Multinational Firms, Outsourcing and Production Fragmentation: Analysing the Effects of Trade and FDI Liberalisation

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Abstract

This paper presents a formal partial equilibrium model of a multinational firm whose boundary is endogenously determined. It analyses operations of an MNC operating in three countries with factor price differences. The model generates fragmented production with intra-firm and arm’s length (inter-firm) trade in final goods and in a continuum of components. The impacts of trade and FDI liberalisation are explored. The model results are broadly consistent with observed changes in production fragmentation and patterns of outsourcing in East Asia.
I. Introduction

Increasingly firms source their intermediate inputs across firm and national borders for assembly of final goods. The use of imported inputs in global and OECD exports had reached 30% by 1990, having increased by 40% since 1970.\(^2\) In East Asia (China, ASEAN-4, NIE, and Japan), intermediate products increased to 30 per cent between 2000 and 2003.\(^3\) Product fragmentation and the resulting vertical intra-industry trade (VIIT) and intra-firm trade (IFT) have become a key feature of global trade in manufactures. Indeed, the rapid increase in global intra-industry trade is mainly due to the increase of VIIT type involving trade in intermediate goods (parts and components).\(^4\) This phenomenon is associated with the rapid expansion of international production networks – largely built around multinational enterprises (MNEs) and FDI – in the context of ongoing trade and investment liberalization. The importance of VIIT and its links to FDI and MNEs have been extensively documented in recent years.\(^5\)

While FDI and MNEs are central to international production fragmentation and VIIT, not all parts and components are produced and sourced within the firm from the various MNE subsidiaries located in different countries. A significant proportion of such intermediates are outsourced to ‘independent’ firms, both within a country and across countries. This means that it is important to distinguish between trade at arm’s length with independent suppliers and intra-firm trade.\(^6\) Kimura and Ando (2005) note that a firm has four main (mutually non-exclusive) options for fragmenting production: within the firm in the same country, outsourcing to independent suppliers within the country, outsourcing to independent suppliers across countries, and intra-firm trade.

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\(^1\) With the usual caveat, authors record grateful thanks to Russell Hillberry; this paper draws on joint work with him.

\(^2\) Hummels, Ishii and Yi (2001). This phenomenon has also been referred in the literature as international production sharing, globalized production, de-localization, slicing up the value chain and off-shoring.

\(^3\) Kimura and Ando (2005)

\(^4\) See Fontagné, Freudenberg and Gaulier (2005) and Fukao, Ishido and Ito (2003). Kimura, Takahashi and Hayakawa (2007) suggest that the fragmentation is particularly well suited to explain Asian production networks in contrast to the horizontal product differentiation model used to explain IIT in ‘core’ Europe. However results in Fontagné, Freudenberg and Gaulier suggest that even in Europe VIIT is quite important in a significant proportion of IIT. Bernard, Jensen, and Schott (2006) find that, over time, the multinational enterprises (MNEs) increase their share of intra-firm trade with low-income countries and increase their share of arm’s length trade with upper income countries.

\(^5\) See, for example, Ando (2006), Athukorala and Yamashita (2006) and Kimura and Ando (2005)

\(^6\) The two organizational forms of trade are distinct by considering who owns the production stage abroad: when it is owned by the same firm it is referred to as vertical FDI or intra-firm trade; and when it is owned by a foreign firm is it referred to as arms length trade or international outsourcing. Antras and Helpman (2004) distinguish between domestic and international outsourcing.
fragmenting to a subsidiary in another country, and outsourcing to a foreign independent supplier; this produces what they call domestic intra-firm fragmentation, domestic arms length fragmentation, cross-border intra-firm fragmentation and cross-border arm’s length fragmentation. The decisions by the firm in relation to these options determine the ‘boundary of the firm’ in terms of the nature of production and sourcing arrangements. Empirical observations point to wide differences in the firm boundary between different firms, industries and countries; the firm boundary also shifts over time in response to various factors.

While empirical trade research inevitably confronts multi-components and multi-country data, formal models of product fragmentation and outsourcing tended to be dominated by models of intra-firm trade between two-countries (North and South) and two production-stages (a component and assembly). The role of arms-length versus intra-firm trade has been the focus of much recent research offering trade models with firm boundaries set by transaction costs, incomplete contracts and property rights to examine the variations in intra-firm trade across destinations and sectors (e.g. Antrás, 2003; Antrás and Helpman; 2004; and Grossman and Helpman, 2004) However, these two-country outsourcing models are generally quite restrictive in their approaches. They often assume a single component (and thereby do not allow for endogenous determination of the set of traded components). Some models address off-shoring issues in a two-country, multi-stage of production framework but do not usually distinguish between intra-firm trade and international outsourcing (see Dixit and Grossman, 1982; Feenstra and Hanson, 1996b; Grossman and Rossi-Hansberg, 2006).

In this paper we present formal partial equilibrium model of a multinational firm that can endogenously determine the firm boundary. We believe that this is the first formal model in the outsourcing literature that analyses operations of an MNC where intra-firm and inter-firm trade in both final goods and multiple components is analysed in a three country framework. It generates the main types of fragmentation and outsourcing discussed in the literature (as, for example, in the conceptual model sketched by Kimura and Ando (2005). This model describes the set of activities and related transactions

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8 This model extends the two country model of Anucoonwattaka (2007) in two major ways: it permits trade in final goods and extends the choice of locations to three countries.

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which take into account the multiple possibilities opened up for sourcing components from both within firm (subsidiaries located both inside and outside a country) and from external suppliers (again, from those located both inside and outside a country). They describe positive and negative incentives for fragmentation associated with transactions crossing firm and country boundaries in two dimensions: geographical distance (locational advantage versus ‘service-link’ costs) and ‘uncontrollability’ (weaker managerial control once the firm boundary is crossed). We refer to these incentives in terms more similar to those used in the literature referred to earlier, using ‘trade costs’ broadly interpreted as similar to ‘service-link’ costs arising from distance and cross border movements, and transactions costs (associated with cross-firm transactions arising from such factors as quality monitoring, contract enforceability, and other costs) as being similar to ‘uncontrollability’. We show how such transactions and trade costs can affect the scope of the firm, and how trade and investment liberalization can impact on the patterns of outsourcing and product fragmentation.

Our motivation for the specific modelling framework comes from some stylised facts about the operations of Japanese MNCs in the Asian automotive industry. We consider three countries ordered by relative (capital and labour) factor prices motivated by the empirically observed situation where MNC subsidiaries operate in several ASEAN countries that differ in factor prices from each other as well as of course from the source country Japan.

We postulate that the MNC has ‘firm specific capital’ that is essential for the production of the final good. The term capital is used in a broad sense here in keeping with the literature on MNCs; it refers to a composite of managerial skills, firm-specific knowledge and technologies, both physical and financial capital. The MNC produces a final good using such firm-specific capital, labour and a continuum of components,

9 We focus on the firm boundary and do not consider the case where the firm undertakes domestic intra-firm fragmentation where the production takes place within the firm boundary but in different ‘fragmented’ units.

10 We use ‘transactions costs’ to include, somewhat broadly and loosely, costs associated with outsourcing across firm boundaries described by Grossman and Helpman (2005: 136): “First, firms must search for partners with the expertise that allows them to perform the particular activities that are required. Second, they must convince the potential suppliers to customize products for their own specific needs. Finally, they must induce the necessary relationship-specific investments in an environment with incomplete contracting.”
rather than a single component, drawing on the ‘continuous tasks’ model of Grossman and Rossi-Hansberg (2006) and the ‘continuous components’ model of Feenstra and Hanson (1996b). We allow the firm to produce all or part of the components in-house, using labour and firm-specific capital in any of the three locations (thus permitting intra-firm trade) or from independent suppliers in either of the three locations, who can produce components using capital and labour. The model has similarities to the Feenstra and Hanson (2005) model which allows endogenous determination of the set of outsourced components; but in their model producing a final good involves only two tasks (input procurement and assembly) has to be conducted in a single location (‘China’).

This model is partial equilibrium so as to focus on firm-level decisions. Hence, non-firm factor prices are assumed exogenously given, and there is no movement towards international FPE. For simplicity, the model assumes away scale economies and ignores game-theoretic complexities. We abstract from, or do not explicitly focus on, many other issues in the literature, such as imperfect information, contractual incompleteness and hold-up problems. The limited supply of firm-specific capital implies that the firm cannot produce all intermediate goods itself. We assume that combining components sourced from different suppliers into a final good is subject to transaction costs that vary across sources and types of components. International trade is subject to trade costs (‘tariffs’). These mechanisms generate a trade off between in-sourcing and outsourcing in a multi-component and three-country framework.

We begin with a situation where the MNC is compelled to produce the final good in-house in all three locations; trade costs are too high for international trade. Initially, each ‘subsidiary’ has a fixed amount of firm-specific (‘headquarters’) capital. The MNCs decide to make-or-buy multiple components differing in factor intensity from the different locations. We then look at the impact of trade liberalization, first in components and, then, in both components and final goods. Trade liberalization facilitates foreign outsourcing and intra-firm trade. We compare trade to autarky patterns of production specialization and trade of the MNC. The model suggests a systematic relationship between the characteristics of countries and the characteristics of the stages of production, and a systematic relationship between the characteristics of the latter and the organizational forms of trade. The second exercise is to analyze impacts of trade
costs on the changes of organizational patterns of trade. We conceptualize trade liberalization as a reduction of cross-country trade costs. Comparative static analysis is applied to analyze how tariff reductions affect arm’s-length and intra-firm trade. Finally, we consider patterns of production specialization, FDI, and trade of the MNC after FDI liberalization when we allow for cross-country relocation of the MNCs firm-specific capital. We discuss possible implications of trade and FDI liberalization for the evolution of patterns of production, outsourcing and trade in both components and final goods. We believe that the model captures key elements of real world MNC behaviour and that its verifiable predictions are broadly consistent with stylised facts; hence it is useful for discussing likely future developments in response to greater trade and investment liberalisation.

The rest of the paper is organized as follows. Section 2 describes the model. Section 3 is empirical investigation, and Section 4 is the conclusions.

II The Model

A MNC operates in three countries (North, Middle and South) producing a final good from a bundle of multiple components that differ from each other in their factor intensity. The endowments and prices of capital and labour in each country are sufficiently different, i.e. \( (r / w)_{\text{North}} < (r / w)_{\text{Middle}} < (r / w)_{\text{South}} \). We assume that the MNC has headquarters in the North and has directly invested (undertaken FDI) in the Middle and the South by setting up subsidiaries in those countries. (We shall call all of them MNC ‘subsidiaries’ for simplicity.)

In each country, the MNC faces downward sloping demands for the final good. Assuming a quasi-linear utility function, the demand function of the final good in country \( j \) takes a simple form: \( P_j = A_j - B_j Q_j \). On the supply side, the final good in country \( j \) may be produced domestically \( (D_j) \) or imported from the MNCs subsidiaries abroad \( (M_{j'}') \): \( Q_j = D_j + \sum_{j' \neq j} M_{j'} \). where \( j \) and \( j' \in \{\text{North, Middle, South}\} \).
Final-good production requires a continuum of intermediate inputs (parts or components), labour, and firm-specific (headquarters) capital in fixed proportions. Components are indexed from 0 to 1. To simplify notation, we assume that the unit requirements of firm-specific capital and components are equal to unity. The production function of the final good takes the following form:

\[
Y = \min \left\{ H_y, \frac{L_y}{a_L}, Z_0, ..., Z_t \right\}
\]

where \( Y \) denotes the quantity of final good. The amounts of firm-specific capital, labour, and component \( i \) used in final-good production are denoted by \( H_y, L_y \) and \( Z_i \), respectively, and \( a_L \) is the unit labour-requirement for final-good production. The fixed-coefficient production functions give the amounts of factors used in final good production in a country as follows: \( H_y = Y \), \( L_y = a_L Y \) and \( Z_i = Y \).

The final-good produced in country \( j \) can be for sale in the domestic-market (\( D_j \)) and for export to other countries \( j' \) (\( X_{j'} \)).

\[
Y_j = D_j + \sum_{j \neq j'} X_{j'} \quad (1)
\]

The MNC subsidiaries in any country can produce components internally, engage in intra-firm trade with the other subsidiaries and, engage in arm’s length trade with domestic or foreign outside suppliers. The MNC uses its firm-specific capital and labour for in-house production. Assuming a fixed-coefficient technology, the firm requires \( b_h \) units of headquarters capital and \( b_l \) units of labour to produce a unit of component \( i \). The capital-to-labour ratio for component \( i \) is, therefore, \( b_h/b_l \). To simplify notation, we assume that \( b_l = 1 \), hence \( b_h \) becomes a normalized capital-to-labour ratio of component \( i \). We arrange the continuum of components such that the capital-intensity of components is increasing with component index, i.e. \( \partial b_h/\partial i > 0 \).

The derived demands for headquarters capital and labour for in-house component \( i \) are,

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11 This is standard in much of the literature; see Markusen, 1984; Helpman and Markusen, 1985; and Markusen, 2002. \( D_j \) and \( X_{j'} \) represent respectively market serving and export-platform (vertical) activities of final-good production in country \( j \).
respectively, \( H_i = b_i Y \), and \( L_i = Y \). While in-house production uses headquarters capital and labour, outside suppliers produce components with the same technology but using ‘normal’ capital (available in the market place at a given rental rate) and labour.

We assume that final good production – assembly - is highly labour intensive. Combining multiple components into a final good is subject to ad valorem transaction costs, \( T_{F(i)} \geq 1 \), that vary across sources and types of components. As in Grossman and Rossi-Hansberg (2006), we assume that production of capital-intensive components are subject to higher ‘transaction costs’ than labour-intensive components, as they involve more sophisticated and complex tasks, i.e. \( \left( \partial T_{F(i)} / \partial b_i \right) > 0 \). In country \( j \), the dual unit-cost of domestically outsourcing component \( i \) in competitive markets is

\[
c_{z(i)_{y_j}} = T_{F(i)} \left( b_i r_j + w_j \right)
\]  

(2)

Importing component from country \( j' \) is subject to ad valorem tariff, \( T \geq 1 \). Then, the dual unit-cost of using arm’s length imports of component \( i \) from country \( j' \) is

\[
c_{m(i)_{y_{j'}}} = T T_{F(i)} \left( b_i r_j + w_j' \right)
\]  

(3)

**Equilibrium conditions**

We solve the MNC’s profit maximization problem in each country to derive final-good supply and demand for intermediate inputs. 13 In country \( j \), the firm maximizes profits with respect to final- and intermediate goods production and trade, i.e. \( D_j, X_j', M_j' \), \( z_{y_{y_j}}, m_{w_{y_j}}, x_{y_{y_j}}, z_{y_j}, x_{y_{y_j}} \), and \( m_{y_{y_j}} \):

\[
\Pi_j = P(Q_j)D_j + \sum_{j' \neq j} P(Q_{j'})X_{j'}' + \sum_{j'} P_{w_{j'}} x_{w_{j'}}' - T P(Q_j) \left[ \sum_{j' \neq j} M_{j'}' \right] - w_{y_{y_j}} \left[ D_j + \sum_{j' \neq j} X_{j'}' \right] \\
- \int_{i=0}^{1} \int_{j' \neq j} T_{F(i)} \left( b_i r_j + w_j \right) z_{w_{i_j}} di - \sum_{j' \neq j} \int_{i=0}^{1} \int_{j' \neq j} T_{F(i)} \left( b_i r_j + w_j \right) m_{w_{i_j}} di - \sum_{j' \neq j} \int_{i=0}^{1} \int_{j' \neq j} w_{y_{j'}} T_{F(i)} \left( z_{w_{i_j}} + \sum_{j' \neq j} x_{w_{i_j}} \right) di
\]

12 Note that these are distinct from inter-firm transactions costs discussed earlier and refer to costs that firms have to bear in combining inputs within a firm.

13 The MNC’s total profit \( \left( \sum_j \Pi_j \right) \) is maximized when the MNC’s profits in each country is maximized. Because component market is competitive, solving the MNC’s profit maximization problem in each country is equivalent to solving the MNCs total profit maximization problem.
- \( T \sum_{j \neq j} \int_{i=0}^{1} p_{ij} m_{ij}^{j} di \)

s.t.  

final-good sufficiency condition:

\[ Q_j \leq D_j + \sum_{j \neq j} M_j^{j} \]

component-sufficiency condition:

\[ D_j + \sum_{j \neq j} X_j^{j} \leq z_{iw} + z_{is} + \sum_{j \neq j} m_{iw}^{j} + \sum_{j \neq j} m_{is}^{j} , \]

fixed short-run supply of firm-specific capital:

\[ \sum_{i} \sum_{j \neq j} X_i^{j} \leq \sum_{i} \sum_{j \neq j} z_{iw} + \sum_{i} \sum_{j \neq j} x_{iw}^{j} \]

Note that exports of country \( j \) to country \( j' \) are imports of country \( j' \) from country \( j \), i.e. \( X_j^{j'} = M_j^{j'} \) for final-good trade, and \( x_{iw}^{j} = m_{iw}^{j} \) for intra-firm component trade. The MNC’s total exports equal its total imports, i.e. \( \sum_{j \neq j} \sum_{i} X_i^{j} = \sum_{j \neq j} \sum_{i} M_i^{j} \), and

\[ \sum_{j \neq j} \sum_{i} x_{iw}^{j} = \sum_{j \neq j} \sum_{i} m_{iw}^{j} . \]

The firm-specific capital has no market-price but a shadow price in each country \( j \), denoted by \( \lambda_j \), and it is the Lagrange multiplier of the endowment constraint whose full-employment condition is satisfied at strict equality:

\[ \left[ D + \sum_{j \neq j} X_j^{j} \right] + \int_{i=0}^{1} b_i \left( z_{iw} + \sum_{j \neq j} x_{iw}^{j} \right) di \leq H_j . \]  (4)

**Dual unit-cost functions**

The marginal (shadow) cost of using domestically in-sourced component \( i \) is

\[ c_{z(i)w} = b_i \lambda_j + T_{F(i)} w_j . \]  (5)

The marginal (shadow) cost of intra-firm import of component \( i \) from country \( j' \) is

\[ c_{m(i)w} = Tc_{z(i)w} - T \left( b_{j'} \lambda_j + T_{F(i)} w_j \right). \]  (6)

The marginal cost of final-good production \( (c_j) \) is the aggregation of unit-shadow cost of capital, -labour cost, and -intermediate inputs:
\[ c_j = \lambda_j + w_j a_k + \int_{i=0}^1 \pi_{ji} \, di. \quad (7) \]

\( p_{ji} \) is the Lagrange multiplier of the component-sufficiency condition. It is the minimal cost of component \( i \) available to the firm in country \( j \).

\[
p_{ji} = \min \left\{ c_{z(i)_{ij}}, c_{z(i)_{ij}}, c_{m(i)_{ij}}, c_{m(i)_{ij}} \right\} \quad (8)
\]

**Intermediate goods**

From the Kuhn-Tucker theorem and dual unit-cost functions (2) to (7), in equilibrium,

\[
D_j + \sum_{j \neq j} X_{fj} = z_{ivj} + z_{isz} + \sum_{j \neq j} m_{ivj} + \sum_{j \neq j} m_{isz} \quad (9)
\]

\[
z_{ivj} = D_j + \sum_{j \neq j} X_{fj} \text{ if } \min \left\{ c_{z(i)_{ij}}, c_{z(i)_{ij}}, c_{m(i)_{ij}}, c_{m(i)_{ij}} \right\} = c_{z(i)_{ij}}, \text{ otherwise } z_{ivj} = 0. \quad (10)
\]

\[
z_{isz} = D_j + \sum_{j \neq j} X_{fj} \text{ if } \min \left\{ c_{z(i)_{ij}}, c_{z(i)_{ij}}, c_{m(i)_{ij}}, c_{m(i)_{ij}} \right\} = c_{m(i)_{ij}}, \text{ otherwise } z_{isz} = 0. \quad (11)
\]

\[
m_{ivj} = D_j + \sum_{j \neq j} X_{fj} \text{ if } \min \left\{ c_{z(i)_{ij}}, c_{z(i)_{ij}}, c_{m(i)_{ij}}, c_{m(i)_{ij}} \right\} = c_{m(i)_{ij}}, \text{ otherwise } m_{ivj} = 0. \quad (12)
\]

\[
m_{isz} = D_j + \sum_{j \neq j} X_{fj} \text{ if } \min \left\{ c_{z(i)_{ij}}, c_{z(i)_{ij}}, c_{m(i)_{ij}}, c_{m(i)_{ij}} \right\} = c_{m(i)_{ij}}, \text{ otherwise } m_{isz} = 0. \quad (13)
\]

Equations (9) to (13) show that the derived demand for intermediate goods in country \( j \) would be met by the minimal-cost options among components sourced from domestic production \( (z_{ivj}) \), domestic outsourcing \( (z_{isz}) \), intra-firm imports \( (m_{ivj}) \) and arm’s length imports \( (m_{isz}) \).

**Final good**

From the Kuhn-Tucker theorem and ‘marginal revenue equals marginal cost’ of final-goods production \( (D_j) \) and imports \( (M_{fj}) \), in equilibrium

\[
Q_j = D_j + \sum_{j \neq j} M_{fj} \quad (14)
\]

where
\[ D_j = \frac{1}{2B_j} \left[ A_j - c_j \right] \quad \text{if} \quad \forall j' \quad c_j \leq Tc_{j'}, \quad \text{otherwise} \quad D_j = 0. \quad (15) \]

\[ M_j^{f=g} = \frac{1}{2B_j} \left[ A_j - Tc_{j=g} \right] \quad \text{if} \quad \forall j' \quad Tc_{j=g} \leq \min \left[ c_j, Tc_j \right], \quad \text{otherwise} \quad M_j^{f} = 0 \quad (16) \]

Equations (14) to (16) indicate that each subsidiary (firm) meets final-good demands in their country by domestic production or imports (from country \( g \)) depending on whether the cost of domestic production is lower or higher than imports that are subject to tariffs.

**The ‘Closed Economy’**

In a ‘closed economy’, trade barriers are prohibitively high (\( T \to \infty \)) for importing components and the final good. Then, in equations (4), (9), (14) and (15), \( X_j' = 0, \ M_j^{f} = 0, \ Q_j = D_j, \ x_{n_j} = 0, \ m_{n_j} = 0, \) and \( m_{i_n} = 0. \) In country \( j, \) the component-sharing pattern is satisfied at the marginal component \( i = n_j \) where unit costs between in-house production and domestic outsourcing are equalized:

\[ c_{z(n_j)_{n_j}} = c_{z(n_j)_{i_n}}. \quad (16) \]

\( c_{z_{n_j}} \) and \( c_{z_{i_n}} \) are defined as in equations (2) and (5), respectively. Cost equalization then gives the equilibrium shadow price (cost) of firm-specific capital in country \( j: \)

\[ \lambda_j = T_{F(n_j)r_j} \]

Therefore, the equilibrium unit-cost of in-house component \( i \) is:

\[ c_{z(i)_{n_j}} = b_i T_{F(n_j)r_j} + T_{F(i)w_j} \quad . \quad (17) \]

For exogenously given \( r_j \) and \( w_j, \) the specialization pattern of production is determined.

Figure (1) illustrates the minimal-cost locus of in-house production and domestic outsourcing. Outsourcing cost \( (c_{z(i)_{n_j}}) \) must lie above in-sourcing cost \( (c_{z(i)_{i_n}}) \) at higher ratios of capital intensity \( (i > n_j), \) because transaction cost \( (T_{F(i)}) \) is increasing with \( i. \)

Hence, in that range, in-house production has a cost advantage over domestic outsourcing. It follows that the components \( i > n_j \) would be produced inside the firm (boundary) in country \( j, \) and the components \( i < n_j \) would be outsourced to domestic suppliers.
For $i > n_j$, \( z_{w_j} = D_j \), \( z_{n_j} = 0 \), and \( p_{ji} = c_{z(i)_{j'}} \).  

(18.1) 

For $i < n_j$, \( z_{w_j} = D_j \), \( z_{n_j} = 0 \), and \( p_{ji} = c_{z(i)_{j'}} \).  

(18.2) 

**Figure (1) In-house Production and Domestic Outsourcing**

The marginal component $i = n_j$ is determined by the full-employment of headquarters capital in equation (4) that becomes

\[
D_j + \int_{i=n_j}^{1} b_j z_{w_j} di = H_j  
\]

(18.3)

The terms $b_j z_{w_j}$ and $D_j$ in equation (18.3) are amounts of headquarters capital employed for producing component $i$ and final good output in country $j$, respectively. Final-good production in the closed economy becomes

\[
D_j = \frac{1}{2B_j} \left[ A_j - \left( \lambda_j + w_j a_L + \int_{i=0}^{n_j} c_{z(i)_{j'}} di + \int_{i=n_j}^{1} c_{z(i)_{j'}} di \right) \right].  
\]

(18.4)

The distinction between in-sourcing and outsourcing components is summarized in the following statement:

**Statement 1:** The MNC may outsource some components because the firm has a limited firm-specific asset that is an input for activities inside the firm boundary. The MNC preserves the specific input for its core activity (final-good production) and relatively capital-intensive components, which are subject to higher transactions costs if they are outsourced to outside firms.
The Trading Economy

If trade barriers are sufficiently low, production and trade patterns are determined by factor-price differences. In this section, we analyse the production specialization of MNCs subsidiaries and outside suppliers in each country. We focus on the distinction between arm’s length and intra-firm trade and look at an equilibrium where the MNC, with limited firm-specific capital, produces and outsources components in every country.

To show the production specialization, we first illustrate the roles of factor price differences on specialization of outside suppliers in different countries by assuming for a moment that the MNC does not produce components. For fixed wage and rental rates, each country has an outsourcing-cost advantage in different components given that factor-price differences are sufficiently large. Figure (2) illustrates the minimal-cost of outsourcing defined as in equations (2) and (3). Note that we specify the equations of the trading economy for the MNCs home country \( j = \text{North} \). \( \alpha_1 \) and \( \alpha_2 \) denote the marginal components where the costs are equalized. The cost locus of outsourcing from the North will lie below that of the other two countries in the range of relatively capital-intensive components. The range within which there is a cost advantage to outsourcing from the South will be in the relatively labour-intensive components and that of the Middle will be in between.

![Figure (2) Minimal costs locus of outsourcing](image-url)
Now consider the option of in-sourcing in this framework. The minimal costs of in-house production and intra-firm imports \( c_{iv_j} \) and \( c_{mv_j} \) are illustrated as dashed lines. The relative cost advantages of intra-firm and arm’s length sourcing determine the firm boundary along the component spectrum. At \( i = n_j \), \( c_{iv_j} = c_{mv_j} \). Then, the shadow cost of headquarters capital reaches the equilibrium value:

\[
\lambda_j = T_{F(v_j)} r_j
\]

The MNC and its subsidiaries produce components in that range where in-sourcing has a cost advantage over outsourcing from the host countries. In-sourced components will be relatively capital-intensive components in the range where the host countries have cost advantages. The marginal components \((i = n_j, \text{ where } j = \text{North}, \text{Middle}, \text{South})\) are those where in-sourcing and outsourcing costs are equalized.

The above discussed specialization pattern is illustrated in Figure 3. The insights from this pattern can be described as follows:

**Statement 2:** The relative cost advantages of each country follow the factor-price differences. The North has the potential to export highly capital-intensive components, while the South is likely to be production base of relatively labour-intensive products. The factor-intensity range of components produced in the Middle is likely to be intermediate. In each country, the MNC will produce in-house (in-source) the relatively capital-intensive components and outsource the more labour-intensive components.

**Figure (3) Component Specialization Patterns**
Along the component spectrum, \( n_j \) denotes the firm-boundary of component sourcing in country \( j \). Let \( \alpha_{kj} \in [\alpha_{1j}, \alpha_{2j}, 1] \) denote the country-boundary, i.e. the marginal components that are off-shored; the marginal components between the South and the Middle are represented by \( \alpha_{kj} = \alpha_{1j} \), and those between the Middle and the North are \( \alpha_{kj} = \alpha_{2j} \). For \( j=\text{North} \), \( \alpha_{kj} = 1 \). As shown in Figure (2), the marginal components of off-shoring (\( \alpha_{1j} \) and \( \alpha_{2j} \)) are determined by the equalization of outsourcing costs.

For \( j = \text{North} \), \( c_{m_{ij}, j} = c_{m_{ij}, \text{Middle}} \) at component \( i = \alpha_{1j} \):

\[
TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{South} + w_{South} \right) = TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{Middle} + w_{Middle} \right)
\]  
(20.1)

For \( j = \text{Middle} \), \( c_{z_{ij}, j} = c_{z_{ij}, \text{Middle}} \) at component \( i = \alpha_{1j} \):

\[
TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{South} + w_{South} \right) = T_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{Middle} + w_{Middle} \right)
\]  
(20.2)

For \( j = \text{South} \), \( c_{z_{ij}, j} = c_{z_{ij}, \text{Middle}} \) at component \( i = \alpha_{1j} \):

\[
T_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{South} + w_{South} \right) = TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{Middle} + w_{Middle} \right)
\]  
(20.3)

Similarly,

For \( j = \text{North} \), \( c_{m_{ij}, \text{Middle}} = c_{z_{ij}, j} \) at component \( i = \alpha_{2j} \):

\[
TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{Middle} + w_{Middle} \right) = T_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{North} + w_{North} \right)
\]  
(21.1)

For \( j = \text{Middle} \), \( c_{z_{ij}, \text{Middle}} = c_{z_{ij}, \text{North}} \) at component \( i = \alpha_{2j} \):

\[
T_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{Middle} + w_{Middle} \right) = TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{North} + w_{North} \right)
\]  
(21.2)

For \( j = \text{South} \), \( c_{m_{ij}, \text{Middle}} = c_{m_{ij}, \text{North}} \) at component \( i = \alpha_{2j} \):

\[
TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{Middle} + w_{Middle} \right) = TT_{F_l(a_{ij})} \left( b_{A(a_{ij})} r_{North} + w_{North} \right)
\]  
(21.3)

The marginal components of in-sourcing (\( i = n_j \)) are determined by the full employment of headquarters capital in country \( j \). Given that \( X'_j = M'_j \) and \( x'_{ij} = m'_{ij} \) (i.e. exports
from country $j$ to $j'$ are imports of country $j'$ from $j$), the full-employment condition of headquarters capital is:

$$
\left[ D_j + \sum_{j' \neq j} M_{j'}^{j} \right] + \int_{n_j}^{a_{nj}} b_i \left( z_{nj} + \sum_{j' \neq j} m_{nj}^{j} \right) di = H_j, \tag{22}
$$

The amount of headquarters capital employed in producing component $i$ in country $j$ is $b_i \left( z_{nj} + \sum_{j' \neq j} m_{nj}^{j} \right)$, while the amount of headquarters capital allocated to final good production is $D_j + \sum_{j' \neq j} M_{j'}^{j}$. The components $i$ produced in country $j$ can be both for domestic final good production and for (intra-firm) export to overseas subsidiaries. In final-good production, the unit-requirement of each component is assumed to be unity. This gives the derived demands for in-house components as follows:

$$
z_{nj} = D_j + \sum_{j' \neq j} M_{j'}^{j}, \tag{23}
$$

$$
m_{nj}^{j} = D_j + \sum_{j' \neq j} M_{j'}^{j}. \tag{24}
$$

Country $j$ imports final-good ($M_{j}^{j} > 0$) if factor price differences are sufficiently large and trade costs are low. The equilibrium conditions in the final-good market (equations 14, 15, and 16) imply that the MNC subsidiary in any location will source final-goods from the cheapest cost location (country). The cost of the final good produced in country $j$ is

$$
c_j = T_{F(n_j)j'} + a_j w_j + \int_{0}^{1} p_i di. \tag{25}
$$

The term $\int_{0}^{1} p_i di$ is the minimal costs of components for the final-good assembler in country $j$. Note that final-good cross-border trade costs are affected by both direct and indirect tariffs. Direct tariff means the tariff applied to the FOB value of a finished good ($T_{c_j}$), indirect tariffs are embedded in the cost of imported components of a final-good assembler ($c_{m(i)j'\text{intrad}}$ and $c_{m(i)j'\text{intrad}}$) If cross-border trade costs are low, for relatively small differences in component costs, wage differences will play the key role in determining the cost advantages of final-good production (assumed to be highly labour-
intensive, i.e. $a_L$ is large). Hence, for $j = \text{South}$, it is likely that $c_j \leq Tc_{j'}$, while for $j \neq \text{South}$, $Tc_{j' \neq \text{south}} \leq \min\left[c_j, Tc_{j' \neq \text{south}}\right]$.

1. Trade Costs and Patterns of Production and Trade

The changes between Table (1a) and Table (1b) summarize how patterns of final-good production and trade will evolve as trade costs decline from high to low (‘trade liberalisation’). As shown in Table (1a), if trade in the final good is subject to prohibitive trade costs, each subsidiary of the MNC produces the profit maximising output of the final good for each country $D_j = \frac{1}{2B_j} \left[A_j - c_j\right]$. In contrast, if trade is liberalized – cross-border trade costs are lowered - in both components and final goods, there can be trade in the final good. Assuming that final-good assembly is highly labour-intensive, final-good production tends to be located in the labour-rich country which becomes the final-good export-platform. If the size of the MNC capital stock in the South is adequate, North and the Middle will cease to produce the final good altogether and import $M_{j'} = \left[A_j - Tc_{j'}\right]$ where $j' = \text{South}$, from their South subsidiary.

Table 1a) Final-good Production and Trade at Intermediate to High Tariff Levels

<table>
<thead>
<tr>
<th>Country $j$</th>
<th>$D_j$</th>
<th>$M_{j'}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$j' = \text{North}$</td>
</tr>
<tr>
<td>North</td>
<td>$\frac{1}{2B_j} \left[A_j - c_j\right]$</td>
<td>-</td>
</tr>
<tr>
<td>Middle</td>
<td>$\frac{1}{2B_j} \left[A_j - c_j\right]$</td>
<td>0</td>
</tr>
<tr>
<td>South</td>
<td>$\frac{1}{2B_j} \left[A_j - c_j\right]$</td>
<td>0</td>
</tr>
</tbody>
</table>
This can be summarised as providing insights into the direction of change in production and trade patterns with trade liberalisation not only components but also in final goods.

**Statement 3:** The South is likely to be an export-platform for the final good if cross-border trade costs (‘tariffs’) are low ($T \rightarrow 1$) and final-good assembly is highly labour-intensive.

**Composition of the MNC Production and Intra-firm Trade**

How does the composition of within firm production shift between the final good and different types and amounts of components? Let the downstream (final-good) and upstream (component) production in country $j$ be $Y_j$ and $Z_j$, respectively. Assume that both $Y_j$ and $Z_j$ are positive so that MNC subsidiary in country $j$ produces final goods as well as components (both for domestic use and export):

$$Y_j = (D_j + \sum_{j'j} M_{j'}^j)$$  \hspace{1cm} (26)

$$Z_j = \int_{a_j}^{a_{j'}} \left( z_{n_{j'}} + \sum_{j'j} m_{n_{j'}} \right) di.$$  \hspace{1cm} (27)

Assume there is intra-firm trade between North, Middle, and South. Let intra-firm final-good and component exports of country $j$ be $X_{v, j}^Y$ and $X_{v, j}^Z$, respectively.

---

**Table 1b) Final-good Production and Trade at a Low Tariff Level ($T \rightarrow 1$)**

<table>
<thead>
<tr>
<th>Country $j$</th>
<th>$D_j$</th>
<th>$M_j^j$</th>
<th>$j' = \text{North}$</th>
<th>$j' = \text{Middle}$</th>
<th>$j' = \text{South}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>$\frac{1}{2B_j} [A_j - Tc_j]$</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>$\frac{1}{2B_j} [A_j - Tc_j]$</td>
<td></td>
</tr>
<tr>
<td>South</td>
<td>$\frac{1}{2B_j} [A_j - c_j]$</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
\[ X^Y_{ij} = \sum_{f \neq j} M^i_f \]  
\[ X^T_{ij} = \sum_{s \neq j} \int_{t \neq s} m^i_{tj} dt. \]  

**Trade Costs and Extensive Margins**

The extensive margins of the production network in country \( j \) are the components between \( n_j \) and \( \alpha_{k,j} \), where \( \alpha_{k,j} \in [\alpha_{ij}, \alpha_{2j}, 1] \). Let us look at the signs of partial derivatives of these variables with respect to cross-border trade costs (‘tariffs’). From equilibrium conditions 20.1-3 and 21.1-3, we find that:

\[
\frac{\partial \alpha_{ij}}{\partial T} = 0 \quad \text{for} \quad j = \text{North} \\
< 0 \quad \text{for} \quad j = \text{Middle} \quad \text{and} \quad \frac{\partial \alpha_{2j}}{\partial T} > 0 \quad \text{for} \quad j = \text{Middle}. \\
> 0 \quad \text{for} \quad j = \text{South} \quad \text{and} \quad \frac{\partial \alpha_{ij}}{\partial T} = 0 \quad \text{for} \quad j = \text{South}
\]

From the equilibrium conditions from (22) to (25) and the implicit function theorem, we find the impact of changes in tariffs on extensive margins of intra-firm sourcing:

\[
\frac{\partial n_j}{\partial T} < 0, \quad j \in [\text{North, Middle, South}].
\]

Arrows in Figure (4) illustrate the shifts of marginal components along the component spectrum as tariff (trade costs) decrease. As shown by the shifts of \( \alpha_{k,j} \), when tariff falls off-shoring of country \( j \) increases along the extensive margin. In contrast, the shifts of \( n_j \) illustrate reductions of in-sourcing, intra-firm trade, and firm-specific capital allocated to components along the extensive margin. Due to reduced firm-specific capital, the number of component varieties produced in-house falls, so that more components have to be outsourced in order to release firm-specific capital for final-good production.
Figure (4) Impacts of Tariff Reductions on Extensive Margins

The North (the MNCs home country)

The Middle

The South

Trade Costs and Intensive Margins

Tariff impacts on intensive margins are derived from the partial derivatives of $Y_j$, $X_{r,j}$, and $X_{t,j}$ (defined in equations (26)-(29) with respect to the tariff. For the final good, using equations (8) and (25) and variables in Tables (1a) or (1b), we find the partial derivatives of equations (26) and (28):

$$\frac{\partial Y_j}{\partial T} < 0, \quad \text{and} \quad \frac{\partial X_{r,j}}{\partial T} = 0 \quad \text{for} \quad j = \text{North, Middle} \quad \text{and} \quad \frac{\partial X_{t,j}}{\partial T} < 0 \quad \text{for} \quad j = \text{South}.$$  

For components, the partial derivatives of equations (27) and (29) are obtained relating to variables defined in equations (8), (20)-(25), and Tables (1a) or (1b):

$$\frac{\partial Z_j}{\partial T} < 0, \quad \text{and} \quad \frac{\partial X_{r,t,j}}{\partial T} < 0.$$  

Thus, cross-border trade cost reductions increase the volume of final goods production and intra-firm trade. Intuitively, lower trade costs allow components to be sourced from cheapest sources so that marginal costs of production decrease, which leads the firm to increases output. Therefore, final good production and intra-firm trade increase along the intensive margins.

2) FDI Liberalisation
So far, we have assumed that the MNC has allocated its limited stocks of firm-specific capital to the headquarters in the North and to subsidiaries in Middle and South and that these stocks cannot be re-allocated among them. As a result, there arise cross-country differences in the shadow costs of firm-specific capital in each subsidiary ($\lambda_j$). The shadow value of headquarters capital is the highest in the labour-rich country, and it is the lowest in the capital-rich one. While this assumption is useful for analyzing the short-run equilibrium of each subsidiary and the overall production network, relaxing this assumption is helpful for discussing the long-run situation when the MNC has the flexibility to change its asset allocation among the locations. Hence we consider the extreme case of perfect ‘FDI liberalisation’ – which we interpret as a situation where all countries have identical investment environments and the MNC is permitted to costlessly move its capital stock between countries. Note that this is clearly an extreme case; it will require not only the lifting of restrictions on FDI, but also wider improvements in institutions so as to produce identical investment environments including risk profiles of the different locations. In such a situation MNCs will choose to allocate headquarters capital among subsidiaries to equate returns across locations (i.e. to equate shadow costs of headquarter capital).

Let \( \lambda_{h0} \) and \( \lambda_{h1} \) be the shadow cost of headquarter capital in country \( j \) before and after capital movement. Before investment liberalization, the shadow cost of capital is highest in the South, lowest in the North, and intermediate in the Middle: \( \lambda_{h0} < \lambda_{h1} < \lambda_{hS} \). When firm-specific capital is mobile, it will flow from low-return country to the high-return country and shadow prices of firm-specific capital will converge. Let the shadow prices of capital in the three countries be equalized at \( \lambda \), where \( \lambda_{hN} = \lambda_{hM} = \lambda_{hS} = \lambda \). The MNC-wide equilibrium shadow cost of capital will be certainly higher than in the North and lower than in the South \( \lambda_{hN} < \lambda < \lambda_{hS} \). However, whether it is higher or lower than the initial internal capital cost in the Middle (i.e. \( \lambda \) is greater or smaller than \( \lambda_{hM} \)) depends on parameter values.\(^{14}\)

\[^{14}\text{For example, the shadow-cost of pooled capital will tend to be high if the final-good markets are large relative to the firm’s total capital endowment (} \frac{A_j}{H} \text{ is much greater than unity).}\]
Statement 4: If shadow cost of capital is the same in all three countries, but wages are lower in the south, then – so long as cross-border trade costs are low – all MNC capital will be moved to the South to take advantage of the lower wages. In other words, production operations in the North and the Middle will cease. But so long as MNC capital is limited, there may be cost advantages to outsourcing some components.

When the shadow cost of internal capital in the North rises, it will exceed the external-capital cost adjusted by transaction cost \( \lambda_{N_1} > \lambda_{N_0} = T_{F(north)} \). This means that in-house production in the North is costlier than outsourcing to firms in the North. Therefore, the MNC ceases to produce components in the North – i.e. it ceases all production – and moves internal capital to the South and expands component production there. As capital flows into the South, its shadow cost in South falls. But if it remains higher than that in the Middle, capital will be brought in from the Middle as well until equality is established. In the South, the lower the cost of internal capital reduces incentives to outsource to outside suppliers (who face a higher cost of capital). The MNC will not only produce all its (labour intensive) final goods in the South but also no longer outsource components in the South if the firm has a sufficiently large internal capital endowment.

Will there be any outsourcing in the Middle? Here the patterns of production depend on the range of \( \lambda \), relative to initial shadow cost there \( \lambda_{M_0} = T_{F(north)} \). There are three possibilities depending (in particular) on the total size of the capital stock of the firm relative to final goods market: the final MNC-wide equilibrium shadow cost can be higher, be the same or be lower than the initial shadow cost of capital in the Middle.

For brevity, we will only discuss here the case where the equilibrium shadow cost of internal capital is higher than the initial levels of both the North and the Middle: \( \lambda_{N_0} < \lambda_{M_0} < \lambda_{1} < \lambda_{S_0} \). [It is obvious that there will be no change if (coincidentally) the initial shadow cost of capital in the Middle happens to be the same as the final MNC-wide equilibrium shadow cost.] Considering the Middle subsidiary, this means there is no incentive to produce any components inside the firm; it will be cheaper to outsource them. In other words, no production of either components or final goods will be
undertaken by the MNC in the Middle. Figure (5) shows the pattern of component specialization in this case where outsourcing and arm’s length exports of the North and the Middle increase along extensive margins. In the South, in contrast, the greater flow of FDI leads to increased in-house sourcing, which expand along the extensive margin. At the same time, the range of components in which the Middle has cost advantages over the South decreases along the extensive margin (i.e. $\alpha_i$ increases from the initial equilibrium).

**Figure (5a): Production Patterns when Capital Mobile between North, Middle, and South**

The Case of $\lambda_{N_0} < \lambda_{M_0} < \lambda_1 < \lambda_{S_0}$

This means that production operations of the MNC subsidiary in the Middle will cease, but the MNC South subsidiary will import intermediate-capital intensive components from independent (outside) suppliers in the Middle. Thus there will be cross-border arm’s length exports from the Middle to the South.

Similarly, it can be shown that if the final MNC-wide equilibrium shadow cost is lower than the initial shadow cost of capital in the Middle, then there is no incentive to outsource in the Middle. It is cheaper to produce components in the South (see Appendix)

3. Patterns of Production, Trade and Outsourcing: Trade and Investment Liberalisation

We summarise some scenarios related to these patterns of production and trade in Table (2) and provide the formal details in Appendix Table 1. In table 2, as we move across to the right in each sub-category, we can observe the direction of change in response to falls in cross-border trade costs and, finally, if MNC capital is free to move across
countries where investment environments have become similar. These results illustrate how production, in-sourcing and out-sourcing patterns emerge from the interaction of comparative cost (country) considerations, cross-border and cross-firm trade (transaction) costs and restrictions on FDI movements; they also indicate the direction in which these patterns are likely to change in response to ongoing falls in trade costs and investment liberalisation.

Table 2: Impact of Trade and FDI liberalisation on Patterns of Production Trade and Fragmentation in a Three Country Setting

<table>
<thead>
<tr>
<th>Country</th>
<th>Component Production</th>
<th>Final Good</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inside MNC</td>
<td>Outside Suppliers</td>
</tr>
<tr>
<td></td>
<td>HTC</td>
<td>LC</td>
</tr>
<tr>
<td>North</td>
<td>E</td>
<td>EX</td>
</tr>
<tr>
<td>Middle</td>
<td>E</td>
<td>EX</td>
</tr>
<tr>
<td>South</td>
<td>E</td>
<td>EX</td>
</tr>
</tbody>
</table>

Notes: (1) HC: High cross-border Trade Costs; LC: Liberalisation of cross-border component trade; LCF: Liberalisation of cross-border component and final good trade; FDIL: Trade and Investment Liberalisation. Case (a) - final equilibrium shadow cost of MNC capital is higher than initial shadow cost in Middle; case (b) - opposite case.

(2) Exists $\equiv E$

Increases $\equiv +$

Decreases $\equiv -$  

None $\equiv 0$

Exports $\equiv EX$

Some of the main points that emerge are:

1. As seen in the HTC columns, with high trade costs and restrictions on FDI, the MNC produces final goods and components for each country separately. With limited stocks of internal capital, the firm outsources the less capital intensive components to outside firms within the country while producing capital-intensive components inside the firm.

2. As cross-border trade costs in components falls (partial trade liberalization with liberalization in components trade but not in the final good –LC columns) intra-firm and arm’s length trade in components is stimulated based on factor-cost
differences between countries and consistent with factor endowment models of trade. This reduces cost of final good production and raises the profit maximizing volume of final good output. The need to allocate firm capital to meet this larger volume of final good production provides incentives to outsource components to both domestic and foreign outside suppliers. Within the range of components supplied by each country, there is a pattern of in-sourcing and outsourcing such that in-house production in each country is more capital intensive than outsourcing in that country.

3. With more comprehensive liberalisation of trade (in both components and the final good – LCF columns), the labour intensive final-good assembly tends to be located in the labour-rich South which becomes the final-good export-platform. The North and the Middle become export-platforms for the more capital intensive and intermediate components respectively. The impact on intra-firm trade is that while it expands along the intensive margin, it shrinks along the extensive margin (i.e. a reduction in the variety of components but larger volumes of a fewer number of component varieties). International production fragmentation and inter-firm trade in components expands.

4. FDI liberalization (FDIL columns) – allows firm’s internal capital to be mobile across subsidiaries – leads to greater FDI into the lowest wage country as capital flows out from the North and the Middle. MNC production ceases in the North and the Middle and shifts to the South. Outsourcing increases in the North. In the South in-house production increases while outsourcing falls. However the impact on outsourcing in the Middle depends on factors such as the size of the internal capital stock relative to the final good market. If the firm’s capital stock is relatively small, the firm may outsource some components in the Middle. But if the firm’s capital stock is relatively large, probably the more ‘realistic’ case for large MNCs, the firm may produce most components in the South so that outsourcing from the Middle can decline. Overall, the results suggest that while the MNCs will increasingly tend to shift their production to the low-wage country, there will continue to be component trade sourced through arm’s length suppliers in the richer countries.
Concluding Remarks

In this paper we present a formal partial equilibrium model of an MNC which operates in three countries with factor price differences. The three country setting is important and relevant in the Asian context because of both middle income countries such as Malaysia and Thailand as well as low income countries such as China and Indonesia. The model generates patterns of production and trade which are both plausible and appear broadly consistent with stylised facts and observed trends of MNCs in East Asia—though rigorous empirical testing is yet to be done.

The model prediction that labour intensive assembly of final goods will be located in the low wage country is - not surprisingly – consistent with the emergence of China as the global assembly platform. But, more interestingly, we note that empirical evidence provided in Kimura and Ando (2005) about Japanese MNC affiliates in Asia indicates a fall in intra-firm trade and an expansion of arm’s length trade – a result broadly consistent with model predictions about the direction of change in sourcing and trade patterns in the context of ongoing trade and investment liberalisation. An econometric investigation based on firm-level data on component imported by Toyota subsidiaries in ASEAN from Thailand under the AICO trade preferential scheme from 1999 to 2003 has provided strong supportive evidence for broad predictions from a simpler two-country model (Anukoonwattaka, 2007). It confirmed that intra-firm sourcing in a given country is relatively more capital-intensive than outsourcing in that country. It also found that trade liberalisation tended to decrease the variety of intra-firm imports. We plan to subject the model predictions to more rigorous empirical testing in ongoing work.

These model predictions, of course, must be tempered with an appreciation of the limitations of the model assumptions, but can be used to gain insights into the directions of movement. We have not incorporated scale (or scope) economies, possible strategic behaviour in contracting, hold up problems that may constrain outsourcing etc. We intend to explore the implications of explicit incorporation of some of these factors in future work. We have also not modelled differences between firms of different nationalities – an important theme in much MNC literature; they can be thought of as outside suppliers producing ranges of component types offering different transactions
costs. It is intuitive that if outside suppliers have longstanding links with an MNC, they would offer lower transactions costs; hence they may be more competitive outsourcing firms.

Greater realism can be built into the model by assuming, for example, that final goods require some ‘essential’ North-headquarter specific inputs and permitting scale economies in the production of both components and final goods. While we have not formally modelled these, we believe that the first assumption would not make a fundamental difference to the core results of the model but ensure a continuing production role for the North even with extensive falls in trade and investment barriers.

A very important limitation in discussing the consequences of FDI liberalisation is the assumption that countries differ only in their wage-capital factor costs. In practice, overall production and trade costs are critically affected by the existence of efficient infrastructure, legal systems and institutions and a myriad other factors. These factors will constrain the tendency we see in the formal model for MNCs to locate all in-house production operations in the lowest-wage economy. Of course it is also important to explore the general equilibrium implications of these developments.
References


Appendix

Figure (5b) shows another possible pattern of component specialization if the cost of internal capital in the Middle remains unaffected. In this case, the derived demand for internal capital in the South is not very high relative to the pooled firm-specific capital endowment. After producing all components in the South, the MNC still has enough internal capital to produce some components in the Middle where the capital return is the second highest. However, the falling internal-capital cost in the South leads to expansion of component sourcing from the South to replace domestic outsourcing in the Middle.

**Figure (5b)**
Production Patterns when Capital Mobile between North, Middle, and South:

The case of $\hat{\lambda}_{N_0} < \hat{\lambda}_{M_0} = \hat{\lambda}_1 < \hat{\lambda}_{S_0}$

Figure 5c illustrates the production patterns if the total capital-stock is large relative to the derived demand from final-good market so that capital flows to the South and the Middle, lowering the shadow costs of capital in both places. This enhances incentives to expand in-house production over outsourcing in each country, thus increasing insourcing and intra-firm exports of the South and Middle along the extensive margin. In addition, the range of components that the North has cost advantages falls (i.e. $\alpha_2$ increases from the initial equilibrium), because of lower cost of capital in the South and the Middle.

**Figure (5c)**
Production Patterns when Capital Mobile between North, Middle, and South:

The Case of $\hat{\lambda}_{N_0} < \hat{\lambda}_1 < \hat{\lambda}_{M_0} < \hat{\lambda}_{S_0}$
## Appendix Table 1: Trade and Investment Liberalization

<table>
<thead>
<tr>
<th>Country</th>
<th>Final good</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production</td>
<td>Import</td>
</tr>
<tr>
<td>j</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D_j</td>
<td>0</td>
</tr>
<tr>
<td>North</td>
<td>D_j</td>
<td>0</td>
</tr>
<tr>
<td>Middle</td>
<td>D_j</td>
<td>0</td>
</tr>
</tbody>
</table>

1) High Trade Costs and Restricted FDI (High Tariffs, No FDI mobility)

2) Partial Trade Liberalization, FDI restrictions
(No Tariffs on Component Trade, High Tariffs on Final Good, No Capital Movement)

3) Fuller Trade Liberalization, FDI restrictions
(No Tariffs in Components and Final good, No Capital Movement) /a

<table>
<thead>
<tr>
<th>Country</th>
<th>Final good</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M^f_j</td>
<td>x_{ivj} \in (n_{Nth},1)</td>
</tr>
<tr>
<td>North</td>
<td>M^f_j</td>
<td>x_{ivj} \in (n_{Mid},\alpha_2)</td>
</tr>
<tr>
<td>Middle</td>
<td>M^f_j</td>
<td>x_{ivj} \in (n_{Sth},\alpha_1)</td>
</tr>
<tr>
<td>South</td>
<td>\sum_{j' \neq j} X_{j'}^f</td>
<td>z_{ivj} \in (n_{Sth},\alpha_1)</td>
</tr>
</tbody>
</table>

/a
### Appendix Table 1 (continued)

<table>
<thead>
<tr>
<th>Country</th>
<th>Final good Component</th>
<th>Production</th>
<th>Import</th>
<th>Production</th>
<th>Intra-firm Imports</th>
<th>Outsourcing</th>
<th>Arm’s length Imports</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td></td>
<td>0</td>
<td>$M_j^f$</td>
<td>0</td>
<td>0</td>
<td>$x_{ij} \in (\alpha_2, n_{Nth})$</td>
<td>0</td>
</tr>
<tr>
<td>Middle</td>
<td></td>
<td>0</td>
<td>$M_j^f$</td>
<td>0</td>
<td>0</td>
<td>$x_{ij} \in (\alpha_1, n_{Mid})$</td>
<td>0</td>
</tr>
<tr>
<td>South</td>
<td>$D_j \sum_{j' \neq j} X_{j'}^f$</td>
<td>$z_{ivj} \in (n_{Nth}, \alpha_1)$</td>
<td>0</td>
<td>0</td>
<td></td>
<td>$m_{ivj}^{Nth} \in (\alpha_2, n_{Nth})$</td>
<td>$m_{ivj}^{Mid} \in (\alpha_1, n_{Mid})$</td>
</tr>
</tbody>
</table>

4.1 The case of $\lambda_{N_{th}} < \lambda_{M_{th}} < \lambda_1 < \lambda_{S_{th}}$ /b

| North    |                       | 0          | $M_j^f$| 0          | 0                  | $x_{ij} \in (\alpha_2, n_{Nth})$ | 0             |
| Middle   |                       | 0          | $M_j^f$| $x_{ivj} \in (n_{Mid}, \alpha_2)$ | 0          | $x_{ij} \in (\alpha_1, n_{Mid})$ | 0             |
| South    | $D_j \sum_{j' \neq j} X_{j'}^f$ | $z_{ivj} \in (n_{Nth}, \alpha_1)$ | 0      | $m_{ivj}^{mid} \in (n_{Mid}, \alpha_2)$ | 0          | $m_{ivj}^{Nth} \in (\alpha_2, n_{Nth})$ | $m_{ivj}^{Mid} \in (\alpha_1, n_{Mid})$ |

4.2 The case of $\lambda_{N_{th}} < \lambda_{M_{th}} = \lambda_1 < \lambda_{S_{th}}$ /c

| North    |                       | 0          | $M_j^f$| 0          | 0                  | $x_{ij} \in (\alpha_2, n_{Nth})$ | 0             |
| Middle   |                       | 0          | $M_j^f$| $x_{ivj} \in (n_{Mid}, \alpha_2)$ | 0          | $x_{ij} \in (\alpha_1, n_{Mid})$ | 0             |
| South    | $D_j \sum_{j' \neq j} X_{j'}^f$ | $z_{ivj} \in (n_{Nth}, \alpha_1)$ | 0      | $m_{ivj}^{mid} \in (n_{Mid}, \alpha_2)$ | 0          | $m_{ivj}^{Nth} \in (\alpha_2, n_{Nth})$ | $m_{ivj}^{Mid} \in (\alpha_1, n_{Mid})$ |

4.3 The case of $\lambda_{N_{th}} < \lambda_1 < \lambda_{M_{th}} < \lambda_{S_{th}}$ /d

| North    |                       | 0          | $M_j^f$| 0          | 0                  | $x_{ij} \in (\alpha_2, n_{Nth})$ | 0             |
| Middle   |                       | 0          | $M_j^f$| $x_{ivj} \in (n_{Mid}, \alpha_2)$ | 0          | 0                  | 0             |
| South    | $D_j \sum_{j' \neq j} X_{j'}^f$ | $z_{ivj} \in (n_{Nth}, \alpha_1)$ | 0      | $m_{ivj}^{mid} \in (n_{Mid}, \alpha_2)$ | 0          | $m_{ivj}^{Nth} \in (\alpha_2, n_{Nth})$ | 0             |

Note:  
a/ Assumption: final-good assembly is highly labour-intensive. 
b/ See Figure (5a). 
c/ See Figure (5b). 
d/ See Figure (5c).