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# The complex integration strategies of multinationals and cross country dependencies in the structure of foreign direct investment

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**Abstract**

The behavior of many multinational enterprises is not well described by existing models of foreign direct investment (FDI). Firms often follow strategies that involve vertical integration in some countries and horizontal integration in others, a strategy known as complex integration. This paper presents a three-country model that is used to analyze why firms might follow a strategy of complex integration. My analysis reveals that complex integration strategies create complementarities between potential host countries that have important implications for the structure of FDI. The analysis also shows that falling transport cost between countries may increase the importance of complex integration strategies.


*Keywords:* Multinationals; Foreign direct investment

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## 1. Introduction

The theory of foreign direct investment (FDI) is built largely on two motives for firms to expand abroad. Some multinational enterprises (MNE) arise to exploit

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factor price differences across countries. These MNE are called *vertically integrated* because they fragment their production process vertically across countries. Some MNE arise to avoid the costs of international trade. These MNE are called *horizontally integrated* because they replicate an identical production process across countries. The structure of FDI that arises from these two motives has been thoroughly explored in two-country general equilibrium models.[1]

In its annual monograph, the *World Investment Report* (1998), the United Nations' Center for Transnational Corporations identifies a third type of MNE. According to these reports, MNE increasingly follow what they call *complex integration strategies*. These MNE are both horizontally and vertically integrated, establishing affiliates in some foreign countries to conserve on transport cost and establishing affiliates in others to take advantage of factor price differentials. The authors of the report (p. 112, 1998) state that as more companies follow this strategy,

> . . . it is getting increasingly difficult to point to a single locational determinant. Instead, [MNE following complex integration strategies] blur the lines between traditional clusters of economic determinants as the boundaries between types of FDI disappear.

Under what circumstances are firms likely to follow complex integration strategies? Can we say more about how these strategies affect the structure of FDI across countries? These questions have been largely neglected in the theoretical literature.[2]

To address these questions, I consider a three-country framework in which transport cost gives rise to the horizontal motive between one set of countries while factor price differentials gives rise to the vertical motive between another. Firms from one developed, northern country may invest in another developed, northern country (horizontal integration), or they may invest in a developing, southern country (vertical integration), or they may invest in both (complex integration), or they may not invest abroad at all (national). The answer to both of the questions posed above follows from one key insight: north–north and north–south FDI reduce the cost of serving international markets in complementary ways, creating a complementarity between the two forms of FDI. Firms that undertake vertical (horizontal) foreign investments lower their unit costs and thereby expand their sales. Having expanded the number of units sold, these firms

[1] See for instance, Helpman (1984), Markusen (1984), Horstmann and Markusen (1987, 1992), Brainard (1993), Venables (1999), and Markusen and Venables (2000).

[2] There are, however, several interesting empirical papers on this phenomenon (e.g. Brainard and Riker, 1997), which report results consistent with the predictions of my model. One theoretical paper that focuses on the interaction between these two motives within a *single* country is Zhang and Markusen (1999).

stand to gain proportionately more by further reducing their unit cost by undertaking horizontal (vertical) foreign investments.

Complex integration strategies dominate other foreign investment strategies when the level of transport costs fall within an intermediate range. Low transport costs encourage vertical FDI by making the use of low cost southern labor attractive while high transport costs encourage horizontal FDI by making international trade expensive. When transport costs lie between these extremes, neither the vertical nor the horizontal motive is by itself sufficient to encourage firms to invest abroad so that FDI is only viable when firms take advantage of the complementarity between north–north and north–south FDI by investing in both locations.

Complex integration strategies create dependence between the level of FDI in one country and the characteristics and policies of its neighbors, and this dependence has important implications for the structure of FDI across countries. The nature of this dependence can take two forms: two locations may either be complements or substitutes. Two locations are complements when events in one country that expand (contract) MNE activity in that country also expand (contract) MNE activity in the other and are substitutes when events in one country that expand (contract) MNE activity in that country also contract (expand) MNE activity in the other. My analysis shows that whether the two foreign locations are substitutes or complements depend critically on the initial level of transport cost.

These results have important implications for empirical research into the determinants of FDI. Complex integration strategies expand the determinants of FDI from the level of the country to the level of the neighborhood, but the effect of a country's neighborhood is a function of industry characteristics such as the level of transport cost, the factor intensity of production, and the cost of investing abroad. As a result, the complete set of FDI determinants includes both country and neighborhood characteristics, and these determinants interact differently across industries. Moreover, as transport costs have fallen, it is possible that locations that were once substitutes may have become complements so that the determinants of FDI may have indeed 'blurred' as the authors of the quote above maintain.

The rest of the paper is organized into four sections. In Section 2, I outline the model. In Section 3, I consider the model in a partial equilibrium setting to expose the potential dependencies that arise between locations. In Section 4, I consider the model in general equilibrium and perform several comparative statics that illustrate the effects of cross-country dependencies on the structure of FDI. The final section discusses the model's implications, provides recommendations for further research, and concludes.

## 2. The model

Since firms can only follow a complex integration strategy if there are multiple foreign locations in which to invest, I consider a three-country framework in which

firms from one country may invest in two possible foreign locations. As in standard trade models, there are two industries: one composed of perfectly competitive firms that produce a homogeneous good that is freely traded internationally, and the other composed of monopolistically competitive firms producing differentiated varieties that are costly to ship internationally. MNE arise only in this second industry.

There are three countries, two factors, and two sectors. Two of the countries are identical and are collectively labeled 'the north.' Following Markusen (1986), I label these countries East and West. The remaining country is 'the south.' Let the subscript $j$ indicate the country: east (E), west (W) or south (S). Each country is endowed with labor $L_j$ and skill $H_j$ with factor prices $W_j$ and $R_j$. Southern labor is the numeraire, so $W_S = 1$. Factors are mobile between sectors but immobile internationally. Northern countries are relatively skill abundant and the distribution of factors between north and south is sufficiently skewed that north–south factor price equalization does not obtain.[3]

There are two traded final goods, X and Y. Good Y is homogeneous, is produced by perfectly competitive firms using a technology that exhibits constant returns to scale, and requires both labor and skill in its production. International trade in good Y is assumed to be costless so there is a single global price for Y. The technology used to produce Y also has the feature that both factors must be located at the same production site. The unit cost function for good Y is assumed to be

$$C_Y(W, R) = W^{\eta} R^{1-\eta} \tag{1}$$

It is in the X sector that multinationals may arise. Goods in the X sector are differentiated by variety and the producers of these varieties are monopolistically competitive. Entry into the X sector requires a firm to employ G units of skill to invent a new variety. Like Y, the production of X requires both labor and skill. Unlike Y, the two factors need not be located at the same site for production of X to take place because good X can be costlessly assembled from two intermediate inputs, one that requires only labor and another that requires only skill.[4] Both of these intermediates are potentially traded. The unit cost function for a unit of final output of X is assumed to be

$$C_X = C_{I1}^{\lambda} C_{I2}^{1-\lambda} \tag{2}$$

where $C_{I1}$ is the unit cost of the component that uses only labor and $C_{I2}$ is the unit cost of the component that uses only skill. It is the ability of firms to split the

[3] Factor price equalization does obtain between each of the two identical northern countries.

[4] This assumption can easily be generalized so that both factors are used in each intermediate good but with different factor intensities. This alternate assumption requires additional notation, making the exposition difficult and so is not considered here.

production process in this manner that gives rise to the potential for vertically integrated firms.[5]

Sector X also differs from sector Y in that there is an iceberg-type transport cost that afflicts X sector goods. These shipping costs create the motive for horizontal integration but dull the motive for vertical integration by making intermediates more costly to ship. For one unit of either an intermediate or final good to arrive at a foreign destination, $\delta > 1$ units must be sent. This transport cost proxies for a variety of costs associated with international trade but not associated with FDI. These costs include physical shipping cost, information costs associated with being distant from one's customers, and the cost associated with the potential for delayed delivery. In the case of intermediate goods, the cost of being far from the downstream users of an intermediate may also stem from any delay in receiving output. I assume initially that these transport costs for intermediate and final goods are identical, leaving the case when they differ to a comparative static exercise.

The act of investing abroad requires the investing firm to incur an additional fixed cost. The form of this cost is an additional administrative burden on the home office associated with managing each additional foreign plant. I allow these fixed costs to vary across countries so that $\theta_S$ units of skill is required to open a plant in the south and $\theta_N$ units of skill is required to open a plant in the other northern country.

Strong assumptions over preferences are necessary to keep the analysis tractable. The north consumes both X and Y while the south consumes only Y.[6] I assume that the preferences of northern consumers take the following functional form:

$$U = Y^{\beta} X^{1-\beta}, X = \left( \sum_{i=i}^{N} x_i^{\alpha} \right)^{1/\alpha}, \alpha = 1 - \frac{1}{\sigma}, \quad \text{and} \quad \sigma > 1. \tag{3}$$

Given these preferences, the demand for a variety '*i*' of an X good in a single northern market is given by

[5]The production structure is kept as simple as possible to bring out the nature of dependence. A more realistic production structure might have a high skilled intermediate that can only be produced at home and must be combined with a low skilled intermediate to form a composite intermediate. This structure would resemble the partial assembly of goods seen in many electronics industries. This structure makes the exposition considerably more difficult but actually increases the importance of complementarity by dulling both the vertical and horizontal motives for FDI vis-a-vis the fixed cost of investing abroad. An alternative interpretation of the stages of production here are that the skill intensive stage involves marketing a finished good that may be produced in either the north or the south.

[6]While adopted purely to simplify the model, this assumption can be motivated by the idea that differentiated products are more likely to be luxuries. Given non-homothetic preferences, horizontal FDI is more likely between similarly endowed (rich) countries. This topic is explored in Markusen (1986). This assumption is more appropriate for some goods, such as computers, than others, such as food products.

$$x_i = (1-\beta)E_N q^{\sigma-1} p_i^{-\sigma}, \text{ where } q = \left(\sum_{i=1}^{N} p_i^{1-\sigma}\right)^{1/1-\sigma} \quad (4)$$

and $E_N$ is the total factor income in each of the northern countries, $p_i$ is the price of variety '$i$', and $q$ is the price index for X sector goods.

## 3. Profit-maximization in the X-sector

In order to illustrate the nature of cross-country dependencies in the pattern of FDI, I begin my analysis by considering equilibrium in the MNE sector at fixed factor prices. I focus on the factors affecting the FDI decisions of a firm originating from one of the two northern countries that may invest in up to two foreign locations, the other northern country and the south.

### *3.1. Profits by firm type*

We begin by deriving the profits associated with each of the four possible firm types. As is well known, if monopolistic competitive firms take the industry price index as given, their profit maximizing price is a constant mark-up over unit cost, $p_i = C_i/\alpha$. This pricing policy then yields the following profits for the producer of variety $i$:

$$\pi_i = \frac{(1-\beta)\alpha^{\sigma-1}}{\sigma} E_N q^{\sigma-1}\{(C_{iE})^{1-\sigma} + (C_{iW})^{1-\sigma}\} - R_N F_i \quad (5)$$

where $F_i$ is the fixed cost in terms of northern skill incurred by the producer of variety $i$, $C_{iE}$ is the unit cost faced by this producer for serving the eastern market and $C_{iW}$ is the unit cost of serving the western market. In equilibrium, the price index $q$ is the same in both of the two identical countries but the price charged by any individual firm in each of the two countries will depend on the production location decisions of that firm.

Firms may differ in two dimensions. First, firms may differ in where they produce the low skill intensive intermediate. Recall that southern labor is the numeraire so that $W_S = 1$. Let the unit cost of serving the home market for firms that have a southern affiliate be $C_S$ ($C_{I1} = \delta$), and let the unit cost of serving the home market for firms that produce exclusively in the north be $C_N$ ($C_{I1} = W_N$). These unit costs are

$$C_N = W_N^{\lambda} R_N^{1-\lambda} \quad (6)$$

$$C_S = \delta^{\lambda} R_N^{1-\lambda} \quad (7)$$

Note that $C_S < C_N$ only if $\delta < W_N$. I assume that this is the case.

Firms may also differ in whether they have an affiliate in the other northern

country. The unit costs of firms in their home market must be either Eqs. (6) or (7) because there is no motive for serving the home market from a foreign affiliate in the other northern country. The unit cost of serving the other northern market will either be the same as in the home market if the firm opens an affiliate there, or will be the unit cost at home adjusted for transport cost.

Finally, firms differ in the fixed costs they incur. Firms hire $G$ units of skill to enter, plus $\theta_N$ units of skill if they open a northern affiliate and $\theta_S$ units of skill if they open a southern affiliate. Table 1 summarizes the relevant information concerning the profitability of alternative strategies in the X-sector.

As long as southern labor is sufficiently cheap, firms that follow the complex integration strategy have the lowest unit cost of serving global markets but the highest fixed costs. National firms, those that have no foreign affiliates, have the highest unit costs but the lowest fixed costs. The costs of horizontally and vertically integrated firms lie within these two extremes.

Combining the information in Table 1 with Eq. (5), we obtain the zero profit conditions for each type of firm. Letting $A = (1-\beta)\alpha^{1-\sigma}\sigma^{-1}E_N q^{\sigma-1}$, these conditions become

$$\text{National firms: } (C_N)^{1-\sigma}\left(1+\delta^{1-\sigma}\right)A - R_N G \leq 0 \tag{8}$$

$$\text{Horizontal MNE: } (C_N)^{1-\sigma}2A - R_N(G+\theta_N) \leq 0 \tag{9}$$

$$\text{Vertical MNE: } (C_S)^{1-\sigma}\left(1+\delta^{1-\sigma}\right)A - R_N(G+\theta_S) \leq 0 \tag{10}$$

$$\text{Complex MNE: } (C_S)^{1-\sigma}2A - R_N(G+\theta_S+\theta_N) \leq 0 \tag{11}$$

Eqs. (6)–(11) provide all the information needed for the analysis in this section.

Table 1
Cost configurations by firm type

| | Home market unit cost | Foreign market unit cost | Total fixed cost, $F$ |
|---|---|---|---|
| No foreign plants (national firms) | $C_N$ | $C_N\delta$ | $G$ |
| Northern only (horizontal Integration) | $C_N$ | $C_N$ | $G+\theta_N$ |
| Southern only (vertical Integration) | $C_S$ | $C_S\delta$ | $G+\theta_S$ |
| Both foreign (complex integration) | $C_S$ | $C_S$ | $G+\theta_N+\theta_S$ |

### 3.2. The complementarity between north–north and north–south FDI

I now show that there is a tendency for FDI in the south and the north to be complements. One way to observe this complementarity between FDI in the north and the south is to compare the change in profits associated with having an affiliate in the other northern country for firms with and without a southern affiliate. Subtracting Eq. (8) from Eq. (9), we find the gain in profits of a national firm that becomes a horizontal MNE is

$$C_{\mathrm{N}}^{1-\sigma}A\left(1-\delta^{1-\sigma}\right)-R_{\mathrm{N}}\theta_{\mathrm{N}} \tag{12}$$

The increase in profits associated with going from a strategy of vertical integration to a strategy of complex integration is found by subtracting Eq. (11) from Eq. (10), which yields

$$C_{\mathrm{S}}^{1-\sigma}A\left(1-\delta^{1-\sigma}\right)-R_{\mathrm{N}}\theta_{\mathrm{N}} \tag{13}$$

The complementarity between investments in the two locations can be seen by comparing Eqs. (12) and (13). Difference of Eq. (13) is greater than Eq. (12) because $C_{\mathrm{S}}<C_{\mathrm{N}}$. Firms that have a southern plant have lower unit costs than those that do not and so expand their sales. Having expanded the number of units sold, they gain proportionately more by lowering their unit cost further by having a plant in the other northern country.

This complementarity is also evident when one compares the profit difference between national and vertically integrated firms to the profit difference between horizontal and complex MNE. Subtracting Eq. (8) from Eq. (10), we find the gain in profits going from a national to a vertically integrated firm is

$$\left(1+\delta^{1-\sigma}\right)A\left(C_{\mathrm{S}}^{1-\sigma}-C_{\mathrm{N}}^{1-\sigma}\right)-R_{\mathrm{N}}\theta_{\mathrm{S}} \tag{14}$$

while the gain in profits going from a horizontal integration strategy to a complex integration strategy, Eq. (11) less Eq. (9), is

$$2A\left(C_{\mathrm{S}}^{1-\sigma}-C_{\mathrm{N}}^{1-\sigma}\right)-R_{\mathrm{N}}\theta_{\mathrm{S}} \tag{15}$$

Because $\delta>1$, Eq. (14) is less than Eq. (15) so the profit gain from opening a second foreign affiliate is greater than the profit gain from opening the first.

While the model presented here is somewhat specific (i.e. identical northern countries, no consumption in the south, etc.), the intuition appears to be more general. Having increased their sales via one method of cost reduction, firms stand to gain even more by lowering their unit cost of production further since the unit cost reduction is applied to a larger number of units of output.[7]

[7]Economies of scale in the fixed cost to opening foreign plants would only reinforce this complementarity.

### 3.3. Firm type viability and industry characteristics

Analyzing the choice of firms over four possible locational configurations would seem an intractable task. In this section, I show that the analysis can be simplified by considering the profitability of each locational configuration as a function of industry characteristics ($\delta$, $\theta$, $\lambda$, $\sigma$, and $G$) alone. I find that given a configuration of industry characteristics at least two firm types are strictly dominated by at least one other so that the set of potentially viable locational configurations never has more than two elements. I also show how the firm types in this set vary with industry characteristics. The section that follows this one implement the second stage of this analysis, which is to show how relative factor prices across countries pin down which of the two potentially viable firm types actually appear in equilibrium.

Consider first the condition derived by Brainard (1993) that would have to hold for both national and horizontally integrated MNE to coexist. By dividing Eq. (9) by Eq. (8) and rearranging, I obtain

$$\delta_U = \left(\frac{1+\theta_N/G}{1-\theta_N/G}\right)^{1/\sigma-1} \tag{16}$$

Eq. (16) relates the level of transport costs, $\delta_U$, that make firms indifferent between being a national firm and being a horizontal MNE. For any $\delta > \delta_U$ all firms strictly prefer to be a horizontal MNE than to be a national firm while the opposite is true for any $\delta < \delta_U$. Hence, we can eliminate one firm type on the basis of $\delta$ relative to $\delta_U$.

Now consider the condition that must hold for firms to be indifferent between following a strategy of vertical integration and a strategy of complex integration. Dividing Eq. (10) by Eq. (11) and rearranging yields

$$\delta_L = \left(1+\frac{2\theta_N/G}{1+\theta_S/G-\theta_N/G}\right)^{1/\sigma-1} \tag{17}$$

For any $\delta > \delta_L$, firms strictly prefer to follow a strategy of complex integration to a strategy of vertical integration while the opposite is true for $\delta < \delta_L$. Hence, we can eliminate another firm type on the basis of the level of transport costs relative to $\delta_L$.

Conditions (16) and (17) can be compared directly because they are functions of purely exogenous variables. It is easily confirmed that our assumption that the fixed cost of entry is greater than the fixed cost of expanding abroad, $G > \theta_N$, $\theta_S$, implies $\delta_U > \delta_L$. Vertical MNEs are potentially viable only when transport costs are very low ($\delta < \delta_L$), complex MNE are potentially viable only when $\delta > \delta_L$ and purely horizontal MNEs are potentially viable only when transport costs are very high ($\delta > \delta_U$). By process of elimination I have established that when transport costs are in the moderate range $\delta \in (\delta_L, \delta_U)$ the only MNE that can ever be

observed are those that follow a strategy of complex integration. I summarize this result in the following proposition:

**Proposition 1.** *When $\delta < \delta_L$, only national and vertical firms are potentially viable, when $\delta > \delta_U$, only firms following horizontal and complex integration strategies are potentially viable and when $\delta \in (\delta_L, \delta_U)$ only national firms and firms following complex integration strategies are potentially viable.*

I define a *regime* as a set of the two firm types that are potentially viable in equilibrium given only industry characteristics. Proposition 1 establishes that there are three regimes, one in which only vertical and national firms can be observed (regime VN), one in which only complex and national firms can be observed (regime CN), and one in which only complex and horizontal firms can be observed (regime CH). Each regime corresponds to a range of transport costs: $\delta < \delta_L$, $\delta \in (\delta_L, \delta_U)$, and $\delta > \delta_U$. Within each regime it may be that only one of the two potentially viable firm types appears in equilibrium. Determining which of these firm types exists in equilibrium is the subject of the next section.

### *3.4. North–south factor price differentials and FDI*

In each of the three regimes just defined, one of the two potentially viable location configurations involved the production of intermediate goods in the south while the remaining potentially viable location configuration did not. In this section, we derive the conditions under which firms produce intermediates in the south, which is equivalent to establishing conditions for which firm type within a regime is actually observed. Obviously, southern production will only occur when southern labor is sufficiently cheap. More interestingly, the magnitude of wage differentials between the north and the south necessary to induce southern production will vary with industry characteristics.

The exercise here is to derive a Wage Threshold Function (WTF) that specifies the relative wage of northern to southern labor that makes firms indifferent to having a southern affiliate for any given level of transport cost. To derive the WTF, I use the relevant zero profit conditions in Eqs. (8)–(11) for each of three regimes found in Proposition One. By substituting Eqs. (6) and (7) into Eqs. (8)–(11), setting the profits of potentially viable firms to zero, and manipulating the resulting expressions, I find that the WTF is given by

$$\text{For } \delta < \delta_L,\ W_N = \delta\left(1 + \frac{\theta_S}{G}\right)^{1/\lambda(\sigma-1)} \tag{18}$$

$$\text{For } \delta \in (\delta_L, \delta_U),\ W_N = \delta\left(\frac{1+\delta^{1-\sigma}}{2}\right)^{1/\lambda(\sigma-1)}\left(1 + \frac{\theta_S + \theta_N}{G}\right)^{1/\lambda(\sigma-1)} \tag{19}$$

$$\text{For } \delta > \delta_U, W_N = \delta\left(1 + \frac{\theta_S/G}{1+\theta_N/G}\right)^{1/\lambda(\sigma-1)} \tag{20}$$

For any $W_N$ greater than that given by the WTF in Eqs. (18)–(20), firms strictly prefer to have a southern affiliate while the opposite is true for any $W_N$ less than that given by the WTF.

There are several features of the WTF that are worth noting. First, the WTF switches continuously in $\delta$ from Eqs. (18) to (19) when $\delta$ is given by Eq. (16) and from Eqs. (19) to (20) when $\delta$ is given by Eq. (17).[8] Note that both Eqs. (18) and (20) are increasing in $\delta$, that Eq. (18) is greater than Eq. (20) for any level of $\delta$, and that Eq. (19) may be increasing or decreasing in $\delta$. Whether the WTF is monotonic in $\delta$ is determined by $\lambda$, the cost share of labor-intensive intermediates in output. Differentiating Eq. (19) yields

$$\text{sgn}\left(\frac{dW_N}{d\delta}\right) = \text{sgn}\left\{\lambda - \frac{1}{\delta^{\sigma-1}+1}\right\} \tag{21}$$

By Eq. (21), the WTF is monotonic when $\lambda$ is large and non-monotonic otherwise. The potential non-monotonicity arises because the motive for FDI in regime CN is a mixture of both the vertical and horizontal motives, where $\lambda$ measures the relative importance of the vertical motive to the horizontal motive.

### *3.5. The structure of foreign direct investment at fixed factor prices*

The information about the structure of FDI derived in the previous two sections is summarized in Fig. 1. The two graphs show the three regimes, the WTF (shown in bold), and the locational outcomes that correspond to levels of the northern relative wage (the vertical axis) and the transport cost (the horizontal axis). The two panels correspond to where the WTF is monotonic ($\lambda$ high) and where it is not ($\lambda$ low).[9]

I first summarize the similarities of these two cases in the following Proposition:

**Proposition 2.** *National firms occur when transport cost, $\delta$, is low to moderate (regimes VN and CN) and the relative wage of northern labor in terms of southern labor, $W_N$, is low. Vertical MNE occur when $\delta$ is low (regime VN) and $W_N$ is high. Horizontal MNE occur when $\delta$ is high (regime CH) and $W_N$ is low. Finally,*

[8] To show that the WTF is continuous in $\delta$, substitute Eq. (16) into Eqs. (18) and (19); and Eq. (17) into Eqs. (19) and (20).

[9] Note there is a third case (not shown) in which the sign of the slope of the wage threshold occurs in the intermediate range of transport costs. This is because Eq. (21) is a function of the level of transport costs.

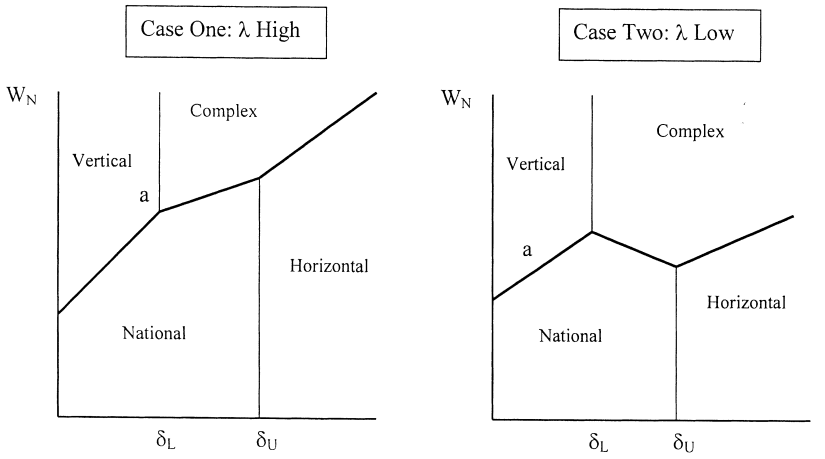


Fig. 1. Integration strategies, transport cost, and relative labor cost.

*complex MNEs occur when δ is moderate to high* (*regimes CN and CH*) *and* $W_N$ *is high.*

To fully understand the effect of industry characteristics on the structure of FDI, I now consider how changes in the fixed cost of investing abroad alter Fig. 1. An increase in $\theta_S$, the fixed cost of investing in the south, has two consequences. The first is to shift the WTF up for all $\delta$ because for higher $\theta_S$ the south must have a greater unit cost advantage to producing intermediates to induce firms to invest there. The second is to shift $\delta_L$ to the left, expanding the CN regime at the expense of the VN regime. A higher fixed cost of investing in the south makes the complementarity between northern and southern investments more important to FDI in the south, and therefore increases the range of $\delta$ over which FDI in the north can be found. An increase in $\theta_S$ may therefore cause a *regime shift* favoring FDI in the north.

An increase in $\theta_N$, the fixed cost of FDI in the north, has two consequences for Fig. 1. The first is to shift the WTF down for $\delta > \delta_L$. The second consequence, which can be confirmed by differentiating Eqs. (16) and (17), is to increase both $\delta_L$, which expands the VN regime at the expense of the CN regime, and $\delta_U$, which expands the CN regime at the expense of the CH regime. Hence, an increase in $\theta_N$ may lead to a *regime shift* that favors FDI in the south. Note that $\delta_U$ increases by more than $\delta_L$, so that the CN regime occurs over a wider range of $\delta$. As north–north FDI becomes less attractive, its viability becomes more dependent on its complementarity with north–south FDI. I summarize these results in the following Proposition.

**Proposition 3.** *An increase in the fixed cost of investing in either the north or the*

*south extends the range of transport costs over which the only type of MNE that are viable in equilibrium are those that follow a complex integration strategy.*

The complementarity between north–north and north–south FDI can also be seen in the non-monotonicity of FDI with respect to transport cost, $\delta$. When $\lambda$ is high (the left-hand panel of Fig. 1) north–north FDI may be non-monotonic in $\delta$. To see this, consider a pair ($\delta$, $W_N$) in the vertical FDI region near the southwest portion of the complex FDI region such as point 'a.' Holding $W_N$ fixed, increase $\delta$. When $\delta$ rises above $\delta_L$, north–north FDI *rises* because the *regime switches* from VN to CN. With further increases in $\delta$ we may leave the complex region of the CN regime for the national region, leading to a *within regime* collapse of northern FDI. This collapse occurs because horizontal FDI is only viable through its complementarity with vertical FDI in regime CN and the vertical motive, which is relatively more important when $\lambda$ is large, is discouraged by high $\delta$. Further increases in $\delta$ may lead to a *regime switch* from CN to CH ($\delta > \delta_U$) so that north–north FDI returns.

When labor intensive components have a small cost share in final output ($\lambda$ low), north–south FDI may be non-monotonic in $\delta$. To see this, consider a pair ($\delta$, $W_N$) in the vertical FDI region near the lower corner of the complex FDI region in the right-hand panel of Fig. 1, such as point 'a'. Initially, an increase in $\delta$ decreases north–south FDI as we leave the vertical for the national region of the VN regime. Increasing $\delta$ further results in a *regime shift* from VN to CN. *Within the CN regime* north–south FDI may not occur until $\delta$ becomes large because a small $\lambda$ makes the horizontal motive, which is encouraged by higher $\delta$, more important than the vertical motive within the complex integration strategy. Further increases in $\delta$ will eventually cause another *regime shift* from CN to CH, leading to a collapse of north–south FDI. Hence, north–south FDI may initially decrease, then increase, and finally decrease in $\delta$.

Now consider how the impact of policies in one country depends on the policies of another. Suppose a country lifts a ban on FDI while the other may or may not maintain a ban on FDI. As we have seen when the motive for investing in one foreign location is weak, FDI in that location will only occur via the complementarity with FDI in another location. For the south, these are the CN and CH regimes in Fig. 1 while for the north this is the CN regime of Fig. 1. The following proposition follows directly from this observation.

**Proposition 4.** *In both the CN and CH regimes, a southern liberalization of a ban on FDI attracts MNE only if the north is open to FDI. In the CN regime, a northern liberalization of a ban on FDI will attract FDI only if the south is open to FDI.*

A subtler point is that the complementarity between investments in the two locations does not always mean that the two investments always behave as

complements.[10] To see why, consider the CH regime where all firms prefer to be horizontal MNE to being national firms. In the presence of a southern ban on FDI, northern openness to FDI results in all firms being horizontally integrated. If the south were to lift its ban, then firms may follow a complex integration strategy by moving production of the labor-intensive component to the south while keeping their production of the skill intensive component in the north. In this case, an increase in FDI in the south is associated with a decline in the employment of MNE affiliates in the north. I summarize this result in the following corollary.

**Corollary.** *In regime CH, if a southern liberalization of a ban of FDI attracts FDI to the south, then it must also reduce MNE employment of northern labor.*

The nature of policy dependence across countries varies with industry characteristics. In regime CN the relationship between the effects of policies in the north and policies in the south is one of complements: FDI in either location requires that FDI be allowed in both. In regime CH, the relationship is asymmetric: lifting a southern ban on FDI attracts MNE to the south only if the north is open to FDI, but if lifting a ban in the south attracts MNE to the south, then it reduces MNE employment in the north. Hence, for $\delta > \delta_U$ northern FDI complements southern but southern FDI substitutes for northern.

## 4. General equilibrium

In general equilibrium the structure of MNE activity is determined jointly by market clearing conditions, which are derived below, and the profit maximization conditions with respect to location, which were derived in the previous section. In the interior equilibria that I consider, firms are indifferent between the two potentially viable firm types (which vary with the regime), and the extent to which firms choose one production location over another is determined by factor market clearing. With factor market clearing conditions in hand, I then consider several comparative statics to draw out the model's full implications for the structure of FDI and to show that the implications of the complementarity between vertical and horizontal FDI stand up to market clearing conditions.

### *4.1. Factor and product market conditions*

I close the model using factor and product market clearing conditions to derive a single equilibrium condition which, when combined with the wage threshold function, characterizes the equilibrium in each of the three regimes discussed in

[10] I thank an anonymous referee for making this point clear.

Section 3. I measure the extent of MNE activity by the quantity of foreign factors they employ, which is a common measure of FDI in the empirical literature. These measures are $L_S^{MNE}$, $L_N^{MNE}$, and $H_N^{MNE}$, which are, respectively, MNE affiliates' employment of southern labor, northern labor, and northern skill.[11]

First, consider the factor market clearing conditions, beginning with the market for northern skill. Since the two countries are identical, I combine the two conditions:

$$R_N 2H_N = (1-\eta)P_Y Y_N + (1-\lambda)\sum_i C_i x_i + R_N \sum_i F_i \tag{22}$$

Eq. (22) accounts for the sources of income for northern skill, which are the sum of its value used in producing Y (the first term on the right), its value used in producing intermediates (the second term), and its value used in the fixed costs of entry and investing abroad (the final term). Each variety $i$ has its own unit cost, $C_i$, output, $x_i$,[12] and fixed cost of production, $F_i$. These variables depend on the firms' production location decisions. Since skill-intensive intermediates are always produced in the north, the value of northern skill used in their production is their cost share multiplied by the total cost of producing all X varieties.

Now consider factor market clearing in the south. Since southern labor is the numeraire, the income accounting condition for southern labor is

$$L_S = \eta P_Y Y_S + L_S^{MNE} \tag{23}$$

The value of southern labor is its value in producing Y plus its value producing the labor-intensive components for MNE affiliates. Since southern skill is only used to produce Y, the southern skill market clearing condition is

$$R_S H_S = (1-\eta)P_Y Y_S. \tag{24}$$

Now consider the product market clearing conditions, beginning with X. Given Cobb–Douglas first tier preferences, the value of total X sales is linear in northern expenditure. Combining this observation with the constant mark-up rule establishes the following relationship:

$$\sum_{i=1}^{N} C_i x_i = \alpha(1-\beta)2E_N \tag{25}$$

Eq. (25) states that the value of output of all varieties must equal the value of total northern demand for these products. The market clearing condition for Y is

$$P_Y(Y_S + Y_N) = 2\beta E_N + E_S \tag{26}$$

[11] Since I consider only equilibria in which factor price equalization does not obtain, skill is never employed by MNE affiliates in the south.

[12] Note that $x_i$ is inclusive of the transport costs incurred shipping goods to foreign markets.

Eq. (26) states that the value of output of firms in both the north and the south must equal global demand, which is a fraction of northern income plus all of southern income. By definition, southern income is equal to the value of its output of Y plus the wages paid by MNE affiliates to their employees in the south or

$$E_S = P_Y Y_S + L_S^{MNE} \tag{27}$$

Now consider the zero profit conditions of firms in the X-sector. Given Dixit–Stiglitz preferences, each firm's revenue is a linear function of its fixed costs so total industry sales must be a linear function of total industry fixed cost. These facts establish the following relationship between aggregate fixed cost and northern expenditure:

$$\frac{(1-\beta)2E_N}{\sigma} = R_N \sum_{i=1}^{N} F_i \tag{28}$$

Finally, since Y is freely traded the cost of producing Y is the same in the north and the south so that by rearranging Eq. (1) we obtain our final equilibrium condition:

$$R_S = W_N^{1/1-\eta} \frac{R_N}{W_N} \tag{29}$$

As shown in Appendix A, by combining Eqs. (22)–(29) the following relationship between $L_S^{MNE}$ and $W_N$ can be derived:

$$L_S^{MNE} = 2\frac{\Phi H_N L_S - \eta\varepsilon(1-\Phi)H_S L_N (W_N)^{\varepsilon}}{2\Phi H_N + \eta H_S (W_N)^{\varepsilon\eta}} \tag{30}$$

where $\Phi = \beta\eta + (1-\beta)\lambda\alpha < 1$ and $\varepsilon = (1-\eta)^{-1} > 1$. From Eq. (30) it is clear that $L_S^{MNE}$ is decreasing in $W_N$. An increase in $L_S^{MNE}$ draws labor out of the south's Y sector, decreasing the relative return to southern skill, $R_S$, and inducing the north to export more Y to the south to maintain trade balance. The resulting increase in northern output of Y drives up $R_N/W_N$. Since the northern and southern costs of producing Y are the same, $W_N$ must fall.

In an interior equilibrium, $W_N$ must satisfy the wage threshold function (WTF) given by Eqs. (18)–(20). Combining the WTF with Eq. (30) pins down $L_S^{MNE}$ as shown in Fig. 2. The locus LL corresponds to the factor market clearing condition, (30), while $W_N^*$ corresponds to Eqs. (18), (19) or (20) depending on the level of transport cost.

Finally, as discussed in Appendix A the following expressions for the quantity of factors employed by MNE foreign affiliates in the north, $L_N^{MNE}$ and $H_N^{MNE}$, can be derived. If $\delta \in (\delta_L, \delta_U)$, then $L_N^{MNE} = 0$ and

$$H_N^{MNE} = \left(\frac{1}{\lambda}\right)\frac{(1-\lambda)\Phi H_N}{1-\eta+2L_N(1-\Phi)\left(W_N/L_S^{MNE}\right)}. \tag{31}$$

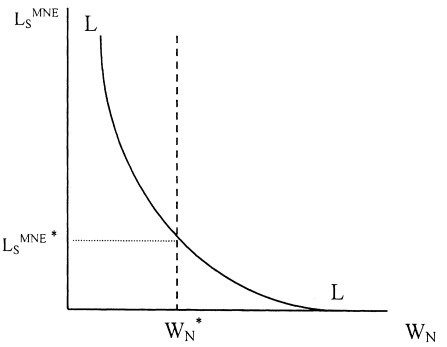


Fig. 2. Equilibrium.

If $\delta > \delta_U$, then

$$L_N^{MNE} = \frac{\lambda\alpha(1-\beta)}{\Phi} L_N - \frac{L_S^{MNE}}{W_N} \frac{\eta}{2} \left[ \frac{\beta + \lambda\alpha(1-\beta)}{\Phi} \right] \tag{32}$$

and

$$H_N^{MNE} = (1-\beta)(1-\lambda) H_N \left( 1 + \frac{\Phi 2 L_N}{2L_N(1-\Phi) + (1-\eta)(L_S^{MNE}/W_N)} \right). \tag{33}$$

Factor employment by MNE affiliates in the north is a function of $W_N$, which is given by the WTF, and the MNE affiliate employment of southern labor, $L_S^{MNE}$, which is determined in Fig. 2. At fixed $W_N$, factor employment by MNE affiliates in the north moves in the same direction as $L_S^{MNE}$ if $\delta \in (\delta_L, \delta_U)$ and in the opposite direction if $\delta > \delta_U$. These results are consistent with our earlier discussion of locations as complements and substitutes.

### *4.2. Comparative statics*

I now consider several comparative statics to illustrate the consequences of complex integration strategies on how the structure of FDI responds to changes in the economic environment. To keep the analysis tractable, I maintain the symmetry of the north, so that changes to one northern country are mirrored in the other. My focus is on marginal changes that occur wholly within regimes.

First, consider the effects of reducing the differences in the relative endowments of the north and the south by reducing $L_S$ and increasing $H_S$ by a small amount.[13] By Eq. (30), the effect of this change is to shift the locus LL in Fig. 2 down. Since changes in factor endowments do not affect the wage threshold function, the effect

[13]Making the north more like the south has identical consequences.

of making the south more similar to the north is to reduce $L_S^{MNE}$. The effect on the north depends on the regime. When $\delta \in (\delta_L, \delta_U)$, a reduction in FDI in the south reduces $H_N^{MNE}$ via Eq. (31), while for $\delta > \delta_U$ the effect is to increase both $L_N^{MNE}$ and $H_N^{MNE}$ via Eqs. (32) and (33). I summarize this result in the following proposition.

**Proposition 5.** *As the factor proportions in the south become more similar to those of the north, the extent of FDI in the south as measured by $L_S^{MNE}$ must fall. The extent of FDI in the north, as measured by $L_N^{MNE}$ and $H_N^{MNE}$, falls if $\delta \in (\delta_L, \delta_U)$ and rises if $\delta > \delta_U$.*

The first part of Proposition 5 is similar to the message of the standard factor proportions model of FDI, such as Helpman (1984). As the south becomes more similar to the north, the vertical motive for FDI is blunted, leading to a reduction in north–south FDI. Unlike the standard factor proportions model, there are additional effects on FDI in the other countries because firms may follow complex integration strategies. Here, greater similarity between the relative factor abundance of the north and the south reduces north–north FDI in regime CN and increases north–north FDI in regime CH.

Proposition 5 suggests that an understanding of the structure of FDI *across* regions may require an understanding of the distribution of factors across countries *within* regions. In industries in which transport costs are in the intermediate range, FDI may be more extensive if countries within a region vary substantially in their factor endowments while in industries where transport costs are in the upper range, locations with different factor endowments may simply substitute for one another.

Another example of how the effects of a change in the economic environment depend critically on the industry characteristics is the effect of a change in transport cost, $\delta$. For $\delta > \delta_U$, an increase in $\delta$ increases $W_N^*$ via Eq. (20), which is associated with a decrease in $L_S^{MNE}$ via Eq. (30). By Eqs. (32) and (33), an increase $W_N^*$ and a decrease in $L_S^{MNE}$ is associated with an increase in both $L_N^{MNE}$ and $H_N^{MNE}$. When $\delta \in (\delta_L, \delta_U)$, the effect of changing $\delta$ is less straightforward and depends on the measure of how important the labor-intensive component is in final cost, $\lambda$. As shown in the panels of Fig. 1, the wage threshold function behaves differently depending on the level of $\lambda$. When $\lambda$ is large (the right-hand panel of Fig. 1), an increase in $\delta$ shifts $W_N^*$ in Fig. 2 to the right, reducing $L_S^{MNE}$, and reducing $H_N^{MNE}$ via Eq. (31). When $\lambda$ is small (the left-hand panel of Fig. 1), an increase in $\delta$ shifts $W_N^*$ to the left increasing $L_S^{MNE}$ and increasing $H_N^{MNE}$ via Eq. (31). I summarize these results in the following proposition.

**Proposition 6.** *If $\delta \in (\delta_L, \delta_U)$, an increase in $\delta$ may increase FDI in both the south and the north if $\lambda$ is small or may decrease FDI in both the south and the north if $\lambda$ is large. If $\delta > \delta_U$, an increase in $\delta$ always reduces FDI in the south and increases FDI in the north.*

The effects of a change in transport cost on FDI in each country cannot be predicted without further knowledge of an industry's characteristics. An increase in $\delta$ always sharpens the horizontal motive for FDI and dulls the vertical motive, but in regime CN both motives are necessary to induce firms to invest abroad. The effect that dominates depends on which motive is relatively important, which is governed by $\lambda$.

The final exercise is to consider the case in which the cost of shipping intermediate goods differs from the cost of shipping the final good. This case is likely to be important in practice, since transport costs for final goods are more likely to reflect information costs associated with distance from one's customers, while transport costs for intermediate goods are more likely to reflect the physical cost of shipping and the cost of delays in shipping that hold up the entire manufacturing process.

Since transport costs do not enter into the market clearing conditions, (30), I need only adjust the wage threshold function, given by Eq. (19),[14] which becomes

$$W_N = \delta_I \left( \frac{1 + \delta_F^{1-\sigma}}{2} \right)^{1/\lambda(\sigma-1)} \left( 1 + 2\frac{\theta}{G} \right)^{1/\lambda(\sigma-1)}.$$

By inspection, this expression is increasing in $\delta_I$, the cost of shipping intermediates, and decreasing in $\delta_F$, the cost of shipping final goods.[15] An increase in $\delta_I$ shifts $W_N^*$ in Fig. 2 to the right, lowering $L_S^{MNE}$ and reducing $H_N^{MNE}$ via Eq. (31). An increase in $\delta_F$ shifts $W_N^*$ to the left, increasing $L_S^{MNE}$ and increasing $H_N^{MNE}$ via Eq. (31). I summarize these results in the following proposition.

**Proposition 7.** *Within regime CN, a reduction in the $\delta_I$, the cost of shipping intermediates, raises both north–north and north–south FDI as measured by the quantity of factors employed, while a reduction in $\delta_F$, the cost of shipping final goods, lowers FDI in both the south and the north.*

A reduction in shipping costs might cause an expansion of FDI across all countries if shipping costs are relatively more important for intermediate goods than for final goods. This is important because empirical research (e.g. Hummels, 2000) has shown that shipping costs, particularly the cost of shipping goods quickly, have fallen dramatically. Yet, as the cost of shipping goods has fallen, the volume of FDI between similarly endowed countries has been growing rather than falling, which is inconsistent with a model based on purely horizontally integrated MNE but is consistent with a model in which MNE follow complex integration strategies.

[14] The cases of low transport cost and high transport cost are straightforward so I only consider the case of intermediate transport costs.

[15] I have dispensed with $\theta$ that varies across countries since it is not central to this point.

## 5. Conclusion

This paper extends the standard models of FDI to allow for the possibility of complex integration. This analysis is motivated by the observation that complex integration strategies are being used more often by multinational firms and by the observation that existing, two-country models are unequipped to analyze these strategies. I found that when a model is formulated to allow for complex integration strategies the issue of interdependencies across countries becomes important to understanding the structure of FDI. These interdependencies mean that the level of FDI in one country depends in part on the policies and characteristics of its neighbors, but the nature of these interdependencies varies with industry characteristics. Furthermore, once firms are allowed to follow complex integration strategies, the structure of FDI becomes a complicated, and often non-monotonic, function of industry characteristics.

The model's prediction that there may be complementarities across locations is supported by existing empirical research. Empirical evidence that investments in the north and the south may be complements can found in Brainard and Riker (1997) and Slaughter (2000), who show that the employment of US multinational affiliates in the north and the south covary in a way consistent with complementarities. The strength of this covariance appears to depend on the industry in question, which is consistent with the prediction of the model that industry characteristics are crucial in determining whether investments in the north and the south are complements or substitutes.

While there is indirect evidence that FDI in different locations may be complementary, little has been done to incorporate the potential cross-country dependencies into the empirical analyses of the determinants of the structure of FDI. As noted by the UNCTC, the traditional country determinants of FDI may have blurred in recent years. Given the potential for such cross-country dependencies, empirical work should give greater consideration to issues of spatial dependence.

While the paper has obtained its objective of bringing these issues to light in the most transparent fashion possible, future research will focus on generalizing the model by introducing asymmetries between northern countries. In particular, more interesting geographies could be further explored to more fully flesh out the nature of cross-country dependencies.

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## Appendix A

In this appendix, I derive the general equilibrium conditions. I begin by deriving Eq. (30). Substituting Eq. (24) into Eq. (23) and rearranging yields

$$L_S = \frac{\eta H_S}{1-\eta} R_s + L_s^{MNE} \tag{A.1}$$

Substituting Eqs. (25)–(28) into Eq. (22) and collecting terms yields

$$R_N 2H_N = 2E_N(1-\Phi) + (1-\eta)L_S^{MNE}$$

Substituting $E_N = W_N L_N + R_N H_N$ into this expression and rearranging yields

$$\frac{R_N}{W_N} = \frac{L_N(1-\Phi)}{H_N \Phi} + \frac{(1-\eta)}{2H_N \Phi}\frac{L_S^{MNE}}{W_N} \tag{A.2}$$

Substituting this expression into Eq. (29) yields

$$R_S = (H_N \Phi)^{-1} L_N (1-\Phi)(W_n)^{\varepsilon} + (2H_N \Phi)^{-1}(1-\eta)L_S^{MNE}(W_n)^{\eta\varepsilon},$$

which, when substituted into Eq. (A.1), yields Eq. (30).

Now consider the factor employment by MNE affiliates in the north, beginning with labor. For $\delta \in (\delta_L, \delta_U)$, MNE do not employ labor in the north. For $\delta > \delta_U$, it can be shown that total labor employed by northern firms in all locations is

$$2W_N L_N^{MNE} + L_S^{MNE} = \lambda\alpha(1-\beta)2E_N.$$

Note that only half of northern labor employed in the X sector is at the foreign affiliates. Using the definition of $E_N$, substituting Eq. (A.2), and rearranging yields Eq. (32).

Now consider the employment of skill by MNE affiliates in the north, beginning with $\delta > \delta_U$. In this range all firms are MNE, but half of their employment is at local plants rather than foreign affiliates. The value of northern skill employed by MNE affiliates is

$$R_N H_N^{MNE} = (1-\lambda)(1-\beta)E_N.$$

To obtain Eq. (33) use the definition of $E_N$, substitute in the inverse of Eq. (A.2) and rearrange.

Finally, the employment of northern skill by MNE affiliates for $\delta \in (\delta_L, \delta_U)$ is

$$R_N H_N^{MNE} = \frac{1}{2}\frac{(1-\lambda)}{\lambda} L_S^{MNE} \Leftrightarrow H_N^{MNE} = \frac{(1-\lambda)}{2\lambda}\left(\frac{L_S^{MNE}}{W_N}\right)\frac{W_N}{R_N},$$

where the right-hand side is simply the left rearranged. This expression follows directly from the Cobb–Douglas assumption over skilled intermediate usage relative to unskilled intermediate usage and the fact that only half of northern skill

is employed at the foreign affiliates of MNE. Substituting in the inverse of Eq. (A.2) and rearranging yields Eq. (31).

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