariff rate levied by country j on X_{ij};
t_i = proportional corporate profit tax levied by country i;
b_i = proportion of firm i's profits, net of corporate taxes, remitted as dividends to firm 1 where $0 \leq b_i \leq 1$ $(i = 2,3)$;
e_i = country i's exchange rate measured in terms of country 1's currency (where $e_1 = 1$);
π_i = profits received by firm i after tariffs but before taxes;
T_i = proportion of π_i that is left for firm i after profit taxes are paid, i.e. the after tax return per dollar of π_i where $0 \leq T_i \leq 1$;[1]
Y = $(T_i - T_j)/T_j$, the profit tax differential between the exporter, firm i, and the importer, firm j;
L_i = $e_i T_i \pi_i$ = after tax or net profits of firm i; and
L = $\Sigma e_i T_i \pi_i$ = global net profits of the MNE.

The relationships between the three divisions of the MNE are illustrated in Figure 2.1. As a heuristic example we assume the Mexican affiliate, firm 3, produces and sells crude petroleum to the US and Canadian affiliates, firms 1 and 2, which process it into plastics for their domestic markets. The US affiliate exports its surplus plastics to the Canadian firm. The vertically integrated

Figure 2.1: A Heuristic Example of MNE Intra-firm Trade Flows



trade flows are $e_3P_{31}X_{31}$ and $e_3P_{32}X_{32}$, while the horizontally integrated trade flow is $P_{12}X_{12}$, all measured in US dollars. We assume $X_{31} = Q_1$, $X_{32} = Q_2$ and $Q_3 = X_{31} + X_{32} = Y_3$. Also $Q_1 - Y_1 = X_{12} = Y_2 - Q_2 > 0$.

II. Review of the Transfer Pricing Literature

A. The Horst Model

The first microeconomic model of horizontally integrated MNE intra-firm trade is developed in Horst (1971). He outlines the global net profit-maximizing strategy for an MNE with monopolistic power in two national markets where the MNE chooses its optimal transfer price and allocates resources, given corporate taxes and tariffs. The analysis breaks down into four cases depending on whether $MC_i' \lesseqgtr 0$ and the MNE can or cannot price discriminate between its markets. We review only the first case where $MC_i' > 0$ and price discrimination is possible.

We set up the initial 'free trade' (i.e. no corporate profit taxes and no tariffs so $t_i = t_j = r_{ij} = 0$) situation as follows. Firms 1 and 2 produce and sell an identical final good. Firm 1 also exports its surplus production to firm 2. The MNE's global profit function under free trade is:

$$L = [R_1 - C_1 + P_{12}(Q_1 - Y_1)] + [R_2 - C_2 - P_{12}(Y_2 - Q_2)] + \lambda(Q_1 + Q_2 - Y_1 - Y_2) \quad (1)$$

where $R_i = R_i(Y_i)$, $C_i = C_i(Q_i)$ and $Q_1 - Y_1 = X_{12} = Y_2 - Q_2$ as outlined in section I. The first (second) square bracket in (1) represents the profits of the exporter (importer) firm. The Lagrange constraint forces total MNE output to equal total MNE sales. Differentiating (1) with respect to Y_i and Q_i and setting the results equal to zero, we have the first order condition for a global profit maximum under free trade:

$$MR_1 = MC_1 = MR_2 = MC_2 = \lambda \quad (2)$$

Equation (2) proves that the Hirshleifer shadow price λ should equal marginal cost of the exporting division under free trade. Let us call this shadow price λ_{12} to identify it as the shadow price of X_{12}. Note that the profit-maximizing transfer price P_{12} does not appear in (2). Under free trade P_{12} divides profits between the divisions of the MNE (i.e. it affects the distribution of MNE income among countries), but does not affect total MNE profits (i.e. it does not influence the efficient levels of output, sales and trade flows). This is illustrated in Figure 2.2 which is based on Figure I in Horst (1973).

The MR_i, MC_i and P_i curves are shown for firm 1 in Figure 2.2(a), and for firm 2 in Figure 2.2(c). Figure 2.2(b) derives the marginal cost and revenue curves for intra-firm trade in X_{12}. The marginal cost of exporting curve MC_x is the horizontal distance between the MR_1 and MC_1 curves while the marginal revenue from importing curve MR_x is the horizontal distance between the MR_2 and MC_2 curves. Where MR_x crosses MC_x (point A with trade of X_{12}^o) equation (2) is satisfied. The shadow transfer price λ_{12} is determined by this intersection and equals MC_1^o, the marginal cost of exports at Q_1^o. Reading across from A we can find Q_1^o, Y_1^o, Q_2^o and Y_2^o where $Q_1^o - Y_1^o = Y_2^o - Q_2^o = X_{12}^o$.

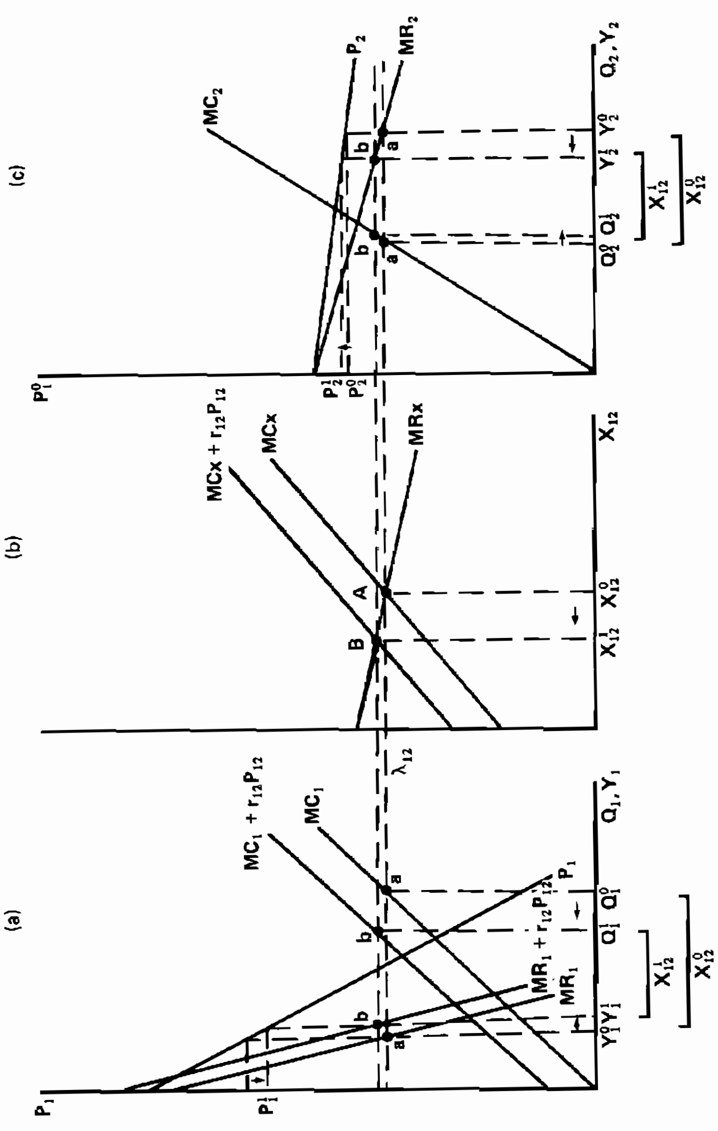


Figure 2.2: The Effects of a Tariff on Horizontally Integrated Trade (The Horst Model)

When the MNE is constrained by corporate profit taxes t_1 and t_2 and a tariff r_{12}, Horst (1971) shows that the MNE's global profit function is:

$$L = (1 - t_1)(R_1 - C_1 + P_{12}X_{12}) + (1 - t_2)(R_2 - C_2 - (1+r_{12})P_{12}X_{12}) \quad (3)$$

He then shows that the profit-maximizing transfer price P_{12} depends upon the tax differential γ (which equals $(t_2 - t_1)/(1 - t_2)$ in Horst's model) compared to the tariff rate r_{12}. Horst was the first to realize that global net profits would be larger if the MNE set a maximum (minimum) value for P_{12} whenever γ was larger (smaller) than r_{12}. Because he expected tax and tariff authorities to impose MC_1 as an effective lower bound and P_1 as an upper bound to P_{12}, he assumed $MC_1 \leq P_{12} \leq P_1$. For $\gamma < r_{12}$, the MNE then chooses $P_{12} = MC_1$ which implies 'a high-tariff policy . . . has the unfortunate side effect of rendering tax policy impotent' (Horst, 1971, p. 1068). We can see this in his first order conditions for a global profit maximum under tax and tariff barriers:

$$MR_i - MC_i = 0 \quad (i=1,2) \quad (4)$$

$$MC_2 - MC_1 - r_{12}P_{12} + \gamma(P_{12} - MC_1) = 0 \quad (5)$$

Sales in each market are determined by $MR_i = MC_i$ while intra-firm trade depends on relative marginal costs adjusted for taxes and tariffs on X_{12}. Based on (5) Horst argues that, for $\gamma < r_{12}$, the last term in (5) becomes zero so small changes in the tax differential have no effect on X_{12} while tariffs remain trade-contracting. Horst's conclusion that tax policy is impotent unfortunately generalizes too much from (5). As we show in section III, changes in γ do have predictable effects on intra-firm trade even when $\gamma < r_{ij}$ if the MNE can set P_{ij} below the shadow transfer price λ. It is true that if $P_{ij} = \lambda$ (i.e. $P_{12} = MC_1$ here), both exporting and importing firms earn zero marginal profits on X_{ij} so that tax changes have no impact on the MNE. Tax policy is actually impotent because P_{ij} equals marginal export costs, not because the tax differential is less than the tariff.

We can illustrate the impacts of the secondary tariff r_{12} on the MNE using Figure 2.2. If $\gamma = 0$, equations (4, 5) can be rewritten as:

$$MR_1 + r_{12}P_{12} = MC_1 + r_{12}P_{12} = MR_2 = MC_2 \qquad (6)$$

The secondary tariff shifts the MR_1 and MC_1 (and therefore the MC_x) curves up by $r_{12}P_{12}$. The new equilibrium is at point B with lower level of trade $X_{12}{}^1$ and a higher level of foreign production $Q_2{}^1$. Note that the profit-maximizing transfer price P_{12} should now be set as low as possible to minimize tariff costs since $\gamma = 0$.

Horst's model is incorporated as the first tier in a two-tier model of the importing country's market in Adler and Stevens (1974). In the second tier third-country imports and domestic firms compete with foreign subsidiary sales Y_2 (= $Q_2 + X_{12}$). In the first tier Adler and Stevens show the export displacement effect $dX_{12}/d\bar{Q}_2$ is negative, i.e. foreign subsidiary production displaces MNE exports. They also show that $dY_1/d\bar{Q}_2 \gtrless 0$ for $MC_1' \gtrless 0$, i.e. home country sales increase as foreign subsidiary output expands. An inspection of Figure 2.2 confirms this: decreases in X_{12} correspond with increases in Y_1 and Q_2 (and decreases in Q_1 and Y_2). Adler and Stevens then empirically test these hypotheses in the full two-tier model for the chemical and electrical engineering industries and find the displacement effect is generally confirmed.

B. The Copithorne Model

The first partial equilibrium micro model of vertically integrated MNE trade is Copithorne (1971) which models firm 3 exporting raw materials to firms 1 and 2 for processing and local sale. The global profit function of the MNE under free trade ($r_{ij} = t_i = t_j = 0$) in this model is:

$$L = [R_1 - C_1 - P_{31}X_{31}]+[R_2 - C_2 - P_{32}X_{32}]+[P_{31}X_{31} + P_{32}X_{32} - C_3] + \lambda_1(Q_1 - X_{31}) + \lambda_2(Q_2 - X_{32}) \qquad (7)$$

where $Q_i = Y_i$ and the Lagrange expressions constrain $Q_1 = X_{31}$ and $Q_2 = X_{32}$. The first order condition is:

$$MR_1 - MC_1 = MR_2 - MC_2 = MC_3 = \lambda_1 = \lambda_2 \qquad (8)$$

where $MR_i - MC_i$ equals the net marginal revenue NR_i from producing and selling Y_i. The two shadow transfer prices for primary trade should, therefore, both equal MC_3, marginal export cost. Let us identify the shadow price of X_{31} as λ_{31} and of X_{32} as λ_{32}.

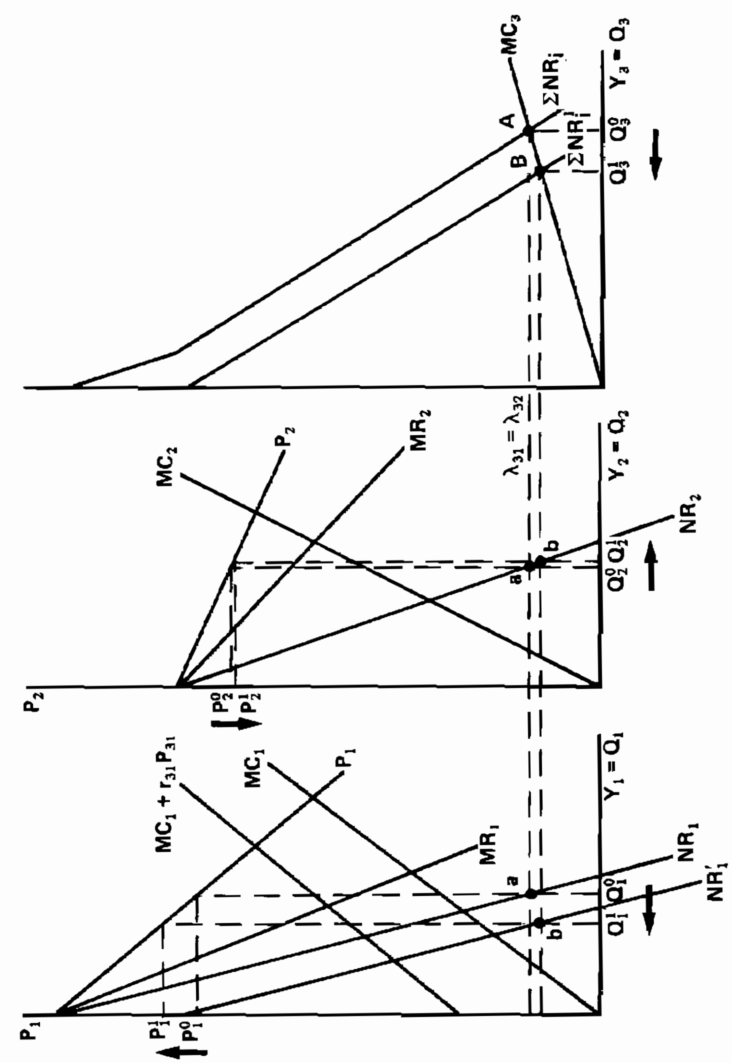


Figure 2.3: The Effects of a Tariff on Vertically Integrated Trade (The Copithorne Model)

Figure 2.3 illustrates Copithorne's model. The NR_i curve is the vertical distance between the MR_i and MC_i curves. The NR_1 and NR_2 curves are then horizontally summed as the ΣNR_i curve in the right-hand graph. The intersection of ΣNR_i and MC_3 curves at point A determines $Y_3^o = Q_3^o$. Reading back from A we find $Y_1^o = Q_1^o$ and $Y_2^o = Q_2^o$. (See also Hirshleifer, 1957, p. 104.)[2]

If country 1 levies a tariff on X_{31}, the new first order condition is:

$$MR_1 - (MC_1 + r_{31}P_{31}) = MR_2 - MC_2 = MC_3 \qquad (9)$$

The MC_1 curve shifts up by $r_{31}P_{31}$, and NR_1 curve shifts down by the same amount, and the ΣNR_i curve shifts in. The new equilibrium at point B implies the primary tariff causes lower overall MNE output, in addition to a smaller output and sales in the importing country. Note that both the Horst secondary tariff and the Copithorne primary tariff cause trade to contract. However, primary trade X_{31} is an input into domestic production Q_1 so the primary tariff is antiprotective to domestic industry, i.e. Q_1 falls in Figure 2.3 in response to r_{31}. On the other hand, secondary trade X_{12} is a substitute for domestic production Q_2 so the secondary tariff is protective to domestic industry, i.e. Q_2 rises in Figure 2.2 in response to r_{12}.

In Copithorne (1976) this model is expanded to include an entrepôt division that buys or sells the primary product on the outside market, and any number of primary and secondary firms. He discusses the interesting aberration of a 'maverick' primary firm (one with $MC_i' < 0$ at the global optimum) and shows there can be at most one such firm to avoid violation of the second order conditions. Copithorne also reviews the existing literature on shadow and decentralized transfer prices, and discusses the relationship between shadow and external transfer prices.

The first attempt to amalgamate the Horst (1971) and Copithorne (1971) models appears in Eden (1978). The Eden model is identical to Copithorne's but allows for trade between the secondary firms. The first order condition under free trade is a simple extension of (2) and (8):

$$MR_1 = MC_1 + MC_3 = MC_2 + MC_3 = MR_2 \qquad (10)$$

We can use Figure 2.4 to explain this model. The MR_1 and MR_2 curves are horizontally summed and shown in the right-hand

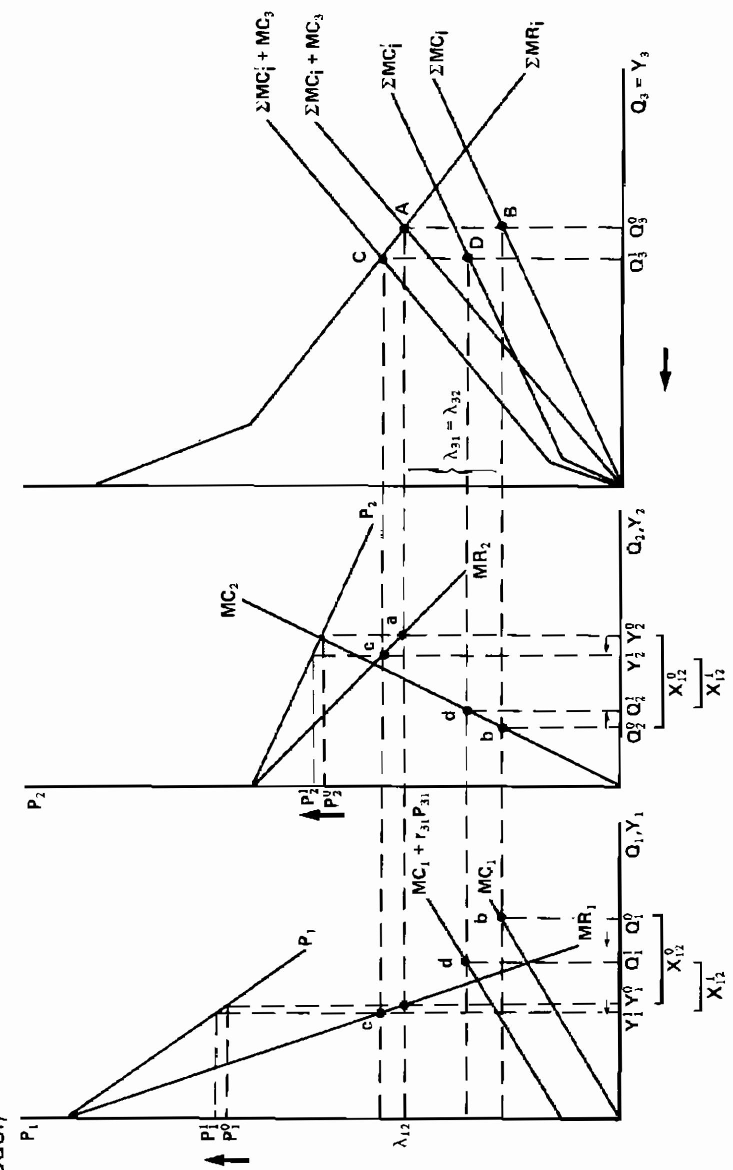


Figure 2.4: The Effects of a Primary Tariff on a Horizontally and Vertically Integrated MNE (The Eden Model)

graph as the ΣMR_i curve. Similarly the horizontal sum of the MC_1 and MC_2 curves is the ΣMC_i curve, to which the MC_3 curve (not shown) is vertically added to give the $\Sigma MC_i + MC_3$ curve. At point A, with global output of Q_3^o ($= Q_1^o + Q_{2o}$), the ΣMR_i and $\Sigma MC_i + MC_3$ curves intersect and (10) is satisfied. Reading back from A to the MR_i curves determines the level of sales in each market, while reading back from point B to the MC_i curves (the distance AB equals MC_3) determines the output of each plant. Secondary trade equals X_{12}^o ($= Q_1^o - Y_1^o = Y_2^o - Q_2^o$). The same three shadow prices exist in this model as in Copithorne (1971) and Horst (1971): two primary trade ($\lambda_{31} = \lambda_{32} = MC_3$ = distance AB in Figure 2.4) and one secondary trade ($\lambda_{12} = MR_1$ = distance AQ_3^o).

If a primary tariff is levied on firm 1's imports as in Copithorne's model (see Figure 2.3), the first order condition is similar to (9):

$$MR_1 = MC_1 + r_{31}P_{31} + MC_3 = MC_2 + MC_3 = MR_2 \qquad (11)$$

The MC_1 curve shifts up by $r_{31}P_{31}$, causing an inward shift in the ΣMC_i and $\Sigma MC_i + MC_3$ curves. The new equilibrium is at point C with a smaller amount of global output Q_3^1. Reading across from C shows that sales decline in both markets, while reading across from point D determines the new output levels. Because the primary tariff is levied on the secondary exporter, X_{12} declines. (A tariff on X_{32} causes X_{12} to expand.) The primary tariff r_{31} causes Q_1 to contract and is therefore antiprotective to the domestic industry (as in Copithorne, 1971).

If a secondary tariff is levied on X_{12}, following Horst (see Figure 2.2), the first order condition is similar to (6):

$$MR_1 + r_{12}P_{12} = MC_1 + r_{12}P_{12} + MC_3 = MR_2 = MC_2 + MC_3 \qquad (12)$$

This is illustrated in Figure 2.5 where the MR_1 and MC_1 curves shift up by $r_{12}P_{12}$, causing ΣMR_i curve to shift out and the $\Sigma MC_i + MC_3$ curve to shift in. The new equilibrium is at point C and total output Q_3 can rise or fall (see Itagaki, 1980).[3] Reading across from C to the $MR_1 + r_{12}P_{12}$ and MR_2 curves determines the new levels of sales, while reading across from point D to the $MC_1 + r_{12}P_{12}$ and MC_2 determines the new output levels. Secondary trade X_{12} declines while subsidiary output Q_2 expands

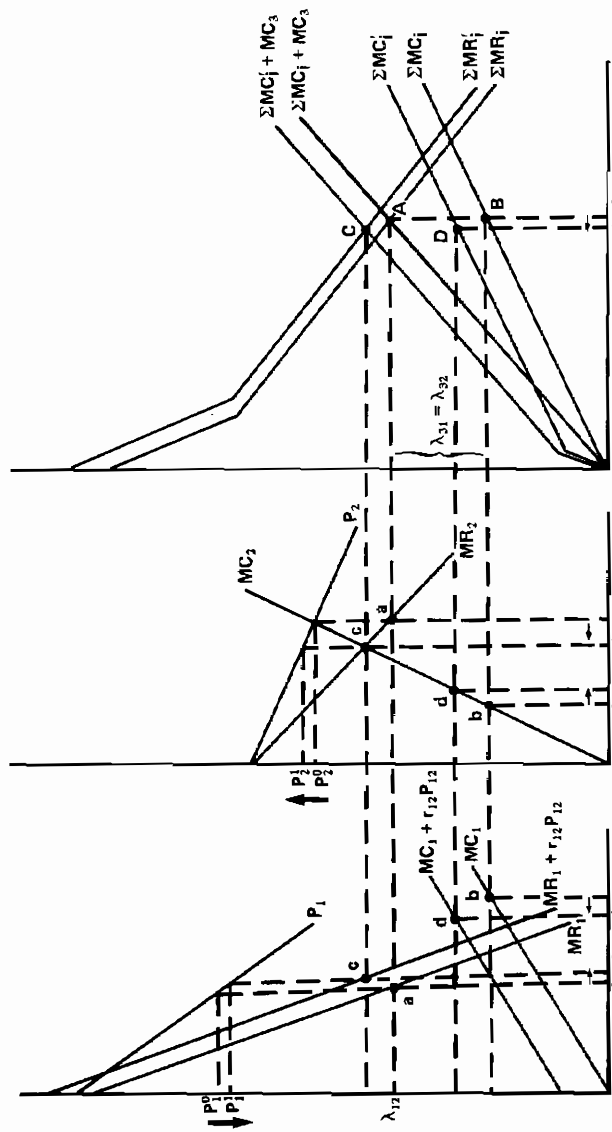


Figure 2.5: The Effects of a Secondary Tariff on a Horizontally and Vertically Integrated MNE (The Eden Model)

so the secondary tariff offers direct protection to the domestic industry (as in Horst, 1971).

Eden (1978) also investigates the effects of home and host country corporate profit taxes on the MNE. Corporate taxes have two sets of impacts: first, on the MR and MC curves (the '*ad valorem* effects'), and second, on the transfer price (the 'specific effects'). Eden shows that a high transfer price $P_{ij} > \lambda$ (a low transfer price $P_{ij} < \lambda$) implies the specific effects dominate (are dominated by) the *ad valorem* effects. If the exporter has the higher tax rate, a high (low) transfer price causes intra-firm trade to contract (expand) as the MNE attempts to shift profits to the importer. In the case where tariffs are zero, residence-branch rules apply ($b = 1$), and foreign firms have deficits of tax credits ($t_1 > t_i$, $i = 2, 3$), Eden shows that all MNE profits wherever earned are taxed at the same rate t_1. In this case changes in either t_1 or t_j fall wholly on pure profits and have no effect on MNE resource allocation decisions.

C. *Endogenous Transfer Prices*

All of the above papers assume the transfer price is fixed by the MNE at either its upper or lower bound, and does not vary with MNE output, sales or trade levels. Recently, however, two papers have recognized that transfer prices when constrained by tax and tariff authorities become endogenous variables.

Samuelson (1982) has a Horst model without foreign subsidiary production, i.e. $Q_1 = Y_1 + X_{12}$, $Q_2 = 0$ and $Y_2 = X_{12}$. He assumes P_{12} is constrained between MC_1 and P_1. If the (positive) tax differential exceeds the tariff, the MNE sets $P_{12} = P_1$. As a result, changes in Y_1 cause changes in P_{12} where $\partial P_{12}/\partial Y_1 = P_1' < 0$. The first order condition in this case is:

$$\begin{aligned} &T_1(MR_1 - MC_1) + (T_1 - T_2(1 + r_{12}))X_{12}P_1' = \\ &T_2MR_2 - T_1MC_1 + (T_1 - T_2(1 + r_{12}))P_1 = 0 \end{aligned} \tag{13}$$

Since $\gamma > r_{12}$ and $P_1' < 0$, $MR_1 - MC_1 > 0$ so that Y_1 is smaller and X_{12} is larger than in the exogenous transfer price case. On the other hand, if $\gamma < r_{12}$, the MNE sets $P_{12} = MC_1$ so that $\partial P_{12}/\partial Q_1 = MC_1' > 0$. In this case, both Y_1 and X_{12} are lower than with an exogenous transfer price. Samuelson then compares the effects of changes in r_{12} and in T_2/T_1 on Y_1 and X_{12} levels for endogenous and exogenous values of P_{12}. Generally the direction

of change is the same. However, if $P_{12} = MC_1$, in the exogenous case a change in T_2/T_1 has no effect on the MNE (as in Horst, 1971), whereas it does in the endogenous case. (See also Eden, 1976, pp. 184-5.)

Eden (1983a) extends her earlier 1978 paper to cover transfer pricing policies imposed on the MNE by tariff authorities, such as the fair market value, cost-plus, resale value and GATT transfer value methods. Eden shows that most customs valuation methods generate endogenous transfer prices because $\partial P_{ij}/\partial X_{ij} = P_{ij}' \gtrless 0$. For a given tariff rate, a $P_{ij}' > (<)\ 0$ method implies X_{ij} falls (rises) relative to an exogenous transfer price, $P_{ij}' = 0$, because the tariff wedge, $r_{ij}\ (P_{ij} + X_{ij}P_{ij}')$, is larger (smaller). She then uses the tariff wedge concept to analyze the impacts of changes in tariff rates on X_{ij}, domestic production Q_j and tariff revenues.

D. *Uncertainty*

The basic Horst and Copithorne models have recently been extended to incorporate uncertainty about exchange rates and foreign demand and cost conditions.

In the exchange rate uncertainty papers, exports are measured in the currency of the exporting country and the MNE is assumed to maximize the expected utility from global net profits. The first paper, Batra and Hadar (1979), uses the Horst model to prove that a rise in the exchange rate e_2 causes X_{12} to increase. The first order condition, assuming $r_{12} = 0$, is:

$$\begin{aligned} &T_1(MR_1 - MC_1) = e_2T_2(MR_2 - MC_2) = \\ &T_1(P_{12} - MC_1) - T_2(P_{12} - e_2MC_2) = 0 \end{aligned} \tag{14}$$

From (14) we see that devaluation of the home currency implies the cost of foreign subsidiary production rises relative to the cost of exports, causing the MNE to reduce Q_2 and expand X_{12}. Under floating exchange rates, the MNE enters the foreign exchange market and buys currency at a spot price of q_2. If $q_2 > (<)\ \bar{e}_2$, the MNE's expected exchange rate, Batra and Hadar prove that X_{12} rises (falls) relative to its level under a fixed exchange rate. They conclude that the absence of a forward market generates uncertainty, causing the MNE to reduce X_{12}.

Itagaki (1979, 1981, 1982) models the behaviour of a vertically integrated, two-firm MNE under fixed and flexible exchange rates. (In his 1982 paper horizontally integrated trade is also separately treated.) In Itagaki (1979) the comparative static effects of changes in T_1, T_3 and e_3 on the MNE are determined for a high transfer price $P_{31} > MC_3$. This is expanded in Itagaki (1981) to include uncertainty about e_3, and in Itagaki (1982) to examine the effects of repeal of deferral and the foreign tax credit. He argues (1979, p. 447) that with MNEs 'the income tax is no longer neutral in general, but has wide-spread effects' and that the size of the transfer price in relation to marginal export cost (i.e. whether P_{ij} is high or low) has a critical influence on these tax effects.

Das (1983) uses the Horst model to analyze the effects of demand or cost uncertainty in the foreign market on MNE resource allocation. He shows that cost uncertainty (i.e. C_2 includes a random term) causes Q_2 to decline while Q_1 and X_{12} increase. Demand uncertainty (i.e. R_2 includes a random term) causes Q_1, Q_2 and X_{12} to decline. He then analyzes the comparative static effects on the MNE of a change in T_2 under demand uncertainty (assuming $T_1 > T_2$ and $P_{12} > MR_1$) and of a change in r_{12} under cost uncertainty. The results are shown to depend upon the MNE's measures of absolute and partial relative risk aversion.

E. Optimal Commercial Policies

This last group of papers all model horizontally integrated MNEs although they are not directly based on Horst (1971). Katrak (1977) examines the optimal tariff or consumption tax a host country should levy on MNE intra-firm imports. If there is no foreign subsidiary production ($Q_2 = 0$), he argues an optimal commerical policy should equate the marginal utility from consumption of Y_2 ($= X_{12}$) to the marginal cost of imports. If the host country can tax profits earned on X_{12}, the optimal tariff rate is lower since a higher tariff reduces profits and therefore taxes. (See also Svedberg, 1979.)

Katrak (1980, 1981) examines optimal government policies towards exporting MNEs. His 1980 paper, which is based on Horst (1973), argues that the social optimum for the exporting country requires the MNE to allocate resources so that $P_1 = MC_1 = MR_2 = MC_2$. Since the MNE equates $MR_1 = MC_1 = MR_2 = MC_2$, its exports are too large. The optimal policy is to order the MNE to produce Q_1 where $P_1 = MC_1$ and also to levy an export tax (subsidy) on X_{12} equating $P_1 = MR_2 = MC_2$ when MC_1' is positive (negative).

Katrak (1981) determines the revenue-maximizing export tax for given profit tax rates. His basic result is similar to his 1977 optimal import tariff result, i.e. higher trade taxes imply lower profit tax revenues. However, Katrak (1981) extends this to incorporate transfer price effects. The optimal specific export tax on exports of X_{12} for country 1 (see Katrak, 1981, p. 464, equation (9)) is:

$$t_x^* = -T_1X_{12}/(dX_{12}/dt_x) + ((1 - T_1)T_2/T_1)(MR_1 - P_{12}) \quad (15)$$

Since $dX_{12}/dt_x < 0$ the first term in (15) is positive implying $t_x^* > 0$. The second term disappears if $T_1 = 1$ (the home country profit tax rate is zero), $T_2 = 0$ (the foreign profit tax rate is 1), or $P_{12} = MR_1$ (the marginal profit on X_{12} is zero for both exporter and importer firms). However, if the MNE sets a high transfer price ($P_{12} > MR_1$) the exporter earns a marginal profit on export sales so that the profit tax loss from raising the export tax is larger. Since the second term in (15) is negative, the optimal export tax is therefore lower. On the other hand, if the MNE sets a low transfer price ($P_{12} < MR_1$), the second term is positive and the optimal export tax is higher. (Note that Katrak's interpretation of (15) is correctly stated in the text (1981, p. 461) but incorrectly reversed in the Appendix (p. 465).)

F. Summary

In section II we reviewed the transfer pricing literature based on Horst (1971) and Copithorne (1971). We discussed the two basic models of horizontally integrated and vertically integrated trade and identified the shadow and profit-maximizing transfer prices in each model. Using graphs, we explained the effects of primary and secondary tariffs on the MNE. We noted the importance of a high or low transfer price for the allocation of profits between exporter and importer and the comparative static effects of corporate profit taxes. Papers incorporating uncertainty and optimal commercial policies towards MNEs were also reviewed. In section III we build a model that incorporates the basic advances in the above literature and that has the major advantage of simultaneously modelling horizontally and vertically integrated trade.

III. A General Model of MNE Intra-firm Trade

A. The Static Model

We assume the MNE consists of three firms as outlined in section I with the following profit functions valued in country 1's currency (see Figure 2.1):

$$L_3 = e_3T_3[P_{31}X_{31} + P_{32}X_{32} - C_3] \quad (16)$$

$$L_2 = e_2T_2[R_2 - C_2 - (e_3/e_2)(1 + r_{32})(P_{32}X_{32} - (1 + r_{12})P_{12}X_{12}/e_2] \quad (17)$$

$$L_1 = T_1[R_1 - C_1 - e_3(1 + r_{31})P_{31}X_{31} + P_{12}X_{12}] \quad (18)$$

Substituting in the relationships assumed in section I, we have the global net profit function of the MNE:

$$L = T_1(R_1 - C_1) + e_2T_2(R_2 - C_2) - e_3T_3C_3 + (T_3 - T_1(1 + r_{31}))e_3P_{31}Q_1 + (T_3 - T_2(1 + r_{32}))e_3P_{32}Q_2 + (T_1 - T_2(1 + r_{12}))P_{12}X_{12} \quad (19)$$

The profit-maximizing transfer prices are determined by taking the partial derivative of (19) with respect to P_{ij} and using the envelope theorem:

$$\partial L/\partial P_{ij} = [T_i - T_j(1 + r_{ij})]e_iX_{ij} \gtreqless 0 \text{ as } T_i \gtreqless T_j(1 + r_{ij}) \quad (20)$$

From (20) we see that P_{ij} should be set at its upper bound (lower bound) whenever T_i, the net return to the exporter, is higher (lower) than $T_j(1 + r_{ij})$, the net return to the importer, per dollar of profits on X_{ij}. (This is equivalent to Horst's $\gamma \gtreqless r_{ij}$.)[4] We consider two cases which are (loosely) referred to as the 'surplus of foreign tax credits' and 'deficit of foreign tax credits' cases. (See note 1 and Eden, 1983b, for detailed explanations of these two cases.)

In the surplus of tax credits case we assume both subsidiaries have effective tax rates in excess of the parent firm which implies $T_1 > T_2$ and $T_1 > T_3$. Therefore $T_3 < T_1(1 + r_{31})$ so the MNE sets P_{31} at its lower bound to shift profits on Q_1 to the importer, firm 1. However, we can assume any combination of $T_1 \gtreqless T_2(1 + r_{12})$ and $T_3 \gtreqless T_2(1 + r_{32})$ since r_{12} may be large enough to offset $T_1 > T_2$, and $T_3 \gtreqless T_2$. We assume $T_3 < T_2(1 + r_{32})$ and $T_1 > T_2(1 + r_{12})$ on the grounds that (1) tax authorities in country 3 would probably prevent large discrepancies between P_{31} and P_{32} and (2) these assumptions generate the largest number of unambiguous comparative static results. (The reader is invited to substitute the other assumptions and trace their implications in what follows.) Therefore in the surplus of tax credits case the MNE sets a high value for P_{12} (to shift profits to the exporter) and low values for P_{31} and P_{32} (to shift profits to the importers).

In the deficit of tax credits case we assume both subsidiaries have effective tax rates below the parent firm (note that we must have $b_i < 1$) which implies $T_1 < T_2$ and $T_1 < T_3$. Therefore $T_1 < T_2(1 + r_{12})$ so the MNE sets a low value on P_{12} to shift profits to firm 2. However, we can have $T_3 \gtreqless T_1(1 + r_{31})$ and $T_3 \gtreqless T_2(1 + r_{32})$. We assume that $T_3 > T_1(1 + r_{31})$ and $T_3 > T_2(1 + r_{32})$ on the grounds noted above and leave the other cases to the reader. Our transfer pricing bounds are, therefore, reversed — the MNE chooses a minimum value for P_{12} and maximum value for P_{31} and P_{32}. In the rest of this section we analyze the surplus of tax credits case, briefly commenting on the effects of the deficit of tax credits case at the end.

The first order conditions for a global net profit maximum are found by differentiating (19) with respect to Q_1, Q_2 and X_{12}:

$$\partial L/\partial Q_1 = [e_3T_3(P_{31} - MC_3)] + [T_1(MR_1 - MC_1 - (1 + r_{31})e_3P_{31})] = 0 \quad (21)$$

$$\partial L/\partial Q_2 = [e_3T_3(P_{32} - MC_3)] + [e_2T_2(MR_2 - MC_2 - (e_3/e_2)(1 + r_{32})P_{32})] = 0 \quad (22)$$

$$\partial L/\partial X_{12} = [T_1(P_{12} - MR_1)] + [T_2(e_2MR_2 - (1 + r_{12})P_{12})] = 0 \quad (23)$$

The first square bracket in ((21), (22), (23)) shows the marginal profit of the exporter, firm i, while the second square bracket measures the marginal profit of the importer, firm j, in the 'market' for X_{ij}. Each first order condition can be interpreted as the condition for 'market equilibrium', i.e. summed global MNE marginal profits on X_{ij} must equal zero (see also Eden, 1983b).

If the MNE sets P_{ij} equal to the shadow transfer price λ (i.e. $P_{31} = P_{32} = \lambda_{31} = \lambda_{32} = MC_3$ and $P_{12} = \lambda_{12} = MR_1$), each firm earns a zero marginal profit on X_{ij}. However, the first order conditions only require that summed marginal profits are zero. From (20) we see that global MNE net profits are higher if P_{ij} is set above (below) λ when T_i is greater (less) than $T_j(1 + r_{ij})$. The relationship between P_{ij} and the marginal profit/loss of the exporting and importing firms is clear from ((21), (22), (23)). If P_{ij} lies above (below) λ, the exporter receives a marginal profit (loss) and the importer receives an equal in value marginal loss (profit) with zero summed marginal profits overall.[5] Assuming $T_3 < T_1(1 + r_{31})$, $T_3 < T_2(1 + r_{32})$ and $T_1 > T_2(1 + r_{12})$, firm 1 earns marginal profits in both the Q_1 and X_{12} markets, firm 3 earns marginal losses in both the Q_1 and Q_2 markets, and firm 2 earns a marginal profit in the Q_2 market and a marginal loss in the X_{12} market. Let us now turn to the comparative static effects of 'small' changes in T_i, r_{ij} and e_i on the MNE (i.e. we assume the sign of $T_i - T_j(1 + r_{ij})$ does not change).

B. The Comparative Statics

Totally differentiating ((21), (22), (23)) and setting the results in matrix form we have:

$$\begin{bmatrix} T_1(MR'_1 - MC'_1) - e_3T_3MC'_3 & -e_3T_3MC'_3 & -T_1MR'_1 \\ -e_3T_3MC'_3 & e_2T_2(MR'_2 - MC'_2) - e_3T_3MC'_3 & e_2T_2MR'_2 \\ -T_1MR'_1 & e_2T_2MR'_2 & T_1MR'_1 + e_2T_2MR'_2 \end{bmatrix} \begin{bmatrix} dQ_1 \\ dQ_2 \\ dX_{12} \end{bmatrix} = \begin{bmatrix} A \\ B \\ C \end{bmatrix} \quad (24)$$

where

$$A = (MC_1 + (1 + r_{31})e_3P_{31} - MR_1)dT_1 + e_3(MC_3 - P_{31})dT_3 + (e_3T_1P_{31})dr_{31} + (T_1(1 + r_{31})P_{31} + T_3(MC_3 - P_{31}))de_3$$

$$B = e_2(e_3(1 + r_{32})P_{32}/e_2 + MC_2 - MR_2)dT_2 + e_3(MC_3 - P_{32})dT_3 + (e_3T_2P_{32})dr_{32} + T_2(MC_2 - MR_2)de_2 + (T_2(1 + r_{32})P_{32} + T_3(MC_3 - P_{32}))de_3$$

$$C = (MR_1 - P_{12})dT_1 + ((1 + r_{12})P_{12} - e_2MR_2)dT_2 + (T_2P_{12})\,dr_{12} + (-T_2MR_2)de_2$$

Denoting the element in the i^{th} row and the j^{th} column by a_{ij} and its cofactor by D_{ij} we assume $a_{ii} < 0$ $(i = 1, 2, 3)$, $a_{12} < 0$, $a_{13} > 0$, $a_{23} < 0$ so that $D_{ii} > 0$ $(i = 1, 2, 3)$, $D_{12} = D_{21} < 0$, $D_{13} = D_{31} > 0$, $D_{23} = D_{32} < 0$ and the determinant $D < 0$.[6] We use Cramer's Rule to determine the impacts of T_i, r_{ij} and e_i on Q_1, Q_2 and X_{12}. Noting the relationships $dY_1 = dQ_1 - dX_{12}$, $dY_2 = dQ_2 + dX_{12}$ and $dQ_3 = dQ_1 + dQ_2$, we can also determine the effects on Y_1, Y_2 and Q_3. The proofs are left for the reader. The

results are summarized in the eight propositions and note 9 below.

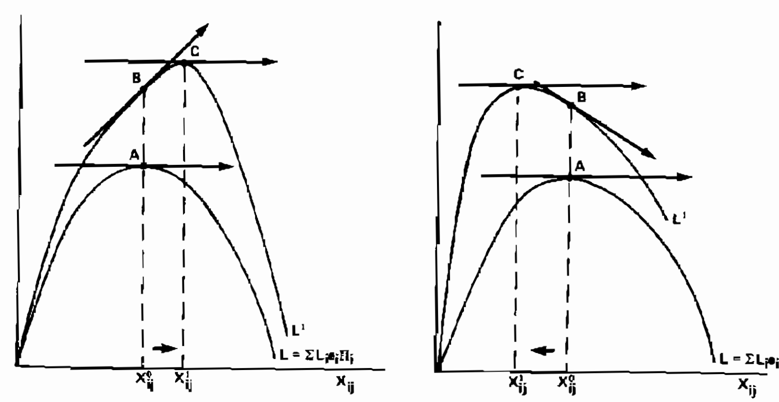
Proposition 1. $dQ_1/dT_1 > 0$, $dQ_2/dT_1 < 0$, $dX_{12}/dT_1 > 0$, $dY_1/dT_1 \gtrless 0$, $dY_2/dT_1 > 0$ and $dQ_3/dT_1 \lesseqgtr 0$

Because firm 1 earns a marginal profit in both the Q_1 and X_{12} markets, a rise in T_1 increases these marginal profits (see (21) and (23)). Both markets are now in disequilibrium because summed marginal profits are positive. Since the global profit function is concave with respect to X_{ij} (i.e. $\partial^2L/\partial X_{ij}^2 = a_{ii} < 0$) the rise in T_1 causes the MNE to expand both Q_1 and X_{12}. The impact of T_1 on the Q_1 market is illustrated in Figure 2.6(a) which shows total MNE net profits in the X_{ij} market. Market equilibrium is at point A where summed marginal profits are zero. In the traditional analysis of a profits tax a rise (fall) in the tax rate shifts the total profit curve L down (up) without altering the equilibrium level of output. However, in the MNE case, only part of the profits from X_{ij} are affected by a change in T_i so the shift in the global profits curve is not uniform. (A proportionate

Figure 2.6: The Effect of a Rise in T_i on Global MNE Profits from X_{ij}

(a) Assuming Firm i Receives a Marginal Profit on X_{ij}

(b) Assuming Firm i Receives a Marginal Loss on X_{ij}



change in T_i and T_j, however, would uniformly shift the L curve, leaving X_{ii} unchanged.) Since firm 1 earns a marginal profit in the Q_1 market, a rise in T_1 creates positive summed marginal profits at X_{ij}° (point B), inducing the MNE to move to point C where summed marginal profits are again zero. Therefore dQ_1/dT_1. Figure 2.6(a) can also be used to explain $dX_{12}/dT_1 > 0$. The increases in Q_1 and X_{12} have secondary effects on the MNE: Q_2 falls, Y_2 rises, the effects on Y_1 and Q_3 are ambiguous.

Proposition 2. $dQ_1/dT_2 < 0$, $dQ_2/dT_2 > 0$, $dX_{12}/dT_2 < 0$, $dY_1/dT_2 > 0$, $dY_2/dT_2 \gtrless 0$ and $dQ_3/dT_2 \gtrless 0$
Firm 2 earns a marginal profit on Q_2 and marginal loss on X_{12}. A rise in T_2 generates summed marginal profits in the Q_2 market (see (22)) and summed marginal losses in the X_{12} market (see (23)). Since Q_2 and X_{12} are substitutes, these effects reinforce one another and Q_2 expands and X_{12} contracts. Figure 2.6(b) illustrates the effects of a rise in T_2 on the X_{12} market. (The effect on Q_2 is illustrated by Figure 2.6(a).) The market is initially in equilibrium at point A. Since firm 2 earns a marginal loss on X_{12}, the rise in T_2 causes the global profit curve to shift up and to the left. Summed marginal losses are now earned at point B, inducing the MNE to move to point C and a lower level of X_{12}. The rise in Q_2 and fall in X_{12} have second round impacts on the MNE: Q_1 falls, Y_1 rises, the effects on Y_2 and Q_3 are ambiguous.

Proposition 3. $dQ_3/dT_3 < 0$, and iff $P_{31} = P_{32}$, $dQ_1/dT_3 < 0$, $dQ_2/dT_3 < 0$, $dX_{12}/dT_3 \gtrless 0$, $dY_1/dT_3 \gtrless 0$ and $dY_2/dT_3 \gtrless 0$
Firm 3 receives marginal losses on both its exports, X_{31} $(= Q_1)$ and X_{32} $(= Q_2)$, but Q_1 and Q_2 are substitutes in production so the impacts of a change in T_3 on Q_1 and Q_2 are contradictory. The impact on $Q_3 = Q_1 + Q_2$, however, is clear: global MNE output declines. If $P_{31} = P_{32}$, the firm receives equal marginal losses in both markets. Only in this case can we prove $dQ_1/dT_3 < 0$ and $dQ_2/dT_3 < 0$. However, the effect on X_{12} and therefore on Y_1 and Y_2 remain ambiguous.

Proposition 4. $dQ_1/dr_{31} < 0$, $dQ_2/dr_{31} > 0$, $dX_{12}/dr_{31} < 0$, $dY_1/dr_{31} < 0$, $dY_2/dr_{31} < 0$ and $dQ_3/dr_{31} < 0$
A glance at Figure 2.4 shows that all of these signs are confirmed. From (21) we see that a rise in r_{31} causes the MNE to earn summed marginal losses on X_{31} and to contract Q_1. This has second round impacts on the other markets. Note that domestic sales fall (and consumer prices rise) in both countries 1 and 2.

Proposition 5. $dQ_1/dr_{32} > 0$, $dQ_2/dr_{32} < 0$, $dX_{12}/dr_{32} > 0$, $dY_1/dr_{32} < 0$, $dY_2/dr_{32} < 0$, and $dQ_3/dr_{32} < 0$
The interpretation is the same as above; however, note that X_{12} now rises instead of falls.

Proposition 6. $dQ_1/dr_{12} < 0$, $dQ_2/dr_{12} > 0$, $dX_{12}/dr_{12} < 0$, $dY_1/dr_{12} > 0$, $dY_2/dr_{12} < 0$, and $dQ_3/dr_{12} \gtrless 0$
These signs are all confirmed in Figure 2.5. The interpretation is again similar to Proposition 4.[7]

Proposition 7. $dQ_1/de_2 > 0$, $dQ_2/de_2 < 0$, $dX_{12}/de_2 > 0$, $dY_1/de_2 < 0$, $dY_2/de_2 > 0$, and $dQ_3/de_2 \gtrless 0$
A rise in the value of country 2's currency has two effects on the MNE. First, firm 2's marginal profit from Q_2 increases by $T_2 (MR_2 - MC_2)de_2$. Second, its marginal loss on X_{12} falls by $T_2 MR_2 de_2$. (Since P_{12} is already valued in country 1's currency, the rise in e_2 has no effect on it.) The rise in e_2 therefore causes positive summed marginal profits in both the Q_2 and X_{12} markets. Because Q_2 and X_{12} are substitutes, the impacts are contradictory. However, an inspection of the two Cramer's Rule terms shows that the rise in marginal profit on Q_2 must be less than the fall in its marginal loss on X_{12}. As a result, the second effect dominates the first and the net impact is a rise in X_{12}.

It is interesting to compare this result with Batra and Hadar (1979). They also have $dX_{12}/de_2 > 0$ based on the positive impact of a rise in e_2 on the X_{12} market (our second effect). However, because they ignore primary trade, their first order condition requires $MR_2 = MC_2$ in the Q_2 market so the first effect we note above does not occur in their model (see (14)). Note also that in their model the rise in e_2 is referred to as a 'devaluation of the home currency'. In our three-country model, a devaluation of currency 1 implies e_2 and e_3 both rise proportionately so that e_2/e_3 remains constant. An examination of ((21), (22), (23)) shows that the effects of a devaluation of the home currency are probably ambiguous. The rise in e_3 causes summed marginal losses in the Q_1 market, inducing a fall in Q_1. Since e_3/e_2 is constant, there is no direct impact on the Q_2 market.

The rise in e_2, however, causes summed marginal profits in the X_{12} market, inducing a rise in X_{12}. Since Q_1 and X_{12} are complements and either effect could dominate, we predict, contrary to Batra and Hadar, that a devaluation of the home currency has ambiguous effects on the MNE.

Proposition 8. $dQ_3/de_3 < 0$
An inspection of (21) and (22) shows that a rise in e_3 causes summed marginal losses in both the Q_1 and Q_2 markets. Since Q_1 and Q_2 are substitutes, the net effect is ambiguous (even if we assume $P_{31} = P_{32}$). The only unambiguous result is $dQ_1/de_3 + dQ_2/de_3 = dQ_3/de_3 < 0$; a rise in country 3's currency causes the MNE to contract global output. This is easily explained: the MNE earns overall marginal losses in country 3. A rise in its currency increases these losses, and causes the MNE to reduce firm 3's total exports.

Our comparative static results for the surplus of tax credits case are summarized in Table 2.1. In the deficit of tax credits case the MNE sets $P_{31} > MC_3$, $P_{32} > MC_3$ and $P_{12} < MR_1$. As a result the comparative static effects of tax changes are reversed because

Table 2.1: The Comparative Static Effects of Changes in T_i, r_{ij} and e_i on the MNE (assuming $P_{31} < MC_3$, $P_{32} < MC_3$ and $P_{12} > MR_1$)[a]

Exogenous Variables	Effects on Endogenous Variables							
	Q_1	Q_2	X_{12}	Y_1	Y_2	Q_3	P_1	P_2
T_1	+	−	+	A[b]	+	A	A	−
T_2	−	+	−	+	A	A	−	A
T_3	−[c]	−[c]	A	A	A	−	A	A
r_{31}	−	+	−	−	−	−	+	+
r_{32}	+	−	+	−	−	−	+	+
r_{12}	−	+	−	+	−	A	−	+
e_2	+	−	+	−	+	A	+	−
e_3	A	A	A	A	A	−	A	A

Notes: a. If $P_{31} > MC_3$, $P_{32} > MC_3$ and $P_{12} < MR_1$, the tax signs are reversed, the tariff signs are unaffected, the signs on e_2 are unaffected, and the sign on e_3 is reversed.
b. A = ambiguous.
c. if $P_{31} = P_{32}$.

they depend on whether P_{ij} is high or low. The tariff effects are unchanged as long as P_{ij} is positive. The effects of a change in e_2 are also unchanged since the net impact on X_{12} is positive regardless of the values of P_{32} and P_{12}. However, $dQ_3/de_3 > 0$ if the MNE sets high values on firm 3's exports because a rise in e_3 increases the value of these marginal profits.

Lastly, let us look at the case where all three profit-maximizing transfer prices are set equal to their shadow prices. An examination of ((21), (22), (23)) shows that changes in T_i or T_j now have no effect on MNE resource allocation because zero marginal profits are earned by both the exporter and importer affiliates. As in Horst (1971) tax policy is impotent when the MNE sets 'equilibrium' transfer prices, i.e. when $P_{ij} = \lambda$. (See also Eden, 1976, p. 195.)[8] The tariff effects are unchanged as long as $P_{ij} > 0$. The effects of a change in e_2 are now the same as Batra and Hadar (1979); only the X_{12} market is affected and X_{12} expands. Lastly, a rise (fall) in e_3 causes summed marginal losses (profits) in the Q_1 and Q_2 markets so Q_3 contracts (expands).

C. *Tariffs and Economic Welfare*

In this section we address two issues: (1) the revenue-maximizing tariff for an importing country; and (2) the impact of tariffs on global welfare. The welfare effects of tariffs have been thoroughly analyzed in the general equilibrium model of international trade between unrelated firms. We examine whether a similar analysis applies to our partial equilibrium model of international trade between related firms.

If an importing country has some monopoly power in trade, it can increase its national welfare by imposing an optimal tariff. Let us assume that welfare in the importing country is positively related to total revenues received from corporate profit taxes and tariffs.[9] We can use Katrak's method for calculating the optimal export tax (1981, p. 464) to determine the importing country's optimal tariff for a given corporate tax rate.

Let us derive the optimal *ad valorem* tariff r_{12}^* for country 2 for a given tax rate $1 - T_2$ and given transfer price P_{12}. (The analysis and final formula are identical for changes in a primary tariff.) We assume firm 2 has a surplus of foreign tax credits so the effective tax rate on π_2 is the foreign tax rate. Total tax and tariff revenues paid by the MNE in country 2, measured in country 1's currency, are:

$$TTR_2 = e_2(1 - T_2)[R_2 - C_2 - (e_3/e_2)(1 + r_{32})P_{32}Q_2 - (1 + r_{12})P_{12}X_{12}/e_2] + r_{12}P_{12}X_{12} + e_3(1 + r_{32})P_{32}Q_2 \quad (25)$$

Differentiating this with respect to r_{12} we have the first order condition for a revenue maximum (since $\partial^2 TTR_2/\partial r_{12}^2 < 0$):

$$\partial TTR_2/\partial r_{12} = e_2(1 - T_2)(MR_2 - (1 + r_{12})P_{12}/e_2)dX_{12}/dr_{12} + T_2P_{12}X_{12} + (r_{12}P_{12})dX_{12}/dr_{12} = 0 \quad (26)$$

Now substituting the first order condition (23) into (26) and solving for r_{12}^*, the optimal *ad valorem* tariff rate is:

$$r_{12}^* = - T_2X_{12}/(dX_{12}/dr_{12}) + ((1 - T_2)\ T_1/T_2\ (P_{12} - M_1)/P_{12} \quad (27)$$

First note the similarities between Katrak's optimal export tax in (15) and the optimal tariff in (27). Since $dX_{12}/dr_{12} < 0$ from Proposition 6, the first term is positive as in (15). The sign of the second term depends upon the sign of $P_{12} - MR_1$ (i.e. $P_{ij} - \lambda$) which is the reverse of (15). A high (low) transfer price implies the optimal tariff r_{12}^* is larger (smaller) than if country 2 simply ignored the impact of transfer pricing on its profit tax revenues. The second term in (27) is zero if either $1 - T_2 = 0$, $T_1 = 0$, or $P_{12} = MR_1$, generating zero marginal tax revenue. (Compare this with the second term in (15).) If $T_2 = 1$ so the profit tax rate is zero, $|(dX_{12}/X_{12})(r_{12}/dr_{12})| = 1$ and r_{12}^* simply maximizes tariff revenues. If $P_{12} < MR_1$, the second term in (27) is negative so the optimal tariff is smaller. With a low transfer price the importer earns a positive marginal profit on X_{12}. Since marginal profit tax revenues are positive, the optimal volume of imports should, therefore, be larger and r_{12}^* smaller. On the other hand, if $P_{12} > MR_1$ the second term is positive and the optimal tariff rate is higher. The effect of the transfer price on the optimal tariff in (27) is, therefore, exactly the reverse of its effect on the optimal export tax in (15), i.e. a high (low) P_{ij} implies a higher (lower) tariff but a lower (higher) export tax.

Now let us examine the impact of tariffs on global welfare. In the traditional two-country/two-good model of international trade, tariffs lower world welfare because (1) global output falls and (2) the tariff drives a wedge between domestic and foreign consumer prices (see Caves and Jones, 1981, pp. 208-10). Can we draw a similar conclusion in our three-country/one-good model, i.e. that a tariff causes Q_3 to fall and the gap between P_1 and P_2 to widen? (Note that, in general, $P_1 \neq P_2$ even if $t_i = t_j = r_{ij} = 0$ since the MNE can price discriminate between markets.) Surprisingly, the answer is 'yes' for primary tariffs but 'no' for secondary tariffs.

The reasoning behind this conclusion lies in the domestic elasticity of demand in the two countries and in the way a tariff affects the MNE's first order conditions. For a global profit maximum under free trade the MNE sets $MR_1 = MC_1 + MC_3 = MR_2 = MC_2 + MC_3$ as in (10). Since $MR_i = P_i(1 - 1/\varepsilon_i)$ where ε_i is the domestic elasticity of demand, and $MR_1 = MR_2$, we have $P_1 \gtrless P_2$ as $\varepsilon_1 \lesseqgtr \varepsilon_2$. We know that, in general, home firms view their domestic demand as less elastic than their demand in foreign markets (Caves and Jones, 1981, pp. 171-2). Therefore $\varepsilon_2 > \varepsilon_1$ and $P_1 > P_2$ under free trade.

Now if either country 1 or 2 levies a primary tariff, Propositions 4 and 5 prove that consumer prices in both countries rise. The primary tariff drives a wedge between the marginal cost curves of the two plants but does not affect the $MR_1 = MR_2$ equality (see (22)). As a result $\Delta MR_1 = \Delta MR_2$ and since $\varepsilon_2 > \varepsilon_1$ we have $\Delta P_1 > \Delta P_2$. Thus the consumer price gap $P_1 - P_2$ widens if either country levies a primary tariff. (See also Figure 2.4). At the same time, primary tariffs unambiguously cause global MNE output Q_3 to fall. We therefore conclude the primary tariffs do lower global welfare because Q_3 falls and $P_1 - P_2$ widens. (Note that this conclusion holds: (1) only in a partial equilibrium sense because this is a one-good model; (2) if the MNE's ability to price discriminate does not depend on the tariff; and (3) assuming the transfer price remains fixed.)

When a secondary tariff r_{12} is levied on intra-firm trade, Proposition 6 proves that consumer price in the importing (exporting) country rises (falls). Since $P_1 > P_2$ under free trade the secondary tariff causes the consumer price gap to shrink. (See also Figure 2.5.) At the same time, the effect of r_{12} on Q_3 is ambiguous. Therefore we cannot prove that a secondary tariff lowers global welfare (in the sense that Q_3 falls and $P_1 - P_2$ widens) although this is true for primary tariffs.

However, we do know that tariffs contract intra-firm trade *per se*, i.e. $dX_{ij}/dr_{ij} < 0$. In this sense a tariff must be global welfare-reducing because the tariff causes the MNE to contract X_{ij} below its free trade level. Since it is the size of the tariff wedge $r_{ij}P_{ij}$ that determines the amount of trade contraction (see (11) and (12)), the inefficiency induced by the tariff can be partly or wholly offset by a lower transfer price P_{ij}. The possibility that transfer price manipulation can reduce the welfare loss caused by tariffs and other trade barriers is explored in the next section. (See also Itagaki (this volume) where the choice between a tariff or quota can be affected by the MNE's ability to change P_{ij} in response to an *ad valorem* tariff.)

D. Transfer Pricing and Economic Efficiency

One important current debate in the transfer pricing literature concerns the efficiency of transfer pricing by MNEs in comparison to the so-called 'arm's-length' price. In the internalization literature (see Rugman, 1981, p. 83) transfer pricing is regarded as an 'efficient response by the MNE to exogenous market imperfections' such as corporate tax differentials and tariffs. MNEs are seen as overcoming these exogenous imperfections by creating an internal market with transfer prices. For Rugman, arm's-length prices do not exist; the MNE's chosen transfer prices are the correct efficient ones. Internalization theory sees transfer pricing as reducing the global inefficiency caused by government interventions designed to segment national markets. Since MNEs can use transfer prices to arbitrage trade barriers between countries, market segmentation is reduced and global welfare improves. (See also Aliber (this volume).)

On the other hand, Diewert (this volume) shows that the deadweight loss due to international tax differentials is larger when the MNE sets the transfer price above or below the optimal regulated price. Similarly, Bond (1980, p. 192) argues that transfer pricing distorts resource allocation as the MNE trades 'the gains from tax evasion against the efficiency losses resulting from resource misallocation' when transfer pricing in response to tax differentials. Most developed countries have regulations (e.g. Section 482 of the US Internal Revenue Code) to force transfer prices equal to arm's-length prices, both on efficiency grounds and to prevent either erosion or double taxation of the revenue base. (See Shoup, this volume, on the arm's-length price as a standard in international transfer pricing disputes.) The popular view clearly is also that transfer pricing worsens global resource allocation.

In this section we try to shed some light on this debate by asking how corporate profit tax differentials and tariffs affect resource allocation when the transfer price is, first, the Hirshleifer shadow price and second, the profit-maximizing price that minimizes these exogenous imperfections. As a benchmark, we assume resources are allocated efficiently by the MNE under free trade. If all corporate taxes and tariffs are zero, the MNE allocates resources so as to satisfy (10). Let us call the free trade level of intra-firm exports X_o. The Hirshleifer shadow price is λ, the marginal cost of the selling division as determined by the intersection of the marginal revenue and marginal cost of export (i.e. excess demand and excess supply) curves (see Figure 2.2). The profit-maximizing transfer price (let us call it P) differs from the shadow price whenever there is a difference between the net returns to the exporter and importer of X. Now let us compare the effects on X under tax and tariff barriers when the MNE is constrained to use the Hirshleifer transfer price λ and when it is free to use P. We define the 'efficient' transfer price as that price which produces an allocation of MNE resources closest to that under free trade, i.e. closest to X_o.

First, if MNE trade is constrained by a tariff only and λ is chosen, the tariff wedge is $r\lambda$ and X_o contracts to X_λ. On the other hand, if the MNE can choose its transfer price, it sets $P < \lambda$ to minimize tariff costs. Because the new tariff wedge rP is less than $r\lambda$, trade contracts to X_P where $X_\lambda < X_P < X_o$. The distortion in resource allocation due to the tariff is less when the MNE can manipulate P compared to the Hirshleifer price. Transfer pricing is therefore an efficient response to tariffs, as argued by Rugman.

Second, if trade is constrained by tax differentials only and the MNE set $P = \lambda$, each firm earns a zero marginal profit on intra-firm trade. Changes in the tax differential γ thus have no effect on MNE resource allocation so $X_\lambda = X_o$. If the MNE can choose P, it sets $P \gtrless \lambda$ when $\gamma \gtrless 0$ to shift profits to the lower taxed firm. Because either profit-maximizing transfer price ($P \gtrless \lambda$) causes positive summed marginal profits in the market for X, intra-firm trade expands. As a result, $X_\lambda = X_o < X_P$.[10] Shadow transfer pricing in response to corporate tax differentials is, therefore, inefficient in the sense that $X_\lambda = X_o \neq X_P$, as argued by Diewert.

Now let us analyze the efficiency of transfer price manipulation when the MNE is jointly constrained by taxes and tariffs. If

$P = \lambda$, γ has no effect on X whereas r causes X to contract. We conclude that $\gamma \gtreqless r$ for $P = \lambda$ implies $X_\lambda < X_o$. On the other hand, if profit-maximizing transfer prices can be chosen, r causes X to fall so that $X_\lambda < X_P < X_o$, whereas the tax differential causes X to expand so that $X_\lambda = X_o < X_P$. If γ dominates r we therefore argue $X_\lambda < X_o < X_P$, whereas if r dominates γ we have $X_\lambda < X_P < X_o$, and if $\gamma = r$ we have $X_\lambda = X_P < X_o$. Therefore the profit-maximizing transfer price is unambiguously more efficient than the Hirshleifer price (in the sense that X_p is closer to X_o than X_λ) when the tariff rate dominates the tax differential, inducing the MNE to set $P < \lambda$. If the tax differential dominates the tariff, neither transfer price is umabiguously more efficient; whereas if $\gamma = r$, both prices imply the same (i.e. too low) level of intra-firm trade. Therefore we conclude that the profit-maximizing transfer price P can be either more or less efficient than the shadow price λ in a world of government-induced market imperfections. Note that although in certain circumstances Hirshleifer and arm's-length prices are the same (see Diewert, this volume), this does not answer the question as to whether profit-maximizing transfer prices are more or less efficient than the arm's-length price rules arbitrarily defined by government regulations such as Section 482. Clearly this is the crucial question and one that is not answered here. Diewert (this volume) does show that an optimal regulated transfer price can be determined which will generate an undistorted level of intra-firm trade, but he is, justifiably, pessimistic as to any government's ability to determine such a price. He does prove, however, that relaxing the regulatory constraints (i.e. moving away from the optimal regulated transfer price) worsens global efficiency. Lastly, we should stress that although the rationale for regulation of transfer pricing on efficiency grounds may not be clear, arm's-length rules may still be justifiable on distributional grounds, as argued by Shoup and Helleiner elsewhere in this volume.

IV. Conclusions: Where Do We Go from Here?

The purpose of this paper was to review and synthesize the existing partial equilibrium microeconomic models of international transfer pricing of tangible goods. In section II we

showed how the theory has progressed from the early models by Horst and Copithorne to the recent work incorporating uncertainty, endogenous transfer prices and optimal commercial policies. In section III we drew on this literature to build a general model of transfer pricing that simultaneously modelled horizontally and vertically integrated trade and incorporated the major results to date. In both sections we developed the concept of a high/low transfer price and stressed its importance for the static and comparative static results of the various models.

Where do we go from here? Several directions are possible:

1. An obvious omission is the failure to model factor markets; i.e. to go behind the MNE's cost curves to determine the impacts of transfer pricing, taxes and tariffs on factor demands and factor incomes. Related to this is the assumption that corporate profit taxes fall only on pure profits and not on equity capital. Incidence effects of the corporate income tax have not been modelled in the transfer pricing literature.

2. The welfare and income distributional effects of transfer pricing on home and host countries need further development, e.g. producer and consumer surplus effects, the index of monopoly power, calculation of optimal commercial and tax policies. (See Bardhan (1982) for some work in this area.)

3. The work on exchange rate and foreign demand/supply uncertainty needs to be extended to a general theory of the MNE under uncertainty.

4. Some of the assumptions of the basic model should be relaxed to determine the implications of oligopolistic domestic markets, imperfectly competitive products and rivalrous behaviour by affiliates for our static and comparative static results. The implications of the recent literature on cross-hauling and intra-industry trade for the MNE model also need examination.

5. The impacts of other exogenous market imperfections on the MNE should be modelled, e.g. exchange controls, price controls, voluntary export quotas. Also the theory of the MNE should be extended to make environmental variables such as government regulations endogenous.

6. The theory of financial manoeuvring of MNE liquid assets (as in Brean, this volume) and the theory of transfer pricing of tangibles need to be jointly developed into a general theory of fiscal transfer pricing. (For some work in this area see Horst (1977 and Rutenberg (1970).)

7. Outside the basic partial equilibrium static framework are other frameworks in which MNEs can be analyzed: general equilibrium models, dynamic investment models (see Samuelson, this volume), models using duality theory (see Diewert, this volume.) The incorporation of transfer pricing into these models lies at the forefront of MNE research.

8. A microeconomic theory of transfer pricing of intangibles, such as technology, in a world of taxes and tariffs has not yet appeared in the Horst-Copithorne literature. (See Horst, 1973, for some preliminary work on this assuming free trade.) Such common cost allocations have public good attributes that should provide interesting and policy relevant comparisons with the standard theory of transfer pricing of tangible private goods.

9. Lastly, we argue that future extensions in the theory of transfer pricing should be developed in the context of an MNE model incorporating both vertically and horizontally integrated trade. An amalgamation of the Horst and Copithorne models not only yields fruitful results, but also more closely approximates the reality of the multidivisional multinational enterprise.

In conclusion we stress that transfer pricing is a phenomenon unique to intra-firm trade. As a result, models of the MNE are incomplete without an explanation of transfer pricing — and the theory of transfer pricing must be an integral part of the theory of the multinational enterprise.

Notes

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1. In the simplest case $T_i = 1 - t_i$ as in Horst (1971). However, this is complicated by extra home country taxes payable on dividends remitted to the parent if the home tax rate exceeds the foreign rate. If $t_1 < t_i$ (firm i has a surplus of foreign tax credits) then $T_i = 1 - t_i$. However, if $t_1 > t_i$ (firm i has a deficit of tax credits) dividends $b_i\pi_i$ are taxed at rate t_1 while retained earnings $(1 - b_i)\pi_i$ are taxed at t_i. The effective foreign tax is, therefore $t_i + b_i(t_1 - t_i)$ and $T_i = 1 - t_i - b_i(t_1 - t_i)$. (Note $T_i = 1 - t_1 = T_1$ if $b_i = 1$ (no deferral and deficit of tax credits).) For more complicated definitions of T_i incorporating withholding taxes see Eden (1983b).

2. Note that Diewert (this volume) also proves more generally that in the absence of taxes and tariffs, the shadow transfer price λ^*, the arm's-length price $\bar{w}$, and the decentralized price w^* coincide, providing the profit functions of the divisions are differentiable and concave functions of the volume of intra-firm trade X. His equation (4) is also equivalent to our (8).

3. Total MNE output declines under a primary tariff (either r_{31} or r_{32}) because the tariff causes the ΣMC_i curve to shift inwards, contracting Q_3. The secondary tariff r_{12} also causes ΣMC_i to shift inwards; however, it simultaneously causes the ΣMR_i curve to shift outwards, and either shift may dominate. The difference between the two tariffs is simple: a primary tariff drives a wedge between the MC_1 and MC_2 curves; a secondary tariff drives a wedge between the MC_1 and the MC_2 curves and also between the MR_1 and MR_2 curves (compare (11) and (12) and Figures 2.4 and 2.5).

4. Diewert (this volume) provides a similar but more general proof in Theorem 4: the profit-maximizing transfer price w_o should be set at its upper (lower) bound as the difference between the net returns to the exporter and importer firms, $\sum_k T_k (1 + \tau^k)X^k$, is positive (negative). He also shows in (53) that the MNE can be decentralized and reach the same global net profit maximum and same level of trade X^k, if the appropriate decentralized transfer price w^k_* is used. (Contrast this with Bond (1980) where the decentralized levels of net MNE profits and intra-firm trade lie below the profit-maximizing levels when tax rates differ.)

5. We assume that corporate profit tax and customs authorities set the effective upper and lower bounds on P_{ij}. The tax officials in the exporting country tend to accept a high transfer price since that raises taxable profits of the exporter. Customs officials in the importing country also tend to accept a high transfer price to raise tariff revenues. Tax authorities in the importing country, however, prefer a lower transfer price to shift profits to the importer. Minimum profit targets for each affiliate, minority shareholders and strong labour unions can also affect the upper and lower bounds to P_{ij}. Several authors (e.g. Horst, 1971; Itagaki, 1979, 1981; Samuelson, 1982) assume marginal export cost as an effective lower bound so $P_{ij} \geq \lambda$. This implies that in equilibrium the exporter never earns a marginal loss, nor the importer a marginal profit, on intra-firm trade. We prefer the alternate assumption that the MNE can set $P_{ij} \gtrless \lambda$ so that either the importer or the exporter shows the marginal loss depending on $T_i \gtrless T_j(1 + r_{ij})$. Our assumption probably best suits MNEs that do not employ the profit centre concept (see Bond, 1980) and that engage in large numbers of intra-firm transactions (see Copithorne, 1976). See also Diewert (this volume) on the upper bound w_2 and lower bound w_1 to the profit-maximizing transfer price w_o.

6. Assuming $a_{12} = a_{21} < 0$ implies $MC_3' > 0$; that is, we ignore the possibility that the primary firm is a Copithorne maverick firm.

7. Note that the secondary tariff r_{12} causes Q_2 to expand while the primary tariff r_{32} causes Q_2 to contract. Eden (1983a) explores the circumstances under which net protection from the domestic tariff structure is positive.

8. Diewert (this volume) reaches similar comparative static tax results in (18).

9. Note that this analysis assumes changes in r_{ij} do not cause the MNE to

change P_{ij}. Also note that the optimal tariff policy should take consumer surplus into account. Since higher primary and secondary tariffs reduce final sales, causing consumer surplus to decline (see Propositions 4, 5 and 6), the optimal import tariff should be lower than that calculated here.

10. Differentiating the first order condition for X_{ij} with respect to P_{ij}, setting it equal to zero and solving (see Varian, 1978, p. 268), we find $dX_{ij}/dP_{ij} = -e_i(T_i - T_j(1 + r_{ij}))/\partial^2L/\partial X_{ij}^2$. Since $\partial^2L/\partial X_{ij}^2 = a_{ii} < 0$ from (24), we have $dX_{ij}/dP_{ij} \gtrless 0$ as $T_i \gtrless T_j(1 + r_{ij})$. Assuming $T_i > T_j(1 + r_{ij})$ implies the MNE chooses a high P_{ij}, so that increasing P_{ij} causes X_{ij} to expand. On the other hand, if $T_i < T_j(1 + r_{ij})$ the MNE chooses a low transfer price to shift profits to the importer, so that lowering P_{ij} also causes X_{ij} to expand. If $T_i = T_j(1 + r_{ij})$, $dX_{ij}/dP_{ij} = 0$. Diewert (this volume) also has similar proofs in (18).

3 TRANSFER PRICING AND ECONOMIC EFFICIENCY

W. Erwin Diewert

I. Introduction

Consider a firm which produces an (intermediate) output in one plant or division and uses it as an input in another plant or division. If there is a well defined external market for the good where units can be bought and sold at a common price w, then there is no transfer price problem: the firm should value the intermediate good at the price w in both plants. However, in many cases, such well defined 'arm's-length' transfer prices will not exist. In this case, how should the firm choose its transfer price for the good?

Hirshleifer (1956) and Arrow (1964, pp. 404-5) suggested the following conceptual framework for choosing a transfer price: it should be that price such that if both plant managers treat it as a fixed (parametric) price and maximize their individual plant profits subject to their own plant technological constraints, then the aggregate net supply of the intermediate good is zero. Thus the Hirshleifer *arm's-length transfer price* acts just like a market price. This concept for a transfer price is also known as a *decentralized profit-maximizing transfer* or a *marginal cost transfer price* and it will be discussed in detail in section IV below.

In the above framework for transfer pricing, the divisional managers maximized profits separately with the common arm's-length transfer price being the only link between the two maximization problems. Horst (1971, 1977) and Copithorne (1971) suggested an alternative conceptual framework for choosing a transfer price: it should be that price which allows the firm to maximize total profits (in a centralized manner) over the two plants. If there are no tax distortions, Copithorne (1971, p. 339) shows that the transfer prices are completely arbitrary. If the plants are located in different jurisdictions and there are unequal income tax rates in the two locations, Horst (1971, p. 1061)