INTERNATIONAL VERTICAL INTEGRATION:
A POSITIVE MODEL OF ENDOGENOUS
MARKET STRUCTURE

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Abstract

This paper provides a simple theoretical model in which a vertically-distorted industry structure is considered in an international setting. Fixed costs, existing in both the final good and intermediate good sectors, result in a bilateral externality. Production as well as equity ownership potentially crosses national boundaries. Differing parameter specifications give rise to various market structures as industrial organization is endogenous to the model. As a result, marginal changes in parameter specifications may lead to jumps in plant ownership and location decisions.

JEL Codes: F12, F23, L11

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1. Introduction

Two rounds of recent trade negotiations are historic in their pursuit of rules and disciplines on trade-related investment measures (TRIMs) between developed market economies and developing economies. The narrow agreement on TRIMs in the Uruguay Round draft of the GATT accord basically restricts domestic-content and trade balance requirements. Somewhat more demanding are the North American Free Trade Agreement (NAFTA) provisions on regional investment flows. NAFTA investors receive the more favorable of either national or most-favored nation treatment, trade-related performance requirements are constrained, and disputes are resolved in an international forum.

Casual observation implies that industries with multi-stage production (vertical industries) may be heavily affected by these policy changes. Yet the response of MNEs, in terms of plant location and production ownership decisions, is unclear. With lower investment barriers, an Northern-based MNE may chose to relocate labor-intensive manufacturing in a low-wage, developing economy. On the other hand, trade liberalization reduces incentives for tariff-jumping direct foreign investment (DFI). The impact of these agreements on global investment patterns and income distribution thus remains an area of inquiry.

Sophisticated models of the MNE have drawn from both industrial organization and international trade theory to explain global business practices of firms. This strand of research recognizes the monopolistic nature of DFI. MNEs are subject to inherent disadvantages relative to local firms. Language and cultural barriers, transportation and communication costs, and government intervention are but a few of the handicaps MNEs must overcome. To exist, MNEs must possess a compensating firm-specific asset providing them with advantages over their domestic rivals. Thus it is proposed that DFI occurs in the presence of imperfections in goods, factors or knowledge markets. As a complement to this approach, authors including Markusen (1984), Horstmann and Markusen (1987, 1992), and Rugman (1980, 1981) provide formal theories of the horizontal MNE by assuming that a firm chooses between
exporting. DFI, and licensing as a method to service foreign markets to internalize market imperfections.

To this point such theories have not been forthcoming for the vertically-integrated MNE. One exception is Caves (1982) who pioneers an informal description of the vertically integrated MNE. In this view international vertical integration occurs to internalize a vertical distortion, such as imperfections in intermediate goods markets stemming from contract and transaction costs. Most formal modelling efforts appeal to industrial organization models of domestic vertical integration. For example, Spencer and Jones (1992) and Rodrik and Yoon (1989) model government policy when a domestic firm attains an input produced more cheaply abroad from a vertically integrated foreign supplier. As both firms compete in the final good market, the price set by a foreign supplier is above that set by a monopolist producing only the input.

The models of Helpman (1985) and Helpman and Krugman (1985) essentially impose a multinational structure by assuming vertical integration. While adequate for explaining the observed global locations of plants, these models treat plant ownership patterns as exogenous. To fully understand the behavior of international businesses one must also recognize the endogenous nature of a firm’s international plant location and ownership arrangements. Important in this analysis is the game structure in which potential rival firms compete globally, the variety of ownership and location configurations available for production, and the unique constraints accompanying alternative regimes. The void in vertical MNE modelling may be due, in part, to the wide array of organizational arrangements that fall under this heading.

This paper provides a positive framework in which the decision to become a vertically-integrated MNE is endogenous to trade policy given imperfections in intermediate and final goods markets. This model captures production techniques of only a few industries but the general methodology employed suggests numerous extensions. Both the plant location and the plant ownership decision are endogenous for a two-stage production process in an international setting. Available to a final good monopolist are
three industrial organizational arrangements for access to an intermediate good, each with varying costs and returns: international vertical integration by an MNE; domestic vertical integration; and imports of the intermediate good from a foreign monopolist.

In this framework it is shown that marginal changes in parameters may cause a jump in the equilibrium regime selection. For example, marginal increases in the transaction cost of foreign equity ownership may result in a shift from multinational enterprise production to foreign-monopoly exports of the intermediate good or even domestically-integrated production. Likewise, other comparative static experiments demonstrate that minor changes in policy parameters may provide incentives for a firm to switch to alternative production regimes.

The following section formalizes the rules of the game with two agents (home firm and foreign firm). Section 3 proposes specific functional forms for production and demand of the intermediate and final good and the characteristics of the implied subgames. Several comparative-static results are developed in Section 4. Finally, closing comments are summarized in Section 5.

2. The Vertical Industry and Extensive Form Game

The partial equilibrium model consists of two countries, home and foreign (denoted by superscript *), and a production process where a final good (X) is the product of an intermediate good (Z). In this asymmetric world, the home country is technologically advanced with an abundant highly skilled labor (S) workforce. The foreign country, on the other hand, has an abundant unskilled labor (L) endowment. The factors S and L are designed to represent any location-specific technical advantages or endowment differences between countries due to education, natural resources, climate, or arable land. Both S and L are fixed in supply and immobile between countries.
For simplicity, assume the X and Z industries are too small to influence factor prices. Reflecting differences in technical efficiency, returns to unskilled labor are higher in the home country than in the foreign country \( (w > w') \) and home has an absolute cost advantage in skilled labor \( (s < s') \). To limit dimensions, it is assumed that home’s skilled labor advantage is sufficient to assure that X production locates at home. Foreign imports of X incur a specific tariff \( (\tau_x^*) \) and home imports of Z, whether inter-firm or intra-firm, incurs a specific tariff \( (\tau_z) \). Finally demand is linear and identical across consumers in both countries.

\[ \text{Z Production} \quad \text{X Production} \]

FIGURE 1: Vertical Production Process

Figure 1 demonstrates a geographically-separable two-stage process where Z is produced as an input into X. Z employs unskilled labor and is used only as an X input. In combination with skilled labor, Z is transformed into X which is sold on the world market. Fixed costs at both stages of production limit the number of producers that can profitably supply the market. It is assumed that market size is sufficiently small to make non-monopoly production in either X or Z unprofitable for all firms in a post-Nash equilibrium. Given the bilateral nature of the industry one of three ownership and location configurations will result. Within the FOR regime the home firm (an X-monopolist) imports Z, at arm’s
length, from a foreign monopolist. In the MNE regime production is vertically integrated with a foreign Z plant and home X plant. Under domestic vertically-integrated production, the DOM regime, both X and Z are produced at home under common administration. The resulting output is sold globally.

To fully understand the mechanisms that determine equilibrium price, output, and regime, a model of agent interaction is specified. Although several models could be created to represent this vertical industry, this paper proposes a non-cooperative game with ordered moves and perfect information as represented in figure 2 and described below.

Consider the extensive form game depicted in figure 2 in which the home firm (and global X monopolist) competes with the potential foreign Z-monopolist in the vertically-related industry. The game begins at open node h.1 where the home firm decides whether to commit to domestic X production. If the home firm chooses no production the game is over and both home and foreign firms receive zero profits.

Given the commitment to X production the home firm decides whether to produce Z internally or to purchase Z at arm's length from a foreign monopolist at node h.2. Under vertically-integrated production, the home firm either invests abroad in a Z plant (becomes an MNE) or it builds a Z plant at home (DOM regime) at node h.3. The game is over if either vertically-integrated regime is chosen with the home firm receiving global monopoly profits while the foreign firm earns a zero payoff.

If instead at node h.2, the home firm decides to import Z at arm's length (the FOR regime) the foreign monopolist enters the game. At node f.4, the foreign firm decides whether to produce Z. Without foreign Z production the game ends with the home firm's loss of its fixed cost (-G) and a zero foreign payoff. Should the foreign firm decide to produce, a bilateral-monopoly subgame is begun at node f.5.
Figure 2: Extensive Form Game
The bilateral-monopoly subgame could take a variety of structures; the payoffs, of which, are largely indeterminate. In general, the foreign firm (Z-monopolist) will charge some markup price above marginal cost. The home firm (X-monopolist) selects X price (or output levels) based on the monopoly price of Z rather than true marginal costs. This double-marginalization results in equilibrium X (and Z) output that is lower than the industry profit-maximizing level.

For ease of demonstration, the first move of the subgame proposed allows the foreign firm to select a price, \( p_z \), at node f.5. Next, the home firm sets the final good price at node h.6. The resulting duopoly payoffs to the home and foreign firms are \( \pi^\text{for} \) and \( \pi^\text{fix} \), respectively. The ordered nature of the pricing decisions allows a backward solution that is characterized as a subgame perfect equilibrium in pure strategies. Start with the bilateral-monopoly subgame at node f.4. The home firm moves last, node h.6, to select an optimal \( p_x \). The price \( p_z \) is viewed as parametric by the foreign firm's announcement one stage prior. Knowing the home monopolist will optimize in the last step, the foreign firm selects a monopoly price, \( p_z \), at node f.5. The successive price markups, or double-marginalization, of \( p_z \) and \( p_x \) result in duopoly profits that are Pareto inferior to a cooperative outcome. As long as \( p_z \) exceeds Z's true marginal cost, the home firm will set X output lower and \( p_x \) higher than would be optimal if X and Z firms could cooperate. This distortion will provide an incentive for vertically-integrated regimes to arise as alternative market structures.

In a second subgame, the home firm selects the best plant location for vertically-integrated production at node h.3. Moving up the tree the home firm chooses the optimal ownership configuration, whether or not to own Z production, at node h.2. Finally, at node h.1 the home firm enters the X market if the optimal production configuration is profitable. Applying this game structure, section 3 discusses the determinants of the various payoffs such as factor costs, transportation costs and demand parameters. For ease of exposition, specific functional forms are assigned to cost and demand functions.
3. Technology and Demand Specifications

In this geographically separable two-stage process, \( Z \) is manufactured solely as an input into \( X \). \( Z \) production employs unskilled labor at a marginal cost \( (w \text{ or } w^*) \) after an initial fixed plant-cost \( (I) \) is incurred. Equation (1) describes the general cost function for domestic \( Z \) production.

\[
(1a) \quad C^i_z = I + w^i Z; \quad w^i = w, w^*
\]

Foreign operations by an MNE require transactional activities beyond those of independent foreign producers such as language translators, cultural blocks and host government discrimination.\(^8\) Some of these costs of DFI may persist over incremental increases in output as represented by the variable transactions cost \( (t^*) \). Others are incurred upon a subsidiary’s entry in a foreign economy, act as a fixed transaction cost \( (T^*) \). The general cost function of \( Z \) for MNE production is characterized as follows. (1b)

\[
(1b) \quad C^*_z = I + T^* + (w^* + t^*) Z
\]

The home firm acquires \( Z \) in one of three potential market structures (FOR, MNE, or DOM). After a plant start-up cost \( (G) \) is incurred, skilled labor \( (S) \) is combined with \( Z \) to produce \( X \) according to the simple Leontief technology \( X = \min [S, Z] \). Intuitively, \( Z \) can be interpreted as a necessary and irreplaceable component in the production of \( X \), such as a circuit board or automobile steering wheel.

The cost function of \( X \) production depends on the market structure which is endogenous. Arm’s length imports of \( Z \) face a specific tariff \( (\tau_z) \) and are sold by the foreign monopolist at a mark-up price \( (p_z) \). When the home \( X \)-monopolist imports \( Z \) from a foreign producer (FOR market structure) the cost function for \( X \) is as follows:

\[
(2a) \quad C^br_x = G + [s + p_z + \tau_z] X
\]
A domestic vertically-integrated enterprise incurs neither transaction costs nor the Z tariff and can attain Z at its true cost rather than at a monopolistic price. The marginal cost of home Z production (w) will, however, exceed that of foreign Z production (w*). The cost function for the DOM regime is:

\[ C_x^{dom} = G + I + [s + w]X \]

By vertically integrating internationally, the MNE incurs transactions costs and the Z tariff but avoids paying either high-cost unskilled laborers or a monopolistic Z price. The associated MNE cost function is:

\[ C_x^{mne} = G + I + T^* + [s + w^* + t^* + \tau]X \]

Domestic demand for X in both countries is assumed to be linear in price and represented by the function \( X^i = \alpha - p_x \); i=h,f. With free trade, the home-based X monopolist cannot price discriminate but chooses a global price (\( p_x \)). Foreign consumers pay a specific tariff (\( \tau_x^* \)) for X imports; thus \( p_x^* = p_x + \tau_x^* \). Assume foreigners consume \( \beta \) (where \( 0 < \beta < 1 \)) share and home citizens consume \( (1-\beta) \) share of the global X market. Global demand for X, where \( p_x \) is the price of X, is given by:

\[ X = \alpha - p_x - \beta \tau_x^* \]

Since Z is used only in X production and in unit fixed proportions, the demand for Z is also:

\[ Z = \alpha - p_x - \beta \tau_x^* \]

Given the demands of equations 3 and 4 combined with the cost functions in equations 1 and 2a-c, the payoffs of the extensive form game in figure 2 may be calculated.
Production under the FOR regime occurs in the bilateral-monopoly subgame described above. In figure 2 node f.5, the foreign firm moves first by announcing \( p_x \). Next, the home firm treats \( p_z \) as fixed and announces world price \( p_x \). The Stackelberg nature of the home and foreign firms' decision allows a backward solution of this subgame.

Begin with the final move at node h.6 in figure 2; the bilateral-monopoly subgame. The home firm selects \( p_x \) according to the technology of equation 2a and the aggregate demand for \( X \) of equation 3. Profits of the downstream home monopolist under the FOR regime are as follows.

\[
\pi^{\text{for}} = (p_x - p_z - s - \tau_z)(\alpha - p_x - \beta \tau_z^*) - G
\]

Only \( p_z \) is viewed as a choice variable as all other parameters and the decision to import \( Z \), are predetermined in the game. The monopoly price, \( p_x \), is an increasing function of true marginal cost, \( w^z + s^z \). In this equilibrium, however, the \( X \) producer is not taking into account the \( Z \) producer's marginal cost, but rather \( p_z \) which includes a monopoly mark-up. Differentiating and solving for the first order conditions of the home firm's problem, the optimal price of \( X \) is determined as a function of \( p_z \).

\[
\beta_x(p_z) = \frac{1}{2} [\alpha - \beta \tau_x^* + p_z + s + \tau_z];
\]

Profits for the downstream \( X \)-producer can be rewritten by substituting equation 6 into equation 5.

\[
\pi^{\text{for}} = \frac{1}{4} [\alpha - \beta \tau_x^* - p_z - s - \tau_z]^2 - G
\]

At node f.4 in figure 2, the upstream \( Z \)-monopolist maximizes its profits (\( \pi^{\text{for}} \)) by selecting a markup price, \( p_z \), given a conjecture about the proceeding determination of \( p_x \). Note that at node h.6, \( G \) is an unavoidable fixed cost and the home firm enters. In the Stackelberg-Nash equilibrium the foreign
Z monopolist’s conjecture of the price of X is \( p_x(p_z) \), the only credible price. The foreign firm’s profit function is determined by the linear demand for \( Z \) in equation 4 and the \( Z \) cost function in equation 1.

\[
\pi^{for} = (p_z - w^*)[\alpha - \tilde{\beta}_z(p_z) - \beta \tau_z^*] - I
\]

Substituting equation 6 for \( p_x(p_z) \) and differentiating yields the first order condition for profit maximization of equation 8.

\[
\alpha - \frac{1}{2} [\alpha - \beta \tau_z^* + p_z + s + \tau_z] - \frac{1}{2}(p_z - w^*) = 0
\]

From which it follows that:

\[
\tilde{\beta}_z = \frac{1}{2} [\alpha - \beta \tau_z^* - s - \tau_z + w^*]
\]

Given equation 10, the optimal price chosen by the home firm in equation 6 can be rewritten in terms of exogenous parameters.

\[
p_x = \tilde{\beta}_x(p_z) = \frac{1}{4} [3(\alpha - \beta \tau_z^*) + s + \tau_z + w^*]
\]

The equilibrium payoffs of the bilateral-monopoly may also be calculated as functions of exogenous parameters. The FOR regime results in the following home and foreign duopoly profits, respectively.

\[
\pi_x^{for} = \frac{1}{4} [\alpha - \beta \tau_x^* - s - \tau_z - w^*]^2 - G
\]

\[
\pi_z^{for} = \frac{1}{4} [\alpha - \beta \tau_z^* - s - \tau_z - w^*]^2 - I
\]
Global profits of the entire X and Z industry are:

\[
\Pi^\text{for} = \frac{3}{16} [\alpha - \beta \tau^* - s - \tau^* - w^* p^2 - I - G]
\]

Compare the foreign firm's bilateral-monopoly payoff ($\pi^\text{for}$) with its no-entry payoff of zero reveals the optimal choice at node f.4. In equilibrium, the foreign firm produces Z only if its duopoly profits are non-negative. Within this game structure FOR profits are always non-Pareto optimal as the joint surplus of foreign and domestic monopolists are not maximized because of the two successive monopoly mark-ups, as shown in the appendix.

Pareto inefficiency of the noncooperative bilateral-monopoly provides an incentive for the home firm to integrate the ownership of production processes. Vertically-integrated plants make joint profit maximizing decisions which avoid the problem of double-marginalization of prices. In this model, the home firm has two available options: MNE production through a foreign Z subsidiary and DOM production with a domestic Z plant. The home firm selects the best location for the vertically-integrated Z plant at node h.3.

A home-based MNE which engages in DFI by establishing a Z plant abroad has two main advantages: access to low-cost foreign labor inputs and the ability to set jointly profit-maximizing prices. The creation of a foreign subsidiary, however, imposes added fixed and variable transactions costs on the firm. Although a vertical distortion in the X-Z market and differential international factor prices are necessary, these conditions are insufficient to assure equilibrium vertical DFI when offsetting transactions costs are present.

The cost of operating a foreign Z subsidiary includes an initial plant start-up cost (I) and a specific tariff ($\tau_z$). The MNE also pays transaction costs (fixed costs, $T^*$, and marginal costs, $t^*$) above those incurred by the foreign Z monopolist. With demand for X given by equation 3 and the cost
function by equation 2c, the MNE selects $p_x$ to optimize the following profit function.

(14) \[ \pi^{mne} = (p_x - s - w^* - t^* - \tau_s)(\alpha - p_x - \beta \tau_x^*) - I - T^* - G \]

From which it follows, by the first-order condition that:

(15) \[ p_x = \frac{1}{2}[\alpha - \beta \tau_x^* + s + w^* + t^* + \tau_s] \]

The MNE’s global profit is thus given by:

(16) \[ \pi^{mne} = \frac{1}{4}[\alpha - \beta \tau_x^* - s - w^* - t^* - \tau_s]^2 - I - T^* - G \]

Another form of vertical integration is the DOM regime where commonly owned X and Z plants are located at home. The DOM firm is able to set a jointly profit-maximizing price and avoid transactions costs ($T^*$ and $t^*$) of extending equity ownership abroad and the Z import tariff ($\tau_s$). The marginal cost of home Z production ($w$), however, exceeds that of foreign Z production ($w^*$). Combining the DOM cost function, equation 2b, and the X-demand function, equation 3, gives the DOM profit function ($\pi^{dom}$).

(17) \[ \pi^{dom} = (p_x - w - s)(\alpha - p_x - \beta \tau_x^*) - I - G \]

Differentiation results in the first-order condition defining the equilibrium price.

(18) \[ p_x = \frac{1}{2}[\alpha - \beta \tau_x^* + w + s] \]

The home monopolist’s profits can be rewritten in terms of exogenous variables by substituting
equation 18 into equation 17.

(19) \[ \pi_{\text{dom}} = \frac{1}{4}[\alpha - \beta \tau_x^* - w - s]^2 - I - G \]

At the subgame beginning node h.3, the home firm selects the Z plant location which maximizes profits for vertically-integrated production.

This procedure of backwards induction allows us to derive the profits for different choices of market structure (equations 12, 16 and 19) as a function of technology and policy parameters. These profits are the payoffs in the game of figure 2 for which the home firm’s strategy space is Z plant location (node h.3), Z plant ownership (node h.2), and initial X-market entry (node h.1). The subgame-perfect Nash equilibrium to the game determined the equilibrium market structure of this model. The home firm’s endogenous choice of market structure is dependent on several key parameters: I [initial costs of producing Z]; \( T^* \) and \( t^* \) [transaction costs of direct foreign investment]; \( s \) [payments to home’s skilled labor], \( w^* \) and \( w \) [payments to foreign’s, home’s unskilled labor]; barriers to trade as represented by the specific tariffs \( \tau_x^* \) and \( \tau_z \); the unit market demand [of which \( \alpha \) is a proxy]; and \( \beta \) [foreign share of world X consumption].

4. Comparative-Statics and Equilibrium Market Structure

A numerical example illustrates the types of market structures that may arise in equilibrium and what factors influence the equilibrium. In each game in Table 1, foreign consumption comprises 40 percent of output (\( \beta = .40 \)). The market size shift parameter is constant at \( \alpha = 1900 \). Trade in either X or Z incurs a tariff of \( t_x^* = t_z = 10 \). The X plant cost of \( G = 51,584 \) is sufficiently high that a second X firm cannot profitably enter under the post-entry Cournot-Nash equilibrium. Home and foreign low-skilled wages are assumed constant at \( w = 480 \) and \( w^* = 25 \), respectively, while home skilled wages are
502. The first number of each pair in Table 1 is the payoff of the home firm while the second number is the foreign firm's payoff. Payoffs are the equilibrium profits associated with the given market structure.\(^9\)

Z plant costs (I) and fixed DFI transactions costs (T\(^*\)) vary between games in Table 1. While Z start-up costs may be largely determined by market conditions, DFI transactions costs are clearly within the realm of policy influence. Negotiating an initial contract for entry and paying an initial licensing fee are both examples of fixed transactions costs included in T which are levied by the host government. The home country could also conceivably change T by offering DFI subsidies of a fixed nature. Governments are under political pressure to raise revenues, protect local producers, or discipline those engaging in DFI. Either government may consider increasing T to accomplish these goals. The analysis in Table 1, however, will suggest that marginal changes in T may result in disjoined jumps in market structure in the neighborhood of some parameter values. Thus, outcomes of government policy changes may not be as expected.

In case 1 of Table 1 (I=50,000 and T\(^*\)=100,000) the subgame-perfect Nash equilibrium is characterized by the MNE market structure. The fixed costs of DFI are low enough to justify MNE production. For higher I or T\(^*\) the home firm may avoid some of these fixed costs by selecting an alternative market structure.

In case 2, Z plant costs remain at I=50,000 while T\(^*\) is increased to 250,000. Now MNE production is less profitable than domestic vertical integration due to excessive transaction costs of DFI. The foreign firm would profitably enter under the FOR market structure. Home firm profits are improved, however, under domestic vertical integration as the foreign Z-price markup is avoided. Thus the subgame perfect equilibrium is associated with the DOM market structure.
TABLE 1

<table>
<thead>
<tr>
<th>Case 1: I=50,000; T*=100,000</th>
<th>MNE</th>
<th>DOM</th>
<th>FOR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(250,000, 0)*</td>
<td>(107,265, 0)</td>
<td>(63,837, 180,860)</td>
</tr>
<tr>
<td>Case 2: I=50,000; T*=250,000</td>
<td>(100,000, 0)</td>
<td>(107,265, 0)*</td>
<td>(63,837, 180,860)</td>
</tr>
<tr>
<td>Case 3: I=100,000; T*=250,000</td>
<td>(50,000, 0)</td>
<td>(57,265 0)</td>
<td>(63,837, 130,860)*</td>
</tr>
<tr>
<td>Case 4: I=250,000; T*=100,000</td>
<td>(50,000, 0)*</td>
<td>(-92,735, 0)</td>
<td>(63,837, -19,140)</td>
</tr>
</tbody>
</table>

Note:
1. In all cases fixed costs, I and G, are sufficiently high that no additional firm enters the market profitably in the post-entry Cournot-Nash equilibrium.
2. An asterisk indicates a subgame-perfect Nash equilibrium market structure.

In case 3, Z plant costs are raised to I=100,000 while T* remains at 250,000. Now Z is produced abroad and imported, at arm's length, by the home firm under the subgame perfect equilibrium. As marginal costs do not change, the foreign Z monopolist charges the same markup price. The higher Z plant costs are absorbed by the foreign firm.

In case 4, I is raised to 250,000 and T* is lowered to 100,000. The difference for the previous case is that now both an independent foreign Z firm and a home vertically-integrated firm would earn negative profits. MNE profitability is unchanged as lower transaction costs offset increased Z plant costs.

The games 1 to 4 illustrate a relationship between equilibrium market structure and the magnitudes of fixed Z plant and DFI transactions costs. Relatively high fixed costs are associated with arm's length foreign production of Z as analyzed in case 3. Vertical integration results from lowering I relative to T* (cases 1 and 2) or raising I sufficiently to make foreign arm's length production unprofitable (case 4).
FIGURE 3: Z Plant Cost Versus Fixed Transactions Cost

The general results are summarized in figure 3 which shows the equilibrium market structures for various sets of \((T^*, I)\) coordinates. Boundaries between regions define coordinates for which either the home or foreign firm is indifferent between market structures. For example, the boundary between MNE and DOM regions gives the \((T^*, I)\) for which the home firm is indifferent between geographic locations of vertically-integrated Z production. This occurs when home profits \(\pi^{dom}\) and \(\pi^{mne}\) are equal, or when the following equation holds.

\[
\frac{1}{4}(\alpha - \beta \tau_x^* - s - w^* - t - \tau_z^2) - \frac{1}{4}(\alpha - \beta \tau_x^* - s - w)^2 = T^*
\]

Because this expression is independent of \(I\), the boundary is a vertical line. For \((T^*, I)\) coordinates to the left of this boundary the home firm would choose MNE production over domestic vertical integration.
To the right of the boundary, home will not produce Z abroad because of high DFI transactions costs and the DOM may be an equilibrium market structure. The boundary between the MNE and the FOR region and the MNE non-negative profit boundary (dotted) are similarly derived; each as straight lines with slope -1. I and T* costs both enter positively in the MNE’s profit function ($\pi^{mne}$) but are not paid by home when Z is imported at arm’s length.

The boundary between FOR and DOM regions is a horizontal line as profits under either market structure are independent of DFI transaction costs. As in cases 2 and 3 above, the FOR region is associated with higher I than the DOM region as the foreign monopolist incurs these costs. The (T*,I) pairs for which the FOR regime is unprofitable is delineated by the northern boundary (dotted) of this region. One qualification is necessary. For sufficiently low I or T, a second (or more) firm could enter either X or Z markets. This problem is beyond the scope of the paper and these regions are designated with a wavy line.

From figure 3, it is clear that marginally raising T* while holding all other variables constant may lead to a jump in regime from MNE to DOM or FOR equilibrium production. Suppose, for example, the host government wants to increase revenues by imposing an entrance fee on new MNEs and thus raising T*. Only for low initial values of I and T*, will a slight increase in T* increase tax revenues and equivalently lower MNE profits (from equation 16, $\partial\pi^{mne}/\partial T=1$). Foreign is limited in its ability to successfully raise and collect the entrance fee by the X-monopolist’s capacity to select alternative methods of Z production. If the government policy raises T too much the X-monopolist will rule out MNE production in favor of alternative equilibrium market strategies.

It is conceivable that some transactions costs faced by MNEs are variable in nature; growing as output quantity increases. For example, language and cultural differences may impose continuous costs; foreign workers may not be familiar with home management practices; or the host government may place quantity or profit taxes or measures on DFI. The above exercise was repeated for variable transactions
costs (t') and the fixed Z plant cost (I). The result, which are not shown, are very similar in structure to those described in table 1 and figure 3 (l versus T') with one important distinction. The boundary which separates FOR and MNE equilibrium regimes is a quadratic, rather than linear, function of t.\textsuperscript{11}

As before, MNE production will dominate for relatively low variable transactions costs. For higher transactions costs, the home firm selects an alternative regime. In this case, the preferred ownership of Z production depends on the level of fixed Z plant costs. For example, domestic vertical-integration is the equilibrium outcome for high variable transactions costs and low Z plant costs.

FIGURE 4: Home versus Foreign Wages

Similarly, boundaries of indifference between market structures are derived in unskilled worker wage space (w, w') in figure 4. The primary reason for locating labor intensive processes abroad is the availability of low cost labor. When the differential between home and foreign wages is wide, a foreign monopolist has a greater ability to mark prices above marginal cost according to demand elasticities. An
MNE will likely arise when foreign wages are relatively low. As home and foreign wages become more similar, the profit opportunities for a foreign firm diminish, making arm’s length Z exports more likely.

This intuition corresponds with figure 4 in which only non-negative profit regions are considered. The boundary between DOM and MNE regimes, is a strictly convex quadratic function with positive slope for values of w and w' yielding a positive root. To the left of this curve, the subgame-perfect equilibrium solution is a domestic vertically-integrated home firm. Foreign wages are not low enough to compensate for the transportation and transactions costs incurred by an MNE. As foreign wages fall, or equivalently home wages rise, an MNE is more likely to arise. This is the result obtained in Helpman’s (1985) model of vertically-integrated MNE plant location.

The global wage boundary between a domestic vertically-integrated equilibrium (DOM) and an equilibrium with arm’s length foreign exports of the Z input (FOR) also has a positive slope and curvature. In this case, the benefits from wage differentials must outweigh the cost of foreign duopoly pricing and transportation before the FOR regime is an equilibrium outcome. Finally, the boundary between FOR and MNE equilibrium outcomes is horizontal at a threshold foreign wage. Above this threshold the cost of double marginalization under the FOR regime is less than the transactions cost of becoming an MNE.
5. Summary and Conclusions

The purpose of this paper is to demonstrate, through a simple theoretical model and several numerical examples, how plant location and ownership decisions can be endogenized in a model with globally, vertically-related markets. An industry is described in which a firm chooses to either domestically integrate final and intermediate goods production, to become a vertically-integrated MNE, or to obtain intermediate inputs from a foreign monopoly supplier. Vertical integration occurs to avoid foreign monopolistic markups on an intermediate good. Taking into account rational conjectured beliefs regarding the foreign supplier’s actions, the home firm compares potential profitability under the range of plant location and ownership options for the low-skilled labor-intensive intermediate good. Relevant parameters include domestic and foreign wages, fixed plant costs at both stages of production, tariff barriers and market size, and intermediate transactions costs of direct foreign investment. The set of equilibrium market structures which emerge depends endogenously on the parameters of the model.

As a result, marginal changes in parameter specifications may lead to jumps in market structure and thus discontinuities in the home and foreign firms’ profit functions. For example, a firm tends to vertically integrate when plant costs are low while arm’s length transactions with a foreign monopolist are more prevalent for high fixed costs. MNE equilibrium production is associated with low transactions costs of direct foreign investment. Plant and ownership decisions are also endogenous to factor prices, such as low-skill labor costs. The international division of labor is enhanced when factor price differentials are large as DFI transactions costs or foreign monopoly markups are more likely offset by factor cost savings.

Several important policy implications are relevant. Consider the potential effect of the North American Free Trade Agreement (NAFTA) on international business decisions. With freer trade from tariff and non-tariff barrier reductions in the region, Stolper-Samuelson type models would predict that factor prices will become more similar within North America. This model suggests that some
international firms will move labor-intensive plant operations from Mexico, with rising low-skilled labor costs, to the United States or Canada whose labor costs are falling. Under NAFTA, however, North American investors will receive the more favorable of national or Most Favored Nation (MFN) treatment in setting up operations or acquiring firms in Mexico, excluding energy and rail sectors (Hufbauer and Schott 1993). This substantially lowers transactions costs of direct foreign investment, thus offsetting factor price influences on DFI in Mexico. According to this model, the net effect on aggregate DFI within the region is ambiguous. As a future research agenda, likely plant location and ownership response to NAFTA could be computed on an industry by industry basis with relevant parameter data.

Another area of inquiry for future research concerns the policy implications of endogenous vertical market structure. This task requires a general-equilibrium model of national welfare for both DFI home and host. An initial policy game would determine equilibrium tariff rates and investment measures. Non-cooperative outcomes could be compared to cooperative solutions achievable through bilateral negotiation.

This paper attempts to model international vertical integration as an endogenous outcome. Such efforts are essential if we are to understand the complex and ever-changing market configurations that arise from an increasingly interwoven international economy. It is hoped that by grounding the study of DFI more thoroughly in an imperfectly competitive framework such as this, a more realistic analysis of policy will result.
ENDNOTES

1. For example, Marton (1986) surveys MNEs in petroleum and mineral processing, pharmaceuticals, mechanical equipment, automobiles and microelectronics. She observes that intra-firm labor-intensive assembly operations are frequently undertaken in developing economies while developed market economies shoulder more technically advanced operations. Casson, et al. (1986) reaches similar conclusions from case studies in motor vehicle, banana, and shipping industries.

2. Kindleberger (1979) and Caves (1982) provide an excellent review of the literature on MNE disadvantages.

3. Empirical evidence of these differential costs and supplemental MNE specific assets is provided for foreign and domestic firms in Mexico by Blomström (1989).

4. See Dixit and Norman (1980, chapter 4) for a discussion of non-factor price equalization in an endowment model.

5. In the presence of fixed costs, average costs are higher than marginal costs. Thus this condition will hold even if $Z$ is produced in monopolistically-competitive industries with zero economic profits.

6. A form of this model originates with Spengler, J. (1950). This standard treatment captures the main elements of the vertical distortion caused by a bilateral-duopoly.

7. One might assert that the home firm could attempt to influence $p_x$ earlier in the game but such threats are incredible.

8. See Maskus and Eby (1990) for a detailed discussion of the scope of current trade-related investment measures (TRIMs) and the perspective an international agreement to discipline TRIMS.

9. Throughout the paper, the model is robust to economically-feasible variations in initial parameter values.

10. The non-negative profit boundary of the DOM regime is not binding for the given parameter assumptions.

11. The boundary's slope is $\frac{\partial I}{\partial t^*} = -\frac{1}{2}[\alpha - \beta t^*_x - w^* - s - t^* - \tau^*_x]^2$ while the curvature is $\frac{\partial^2 I}{\partial t^2} = \frac{1}{2}$ (strictly convex).

12. The boundary has slope and curvature, respectively, as follows:

$$\frac{\partial w^*}{\partial w} = \frac{\alpha - \beta t^*_x - s - w^* - t^* - \tau^*_x}{\alpha - \beta t^*_x - s - w}$$

and $\frac{\partial^2 w^*}{\partial w^2} = 1.$
13. The boundary has slope and curvature, respectively, as follows:

\[
\frac{\partial w^*}{\partial \varphi} = \frac{4[\alpha - \beta r_x^{*} - s - w]}{\alpha - \beta r_x^{*} - s - w^* - \tau_z}
\]

\[
\frac{\partial^2 w^*}{\partial \varphi^2} = \frac{1}{4}.
\]

and
REFERENCES


Appendix

To understand the distortion caused by successive price markups (\(p_x\) and \(p_z\)) in the FOR equilibrium, contrast the results of equation 13 with the global profits available if firms could credibly cooperate. Suppose the home and foreign firms are able to collaborate in X and Z manufacturing. Perhaps a contract is drafted to allow home to import Z at the marginal cost of production (\(w^* + \tau_z\)). For this privilege, home transfers an agreed upon lump-sum payment to the foreign producer at least sufficient to cover Z-plant cost (I). The home duopolist will now maximize joint (home and foreign firm) profits while considering true marginal costs of production.

\[(A1)\]
\[\Pi^{\text{join}} = (p_x - s - w^* - \tau_z)(\alpha - p_x - \beta \tau_x^*) - G - I > 0\]

Solving for the first-order condition, the optimal final good price is

\[(A2)\]
\[p_x = \frac{1}{2} [\alpha - \beta \tau_x^* + s + w^* + \tau_z]\]

It follows that joint-equilibrium profits (\(\Pi^{\text{join}}\)) are:

\[(A3)\]
\[\Pi^{\text{join}} = \frac{1}{4} [\alpha - \beta \tau_x^* - s - w^* - \tau_z]^2 - I - G > 0\]

These global profits exceed those available in a non-cooperative framework (equation 13). With an adequate contract, global profits are shared by home and foreign monopolists. In contrast, a non-cooperative game results in two successive price markups and thus final good output is lower than is jointly optimal. As is commonly recognized, a chain of monopolies diminishes industry profits (Spengler (1950)). The home duopolist has an incentive to consider alternative regimes in order to gain some of the profits lost in bilateral monopoly pricing under the FOR regime.