

14.581 MIT International Trade  
— Lecture 22: Multinationals Theory (II) —  
Contractual Theories and Fragmentation

# Today's Plan

- 1 Contractual theories of MNEs
- 2 Fragmentation of production

# Why Do Multinational Firms Exist?

- Answer so far: “Technological” theories of the multinational firm
  - According to these theories, MNEs will emerge whenever concentrating production in a unique location is *not* profit-maximizing
  - Horizontal vs. Vertical FDI
- In developing global sourcing strategies, firms not only decide on where to **locate** different stages of value chain, but also on extent of **control**:
  - Why is fragmentation occurring within or across firm boundaries?
  - This is nothing more than the classical “**make-or-buy**” decision in IO.

# What Determines (Multinational) Firms' Boundaries?

- Over the last 10 years, trade economists have incorporated various theories of the firm into general equilibrium models:
  - ① Williamson's transaction-cost approach [Grossman Helpman 2002]
  - ② Grossman-Hart-Moore's property-rights approach [Antras 2003, Antras Helpman 2004]
  - ③ Aghion-Tirole's approach [Marin Verdier 2008, Puga Trefler 2007]
- We will focus on **property-rights approach**:
  - Integration means acquisition of assets; when contracts are incomplete, the parties encounter contingencies that were not foreseen in the initial contract, and the owner of the asset has the residual rights of control; the residual rights of control affect the outside options and therefore how the surplus from the relationship is divided ex-post (ownership = power)
  - In the presence of relationship-specific investments, these considerations lead to a theory of the boundaries of the firm in which both the benefits and the costs of integration are endogenous

- **Fact 1:** *In cross-section of industries, share of intra-firm imports in total US imports increases with capital intensity*
- **Fact 2:** *In cross-section of countries, share of intra-firm imports in total US import increases with capital labor ratio of exporting country*
- In order to explain facts 1 and 2, Antras (2003) proposes to combine Grossman-Hart and Helpman-Krugman:
  - ① If final good producers always need an intermediate producer for labor decision, these producers should keep property rights when their decision matters more, i.e. in the labor-intensive sectors
  - ② Since capital abundant countries produce capital intensive goods, and these goods are produced within the boundary of the firm, their share of intra-firm trade will be higher

# Antràs (2003)

## A Simple Property-Rights Model

- Consumer preferences are such that  $F$  faces a demand given by

$$y = Ap^{-1/(1-\alpha)}, \quad 0 < \alpha < 1. \quad (1)$$

- Production of good  $y$  requires the development of **two** specialized intermediate inputs  $h$  and  $m$ . Output is Cobb-Douglas:

$$y = \left(\frac{h}{\eta}\right)^\eta \left(\frac{m}{1-\eta}\right)^{1-\eta}, \quad 0 < \eta < 1, \quad (2)$$

where a higher  $\eta$  is associated with a more intensive use of  $h$  in production.

- There are two agents engaged in production:
  - a final-good producer (denoted by  $F$ ) who supplies the input  $h$  and produces the final good  $y$ ,
  - an operator of a manufacturing plant (denoted by  $S$ ) who supplies the input  $m$ .
- $F$  can produce  $h$  at a constant marginal cost  $c_h$ ;  $S$  can produce  $m$  at  $MC = c_m$ . In addition, production requires fixed cost  $f \cdot g(c_h, c_m)$ .
- Inputs are tailored specifically to other party and useless to anybody else.

# Antràs (2003)

## A Simple Property-Rights Model (cted.)

- **Contractual structure:** before investments  $h$  and  $m$  are made, the only contractibles are the allocation of residual rights (i.e., the ownership structure) and a lump-sum transfer between the two parties.
- Ex-post determination of price follows from generalized Nash bargaining.
- *Ex-ante*,  $F$  faces a perfectly elastic supply of potential  $S$  agents so that, in equilibrium, the initial transfer will be such that it secures the participation of  $S$  in the relationship at minimum cost to  $F$ .
- Key features:
  - 1 ex-post bargaining takes place both under outsourcing and under integration;
  - 2 the distribution of surplus, however, is sensitive to the mode of organization because the outside option of  $F$  is naturally higher when it owns  $S$  than when it does not.
- Outside options are as follows:
  - under outsourcing, contractual breach gives 0 to both agents;
  - under integration,  $F$  can selectively fire  $S$  and seize input  $m$  (at a productivity cost  $\delta$ ) – because of property rights over input.

- In light of equations (1) and (2), the potential revenue from the sale of  $y$  is

$$R(h, m) = \lambda^{1-\alpha} \left(\frac{h}{\eta}\right)^{\alpha\eta} \left(\frac{m}{1-\eta}\right)^{\alpha(1-\eta)}. \quad (3)$$

- Given the specification of the ex-post bargaining,  $F$  obtains share  $\beta_O = \beta$  of sale revenue under outsourcing and share  $\beta_V = \delta^\alpha + \beta(1 - \delta^\alpha) > \beta_O$  under integration.
- Optimal ownership structure  $k^*$  is thus the solution to:

$$\begin{aligned} \max_{k \in \{V, O\}} \quad & \pi_k = R(h_k, m_k) - c_h \cdot h_k - c_m \cdot m_k - f \cdot g(c_h, c_m) - \bar{U} \\ \text{s.t.} \quad & h_k = \arg \max_h \{\beta_k R(h, m_k) - c_h \cdot h\} \\ & m_k = \arg \max_m \{(1 - \beta_k) R(h_k, m) - c_m \cdot m\} \end{aligned} \quad (\text{P1})$$

where  $R(\cdot)$  is given in (3) and  $\bar{U}$  is the outside option of the operator  $S$

- First-best level of investments would simply maximize  $\pi_k$



# Antràs (2003)

## A Useful Result

- The solution to the constrained program (P1) delivers the following result (see Antràs, 2003 for details):
- **Proposition:** There exists a unique threshold  $\hat{\eta} \in (0, 1)$  such that for all  $\eta > \hat{\eta}$ , integration dominates outsourcing ( $k^* = V$ ), while for all  $\eta < \hat{\eta}$ , outsourcing dominates integration ( $k^* = O$ ).
- As in Grossman and Hart (1986), in a world of incomplete contracts, ex-ante efficiency dictates that residual rights should be controlled by the party undertaking a relatively more important investment:
  - if production is very intensive in the  $m$  input, then choose **outsourcing** to alleviate the underinvestment in the provision of the  $m$  input,
  - when production is intensive in the  $h$  input,  $F$  will optimally choose to tilt the bargaining power in its favor by obtaining these residual rights, thus giving rise to **vertical integration**.
- Convenient Feature: threshold  $k^*$  is independent of factor prices (Cobb-Douglas assumption important).

# Antràs (2003)

## General Equilibrium Model

- Antràs (2003) embeds this structure in a Helpman-Krugman model of trade
- $J$  countries produce differentiated varieties in two sectors ( $Y, Z$ ) using two factors ( $K, L$ )
- $K$  and  $L$  are inelastically supplied and freely mobile across sectors
- Preferences of the representative consumer in each country are of the form:

$$U = \left( \int_0^{n_Y} y(i)^\alpha di \right)^{\frac{\mu}{\alpha}} \left( \int_0^{n_Z} z(i)^\alpha di \right)^{\frac{1-\mu}{\alpha}}, \quad \mu, \alpha \in (0, 1).$$

- Demands are then  $y(i) = A_Y p_Y(i)^{-1/(1-\alpha)}$  and  $z(i) = A_Z p_Z(i)^{-1/(1-\alpha)}$
- Free entry  $\Rightarrow$  zero expected profits for a potential entrant

# Antràs (2003)

## General Equilibrium Model

- Production is as described before with the following new features:
- $h$  and  $m$  are *nontradable*, but combined yield a tradable composite input
- $h$  is capital-intensive relative to  $m$  (cost-sharing in capital expenditures).  
Extreme factor intensity:  $c_h^\ell = r^\ell$  and  $c_m^\ell = w^\ell$ 
  - see Table 1 in paper for a supportive evidence
- tradable composite input can be produced in any country according to Cobb-Douglas technology as in (2) with  $\eta_Y > \eta_Z$
- homothetic cost functions:  $g_j^\ell(r^\ell, w^\ell) = (r^\ell)^{\eta_j} (w^\ell)^{1-\eta_j}$  and  $f_k^\ell = f$
- final goods are nontradable, but can be produced one-to-one with inputs (helps pin down world trade flows)
- the same  $\beta$  and  $\delta$  apply to both sectors and  $\bar{U} = 0$ .

- Under these assumptions the ownership structure and locational decisions in (P2) can be analyzed separately.
  - Optimal ownership structure in sector  $j \in \{Y, Z\}$  solves (P1) – Proposition 1 applies;
  - Optimal location decision solves  $\min_{\ell} \left\{ \left( r^{\ell} \right)^{\eta_j} \left( w^{\ell} \right)^{1-\eta_j} \right\}$ .
- Pattern of specialization of intermediate inputs responds to Heckscher-Ohlin forces as well as Helpman-Krugman forces:
  - because of IRS and product differentiation, countries specialize in certain intermediate input varieties and export them worldwide,
  - but capital-abundant countries tend to produce a larger share of capital-intensive varieties than labor-abundant countries.
- Intermediate inputs can be traded at zero cost, while final goods are nontradable so that each  $F$  (costlessly) sets  $J$  plants to service the  $J$  markets.
- It can then be shown that, with FPE, for any country  $j \in J$ :
  - “probability” of imports being intrafirm is increasing in capital-intensity of the industry.
  - the share of capital-intensive (and *thus* intrafirm) imports in total imports is an increasing function of the capital-labor ratio of the exporting country.

# Antràs and Helpman (2004)

## Global Sourcing with Heterogenous Firms

- The technological theories of MNEs emphasizes the location decision
- Antras (2003) emphasizes the boundary decision
- Antras and Helpman (2004) offer a model in which final good producers will simultaneously decide:
  - 1 Where to source their inputs, North or South
  - 2 Whether to make or buy these inputs
- As in Melitz (2003) and HMY (2004), they introduce firm-level heterogeneity
  - Global sourcing decisions will depend both on firm- and industry-characteristics

# Antràs and Helpman (2004)

## The Model

- **Environment and Preferences:** Consider a world with two countries, the North and the South, and a unique factor of production, labor. There is a representative consumer in each country with quasi-linear preferences:

$$U = x_0 + \frac{1}{\mu} \sum_{j=1}^J X_j^\mu, \quad 0 < \mu < 1.$$

where  $x_0$  is consumption of a homogeneous good,  $X_j$  is an index of aggregate consumption in sector  $j$ , and  $\mu$  is a parameter.

- Aggregate consumption in sector  $j$  is a CES function

$$X_j = \left[ \int x_j(i)^\alpha di \right]^{1/\alpha}, \quad 0 < \alpha < 1,$$

of the consumption of different varieties  $x_j(i)$ , where the range of  $i$  will be endogenously determined.

- This specification leads to the following inverse demand function for each variety  $i$  in sector  $j$ :

$$p_j(i) = X_j^{\mu-\alpha} x_j(i)^{\alpha-1}.$$

# Antràs and Helpman (2004)

## The Model (cted.)

- **Technology:** Producers of differentiated goods face a perfectly elastic supply of labor. Let the wage in the North be strictly higher than that in the South ( $w^N > w^S$ ). The market structure is one of monopolistic competition.
  - As in Melitz (2003), producers need to incur sunk entry costs  $w^N f_E$ , after which they learn their productivity  $\theta \sim G(\theta)$ .
  - As in Antràs (2003), final-good production combines two specialized inputs according to the technology:

$$x_j(i) = \theta \left( \frac{h_j(i)}{\eta_j} \right)^{\eta_j} \left( \frac{m_j(i)}{1 - \eta_j} \right)^{1 - \eta_j}, \quad 0 < \eta_j < 1.$$

- $h$  is controlled by a final-good producer (agent  $F$ ),  $m$  is controlled by an operator of the production facility (agent  $S$ ).
- Sectors vary in their intensity of headquarter services  $\eta_j$ . Furthermore, within sectors, firms differ in productivity  $\theta$ .
- Intermediates are produced using labor with a fixed coefficient.
- $h_j(i)$  is produced only in the North, which implies that the headquarters  $H$  are always located in the North.
- Productivity in the production of  $m_j(i)$  is assumed identical in both countries.

# Antràs and Helpman (2004)

## The Model (cted.)

- After observing  $\theta$ ,  $H$  decides whether to exit the market or start producing.
- In the latter case additional fixed cost of organizing production need to be incurred.
  - It is assumed that these additional fixed cost are a function of the structure of ownership and the location of production.
  - In particular, if an *organizational form* is  $k \in \{V, O\}$  and  $\ell \in \{N, S\}$ , these fixed costs are  $w^N f_k^\ell$  and satisfy

$$f_V^S > f_O^S > f_V^N > f_O^N. \quad (4)$$

- Contracting is as in the previous models, but we let  $\delta^N \geq \delta^S$ .
- Following Antràs (2003), the ex-post division of surplus is as follows:

|                 | North   | South   |
|-----------------|---|---|
| Non-Integration | $\beta_O^N = \beta$   | $\beta_O^S = \beta$   |
| Integration     | $\beta_V^N = (\delta^N)^\alpha + \beta [1 - (\delta^N)^\alpha]$ | $\beta_V^S = (\delta^S)^\alpha + \beta [1 - (\delta^S)^\alpha]$ |

- Notice that

$$\beta_V^N \geq \beta_V^S > \beta_O^N = \beta_O^S = \beta.$$



- We show that after solving for investment levels (in the constraints), the general program in (P2) reduces to

$$\max_{\beta_k^\ell \in \{\beta_V^N, \beta_V^S, \beta_O^N, \beta_O^S\}} \pi_k^\ell(\theta, X, \eta) = X^{(\mu-\alpha)/(1-\alpha)} \theta^{\alpha/(1-\alpha)} \psi_k^\ell(\eta) - w^N f_k^\ell \quad (5)$$

where

$$\psi_k^\ell(\eta) = \frac{1 - \alpha \left[ \beta_k^\ell \eta + (1 - \beta_k^\ell) (1 - \eta) \right]}{\left[ \frac{1}{\alpha} \left( \frac{w^N}{\beta_k^\ell} \right)^\eta \left( \frac{w^\ell}{1 - \beta_k^\ell} \right)^{1-\eta} \right]^{\alpha/(1-\alpha)}}.$$

- By choosing  $k$  and  $\ell$ ,  $H$  is effectively choosing a triplet  $(\beta_k^\ell, w^\ell, f_k^\ell)$ . And:
  - $\pi_k^\ell$  is decreasing in  $w^\ell$  and  $f_k^\ell$ .
  - $\pi_k^\ell$  is largest when  $\beta_k^\ell = \beta^*(\eta)$ , with  $\beta^{*'}(\eta) > 0$ ,  $\beta^*(0) = 0$  and  $\beta^*(1) = 1$  (remember Figure 1). Intuitively,  $H$  wants to allocate relatively more power to the party undertaking a relatively more important investment in production.
- One can solve for industry equilibrium as in Melitz (2003) or HMY (2004).

# Antràs and Helpman (2004)

## Relevant Trade-offs

- The choice of an organizational form faces two types of tensions:
  - Location decision: variable costs are lower in the South, but fixed costs are higher there – a firm's productivity  $\theta$  will turn out to affect crucially the participation in international trade;
  - Integration decision: integration improves efficiency of variable production when the  $\eta$  is high, but involves higher fixed costs. This decision will thus crucially depend on  $\eta$  but also on  $\theta$ .
- To simplify the discussion, we focus on two types of sectors:
  - ① A **Component-intensive sector** ( $\eta < \beta^{*-1}(\beta)$  and  $w^N/w^S < (f_O^S/f_O^N)^{(1-\alpha)/\alpha(1-\eta)}$ ):
    - This implies  $\psi_O^\ell(\eta) > \psi_V^\ell(\eta)$  for  $\ell = N, S$ , which together with (4), implies that any form of integration is dominated in equilibrium (see Figure).
  - ② A **Headquarter-intensive sector** with  $\eta > \beta^{*-1}(\beta_V^N)$ , and  $(w^N/w^S)^{1-\eta}$  "high enough"
    - This implies the ranking of slopes

$$\psi_V^S(\eta) > \psi_O^S(\eta) > \psi_V^N(\eta) > \psi_O^N(\eta). \quad (6)$$

which together with (4) leads to the Figure below.

# Antràs and Helpman (2004)

## Prevalence of various organizations

- Last part of the paper quantifies the relative prevalence of different organizational forms
- This requires parameterizing the distribution of  $\theta$ . Following HMY (2004), we choose  $G(\theta)$  to be a Pareto distribution with shape  $z$ , i.e.,

$$G(\theta) = 1 - \left(\frac{b}{\theta}\right)^z \text{ for } \theta \geq b > 0. \quad (7)$$

- Remember that  $z$  is inversely related to the variance of the distribution.
- In the component-intensive sector, foreign outsourcing is more prevalent:
  - the higher is  $w^N/w^S$  (or the lower are transport costs  $\tau$ ),
  - the lower are  $z$  and  $\eta$ .
- In the headquarter-intensive sector:
  - the share of intrafirm imports in total imports should be higher in industries with higher  $\eta$ , but also in industries with higher productivity dispersion (lower  $z$ ) and higher transport costs ( $\tau$ ).
  - a higher  $w^N/w^S$  (or lower  $\tau$ ) increase the amount of international sourcing, but also increase the share of foreign outsourcing in total foreign sourcing.

# Antràs and Helpman (2004)

## Comments

- Antràs and Helpman (2004) offer a rich set of *positive* predictions:
  - ① Share of intra-firm trade
  - ② Prevalence of offshoring
- We now know much less about the *normative* and *policy* implications of contractual theories of MNEs
- Antràs and Staiger (2010) offer a first look at the implications of contractual theories of MNEs for the design of trade agreements

### 3. Fragmentation of Production

# Fragmentation of production

## Overview

- In recent years, a lot of attention has been given to “fragmentation of production” a.k.a. the “slicing of the value chains” or “trade in tasks”
  - Baldwin (2006) has referred to this period as “the great unbundling”
- Fragmentation is related to activities of MNEs, though less than perfectly
  - Intuitively, if US firm outsources services in India, we would like to say that there is “fragmentation”
  - but this may not show up in the data (in U.S. statistics, a U.S. company needs to hold 10% or more of the stock of a foreign company in order to be considered a MNE)
- **Question:**

Is “fragmentation” just a fancy name for “trade in intermediate goods”?
- **Answer(s):**
  - 1 It is about trade in intermediate goods, but new models emphasize differences in trade costs across goods (e.g. how routine a particular “task” may be), which previous models abstract from
  - 2 It is *not just* about trade in intermediate goods, since “fragmentation” also usually includes a transfer of technology from one country to another

# Grossman and Rossi-Hansberg (2008)

## Assumptions

- As in Heckscher-Ohlin model:
  - There are two countries, Home and Foreign
  - There are 2 tradeable goods,  $i = 1, 2$
  - There are two factors of production,  $L$  and  $H$
- In contrast with Heckscher-Ohlin model:
  - Production process involves a large number of *tasks*  $j \in [0, 1]$
- Tasks are of two types:
  - $L$ -tasks which require 1 units of low-skilled labor
  - $H$ -tasks which require 1 units high-skilled labor

# Grossman and Rossi-Hansberg (2008)

## Offshoring Costs

- Tasks vary in their offshoring costs
  - because some tasks are easier to codify
  - because some services must be delivered personally, while others can be performed at a distance with little loss in quality
- To capture this idea, GRH assume that:
  - $H$ -tasks cannot be offshored
  - $L$ -tasks can be offshored, but amount of low-skilled labor necessary to perform task  $j$  abroad is given by  $\beta t(j) > 1$
- Under this assumption,
  - $\beta$  reflects overall feasibility of offshoring at a point in time (e.g. communication technology)
  - $t(j)$  is an increasing function which captures differences in offshoring costs across tasks (e.g. cleaning room vs. call center)



# Grossman and Rossi-Hansberg (2008)

## The Offshoring Decision

- Suppose that wages for low-skilled labor are higher at Home

$$w_L > w_L^*$$

- Benefit of offshoring  $\equiv$  lower wages abroad
- Cost of offshoring  $\equiv$  loss in productivity captured by  $\beta t(j)$
- In a competitive equilibrium, firm will offshore tasks if and only if:

$$\beta t(j) w_L^* < w_L$$

- Let  $J \in [0, 1]$  denote the marginal task that is being offshored

$$\beta t(J) w_L^* = w_L \tag{8}$$

# Grossman and Rossi-Hansberg (2008)

## Offshoring as Factor Augmenting Technological Change

- The cost of producing one unit of some good is given by

$$c_i = a_{Li} [w_L(1 - J) + w_L^* \beta T(J)] + a_{Hi} w_H \quad (9)$$

with  $T(J) \equiv \int_0^J t(j) dj$ ,  $w_H \equiv$  wage of high-skilled workers at Home

- Substituting (1) into (2), we obtain

$$c_i = a_{Li} w_L \Omega + a_{Hi} w_H$$

where  $\Omega = (1 - J) + \frac{T(J)}{t(I)} < 1$

- This looks just like the cost equation of a firm that employs low-skilled workers whose productivity is (inversely) measured by  $\Omega$ 
  - Hence, offshoring is economically equivalent to labor-augmenting technological progress

# Grossman and Rossi-Hansberg (2008)

## Productivity effect

- **Proposition** *If Home is a small open economy, a decrease in  $\beta$  increases  $w_L$*
- **Proof:**
  - 1 Zero profit requires:

$$p_i = a_{Li}w_L\Omega + a_{Hi}w_H, \quad i = 1, 2$$

- 2 Since Home a small open economy,  $p_i$  does not depend on  $\beta$
- 3 This implies that  $w_L\Omega$  (and  $w_H$ ) do not depend on  $\beta$  either
- 4 Since  $\Omega$  is decreasing in  $\beta$ , we get  $w_L$  increasing in  $\beta$

# Grossman and Rossi-Hansberg (2008)

## Other effects

- **Productivity effect** implies that workers whose jobs are being offshored benefit from decrease in offshoring costs
- In general, a decrease in offshoring costs would also have:
  - ① **Relative-price effect.** If country is not small compared to the rest of the world, changes in  $\beta$  will also affect  $p_2/p_1$
  - ② **Labor-supply effect.** If there are more goods than factors, changes in  $\beta$  will also affect  $w_L\Omega$  and  $w_H$  at constant prices
- Simplest way to illustrate labor-supply effect is to consider case where Home is completely specialized in one good
  - this is the effect that has received the most attention in popular discussions
  - empirically, is it more or less important than the other two?

# Grossman and Rossi-Hansberg (2009)

## Overview

- Most models of fragmentation of production are "North-South"
  - Rationale for offshoring  $\equiv$  factor price differences
- In practice, fragmentation often takes place between countries with similar income levels
- GRH (2009) develop a "North-North" theory of offshoring
- **Basic Idea:**  
Rationale for offshoring  $\equiv$  external economies of scale (at the task level)
- **Technical issue:**  
How to deal with multiplicity of equilibria with external economies of scale?
- **Main prediction:**  
In equilibrium, country with higher wages and output performs the tasks—among those concentrated—that are more difficult to offshore