Global Sourcing

Luca David Opromolla

North Carolina State University

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1 Introduction

Made in Portugal. Made in China. Made in Italy. These labels are familar to all of us. But, in reality, nowadays most of the products we consume are invented, designed, planned and assembled in multiple countries. The case of the Apple Ipad 3 tablet nicely exemplify the patterns that underlie most of today's production and distribution flows.The tablet itself is designed in California but it's assembled in China and Brazil by two Taiwan-based companies, Foxconn and Pegatron. The retina display seems to be produced by Samsung of South Korea in Wujiang City, China. The iPad 3 also incorporates a variety of chips and other small components provided by various plants and R&D centers scattered all over the world: U.S.-based Qualcomm supplies the 4G modules, the Italian-French joint-venture STMicroelectronics contributes to the sensors. The decisions of firms of where to do different parts of the design, production and assembly process, as well as the decision of doing each part of the process in-house vs. outsourcing it to an independent party is, nowadays a key part of a firm's strategy and a major determinant of its performance, competitiveness and resilience to shocks. This course is designed to provide graduate students, or advanced undergraduate students, the tools to understand how firms take these decisions and to study how obstacles to a smooth global sourcing strategy can hinder a firm's growth prospects, and a firm's survival as well.

2 Setup

2.1 Goals

The goal of the course is to teach the students the main tools used in frontier research to understand firms' decisions to fragment their production process across multiple plants and geographic locations. This requires the students to learn models of trade with heterogeneous firms, the theory of the firms and their boundaries, and the problem of contract incompleteness. These tools are essential to understand how shocks that we see more and more taking place in the world, like a pandemic, a war creating large outflow of refugees, or an economic crises, affect production via their impact on global supply chains.

2.2 Pre-requisites

The course is designed as a component for a Ph.D course in international economics or for an advanced Master course. Pre-requisites include standard models of international trade with monopolistic competition, and tools from microeconomics like Nash bargaining.

3 Syllabus

3.1 Overview

In the first module of the course, we describe the key characteristics of international trade flows. More and more firms organize production on a global scale, and choose to offshore parts, components, or services to foreign countries. When the production is scattered around the world, so that most of international trade is trade in intermediate products, conventional measures of trade flows that keep track of the gross value of goods at each border crossing lead to a distorted view of world trade. For example, if Korean intermediates are assembled in China into final goods exported to the US, then Chinese bilateral gross exports to the US embody Korean content. These chains make bilateral trade flows a misleading guide to the true origin or destination where content is produced or consumed. A first goal of the course is then to understand how to quantify the value-added content of trade and how to compute measures of the upstreamness of an industry. The second goal, which is discussed at the end of this first module, is to discuss to key characteristics of global production: trade in differentiated inputs and the problems of contracting between parties located in different countries.

In the second module, we lay out the first theoretical model of global sourcing with heterogeneous firms. First, we extend the canonical model of trade with heterogeneous firms (Melitz (2003)) to a multi-sectoral version. Next, we introduce an off-shoring choice into the model: we extend the model to let firms make global sourcing decisions related to the location and quantity of inputs to buy from different countries. The key innovation is that the production of varieties in the differentiated-good sectors now involve two stages, headquarter services and manufacturing production that may be *geographically separated.*, and located either in the North or in the South. The model predicts selection into off-shoring and allows to identify key determinants of the relative prevalence of offshoring in an industry.

In the third module we turn our attention on the implications of weak contracting enforcement between Northern headquarters and Southern manufacturing plants. We therefore turn to the discussion of the microeconomic structure of contracting considering the case of contracts that are complete and entirely enforceable vs. the case of contracts that are incomplete and only weakly enforceable. We then focus on the case in which contracting is complete in the domestic sourcing relationships, and totally incomplete between geographically-separated parties. We discuss the well-known "hold-up" problem. Finally, we update the discussion on the key determinants of the relative prevalence of offshoring in an industry when international contracts are incomplete.

In the fourth module we consider extension of the baseline framework outlined above to consider the case of financial constraints, partial contractibility, partial relationship-specificity, and sequential production.

In the fifth module, we discuss more in detail the case of sequential production by going over the paper Antràs and Chor (2013).

In the sixth module we focus on the Property Rights Theory of the firm, starting with the seminal work of Grossman and Hart (1986), We use this paper as a pedagogical example of how to conduct research in economics.

In the remainder of the course students prepare presentations of key related paper, and an assistant professor is invited to share the experience gained as a Ph.D student and as an assistant professor.

3.2 Detailed Schedule

1. Introduction
   (a) Value-added content of trade
   (b) Measures of upstreamness
   (c) Key characteristics of trade flows: differentiated products and contract incompleteness.
2. Review of the Melitz (2003) model.
   (a) Extension to multiple sectors.
   (b) Introduction of a global sourcing choice.
   (c) Self-selection into offshoring.
   (d) Determinants of industry off-shoring.
3. Weak contracting and the hold-up problem.
4. Extensions of the baseline model.
5. The sequential production case (Antràs and Chor (2013)).
6. The Property Rights Theory of the Firm.
7. Student presentations.
8. Guest lecturer.

4 Evaluation

Students are evaluated on in-class participation, presentations and a research proposal (or a referee report for Master students).

5 Appendix

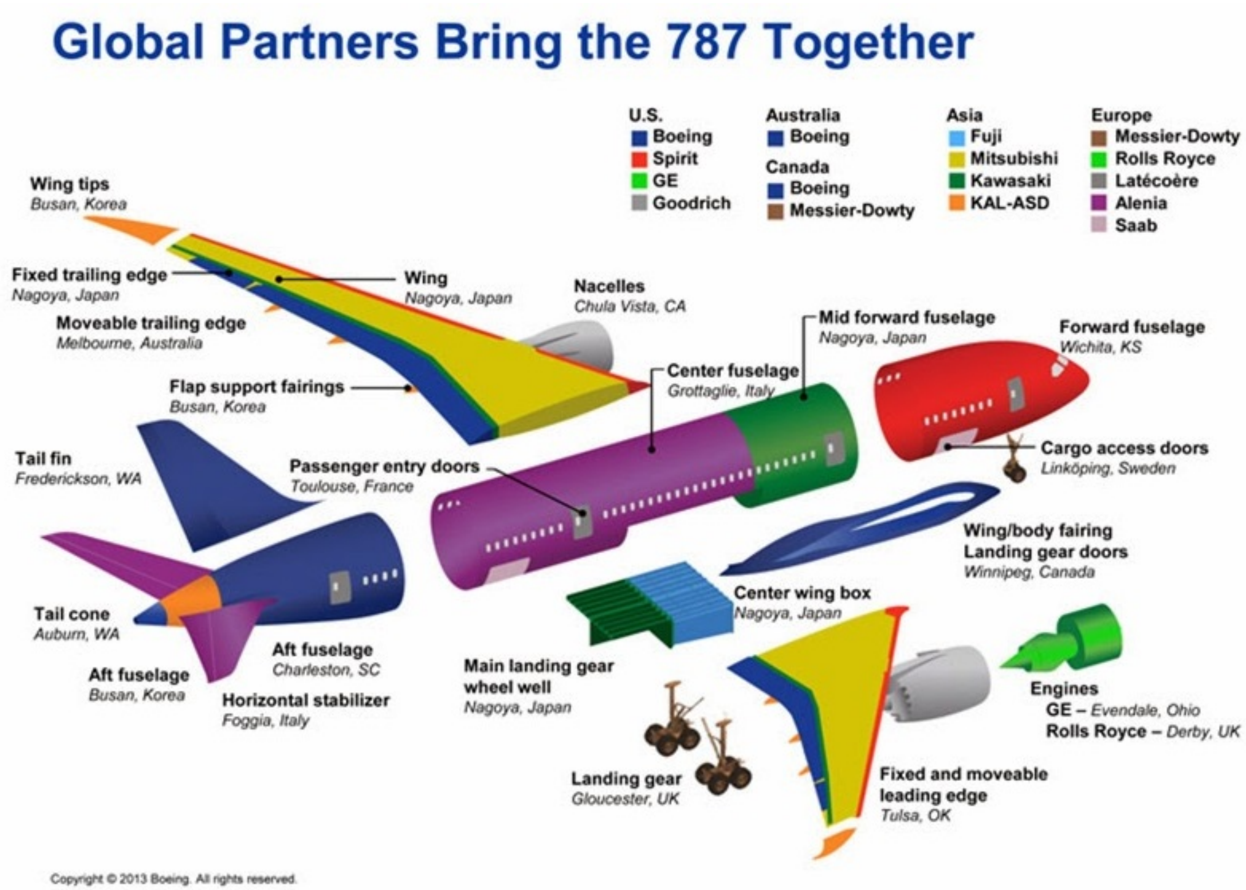
The following slides have been used for Luca David Opromolla's Ph.D course in international economics at NC State University.

Global Production - An Overview

Luca David Opromolla

NC State, Spring 2024

Topic


Global Partners Bring the 787 Together
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Europe
Messier-Dowty
Rolls Royce
Latécoère
Alenia
Saab
Wing tips
Busan, Korea
Fixed trailing edge
Nagoya, Japan
Wing
Nagoya, Japan
Nacelles
Chula Vista, CA
Moveable trailing edge
Melbourne, Australia
Mid forward fuselage
Nagoya, Japan
Forward fuselage
Wichita, KS
Center fuselage
Grottaglie, Italy
Flap support fairings
Busan, Korea
Cargo access doors
Linköping, Sweden
Tail fin
Frederickson, WA
Passenger entry doors
Toulouse, France
Wing/body fairing
Landing gear doors
Winnipeg, Canada
Tail cone
Auburn, WA
Center wing box
Nagoya, Japan
Aft fuselage
Charleston, SC
Aft fuselage
Busan, Korea
Main landing gear
wheel well
Nagoya, Japan
Engines
GE – Evendale, Ohio
Rolls Royce – Derby, UK
Horizontal stabilizer
Foggia, Italy
Landing gear
Gloucester, UK
Fixed and moveable
leading edge
Tulsa, OK
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Topic

More and more firms organize production on a global scale, and choose to offshore parts, components, or services to foreign countries.

- Example. Apple Ipad 3 manufacturing involves a variety of firms with headquarters, R&D centers and manufacturing plants scattered around the world, like Korea's Samsung (main processor), U.S.-based Qualcomm (4G modules), Italo-French STMicroelectronics (sensors).

- Roughly two-thirds of international trade is in intermediate goods.

Topic

- This could be the result of three main developments:
  - Information and technology revolution (computers' processing power & memory, optical network speed, # of Internet users). Cost of processing and transmitting information at long distance has dramatically fallen.
  - Dismantling of man-made trade barriers (GATT, EU, NAFTA, MERCOSUR, ASEAN, China in the WTO....). World's weighted average tariff applied on traded manufactured goods fell from 5.14% in 1996 to 3.03% in 2010.
  - Political developments that increased the share of world population actively participating in the process of globalization.

Topic

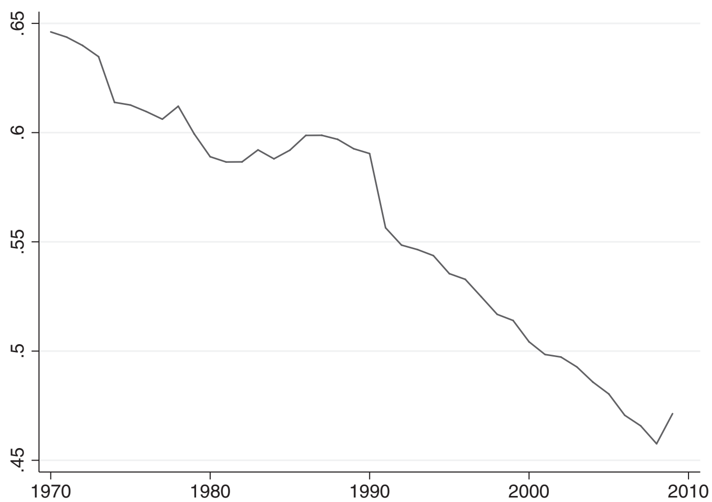
Result: “Made in” labels have become archaic symbols of an old era. Most goods are “Made in the World”.

The value-added content of trade

- Measures of trade flows that tally the gross value of goods at each border crossing lead to a distorted view of world trade.
  - For example, if Korean intermediates are assembled in China into final goods exported to the US, then Chinese bilateral gross exports embody Korean content.
  - These chains make bilateral trade flows a misleading guide to the true origin or destination where content is produced or consumed.
  - Using input-output tables for individual G7 countries, existing estimates suggest that the import content of exports is 20%-30% and rising over time (Hummels et al. 2001, NRC 2006). Estimates for countries heavily engaged in processing trade (e.g. China) are on the order of 50% (Koopman et al. 2008).
  - The US-China imbalance of 2004 is approximately 40% smaller when measured on a value added basis, while the US-Japan imbalance is approximately 33% higher.

The value-added content of trade

Figure: Ratio of Value-Added to Gross Exports for the World, Manufacturing



Note: Robert C. Johnson, Guillermo Noguera; A Portrait of Trade in Value-Added over Four Decades. The Review of Economics and Statistics 2017; 99 (5): 896–911. doi: https://doi.org/10.1162/REST_a_00665

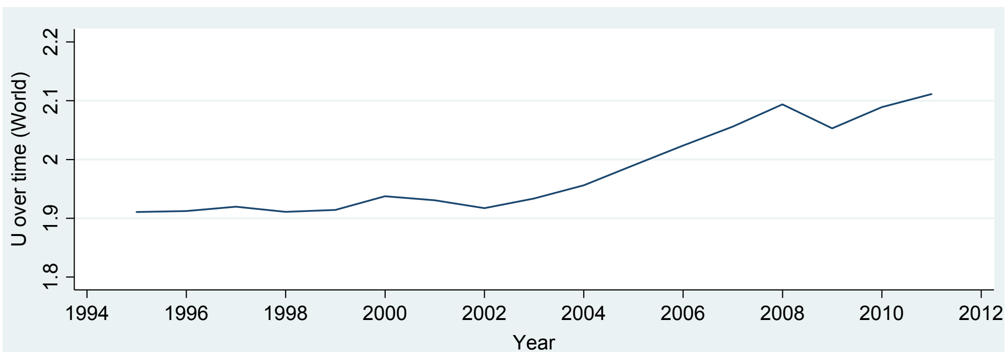
[Class task 1] Explain in 5 slides the Johnson-Noguera methodology to compute the value-added content of trade.

The upstreamness of production and trade flows

- A continuous measure of "upstreamness"
- Antras, Chor, Fally, and Hillberry (2012) use Input-Output data to construct a weighted index of the average position in the value chain an industry's output is used (i.e. as final consumption, as direct input to other industries, as direct input to industries serving as direct input to other industries, etc.)
- The higher the index the more removed from final good use is the industry's output.

The upstreamness of production and trade flows

Figure: Average Upstreamness of World Exports



Note: Antras, Chor, Fally, and Hillberry (2012), American Economic Review: Papers & Proceedings, 102(3): 412–416

[Class task 2] Explain in 5 slides the Antras, Chor, Fally, and Hillberry methodology to compute the upstreamness of production.

Two key characteristics of global production

- Parts and components are frequently customized to the needs of their intended buyers => the disintegration of the production process is more suitably associated to growth of trade in *differentiated* intermediate inputs
- Global production networks entail intensive *contracting* between parties located in different countries and thus subject to different legal systems.
    - Real-world commercial contracts are incomplete, i.e. they cannot possibly specify a course of action for all contingencies that could arise during the course of a business relationship.
    - This is even more true for international transactions.

A reflection on contracts in international trade

Why are contractual disputes involving international transactions particularly difficult?

- Which country's law applies? Parties can specify a *choice-of-law* clause. But many contract don't. And there is no guarantee that the court of law adjudicating a dispute will uphold the expressed desire of the parties. Or that the court will be able to properly apply the desired foreign law.
- Home bias. Even when the court is competent judges may be reluctant to rule against local residents.
- Enforcement. Suppose the court rules in favor of a local importer. Unless the exporter has assets in the importer's country, it is difficult to compel the exporter to pay the importer.

A reflection on contracts in international trade

Why are contractual disputes involving international transactions particularly difficult? (continued)

- Alternative routes to ameliorate the perceived contractibility of international transactions do not work well (UN Convention of Contracts for the International Sale of Goods, or Vienna Convention) or are costly (international arbitration or *forum-of-law* clause).
- International transactions are less likely to be repetead or face-to-face, thereby making implicit contracting to sustain “cooperation” or community enforcement less applicable. Intermediate inputs transaction are also more associated with long time lags between order and delivery, and parts and components often entail significant relationship-specific investments (lock-in).

How this affects firm-level behavior

When designing global sourcing strategies, firms face two key decisions.

1. Location of the different stages of the value chain. Where to conduct R&D and product development, parts and components production, assembly of the final good...
2. Exert of control over these different production stages. Firms may decide to keep some stages within firm boundaries (Foreign Direct Investment) and to contract other stages at arm's length.
    1. Internalization is a double-edged sword.
    2. It may protect the integrating party from the difficulties of international contracting but...
    3. ...it may dilute the incentive of the integrated party, which is now more tightly controlled and has less power in the relationship, to produce efficiently (Grossman and Hart, 1986)

How this affects firm-level behavior

- The boundaries of the firm in the world economy are thus the result of the constrained optimal decisions of firms attempting to organize production in the most profitable way possible.

- Delineating the boundaries of multinational firms is a necessary first step for properly studying the causal implications of multinational activity on growth, factor price movements, welfare...

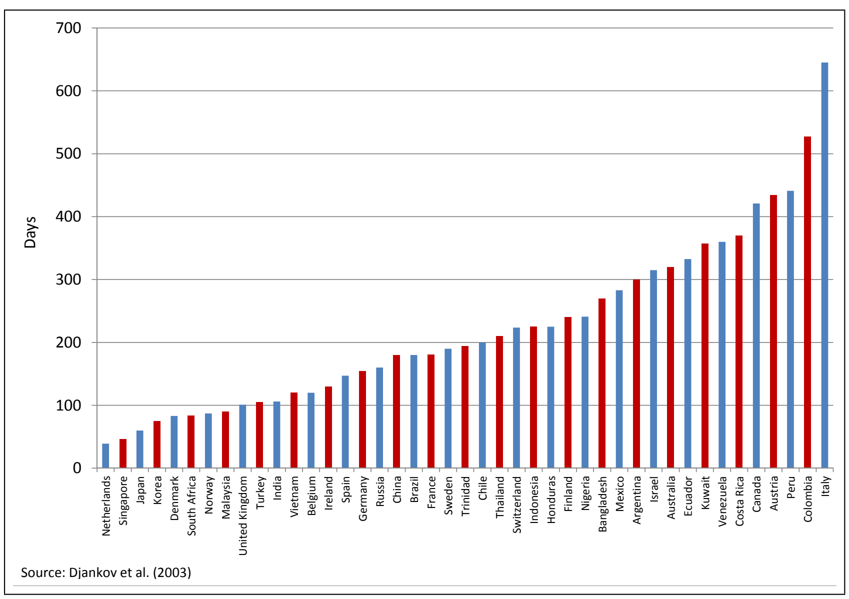
How this affects firm-level behavior

- Contractual frictions affect the internalization decision and, as a consequence, the geographical location decision.
- In neoclassical models of offshoring, profit-maximizing firms will organize production in a cost-minimizing manner...
- ...but the effective costs of doing international business are not explained solely by wage and technology differentials.
  - Firms might be reluctant to offshore production lines to low-wage countries where suppliers are unreliable and courts are unlikely to enforce contracts.
  - Similarly, firms might be unwilling to operate in countries in which their advanced technologies could be effectively deployed (given the existence of local complementary factors), but in which they risk intellectual property rights expropriation.

How this affects firm-level behavior

- Djankov, La Porta, Lopez-De-Silanes and Shleifer (2003) have proposed a measure of judicial quality that relies on the time it takes a plaintiff using an official court to evict a nonpaying tenant and to collect a bounced check.

Figure: Duration of a Legal Procedure Aimed at Collecting a Bounced Check

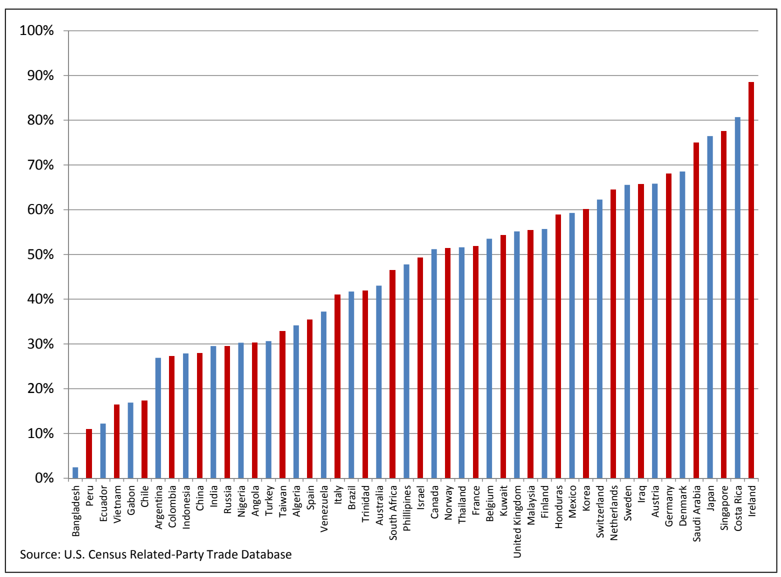


Some facts on the global sourcing strategies of firms

- In U.S. trade intrafirm transactions are predominant: 48.3% of total U.S. imports in 2011. Related-party exports are about 30% of total exports in recent years.

- The share of U.S. intrafirm imports varies widely across countries...

  Figure: Share of U.S. Intrafirm Imports for Largest 50 Exporters to the U.S. in 2011

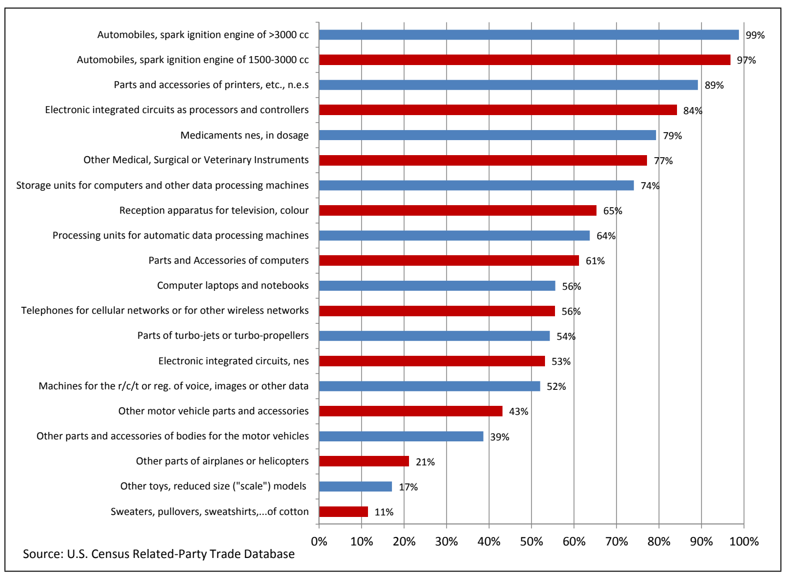


Source: U.S. Census Related-Party Trade Database

Some facts on the global sourcing strategies of firms

- ...and products

Figure: Share of U.S. Intrafirm Imports in Top 20 Industries by U.S. Import Volume in 2011

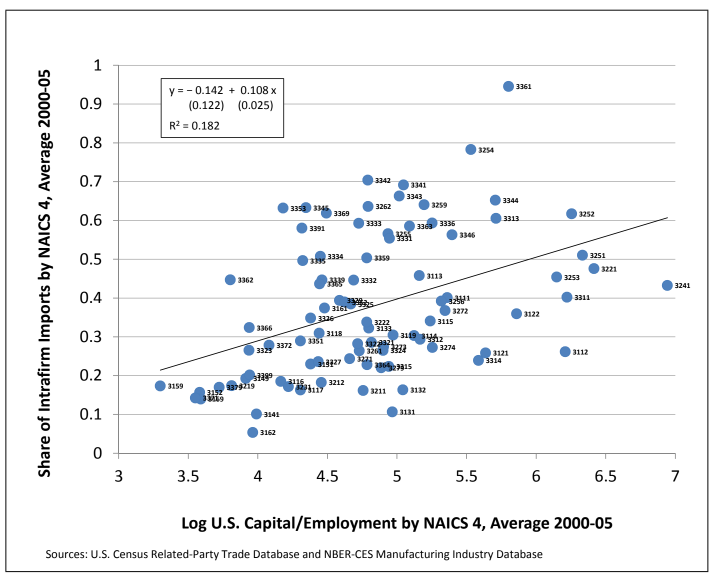


Source: U.S. Census Related-Party Trade Database

Some facts on the global sourcing strategies of firms

- But the large variation in the importance of intrafirm trade is not just idiosyncratic. It is correlated to industry or country-level variables.
- For example, Antras (2003) shows that the share of intrafirm imports in total U.S. imports is significantly higher the higher the U.S. capital intensity in production of the good being imported...

Figure: The Share of Intrafirm U.S. Imports and Capital Intensity

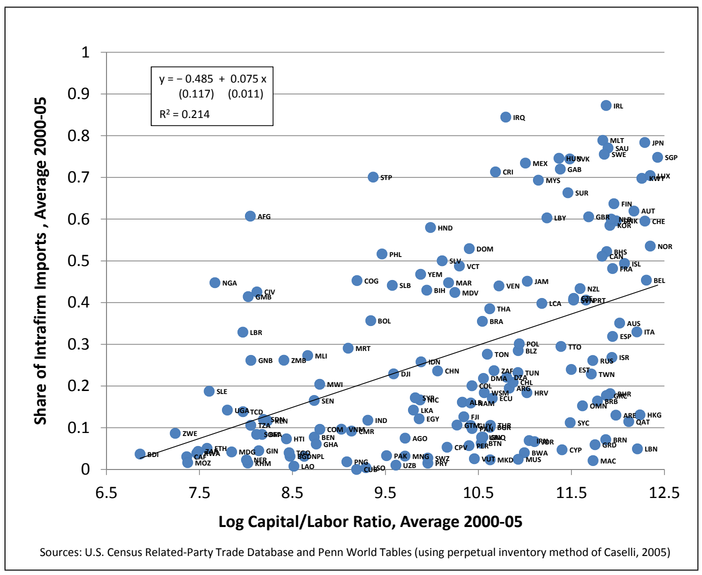


Source: U.S. Census Related-Party Trade Database and NBER-CES Manufacturing Industry Database

Some facts on the global sourcing strategies of firms

- ...and the higher the capital-labor ratio of the exporting country.

Figure: The Share of Intrafirm U.S. Imports and Capital Abundance



Source: U.S. Census Related-Party Trade Database and NBER-CES Manufacturing Industry Database

Next

We will, gradually, develop a model of global sourcing with heterogeneous firms, in order to explore the implications of contractual imperfections for the global organization of production.

A Model of Global Sourcing with Heterogeneous Firms

Luca David Opromolla

NC State, Spring 2024

Recap and way forward

- More and more firms organize production on a global scale, and choose to offshore parts, components, or services to foreign countries.
- Way forward:
  - First, we revisit the Melitz (2003) model by building up a multi-sectoral version of it.
  - Next, we introduce an off-shoring choice into the model.

A Multi-Sector Melitz Model

- Consider a world of J countries.
- Each producing in $S+1$ sectors, one sector produces the homogeneous good z, while each of the others a continuum of differentiated products.
- Preferences are identical everywhere and given by:

$$U = \beta_z \log z + \sum_{s=1}^{S} \beta_s \log Q_s, \text{ with } \beta_z + \sum_{s=1}^{S} \beta_s = 1$$

and

$$Q_s = \left(\int_{\omega \in \Omega_s} q_s(\omega)^{(\sigma_s - 1)/\sigma_s} \, d\omega \right)^{\sigma_s/(\sigma_s - 1)}, \ \sigma_s > 1.$$

A Multi-Sector Melitz Model

Note:

1. Unit elasticity of substitution across sectors => industry spending shares are constant (and equal to the betas) [**HW: prove that**]

2. Within sectors: (i) preferences are Dixit-Stiglitz, (ii) symmetric, constant, higher-than-one-elasticity of substitution between any pair of varieties, (iii) with $\beta_z = 0$ and $S = 1$ same preferences as in Krugman (1980) and Melitz (2003)

Let's drop the sector s and time t subscripts.

Demand

- Within a representative differentiated-good sector, consumers allocate spending across varieties to max Q. This gives rise to the following demand for variety ω in country j: [**HW: prove that**]

$$q_j(\omega) = \beta_j P_j^{\sigma-1} p_j(\omega)^{-\sigma},$$

- $p_j(\omega)$ is the price of variety ω.
- P_j is the ideal price index associated with Q,

$$P_j = \left[\int_{\omega \in \Omega_j} p_j(\omega)^{1-\sigma} \, d\omega\right]^{1/(1-\sigma)},$$

and Ω_j is the set of varieties available to consumers in j.

Supply - Homogeneous Good

- The homogeneous good is produced with labor (inelastically supplied and freely mobile across sectors) under perfect competition and using a constant-returns-to-scale technology which is allowed to vary across countries.
- Output is equal to
$$z_i = L_{zi}/a_{zi},$$
where L_{zi} is the amount of labor in country i allocated to the production of good z, and a_{zi} is a country i's unit labor requirement in that sector.
- The homogeneous good z is freely tradable across countries and will serve as the numeraire in the model.

Supply - Differentiated Sectors

- The differentiated-good industries are monopolistically competitive. Each variety is produced by a single firm under increasing returns to scale. There is free entry in each industry.
- Increasing returns to scale stem from three fixed costs:
  - The process of entry and differentiation of a variety entails a fixed cost of f_{ei} units of labor in country i.
  - Production entails an overhead cost equal to f_{ii} units of country i's labor.
  - Firms in i need to incur a "market access" (e.g. marketing, distribution) cost equal to f_{ij} units of labor in order to export to $j \neq i$
- Fixed costs are common across firms within an industry.

Supply - Differentiated Sectors

- Intraindustry heterogeneity stems from differences in marginal cost of production faced by firms.
- After incurring the fixed cost f_{ei}, firms learn their productivity level φ, which determines their marginal cost of production, $1/\varphi$, in terms of labor.
- Productivity levels are independently drawn from a cumulative distribution function $G_i(\varphi)$, which is assumed to be Pareto with shape parameter $\kappa > \sigma - 1$, so

$$G_i(\varphi) = 1 - \left(\frac{\underline{\varphi}_i}{\varphi}\right)^{\kappa}, \text{ for } \varphi \geq \underline{\varphi}_i > 0.$$

- The assumption $\kappa > \sigma - 1$ is required to ensure a finite variance in the size distribution of firms.

Trade

- Iceberg trade costs: $\tau_{ij} > 1$ units of outputs need to be shipped from country i for 1 unit to make it to country j
- Firm productivity is time-invariant, but firms face a common, exogenous, probability $\delta \in (0,1)$ of being subject to a bad shock that would force them to exit. This keeps the value of the firm bounded for any φ.
- The cost for a firm with productivity φ of producing q units of output in country i and selling them in country j (can be i) is

$$C_{ij}(q) = \left(f_{ij} + \frac{\tau_{ij}}{\varphi} q \right) w_i$$

Relationship to the literature

- The structure of the model is closely related to that of the multi-sector Melitz models in Arkolakis, Demidova, Klenow, and Rodriguez-Clare (2008), and Helpman, Melitz, and Rubinstein (2008).
- The original Melitz (2003) model corresponds to the particular case in which $\beta_z = 0$ and $S = 1$, and parameters are fully symmetric across countries, so $f_{ei} = f_e$, $f_{ii} = f$, $f_{ij} = f_X$, $\tau_{ij} = \tau$, and $L_i = L$ (but Melitz considers a general cumulative probability distribution $G_i(\varphi)$).
- In Krugman (1980), on top of the assumptions in Melitz (2003), there are no fixed export costs $f_X = 0$ and the distribution of productivity $G_i(\varphi)$ is degenerate, so firms are homogeneous.
- This baseline model can be easily turned into the standard neoclassical Ricardian and Heckscher-Ohlin models by setting $\sigma \to \infty$ and all fixed costs to 0.

Selection into Exporting

- Given the isoelastic demand, firms will charge a price in each market in which they sell equal to a constant markup $\sigma/(\sigma-1)$ over the marginal cost of servicing that market. [**HW: prove that**]

- Then potential operating profits for a firm i with productivity φ considering servicing a particular market j are

$$\pi_{ij}(\varphi) = (\tau_{ij} w_i)^{1-\sigma} B_j \varphi^{\sigma-1} - w_i f_{ij}$$

  where

$$B_j = \frac{1}{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} P_j^{\sigma-1} \beta E_j.$$

- Note that: (i) latent profits are increasing in φ, (ii) for sufficiently low φ it is not profitable to sell to market j, (iii) only firms with $\varphi \geq \tilde{\varphi}_{ij}$ with

$$\tilde{\varphi}_{ij} \equiv \tau_{ij} w_i \left(\frac{w_i f_{ij}}{B_j}\right)^{1/(\sigma-1)}$$

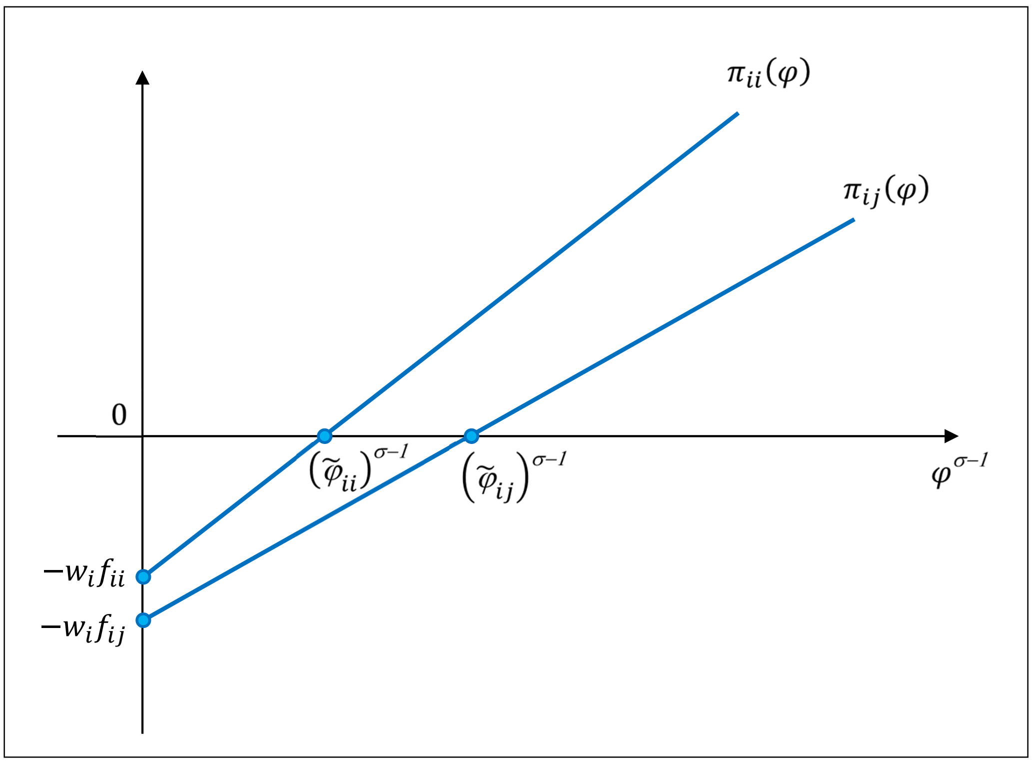
  will find it optimal to export to j.

Selection into Exporting

- The higher are trade barriers between i and j (τ_{ij} and f_{ij}) the lower the share of firms in i choosing to export to j. This contrasts with homogeneous firm models, in which all firms from i would sell to all possible markets j.
- The model provides a rationale for why exporters appear to be more productive than non-exporters: if market demand B_j is similar across markets, but $f_{ij} > 0$ while $f_{ii} = 0$, then firms will find it harder to profitably sell in foreign markets than in their local market.
  - More precisely, if $\tau^{\sigma-1} f_{ij} > f_{ii}$ for all $j \neq i$, it will necessarily be the case that a positive measure of firms sell domestically but does not export.

Selection into Exporting

Figure: Selection into Exporting with Heterogeneous Firms



Notes: The figure assumes that $f_{ij} > f_{ii}$ and that $B_i = B_j$ (or similar)

The Extensive Margin

- Aggregate exports from i to j at the sectoral level

$$X_{ij} = N_i \int_{\tilde{\varphi}_{ij}}^{\infty} \sigma \left(\tau_{ij} w_i\right)^{1-\sigma} B_j \varphi^{\sigma-1} dG_i\left(\varphi\right),$$

  where N_i is the measure of potential producers from i in that sector (set of firms that paid $w_i f_{ei}$)

- Variation in exporting across destination markets j (within a sector) is composed of an extensive and an intensive margin:

$$X_{ij} = N_{ij} \cdot \bar{x}_{ij}$$

  where $N_{ij} = \left(1 - G_i\left(\tilde{\varphi}_{ij}\right)\right)$ is the measure of firms from i selling in j (the extensive margin) and

$$\bar{x}_{ij} = \frac{N_i}{N_{ij}} \int_{\tilde{\varphi}_{ij}}^{\infty} \sigma \left(\tau_{ij} w_i\right)^{1-\sigma} B_j \varphi^{\sigma-1} dG_i\left(\varphi\right)$$

  are average firm-level exports (the intensive margin).

The Extensive Margin

- When productivity is distributed Pareto the intensive margin simplifies to
$$\bar{x}_{ij} = \frac{\kappa}{\kappa - \sigma + 1} \sigma w_i f_{ij}$$
and thus the intensive margin is independent of variable trade costs and of market size.

- So, unlike in the Krugman (1980) model—where lower exports to a destination means that average firm-level exports are lower—in this model variation in exporting across destination is driven by the extensive margin (conditional on the same fixed cost).

- Bernard, Jensen, Redding, and Schott (2009) show that the empirical evidence is consistent with the extensive margin accounting for a much larger share of the cross-sectional variation in trade flows than does the intensive margin.

- Eaton, Kortum and Kramarz "An Anatomy of International Trade: Evidence from French Firms" (ECMA 2011) is an important paper that also emphasizes the importance of the extensive margin. Yoko Shibuya (Duke) has a paper analyzing the interaction between the market and product extensive margins.

Gravity

- The model delivers a gravity equation for trade flows. In the Pareto case,

$$X_{ij} = \frac{Y_i}{\Theta_i}\left(\frac{\beta E_j}{P_j^{1-\sigma}}\right)^{\frac{\kappa}{(\sigma-1)}} \tau_{ij}^{-\kappa} f_{ij}^{-\frac{\kappa-(\sigma-1)}{\sigma-1}},$$

  where $Y_i$is the aggregate industry output in i (i.e. $Y_i \equiv \sum_j X_{ij}$) and $\Theta_i \equiv \sum_j \left(\frac{\beta E_j}{P_j^{1-\sigma}}\right)^{\frac{\kappa}{(\sigma-1)}} \tau_{ij}^{-\kappa} f_{ij}^{-\frac{\kappa-(\sigma-1)}{\sigma-1}}$ is a structural measure of country i's market potential in that industry.

- This gravity equation structurally justifies the use of empirical log-linear specifications for sectoral trade flows with importer-sector and exporter-sector asymmetric fixed effects and measures of bilateral trade frictions.

[Class task 3] Present AER "Gravity with Gravitas: A Solution to the Border Puzzle" by Anderson and Van Wincoop

[Class task 4] Present Sections 2 and 3 of "Chapter 3 - Gravity Equations: Workhorse,Toolkit, and Cookbook" by Head and Mayer

Reallocation

- The model rationalizes the reallocation effects following trade liberalization documented by the empirical evidence (e.g. Pavcnik, 2002).
- In the one-sector model of Melitz (2003), without parametric assumptions on $G_i(\varphi)$, reductions in trade costs will not only expand the number and revenues of exporting firms, but will also (via competition effects through the labor market) reduce the scale of non-exporting firms, and will also lead to the exit of a set of producers that were marginally profitable before the reduction in trade costs.
- Formally, a reduction in trade costs decreases $\tilde{\varphi}_{ij}$ and increases $\tilde{\varphi}_{ii}$.
- Several applications and extension of the Melitz model are reviewed in Melitz and Redding (2013).

Global Sourcing with Heterogeneous Firms

- In the Melitz (2003) model, the only involvement of firms with foreign markets is via the exportation of final goods.

- We now extend the model to let firms make global sourcing decisions related to the location and quantity of inputs to buy from different countries.

- First step: we assume that the production of varieties in the differentiated-good sectors now involve two stages, *headquarter services* and *manufacturing production* that may be *geographically separated*.
  - Headquarter services may include R&D expenditures, brand development, accounting, finance operations, high-tech manufacturing or assembly. All activities that need to be produced where the entry cost f_{ei} was incurred.
  - Manufacturing production may include low-tech manufacturing or assembly of inputs into a final product.

- To keep things (relatively) simple we shall assume that there are no costs of exporting, so that all firms producing final goods export them worldwide.

Global Sourcing with Heterogeneous Firms

- The overall costs of producing q units of a final-good variety for a firm with headquarters in country i and manufacturing production in country j are given by

$$C_{ij}(q,\varphi) = f_{ij} w_i + \frac{q}{\varphi}(a_{hi} w_i)^{\eta} (\tau_{ij} a_{mj} w_j)^{1-\eta}.$$

- The parameters a_{hi}, a_{mj},f_{ij}, τ_{ij} and η are sector-specific but common across firms within a sector, while the wage rates w_i and w_j vary only across countries. f_{ij} and τ_{ij} now reflect the fixed and variable costs of a particular outsourcing strategy. It is natural to assume that $\tau_{ij} > \tau_{ii}$ and $f_{ij} > f_{ii}$ whenever $j \neq i$.
- η captures *headquarter services intensity* of the production process. Technology is Cobb-Douglas in headquarter services h and manufacturing production m:

$$q(\varphi) = \varphi \left(\frac{h(\varphi)}{\eta}\right)^{\eta} \left(\frac{m(\varphi)}{1-\eta}\right)^{1-\eta},\ 0 < \eta < 1.$$

- a_{hi} and a_{mj} capture unit labor requirements associated with headquarter service provision and manufacturing production, and

Global Sourcing with Heterogeneous Firms

- We now make some simplifying assumptions:
  - The world consists of two countries, North and South.
  - The homogeneous good is produced in both countries but with a higher productivity in the North, so that $w^N = 1/a_{zN} > 1/a_{zS} = w^S$.
  - All headquarters service provision occurs in the North (either because the South features low productivity in producing headquarter services or because of a high fixed cost of entry).
  - Plant production can be done with the same physical productivity—in particular, $a_{mN} = a_{mS} = 1$—in both North and South, so offshoring to South offers a production cost advantage.
- Note: these assumptions turn our model in a complete-contract version of Antras and Helpman (2004) (we will return to this paper later).
- Domestic and offshoring production costs are now

$$C_D(q,\varphi) = \left(f_D + \frac{q}{\varphi}\right) w_N,$$

and

$$C_O(q,\varphi) = f_O w_N + \frac{q}{\varphi}(w_N)^{\eta}(\tau w_S)^{1-\eta}.$$

Selection into Offshoring

- Given that firms charge a constant markup $\sigma / (\sigma - 1)$ over the marginal cost of production [**HW: prove that**], the potential (or latent) operating profits for a Northern firm with productivity φ associated with Domestic sourcing and Offshoring can be expressed as

$$\pi_D(\varphi) = (w_N)^{1-\sigma} B\varphi^{\sigma-1} - f_D w_N$$

and

$$\pi_O(\varphi) = \left((w_N)^{\eta} (\tau w_S)^{1-\eta}\right)^{1-\sigma} B\varphi^{\sigma-1} - f_O w_N,$$

respectively, where

$$B = \frac{1}{\sigma}\left(\frac{\sigma}{(\sigma-1) P}\right)^{1-\sigma} \beta (w_N L_N + w_S L_S)$$

and P is the common price index, as in the Melitz model, in each country, given costless international trade in final goods.

Selection into Offshoring

- Similarly to what we saw for the Melitz model, the fact that $f_O > f_D$ ensures that for sufficiently low levels of productivity, we have that offshoring might not be a viable option in situations in which domestic sourcing is profitable. In fact, whenever

$$f_O > \left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)} f_D,$$

there always exists a subset of firms that prefer domestic sourcing to offshoring.

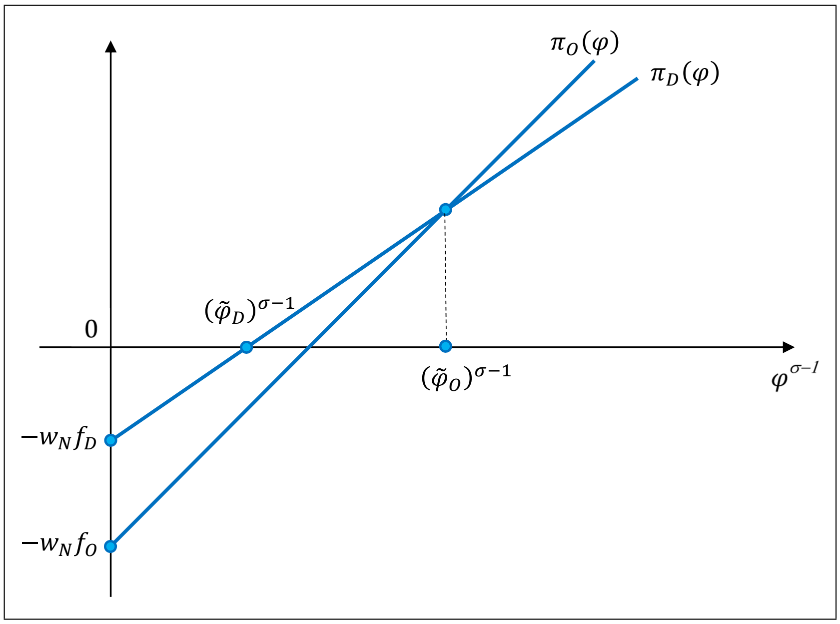
- For some firms to find it optimal to offshore we need $\tau w_S < w_N$.

- Only the most productive firms within an industry,—those with $\varphi \geq \tilde{\varphi}_O$ [**HW: prove that**]—find it optimal to pay the fixed cost of fragmentation f_O to benefit from the lower production costs associated with manufaturing in the South

$$\tilde{\varphi}_O \equiv \left(\frac{f_O - f_D}{B} \frac{w_N}{\left((w_N)^{\eta}(\tau w_S)^{1-\eta}\right)^{1-\sigma}}\right)^{1/(\sigma-1)}.$$

Selection into Offshoring

Figure: Equilibrium Offshoring Sorting with High Wage Differences



- Notes: The figure assumes that $\tau w_S < w_N$ and that $f_O > (w_N/\tau w_S)^{(1-\eta)(\sigma-1)} f_D$.
- This sorting is consistent with the evidence on selection into importing in Bernard, Jensen, Redding, and Schott (2007) who show that U.S. manufacturing plants engaged in importing employ more workers, sell more, are more productive, pay higher wages and are more capital and

Selection into Offshoring

Figure: Equilibrium Offshoring Sorting with High Wage Differences

Table 2.1. Trading Premia in U.S. Manufacturing, 1997

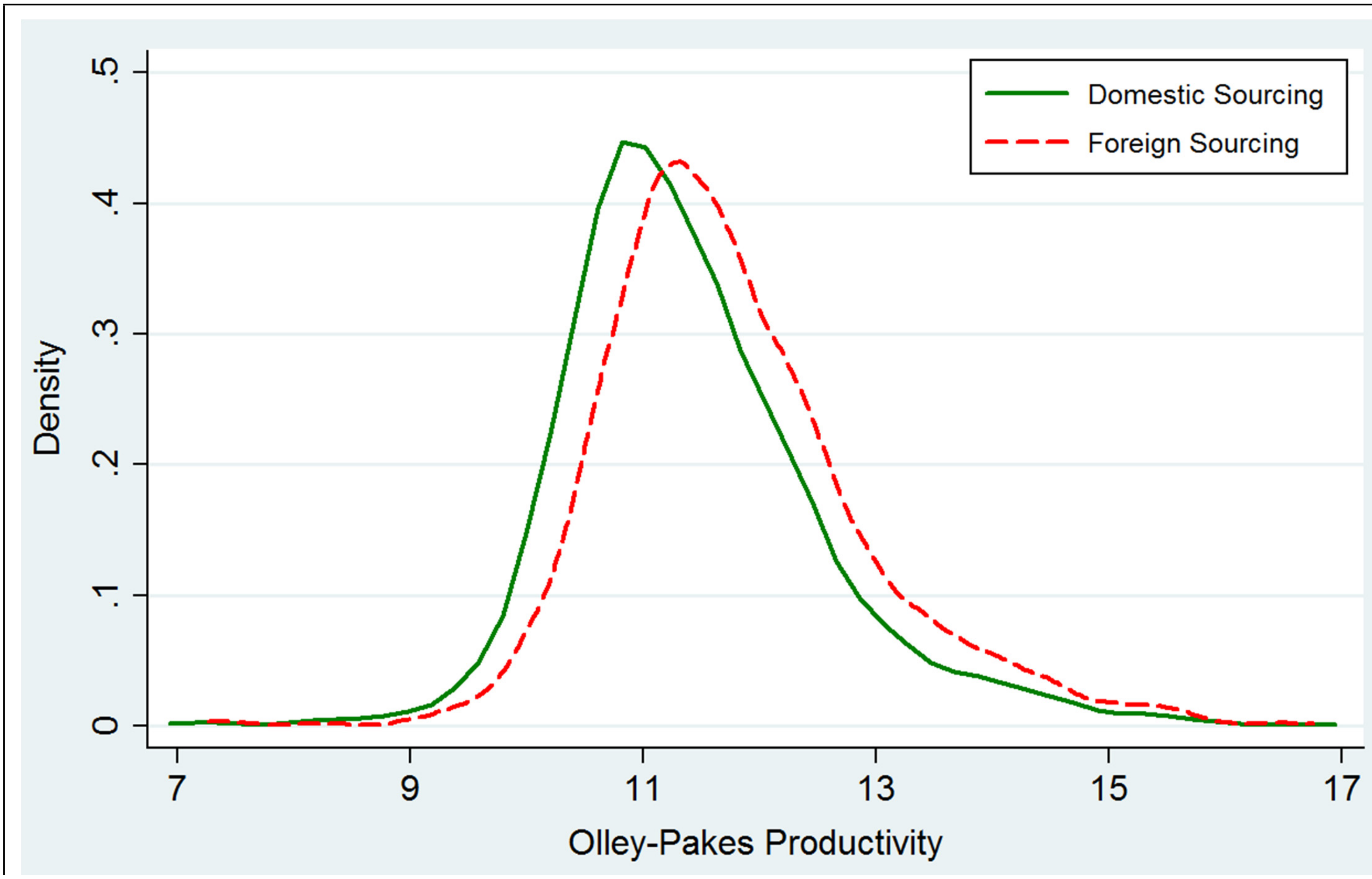
	Exporter Premia	Importer Premia
Log Employment	1.50	1.40
Log Shipments	0.29	0.26
Log Value-Added per Worker	0.23	0.23
Log TFP	0.07	0.12
Log Wage	0.29	0.23
Log Capital per Worker	0.17	0.13
Log Skill per Worker	0.04	0.06

Source: Bernard, Jensen and Schott (2009), Table 8.

- Bernard, Jensen, Redding and Schott (2007) also report that only 14 percent of U.S. manufacturing plants report positive imports (versus 27 percent of plants reporting positive exports), which is again suggestive of the existence of significant fixed costs of

Selection into Offshoring

Figure: Selection into Offshoring in Spain



Determinants of the Prevalence of Offshoring

- We can use this simple model of global sourcing to study the determinants of the relative prevalence of offshoring in an industry.

- The share of spending on imported manufacturing inputs over total manufacturing input purchases in an industry—under Pareto distributed productivity—is

$$\Upsilon_O = \frac{\left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)}}{\left(\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D}\right)^{\kappa-(\sigma-1)} - 1 + \left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)}},$$

where

$$\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D} = \left[\frac{(f_O/f_D)-1}{(w_N/\tau w_S)^{(1-\eta)(\sigma-1)}-1}\right]^{1/(\sigma-1)}.$$

- The prevalence of offshoring in an industry is increasing in the wage gap (w_N/w_S), and decreasing in fragmentation barriers $(f_O/f_D,\tau)$.

Determinants of the Prevalence of Offshoring

$$\Upsilon_O = \frac{\left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)}}{\left(\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D}\right)^{\kappa-(\sigma-1)} - 1 + \left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)}},$$

where

$$\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D} = \left[\frac{(f_O/f_D)-1}{(w_N/\tau w_S)^{(1-\eta)(\sigma-1)}-1}\right]^{1/(\sigma-1)}.$$

- Moreover, given Pareto productivity and CES preferences, the sales distribution of active firms is also Pareto with shape parameter $\kappa/(\sigma-1)$. Therefore, a decrease in κ raises the sales and input purchases of firms with productivity $\varphi > \tilde{\varphi}_O$ (offshoring firms) relative to those of firms with $\varphi \in (\tilde{\varphi}_D, \tilde{\varphi}_O)$ (domestic firms).
- How to see this in the data? The standard deviation of the logarithm of sales by all active firms in the industry is equal to $(\sigma-1)/\kappa$, so the prevalence of offshoring should be higher in industries with a larger dispersion in firm size.
- An increase in the elasticity of substitution σ increases the prevalence of offshoring also via another channel (see the exponent of $w_N/(\tau w_S)$): the more substitutable final-good varieties are, the more elastic demand will

Contract and Global Sourcing

Luca David Opromolla

NC State, Spring 2023

Recap and way forward

- In the previous class we introduced the baseline two-country model of global sourcing
- Way forward:
  - We turn our attention on the implications of weak contracting enforcement between Northern headquarters and Southern manufacturing plants

(Implicit) Assumptions on the Profit Function

- Recap. The operating profits for a Northern firm with productivity φ associated with Domestic sourcing and Offshoring can be expressed as

$$\pi_D(\varphi) = (w_N)^{1-\sigma} B\varphi^{\sigma-1} - f_D w_N$$

and

$$\pi_O(\varphi) = \left((w_N)^{\eta} (\tau w_S)^{1-\eta}\right)^{1-\sigma} B\varphi^{\sigma-1} - f_O w_N,$$

respectively, where

$$B = \frac{1}{\sigma}\left(\frac{\sigma}{(\sigma-1)P}\right)^{1-\sigma} \beta\left(w_N L_N + w_S L_S\right)$$

and P is the common price index, as in the Melitz model, in each country, given costless international trade in final goods.

(Implicit) Assumptions on the Profit Function

- The realization of the entire profit flow by Northern final goods producers rests on strong assumptions:
  - Having information on all parameters of the model.
  - Frictionless contracting between Northern and Southern producers, and between producers and workers.
- We focus on the implications of weak contracting enforcement between Northern headquarters and Southern manufacturing plants.

Microeconomic Structure and Contracting

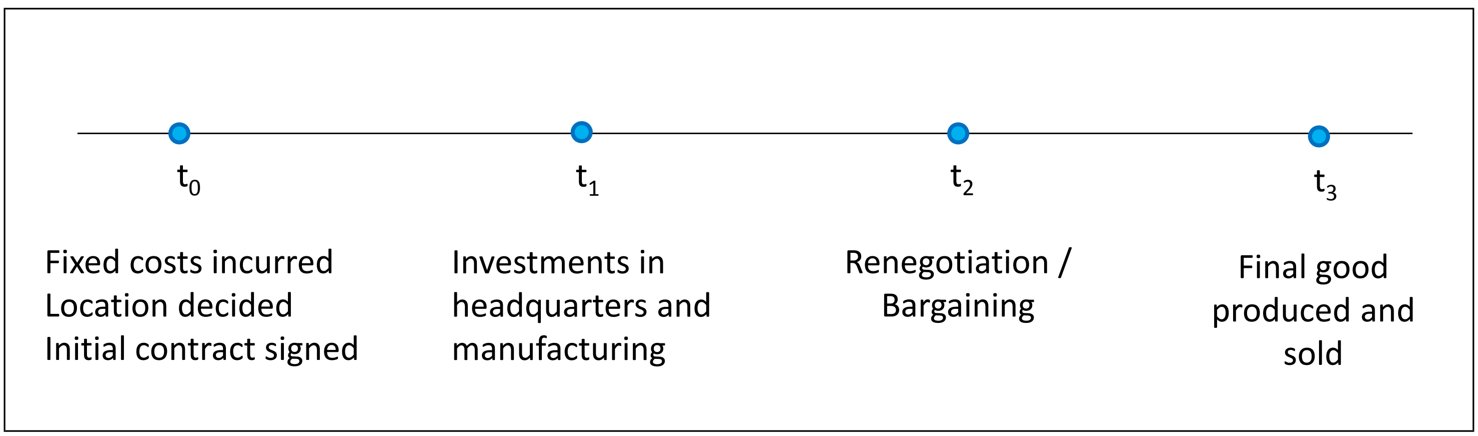
- A discussion of contracting issues requires a more detailed discussion of the agents involved in production and the timing of events.
- Two agents:
  - Final-good producer F: in charge of fixed costs, and of headquarter services.
  - Manufacturing manager M: in charge of providing manufacturing services.
- Both agents have an outside opportunity that delivers them an income level normalized to 0.

Microeconomic Structure and Contracting

- Timing of events:
  - t_0 (initial stage): final-good producer F incurs the fixed cost of entry $w_N f_e$, upon which the productivity level φ is revealed, and F decides whether to have the manufacturing stage controlled by a Northern or Southern manager. F then approaches a manager and offers a formal sourcing contract.
  - t_1 (investment stage): F produces headquarter services and M manufacturing production. Simultaneously (for now).
  - t_2 (renegotiation): Before the manager M hands over the manufactured goods to the final-good producer, the initial sourcing contract can be renegotiated.
  - t_3: the terms of the (final) sourcing contract are executed, and the final good is produced and sold.

Microeconomic Structure and Contracting

Figure: Timing of Events



Microeconomic Structure and Contracting

If the sourcing contract is entirely enforceable, then F can attain the "frictionless" level of operating profits.

- Suppose F chooses a Southern manager. We assume there is a competitive fringe of potential managers willing to work at a reservation wage equal to 0. In the initial contract M provides a quantity m^c of manufacturing production to F in exchange for a fee s^c paid by F.

- Assume that the initial contract includes a clause such that, if any party deviates the other party is entitled to **arbitrarily large** damages. This way F can be sure that M will honor the contract.

- Then F can safely choose $h^c(\varphi)$, $s^c(\varphi)$, $m^c(\varphi)$ to solve

$$\max_{h(\varphi),s(\varphi),m(\varphi)} p(q(\varphi))\,q(\varphi) - w_N h(\varphi) - w_N f_O - s(\varphi)$$

$$s.t.\ s(\varphi) - \tau w_S m(\varphi) \geq 0$$

- F will set $s^c(\varphi)$ in the initial contract to make the participation constraint of the manager M bind. As a result, F will choose $h^c(\varphi)$ and $m^c(\varphi)$ to maximize the overall surplus from the relationship, and attain "frictionless" profits.

- Note that the timing of events, investments or payments is irrelevant for this result.

Incomplete Contracts and Weak Contract Enforcement

- As simple as the above contract may seem, it is hard to believe that agents will be able to (i) write such a type of contract, and (ii) find a court of law to (correctly) enforce it.
  - In the contract $m^c(\varphi)$ does not merely reflect the number of physical units of manufacturing goods. Suppose M has to deliver bottles of soap. Flimsy bottles or abrasive soap would each lead to a low value of m in the model, for a given number of bottles.
  - Some aspects of m are difficult to define by the agents (**noncontractible elements**), or hard to verify by a court. And the cross-border enforcement of damages still remains an issue.

Incomplete Contracts and Weak Contract Enforcement

- What types of contracts are feasible or enforceable?
  - Suppose the contract specifies all contractibles elements and stipulates large penalties from deviations, thus ruling out any ex-post renegotiation. For example, number of bottles and their price. Then M would have an incentive to produce m in the least-cost possible manner. And, foreseeing that, F would set a low price for the final goods, thereby reducing the overall surplus of the relationship.
  - Suppose F and M can shares revenues. Whenever certain aspects of the investments in h and m remain noncontractible, revenue-sharing contracts will not lead to the frictionless levels of investment and profits of the complete-contracting environment, a result reminiscent of Holmstrom's (1982) moral-hazard-in-teams problem.
  - The mechanism design literature has proposed mechanisms to restore efficiency in environments in which the contracting parties (i) have symmetric information, (ii) can commit not to renegotiate an initial contract, and (iii) can resort to a third party (presumably a court of law or arbitrator) to enforce off-the-equilibrium-path penalties (see, for instance, Aghion, Dewatripont and Rey, 1994, or Maskin and Tirole, 1999).

"Totally Incomplete" Contracts

- **Definition**. A contract is said to be "totally incomplete" whenever no aspect of the contract is perceived to be enforceable, with the possible exception of a lump-sum transfer exchanged at the time of the agreement.

- We focus on the case in which contracting is complete in the domestic sourcing relationships (resulting in the "frictionless" domestic profit flow), and totally incomplete in offshoring relationships.

- When the initial contract does not stipulate the levels of h and m nor a revenue sharing mechanism, what is left is to decide how the renegotiation at t_2 takes place.
  - Lock-in effects: manufacturing inputs, as well as headquarter services, are often customized or relationship-specific, and search frictions may be relevant.
  - Incomplete contracting and lock-in effects lead to a situation of bilateral monopoly in which the terms of exchange between F and M will only be determined ex-post (at t_2), after these agents have incurred investments that are by then sunk and have a relatively lower value outside that particular business relationship (**hold-up problem**).

Hold-up

- On one end, F will try to push down the price paid for M's manufacturing input, realizing that M might be inclined to accept a reduced price due to the lower value of those inputs for alternative buyers.
- At the same time, however, M will try to raise the price of m as much as possible, knowing that it might also be in F's best interest to accept a relatively high price if that avoids having to search for a new supplier.
- In deciding how assertively to bargain, each party takes into account that a too aggressive offer might lead the other party to refuse to trade, an outcome that is not appealing given the lower value of the sunk investments outside the relationship.
- As a result, even when bargaining is efficient and trade takes place in equilibrium, the possibility of a disagreement implies that F and M have lower incentives to invest in h and m than in the complete contracting case: the payoff obtained by each party in the ex-post negotiations will put a positive weight on off-the-equilibrium path situations in which the return to each party's investments is lower than on the equilibrium path.

Nash Bargaining

- It is common to characterize the ex-post bargaining at t_2 using the Nash Bargaining solution and assuming symmetric information between F and M with regards to all parameters of the model.
- **Each party ends up with a payoff equal to the value of their outside option (their payoff under no trade) plus a share of the ex-post gains from trade, which correspond to the difference between the sum of the agents' payoffs under trade and their sum under no trade.**
- We assume that both h and m are fully tailored so that they are useless outside the relationship. The outside option is then 0 for both F and M.
- We consider the case of symmetric Nash bargaining, which implies that F and M share equally the ex-post gains, which with zero outside options equal sales revenues.

Final-goods Producer Problem

- At t_0 there is a competitive fringe of potential managers M willing to work for each final-good producer F at a reservation wage equal to 0.
- Each F then decides the terms of the initial contract and makes a take-it-or-leave it offer to one of those managers.
- F sets the lump-sum transfer such that the participation constraint of M exactly binds.

Final-goods Producer Problem

- As with complete contracts, F ends up with profits equal to

$$\pi_O(\varphi) = p(q(\varphi))\, q(\varphi) - w_N h(\varphi) - \tau w_S m(\varphi) - w_N f_O. \tag{1}$$

- Key difference: now $h(\varphi)$ and $m(\varphi)$ are no longer set to maximize (1) but are chosen simultaneously and non-cooperatively by F and M to solve

$$\max_h \frac{1}{2} p(q(\varphi))\, q(\varphi) - w_N h$$

and

$$\max_m \frac{1}{2} p(q(\varphi))\, q(\varphi) - \tau w_S m$$

where

$$q(\varphi) = \varphi \left(\frac{h}{\eta}\right)^{\eta} \left(\frac{m}{1-\eta}\right)^{1-\eta}$$

and

$$p(q(\varphi)) = B^{1/\sigma} \sigma (\sigma - 1)^{(\sigma-1)/\sigma}\, q(\varphi)^{-1/\sigma}.$$

Final-goods Producer Problem

- In a more compact way,

$$\max_{h(\varphi),m(\varphi),s(\varphi)} \frac{1}{2} p\left(q\left(\varphi\right)\right) q\left(\varphi\right) - w_N h\left(\varphi\right) - s\left(\varphi\right) - w_N f_O$$

$$s.t.\ s\left(\varphi\right) + \frac{1}{2} p\left(q\left(\varphi\right)\right) q\left(\varphi\right) - \tau w_S m\left(\varphi\right) \geq 0$$

$$h\left(\varphi\right) = \arg\max_{h} \left\{ \frac{1}{2} p\left(q\left(\varphi\right)\right) q\left(\varphi\right) - w_N h\left(\varphi\right) \right\}$$

$$m\left(\varphi\right) = \arg\max_{m} \left\{ \frac{1}{2} p\left(q\left(\varphi\right)\right) q\left(\varphi\right) - \tau w_S m\left(\varphi\right) \right\}$$

- The effect of incomplete contracting is captured by the addition of the last two constraints, which represent incentive compatibility constraints faced by both F and M.

- **Because the bargaining payoffs of each agent put a positive weight on an off-the-equilibrium-path zero return to producing in h and m, the hold up problem leads to inefficiently low investment levels at t_1, and results in depressed overall profits as well.**

Final-goods Producer Problem

- F's latent profits are then

$$\pi_O = \left((w_N)^{\eta} (\tau w_S)^{1-\eta} \right)^{1-\sigma} B\Gamma_O \varphi^{\sigma-1} - w_N f_O,$$

where

$$\Gamma_O = (\sigma+1)\left(\frac{1}{2}\right)^{\sigma} < 1 \text{ for } \sigma > 1.$$

- The Γ_O term reflects the loss of efficiency due to incomplete contracting.
    - Note that, under $\sigma > 1$, the profit losses from incomplete contracting are increasing in σ. The effect of incomplete contracting on the choice of h and m is equivalent to a doubling of the marginal cost of each of these two stages, and this reduces profits more the more price elastic demand is.

Choice of Location

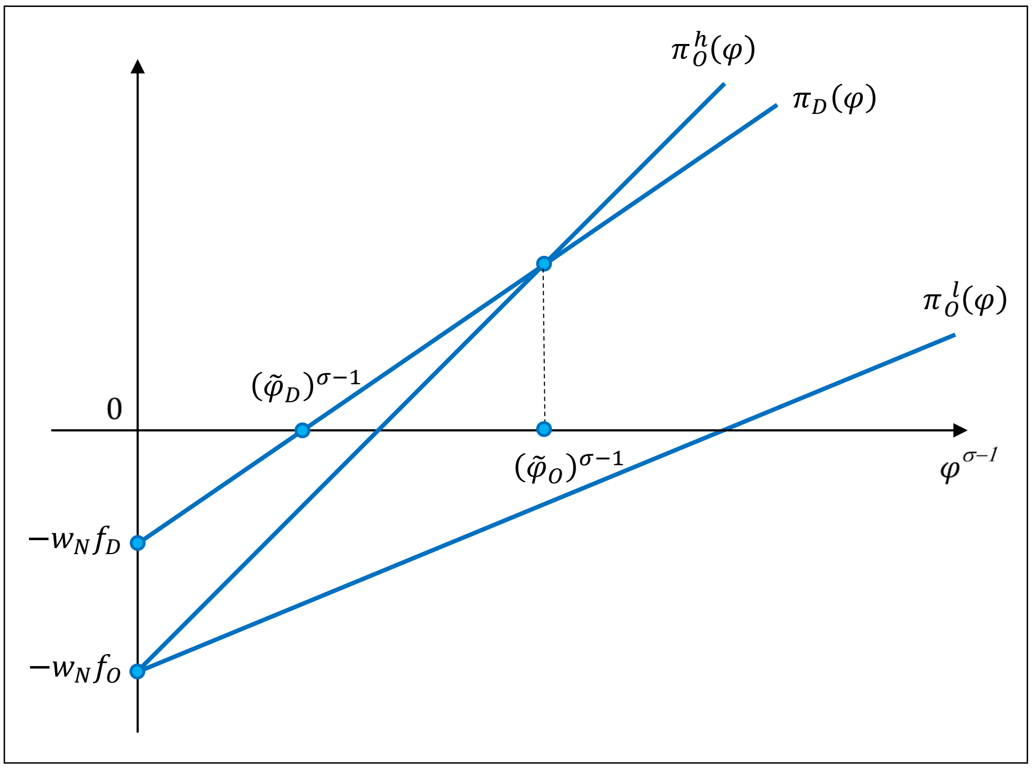
- Knowing the anticipated profits associated with domestic sourcing and offshoring, we can study the choice of location of the final-good producer in the initial period t_0.
- We can write profits as

$$\pi_l(\varphi) = \psi_l B \varphi^{\sigma-1} - w_N f_l \text{ for } l = D, O$$

with

$$\frac{\psi_D}{\psi_O} = \frac{1}{\Gamma_O}\left(\frac{w_N}{\tau w_S}\right)^{-(1-\eta)(\sigma-1)}.$$

Choice of Location



-
- π_O^h line: high wage differences across countries, so that $\psi_D < \psi_O$
- π_O^l line: low wage differences across countries, so that $\psi_D > \psi_O$

Prevalence of Offshoring

- For all firms sourcing domestically, input purchases constitute a fraction $(1-\eta)(\sigma-1)$ of operating profits (revenue minus variable costs).
- We assume that foreign inputs are priced such that these expenditures constitute the same multiple $(1-\eta)(\sigma-1)$ of operating profits.
- Assuming Pareto productivity, we can solve for the share Υ_O of imported manufacturing input purchases in a given industry,

$$\Upsilon_O = \frac{\Gamma_O \left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)}}{\left(\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D}\right)^{\kappa-(\sigma-1)} - 1 + \Gamma_O \left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)}},$$

where

$$\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D} = \left[\frac{f_O/f_D - 1}{\Gamma_O \left(\frac{w_N}{\tau w_S}\right)^{(1-\eta)(\sigma-1)} - 1}\right].$$

Prevalence of Offshoring

- The model predicts that the share Υ_O of imported manufacturing input purchases in a given industry is
  - increasing in wage differences (w_N/w_S)
  - increasing in productivity dispersion $(1/\kappa)$
  - decreasing in fragmentation barriers $(f_O/f_D, \tau)$
  - decreasing in headquarters intensity (η)
- The overall effect of the elasticity of substitution on Υ_O is now ambiguous:
  - As in the complete-contracting case, a higher σ makes offshoring more prevalent by reducing the Pareto shape parameter $\kappa/(\sigma-1)$ for firm sales and by increasing the percentage gain from a reduction in marginal costs of labor from w_N down to τw_S
  - A larger σ aggravates the inefficiencies caused by incomplete contracting, hence reducing Υ_O

Extensions

- Generalized Nash bargaining.
  - Suppose the final-good producer gets a share β of the expost gains from trade.
  - Then the level of countractual frictions Γ_O also depends on β and η: when β increases, the underinvestment in headquarter services is alleviated, while the underinvestment in manufacturing production is aggravated. Whether the net effect is positive or negative naturally depends on the intensity with which these two stages are combined in production.

Extensions

- Limitations on Ex-Ante Transfers: Financial Constraints
  - From the participation constraint of the manager M

$$s(\varphi) = \tau w_S m(\varphi) - \frac{1}{2} p(q(\varphi)) q(\varphi)$$

  - Plugging the equilibrium values of $m(\varphi)$ and $q(\varphi)$ it is straightforward to show that $s(\varphi) \leq 0$ and thus the optimal contract calls for the manager M to post a bond in order to be able to transact with the final good producer F.

Extensions

- Limitations on Ex-Ante Transfers: Financial Constraints (continued)
  - M might be able to pledge to external financiers in his domestic economy at most a share ϕ of the net income it receives from transacting with F, so that the additional constraint

$$-s(\varphi) \leq \phi \left[\frac{1}{2} p(q(\varphi)) q(\varphi) - \tau w_S m(\varphi) \right]$$

    applies, and we can solve for a new $\Gamma_\phi \leq 1$ that is increasing in ϕ.
  - The profitability of offshoring will be increasing in the quality of financial contracting in the manager's foreign country.
  - Moreover, Γ_ϕ will be decreasing in headquarter intensity η: the higher is η the higher are the rents that M obtains in the ex-post bargaining at t_2 relative to the costs of production he or she incurs at t_1; so, the higher is η the larger are the losses in terms of rents that F suffers because of a low ϕ.

Extensions

- Partial Contractibility (as in Antras and Helpman, 2008).
- Partial Relationship Specificity.
- Sequential Production (we will look at this when we cover Antras and Chor, 2013).

Organizing the Global Value Chain

Pol Antràs **Davin Chor**

Harvard SMU

9-12 July 2012

NBER SI

Motivation and Introduction

Many production processes are sequential in nature:

- Raw materials processing $\longrightarrow$ Basic components

  $\longrightarrow$ Complex assembly $\longrightarrow$ Sales and Distribution
- Downstream stages often cannot commence before upstream stages
- Classic motivating example: Henry Ford's Model T production line
- More recently: Sequential production processes now often fragmented across country borders
- Existing literature: On the consequences of sequential location decisions

Motivation and Introduction

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- More recently: Sequential production processes now often fragmented across country borders
- Existing literature: On the consequences of sequential location decisions
- **This paper:** What is the optimal way to organize production along such global sequential production processes?

Motivation and Introduction

Our premise: Contractual frictions matter for the organizational decisions of firms over particular production stages

Motivation and Introduction

Our premise: Contractual frictions matter for the organizational decisions of firms over particular production stages

Example: The Boeing Dreamliner

- Repeated delays led to reorganization of the sourcing model
- In 2008-09, Boeing successively acquired Vought Aircraft Industries' operations in South Carolina, which were producing rear sections of the Dreamliner's fuselage
- Culminated in a full buyout in Jul 2009:

> *"The 787's entry into service has been set back five times, in part because multiple suppliers didn't do all the work they had agreed to, leaving more for Boeing workers to complete."*

Source: http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aF6uWvMb9C08

Some Questions

- Why does the firm not bring the whole production process within its firm boundaries?
- What determines which suppliers are brought inside the firm and which are not, and why might "downstreamness" matter for this?

Some Questions

- Why does the firm not bring the whole production process within its firm boundaries?
- What determines which suppliers are brought inside the firm and which are not, and why might "downstreamness" matter for this?
- Property-rights theory (Grossman and Hart, 1986, Hart and Moore, 1990) provides the most convincing framework to answer the first question...
- ... so it seems a natural approach to use to tackle the second question as well

What We Do

Analyze the organizational decision along sequential production lines:

- Develop a model of firm production with a continuum of uniquely sequenced production stages
  - In each stage: Firm contracts with a distinct supplier for a stage-specific input that needs to be made compatible with all other stage inputs
  - In an incomplete contracts setting, obtain a sharp characterization of the optimal ownership structure along the value chain

What We Do

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- Empirically, test predictions of the model using:
  - (i) the intrafirm trade share (to capture the prevalence of integration);
  - (ii) novel measures of the downstreamness of particular inputs (which we develop from Input-Output Tables)

Related Literature

1. Sequential production
   - Eg: Findlay (1978), Dixit and Grossman (1982), Sanyal (1983), Kremer (1993), Yi (2003), Harms, Lorz, and Urban (2009), Baldwin and Venables (2010), Costinot et al. (2011)
   - Small literature on incentives in sequential production processes. Eg: Winter (2006), Kim and Shin (2011)
2. Property rights theory of the firm in international trade
   - Eg: Grossman and Helpman (2002, 2005), Antràs (2003), Antràs and Helpman (2004, 2008)
3. Empirical evidence (determinants of the intrafirm trade share)
   - Eg: Antràs (2003), Tomiura (2007), Defever and Toubal (2007), Nunn and Trefler (2008a,b), Corcos et al. (2009), Díez (2010), Bernard et al. (2010), Kohler and Smolka (2010)

Plan of Talk

1. Motivation and Introduction
2. **Setup of the Core Model**
3. Key Predictions
4. Extensions
5. Empirical Evidence
6. Conclusion

Basic Setup: Production Function

- Production requires the completion of a continuum of stages indexed by $j \in [0,1]$
- Unique sequence of stages: j increasing as production moves downstream
- Let $x(j)$ be the services of compatible intermediate inputs that supplier j delivers to the Firm. *Quality-adjusted* volume of final-good production is

$$q = \theta \left(\int_0^1 x(j)^{\alpha} I(j)\, dj \right)^{1/\alpha}, \tag{1}$$

$$I(j) = \begin{cases} 1 & \text{if input } j \text{ is produced after all inputs } j' < j \\ 0 & \text{otherwise} \end{cases}$$

- $\alpha \in (0,1)$: captures how substitutable the stage inputs are
- θ: firm productivity parameter

Basic Setup: Production Function (cont.)

Short remark:

- Alternative recursive representation of technology in (1):

$$q'(m) = \frac{1}{\alpha}\theta^{\alpha} x(m)^{\alpha} q(m)^{1-\alpha} I(m)$$

- Change in quality-adjusted output brought about by supplier at stage m is Cobb-Douglas in input m and $q(m)$

Basic Setup: Supply of inputs

- Each intermediate input needs to be produced by a different supplier
- Suppliers need to undertake a *relationship-specific* investment to produce a *compatible* input
- One unit of investment generates one unit of $x(j)$, the services of the stage j compatible input
- Marginal cost of investment is common for all suppliers and equal to c (although this can be relaxed)
- Incompatible inputs can be produced by all agents (including the Firm) at a negligible marginal cost, but they add no value to final-good production (other than allowing completion)

Basic Setup: Final good demand

- Consumers have preferences:

$$U = \left(\int_{\omega \in \Omega} \left(\varphi\left(\omega\right) \tilde{q}\left(\omega\right) \right)^{\rho} d\omega \right)^{1/\rho}, \text{ with } \rho \in (0,1) \tag{2}$$

- $\varphi\left(\omega\right)$: quality of a variety
- $\tilde{q}\left(\omega\right)$: consumption in physical units

- Implied revenue function of any firm in the industry is concave in quality-adjusted output $q\left(\omega\right) = \varphi\left(\omega\right) \tilde{q}\left(\omega\right)$ with a constant elasticity ρ:

$$r = A^{1-\rho} q^{\rho} = A^{1-\rho} \theta^{\rho} \left(\int_0^1 x\left(j\right)^{\alpha} dj \right)^{\rho/\alpha} \tag{3}$$

Some Key Features

Value generated up to stage m if all inputs are compatible:

$$r(m) = A^{1-\rho}\theta^{\rho}\left[\int_0^m x(j)^{\alpha}\, dj\right]^{\frac{\rho}{\alpha}} \tag{4}$$

Incremental value generated at stage m by producing a compatible input:

$$r'(m) = \frac{\partial r(m)}{\partial m} = \frac{\rho}{\alpha}\left(A^{1-\rho}\theta^{\rho}\right)^{\frac{\alpha}{\rho}}[r(m)]^{\frac{\rho-\alpha}{\rho}}\, x(m)^{\alpha} \tag{5}$$

Key consideration: How does the value of production up to stage m affect the marginal contribution of supplier m?

- If $\rho > \alpha$, the effect is positive (*sequential complements* case)
- If $\rho < \alpha$, the effect is negative (*sequential substitutes* case)

Some Key Features (cont.)

Why does ρ matter?

- From a technological point of view, all inputs are complements since $\alpha \in (0, 1)$
- But when ρ is small, firm faces an inelastic demand function, so marginal revenue falls quickly with quality-adjusted output
- Large investments prior to stage *m* therefore discourage supplier effort at stage *m*
- It turns out that when $\rho < \alpha$, this revenue effect is strong enough to dominate the physical input complementarity effect

Benchmark: Complete Contracts

If contracting frictions are absent, firm signs a contract with each input supplier specifying the optimal quantity of compatible inputs, $x(j)$, to maximize:

$$\pi_F = A^{1-\rho}\theta^{\rho}\left(\int_0^1 x(j)^{\alpha}dj\right)^{\frac{\rho}{\alpha}} - c\int_0^1 x(j)dj \tag{6}$$

Solution entails:

- A common investment level, $x = \left(\rho A^{1-\rho}\theta^{\rho}/c\right)^{1/(1-\rho)}$, for all inputs j
- Suppliers are paid their marginal cost: cx
- Even though

  $$r'(m) = \frac{\partial r(m)}{\partial m} = \frac{\rho}{\alpha}\left(A^{1-\rho}\theta^{\rho}\right)^{\frac{\alpha}{\rho}}[r(m)]^{\frac{\rho-\alpha}{\rho}}x(m)^{\alpha},$$

  the Firm internalizes the downstream effects of upstream investments

Incomplete Contracting

Suppose that the environment is one of incomplete contracts

- Compatibility cannot be verified and enforced by a third-party court
- But Firm and suppliers have symmetric information regarding compatibility
- Contracts contingent on total revenue are not useful in our context
- Abstract from mechanisms
- Suppliers' payoffs are determined in *ex post* (re)-negotiation, after $x(m)$ has been produced

Bargaining

- Supplier m and Firm engage in generalized Nash bargaining over the incremental value contribution made by supplier m, $r'(m)$
- Supplier m's outside option normalized to 0
- Under integration, Firm's control rights tilt the ex-post division of surplus in its favor relative to under outsourcing (as in Grossman and Hart, 1986).
- Let $\beta(m)$ be the share of $r'(m)$ that accrues to the firm in the bargain:

$$\beta(m) = \begin{cases} \beta_O & \text{if the firm outsources stage } m \\ \beta_V > \beta_O & \text{if the firm integrates stage } m \end{cases}$$

Timing

1. Firm posts contracts for suppliers for each stage $j \in [0,1]$, stating the organizational mode (integration vs outsourcing).
2. Suppliers apply. Firm chooses one supplier for each stage j.
3. Production takes place sequentially. The supplier chooses $x(m)$ after observing the value of $r(m)$.
4. At the end of stage m, the supplier and Firm bargain over $r'(m)$. Firm pays the supplier.
5. Total revenue, $A^{1-\rho}q^{\rho}$, $\rho \in (0,1)$, from the sale of the final good is collected by the Firm.

Discussion

- Bargaining is over supplier's marginal contribution at stage m, not its ultimate (or average marginal) contribution
- Can be rationalized by limited commitment frictions: Hart and Moore (1994), Thomas and Worrall (1994)
- Supplier does not want to delay receiving payment; or Firm might be constrained in borrowing more than $r'(m)$
- **Note:** Results surprisingly robust to alternative bargaining protocols

Plan of Talk

Key Tradeoffs

- Ownership confers a higher fallback option to the firm and allows it to extract more surplus
- But foreseeing a lower return to their investments, integrated suppliers will under-invest relatively more, ie choose a lower $x(m)$:

$$\max_{x(m)} \quad (1 - \beta(m))\, r'(m) - cx(m) \tag{7}$$

- Downstream effect: on the incentives to invest of all suppliers that are positioned downstream relative to the supplier being integrated
- This downstream effect is negative in the complements case, but it is positive in the substitutes case

Supplier Behavior Along the Value Chain

Plug the expression for $x(m)$ to obtain a differential equation in $r(m)$:

$$r'(m) = \frac{\rho}{\alpha}\left(\frac{(1-\beta(m))\,\rho\theta}{c}\right)^{\frac{\alpha}{1-\alpha}} A^{\frac{\alpha(1-\rho)}{\rho(1-\alpha)}} (r(m))^{\frac{\rho-\alpha}{\rho(1-\alpha)}}$$

Solving this yields revenues up to stage m as a function of model parameters and in particular, the $\beta(j)$'s for $j < m$:

$$r(m) = A\left(\frac{1-\rho}{1-\alpha}\right)^{\frac{\rho(1-\alpha)}{\alpha(1-\rho)}} \left(\frac{\rho\theta}{c}\right)^{\frac{\rho}{1-\rho}} \left[\int_{j=0}^{m} (1-\beta(j))^{\frac{\alpha}{1-\alpha}}\, dj\right]^{\frac{\rho(1-\alpha)}{\alpha(1-\rho)}} \quad (8)$$

Then, solve for the overall profits of the firm by integrating over stages:

$$\Pi_S = \int_{j=0}^{1} \beta(j) r'(j)\, dj$$

The Make-or-Buy Decision

Before production begins, firm chooses $\beta(j) \in \{\beta_V, \beta_O\}$ for $j \in [0,1]$ to maximize Π_S

Proposition

In the complements case ($\rho > \alpha$), there exists a unique $m_C^* \in (0,1]$, such that: (i) all production stages $m \in [0, m_C^*)$ are outsourced; and (ii) all stages $m \in [m_C^*, 1]$ are integrated within firm boundaries.

In the substitutes case ($\rho < \alpha$), there exists a unique $m_S^* \in (0,1]$, such that: (i) all production stages $m \in [0, m_S^*)$ are integrated within firm boundaries; and (ii) all stages $m \in [m_S^*, 1]$ are outsourced. Proof

Remark: m_C^* and m_S^* can be solved for in closed-form

The Make-or-Buy Decision (cont.)

Additional predictions:

Proposition

Whenever integration and outsourcing coexist along the value chain, i.e., $m_C^* \in (0,1)$ when $\rho > \alpha$ or $m_S^* \in (0,1)$ when $\rho < \alpha$, a decrease in ρ will necessarily expand the range of stages that are vertically integrated.

Intuition:

- When ρ is low, firm has high market power, and hence will focus on the rent extraction motive for integration

Plan of Talk

1. Motivation and Introduction
2. Setup of the Core Model
3. Key Predictions
4. **Extensions**
5. Empirical Evidence
6. Conclusion

Extensions

Benchmark model can be readily extended to connect it to the global sourcing framework in Antràs and Helpman (2004) by adding:

1. Headquarter intensity
2. Firm heterogeneity
3. Supplier heterogeneity

Extensions are important for helping us to map the theoretical predictions to the empirics

Summary of Extensions

1. Headquarter intensity: ▸ Extension 1
   - Introduce Firm investment in headquarter services prior to stage 0; fully non-contractible
   - Obtain: integration more prevalent in headquarter intensive sectors
   - Otherwise: Similar to core model, but with ρ replaced by $\tilde{\rho} \equiv (1 - \eta)\rho$
2. Firm heterogeneity: ▸ Extension 2
   - θ's drawn from Pareto distribution; introduce fixed organizational costs
   - Converts previous within-firm results into predictions on the relative prevalence of integration at the *industry* level
3. Supplier heterogeneity: ▸ Extension 3
   - Results generalize, but it might be important to control for unobserved country cost differences and for selection

Plan of Talk

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Empirical specification

$$\begin{aligned} S_{it} \quad = \quad & \beta_1 D_i \times \mathbf{1}(\rho_i < \rho_{med}) + \beta_2 D_i \times \mathbf{1}(\rho_i > \rho_{med}) + \beta_3 \mathbf{1}(\rho_i > \rho_{med}) \\ & + \beta_X X_i + \alpha_t + \varepsilon_{it} \end{aligned}$$

- S_{it}: share of intrafirm trade in U.S. imports for industry i, year t
  - Data source: U.S. Census Bureau Related Party Database
  - 253 manufacturing industries, 11 years (2000-2010)
- D_i: "downstreamness" of an industry
- $\mathbf{1}(\rho_i \gtrless \rho_{med})$: indicator for complements vs substitutes case

Empirical specification

$$\begin{aligned} S_{it} &= \beta_1 D_i \times \mathbf{1}(\rho_i < \rho_{med}) + \beta_2 D_i \times \mathbf{1}(\rho_i > \rho_{med}) + \beta_3 \mathbf{1}(\rho_i > \rho_{med}) \\ &\quad + \beta_X X_i + \alpha_t + \varepsilon_{it} \end{aligned}$$

- S_{it}: share of intrafirm trade in U.S. imports for industry i, year t
  - Data source: U.S. Census Bureau Related Party Database
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- D_i: "downstreamness" of an industry
- $\mathbf{1}(\rho_i \gtrless \rho_{med})$: indicator for complements vs substitutes case
- X_i: other industry controls
- α_t: year fixed effects (in country-industry-year specifications, include country-year fixed effects, α_{ct}, instead)
- Cluster standard errors by industry

Measuring downstreamness: Preliminaries

Start with the output identity for industry i in a closed-economy:

$$\begin{aligned} Y_i &= F_i + \sum_j d_{ij} Y_j \\ &= F_i + \underbrace{\sum_j d_{ij} F_j}_{\text{direct use of } i \text{ as input}} + \underbrace{\sum_j \sum_k d_{ik} d_{kj} F_j + \sum_j \sum_k \sum_l d_{il} d_{lk} d_{kj} F_j + \ldots}_{\text{indirect use of } i \text{ as input}} \end{aligned}$$

In compact matrix form:

$$\begin{aligned} Y &= F + DF + D^2 F + D^3 F + D^4 F + \ldots \\ &= [I - D]^{-1} F. \end{aligned}$$

where D is the $N \times N$ matrix of direct requirement coefficients; F is the $N \times 1$ matrix of final use values (going to consumption and investment)

Measures of downstreamness 1

Constructed from 2002 U.S. Input-Output Use Tables:

- $DUse\_TUse_i$: Ratio of aggregate direct use to aggregate total use of i as an input in the production of final goods
  - Direct Use $= \sum_j d_{ij} F_j$
  - Total Use $= \sum_j d_{ij} F_j + \sum_j \sum_k d_{ik} d_{kj} F_j + \sum_j \sum_k \sum_l d_{il} d_{lk} d_{kj} F_j + \ldots$

Interpretation: Higher $DUse\_TUse_i$ implies larger share of input i is used directly rather than entering indirectly earlier in the production process

Consistent with input being used further downstream on average

Computation: i-th entry of DF divided by i-th entry of $Y - F$

Measures of downstreamness 2

- Start with:

$$U_i = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} d_{ij} F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N} \sum_{k=1}^{N} d_{ik} d_{kj} F_j}{Y_i}$$
$$+ 4 \cdot \frac{\sum_{j=1}^{N} \sum_{k=1}^{N} \sum_{l=1}^{N} d_{il} d_{lk} d_{kj} F_j}{Y_i} + \ldots$$

  Interpretation: Take a weighted average distance from final use, where the weights are the industry's use value at each stage (normalized by Y_i)

  Computation: i-th entry of $[I - D]^{-2} F$ divided by i-th entry of Y

  See Antràs, Chor, Fally, and Hillberry (AER P&P 2012) for more

- $U_i \geq 1$: Reciprocate to get *DownMeasure$_i$*, increasing in downstreamness

Measures of downstreamness 2

Remarks:

- ACFH (2012) show that U_i is equivalent to a recursively-defined measure of distance from final use in Fally (2012)

- Also equivalent to a measure of cost-push effects or total "forward linkages" in supply-side I-O analysis

  U_i is equal to the dollar amount by which output of *all* sectors increases following a \$1 increase in value-added in sector i

- Empirical implementation: ACFH (2012) show how to apply an open-economy adjustment to D and F as reported in I-O Tables, to account for net exports and net change in inventories

Measures of downstreamness (cont.)

IO2002	Industry	DUse_TUse
Lowest 10 values		
331314	Secondary smelting and alloying of aluminum	0.0000
325110	Petrochemical	0.0599
331411	Primary smelting and refining of copper	0.0741
325211	Plastics material and resin	0.1205
325910	Printing ink	0.1325
311119	Other animal food	0.1385
333220	Plastics and rubber industry machinery	0.1420
33131A	Alumina refining and primary aluminum	0.1447
335991	Carbon and graphite product	0.1615
331420	Copper rolling, drawing, extruding, and alloying	0.1804
Highest 10 values		
334517	Irradiation apparatus	0.9669
339930	Doll, Toy, and Game	0.9686
337910	Mattress	0.9779
322291	Sanitary paper product	0.9790
337121	Upholstered household furniture	0.9864
337212	Office furniture and custom woodwork & millwork	0.9868
336213	Motor home	0.9879
33299A	Ammunition	0.9956
316200	Footwear	0.9967
336111	Automobile	0.9997

IO2002	Industry	DownMeasure
Lowest 10 values		
325110	Petrochemical	0.2150
331411	Primary smelting and refining of copper	0.2296
331314	Secondary smelting and alloying of aluminum	0.2461
325190	Other basic organic chemical	0.2595
33131A	Alumina refining and primary aluminum	0.2622
325310	Fertilizer	0.2658
335991	Carbon and graphite product	0.2668
325181	Alkalies and chlorine	0.2769
331420	Copper rolling, drawing, extruding, and alloying	0.2769
325211	Plastics material and resin	0.2800
Highest 10 values		
339930	Doll, Toy, and Game	0.9705
311111	Dog and cat food	0.9717
337910	Mattress	0.9720
315230	Women's and girl's cut and sew apparel	0.9762
321991	Manufactured home (mobile home)	0.9810
336212	Truck trailer	0.9837
336213	Motor home	0.9879
316200	Footwear	0.9927
337121	Upholstered household furniture	0.9928
336111	Automobile	0.9997

Measure of ρ_i

Constructed from Broda and Weinstein's (2006) estimates of U.S. import demand elasticities for HS10 products:

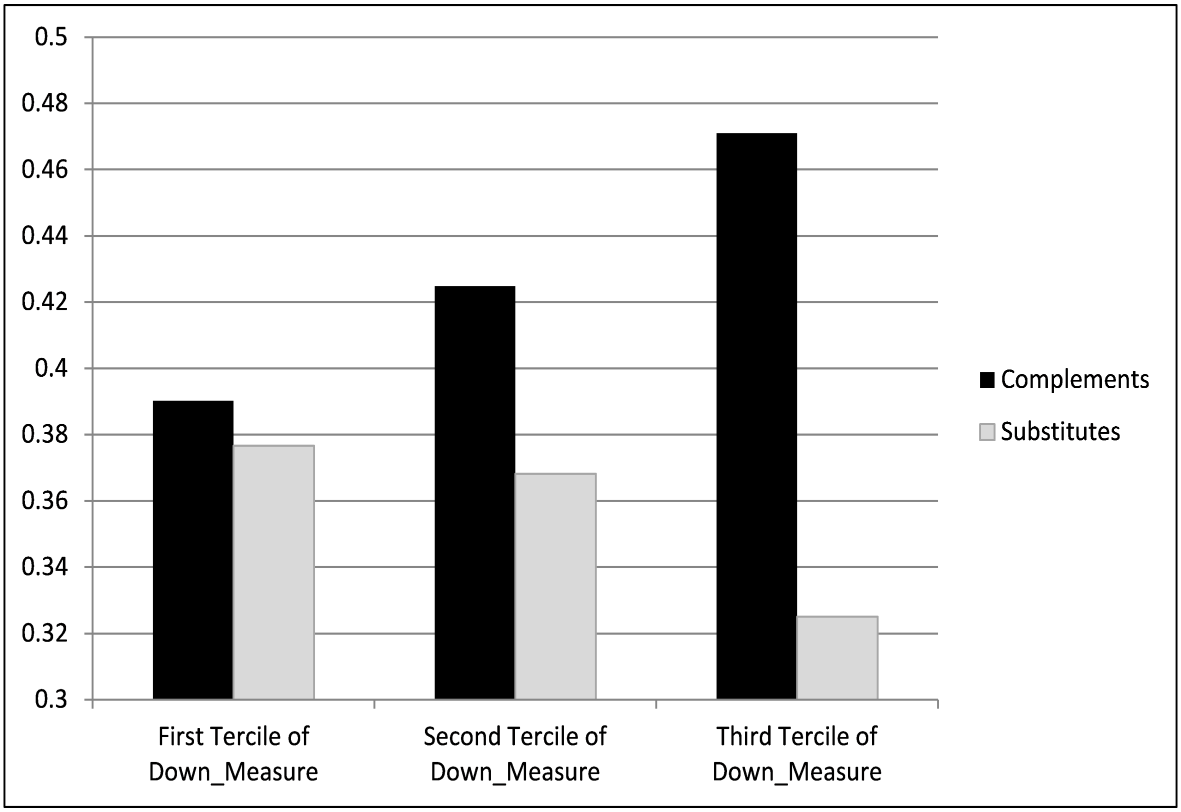
- Convert to IO2002 categories using HS-IO concordance
- ρ_i is the average elasticity taken over all "buying" industries, i.e. industries that use i as an input, weighted by the value of input i use in the 2002 Input-Output Tables

  (Final-use value is included in this calculation; assign it the elasticity of industry i itself)
- Baseline specification uses a median value cutoff:
  - $\mathbf{1}(\rho_i > \rho_{med})$: complements case
  - $\mathbf{1}(\rho_i < \rho_{med})$: substitutes case

Other industry variables

- HQ intensity: $\log(s/l)$, $\log(k/l)$, $\log(m/l)$ from NBER-CES Manufacturing Database
  - 2000-2005 averages
  - Also: consider a breakdown of $\log(k/l)$ into $\log(\textit{equipment } k/l)$ and $\log(\textit{plant } k/l)$, in the spirit of Nunn and Trefler (2008b)
- R&D intensity: $\log(R\&D/Sales)$ from Orbis, from Nunn and Trefler (2008b)
- Dispersion: log sd of U.S. exports across ports and destinations (Nunn and Trefler 2008a)
- Distinguish between industry variables constructed for the:
  - input "selling" industry
  - input "buying" industry (more consistent with our model)

Preliminary Evidence: Downstreamness and the Intrafirm Trade Share



Evidence: $DUse\_TUse_i$

- Greater propensity to integrate downstream in complements case; to outsource downstream in substitutes case

	(1)	(2)	(3)	(4) Elas < Median	(5) Elas >= Median	(6) Weighted	(7)	(8) Weighted
Log (s/l)	0.005	0.039	0.056	0.112*	0.038	-0.098	0.005	-0.068
	[0.044]	[0.043]	[0.042]	[0.064]	[0.055]	[0.079]	[0.020]	[0.076]
Log (k/l)	0.044	0.034						
	[0.029]	[0.027]						
Log (equipment k / l)			0.085**	0.022	0.153***	0.188***	0.026	0.134***
			[0.034]	[0.047]	[0.043]	[0.061]	[0.016]	[0.051]
Log (plant k / l)			-0.077*	-0.011	-0.159**	-0.151**	-0.056***	-0.142***
			[0.045]	[0.057]	[0.064]	[0.070]	[0.019]	[0.050]
Log (materials/l)	0.058*	0.060*	0.065*	0.049	0.072	0.060	0.025*	0.080
	[0.035]	[0.034]	[0.033]	[0.049]	[0.047]	[0.058]	[0.014]	[0.049]
Log (0.001+ R&D/Sales)	0.055***	0.054***	0.053***	0.050***	0.054***	0.090***	0.031***	0.073***
	[0.009]	[0.009]	[0.009]	[0.013]	[0.013]	[0.018]	[0.004]	[0.016]
Dispersion	0.081	0.061	0.103	0.034	0.188*	0.160	0.108***	0.083
	[0.070]	[0.070]	[0.075]	[0.108]	[0.100]	[0.124]	[0.038]	[0.108]
DUse_TUse	**-0.018**			**-0.216*** **	**0.225*** **			
	[0.054]			**[0.075]**	**[0.069]**			
DUse_TUse X 1(Elas < Median)		**-0.196*** **	**-0.174** **			**-0.166* **	**-0.115*** **	**-0.075**
		[0.071]	**[0.072]**			**[0.089]**	**[0.033]**	**[0.073]**
DUse_TUse X 1(Elas > Median)		**0.171** **	**0.198*** **			**0.482*** **	**-0.035**	**0.352*** **
		[0.067]	**[0.068]**			**[0.123]**	**[0.030]**	**[0.118]**
1(Elas > Median)		-0.191***	-0.191***			-0.410***	-0.049*	-0.291***
		[0.062]	[0.061]			[0.085]	[0.029]	[0.075]
Industry controls for:	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer
Year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Country-Year fixed effects?	No	No	No	No	No	No	Yes	Yes
Observations	2783	2783	2783	1375	1408	2783	207991	207991
R-squared	0.27	0.32	0.33	0.37	0.28	0.61	0.18	0.59

Evidence: $DownMeasure_i$

- Similarly strong evidence particularly for the complements case

	(1)	(2)	(3)	(4) Elas < Median	(5) Elas >= Median	(6) Weighted	(7)	(8) Weighted
Log (s/l)	-0.011	0.019	0.037	0.088	0.032	-0.143**	0.000	-0.097*
	[0.045]	[0.042]	[0.041]	[0.067]	[0.051]	[0.058]	[0.020]	[0.054]
Log (k/l)	0.062**	0.058**						
	[0.027]	[0.026]						
Log (equipment k / l)			0.125***	0.061	0.192***	0.157**	0.039**	0.139***
			[0.036]	[0.047]	[0.048]	[0.066]	[0.017]	[0.047]
Log (plant k / l)			-0.100**	-0.027	-0.192***	-0.091	-0.062***	-0.117**
			[0.049]	[0.061]	[0.073]	[0.080]	[0.020]	[0.052]
Log (materials/l)	0.050	0.043	0.049	0.022	0.064	0.032	0.017	0.046
	[0.033]	[0.033]	[0.032]	[0.050]	[0.043]	[0.055]	[0.014]	[0.043]
Log (0.001+ R&D/Sales)	0.058***	0.054***	0.054***	0.053***	0.050***	0.089***	0.032***	0.072***
	[0.010]	[0.009]	[0.009]	[0.014]	[0.014]	[0.017]	[0.004]	[0.014]
Dispersion	0.087	0.092	0.150*	0.082	0.258**	0.249*	0.116***	0.163
	[0.072]	[0.076]	[0.079]	[0.114]	[0.105]	[0.147]	[0.043]	[0.114]
DownMeasure	**0.101***			**-0.036**	**0.342*****			
	[0.055]			**[0.069]**	**[0.081]**			
DownMeasure X 1(Elas < Median)		**-0.024**	**0.025**			**-0.119**	**-0.002**	**-0.002**
		[0.064]	**[0.065]**			**[0.107]**	**[0.035]**	**[0.091]**
DownMeasure X 1(Elas > Median)		**0.249*****	**0.298*****			**0.526*****	**-0.039**	**0.440*****
		[0.085]	**[0.081]**			**[0.100]**	**[0.033]**	**[0.089]**
1(Elas > Median)		-0.115*	-0.110*			-0.386***	0.022	-0.279***
		[0.064]	[0.062]			[0.081]	[0.030]	[0.072]
Industry controls for:	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer
Year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Country-Year fixed effects?	No	No	No	No	No	No	Yes	Yes
Observations	2783	2783	2783	1375	1408	2783	207991	207991
R-squared	0.28	0.31	0.33	0.33	0.33	0.64	0.18	0.61

Evidence: Production Line Position and the Boundaries of the Firm

- Results evident with a more flexible quintile treatment of ρ_i

	(1)	(2)	(3)	(4)	(5)	(6)
Downstreamness:	DUse_TUse	DUse_TUse Weighted	DUse_TUse Weighted	DownMeasure	DownMeasure Weighted	DownMeasure Weighted
Downstream X 1(Elas Quintile 1)	-0.165*	-0.252*	-0.138	0.049	-0.283	-0.089
	[0.093]	[0.148]	[0.100]	[0.119]	[0.202]	[0.142]
Downstream X 1(Elas Quintile 2)	-0.173	-0.100	-0.037	-0.042	-0.154	-0.040
	[0.108]	[0.136]	[0.115]	[0.099]	[0.139]	[0.122]
Downstream X 1(Elas Quintile 3)	-0.145	0.008	0.051	0.019	0.114	0.224
	[0.130]	[0.166]	[0.153]	[0.124]	[0.166]	[0.172]
Downstream X 1(Elas Quintile 4)	0.215**	0.159	0.066	0.332***	0.066	0.073
	[0.100]	[0.142]	[0.119]	[0.126]	[0.174]	[0.120]
Downstream X 1(Elas Quintile 5)	0.198*	0.781***	0.637***	0.312**	0.736***	0.621***
	[0.103]	[0.194]	[0.199]	[0.130]	[0.110]	[0.096]
Industry controls for:	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer
Elas Quintile dummies?	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	No	Yes	Yes	No
Country-Year fixed effects	No	No	Yes	No	No	Yes
Observations	2783	2783	207991	2783	2783	207991
R-squared	0.34	0.64	0.61	0.34	0.67	0.62

Robustness Tests

- Robust to controlling for: (i) value-added share; (ii) input "importance"; (iii) contractibility (Nunn and Trefler 2008); (iv) intermediation (Bernard et al. 2010)

	(1)	(2)	(3)	(4)	(5)
DUse_TUse X 1(Elas < Median)	-0.187**	-0.177**	-0.103	-0.180**	-0.130*
	[0.074]	[0.072]	[0.071]	[0.077]	[0.079]
DUse_TUse X 1(Elas > Median)	0.157**	0.198***	0.236***	0.159**	0.158**
	[0.077]	[0.068]	[0.065]	[0.068]	[0.074]
Value-added / Value shipments	0.187				0.216*
	[0.135]				[0.125]
Input "Importance"		-1.687			-1.453
		[1.231]			[1.302]
Intermediation			-0.464***		-0.413***
			[0.106]		[0.102]
Own Contractibility				0.019	0.024
				[0.048]	[0.047]
Buyer contractibility				-0.199***	-0.169**
				[0.067]	[0.065]
Year fixed effects?	Yes	Yes	Yes	Yes	Yes
Observations	2783	2783	2783	2783	2783
R-squared	0.33	0.33	0.38	0.37	0.41

Extension 1: Headquarter Intensity

Theory predicts that:

- In complements case, $\rho(1-\eta)$ high, greater propensity to integrate downstream when ρ is high and η is low
- In substitutes case, $\rho(1-\eta)$ low, greater propensity to outsource downstream when ρ is low and η is high
- Suggests a triple interaction approach: further interaction with hq intensity

Use first principal component of $\log(s/l)$, $\log(\textit{equipment } k/l)$, and $\log(R\&D/Sales)$ as measure of headquarter intensity.

- Complements case: results indeed strongest in lowest quintile of η
- Substitutes case: results more noisy but broadly supportive

Extension 1: Headquarter Intensity (cont.)

	(1)	(2)	(3)	(4)	(5)	(6)
Downstreamness:	DUse_TUse	DUse_TUse	DUse_TUse	DownMeasure	DownMeasure	DownMeasure
Buyer industry hq intensity:	First Principal Component: Log (s/l), Log (equipment k/l), and Log (0.001+R&D/Sales)					
		Weighted	Weighted		Weighted	Weighted
Downstream X 1 (Elas < Med) X (HQ Quintile 1)	0.049	0.009	-0.016	0.351***	0.301**	0.290**
	[0.129]	[0.139]	[0.118]	[0.128]	[0.134]	[0.129]
Downstream X 1 (Elas < Med) X (HQ Quintile 2)	-0.268**	-0.477***	-0.331**	-0.161	-0.312*	-0.169
	[0.118]	[0.162]	[0.148]	[0.103]	[0.186]	[0.150]
Downstream X 1 (Elas < Med) X (HQ Quintile 3)	-0.175	-0.162	-0.158	0.072	-0.02	-0.058
	[0.148]	[0.138]	[0.124]	[0.131]	[0.160]	[0.145]
Downstream X 1 (Elas < Med) X (HQ Quintile 4)	**-0.377*** **	**-0.658*** **	**-0.455*** **	**-0.121**	**-0.394** **	**-0.280** **
	[0.134]	**[0.108]**	**[0.069]**	**[0.128]**	**[0.172]**	**[0.125]**
Downstream X 1 (Elas < Med) X (HQ Quintile 5)	**0.177**	**-0.046**	**0.024**	**0.229**	**-0.181**	**-0.05**
	[0.171]	**[0.192]**	**[0.172]**	**[0.157]**	**[0.160]**	**[0.158]**
Downstream X 1 (Elas > Med) X (HQ Quintile 1)	**0.196**	**0.805** **	**0.798*** **	**0.465*** **	**0.624*** **	**0.593*** **
	[0.248]	**[0.325]**	**[0.278]**	**[0.163]**	**[0.113]**	**[0.087]**
Downstream X 1 (Elas > Med) X (HQ Quintile 2)	**-0.037**	**-0.099**	**-0.180**	**0.032**	**-0.001**	**-0.061**
	[0.146]	**[0.181]**	**[0.175]**	**[0.130]**	**[0.238]**	**[0.189]**
Downstream X 1 (Elas > Med) X (HQ Quintile 3)	0.216*	0.172	0.027	0.358***	0.357	0.099
	[0.119]	[0.207]	[0.145]	[0.135]	[0.257]	[0.199]
Downstream X 1 (Elas > Med) X (HQ Quintile 4)	0.130	0.819**	0.427	0.280*	0.519	0.079
	[0.161]	[0.390]	[0.341]	[0.159]	[0.427]	[0.352]
Downstream X 1 (Elas > Med) X (HQ Quintile 5)	0.183**	0.271*	0.162	0.179	0.274	0.225*
	[0.082]	[0.144]	[0.114]	[0.117]	[0.197]	[0.117]
Industry controls for:	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer
Main and double interaction effects?	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects?	Yes	Yes	No	Yes	Yes	No
Country-Year fixed effects?	No	No	Yes	No	No	Yes
Observations	2783	2783	207991	2783	2783	207991
R-squared	0.40	0.69	0.63	0.40	0.71	0.65

Extension 2: Firm Heterogeneity

- Highest propensity to integrate in the first quintile of downstreamness when $\rho < \rho_{med}$; and in the last quintile of downstreamness when $\rho > \rho_{med}$

	(1)	(2)	(3)	(4)	(5)	(6)
Downstreamness:	DUse_TUse	DUse_TUse Weighted	DUse_TUse Weighted	DownMeasure	DownMeasure Weighted	DownMeasure Weighted
(Downstream Quin 1) X 1(Elas < Median)	**0.101****	**0.210*****	**0.145*****	**0.060**	**0.184*****	**0.145****
	[0.045]	**[0.058]**	**[0.045]**	**[0.051]**	**[0.067]**	**[0.059]**
(Downstream Quin 2) X 1(Elas < Median)	0.041	0.131**	0.096*	-0.005	0.062	0.019
	[0.043]	[0.062]	[0.054]	[0.045]	[0.069]	[0.055]
(Downstream Quin 3) X 1(Elas < Median)	0.008	0.063	0.010	-0.016	0.089	0.049
	[0.046]	[0.057]	[0.046]	[0.049]	[0.076]	[0.060]
(Downstream Quin 4) X 1(Elas < Median)	-0.047	0.092	0.047	0.024	0.064	0.032
	[0.043]	[0.065]	[0.051]	[0.045]	[0.075]	[0.058]
(Downstream Quin 5) X 1(Elas < Median)	0.017	0.084	0.082	0.023	0.039	0.058
	[0.042]	[0.063]	[0.053]	[0.042]	[0.081]	[0.064]
(Downstream Quin 2) X 1(Elas > Median)	0.021	0.031	0.016	0.013	-0.054	-0.068
	[0.036]	[0.067]	[0.056]	[0.039]	[0.069]	[0.052]
(Downstream Quin 3) X 1(Elas > Median)	0.086**	0.150**	0.072	0.035	0.076	0.018
	[0.044]	[0.065]	[0.052]	[0.047]	[0.069]	[0.066]
(Downstream Quin 4) X 1(Elas > Median)	0.030	0.086	0.017	0.073*	0.056	0.013
	[0.048]	[0.056]	[0.050]	[0.043]	[0.072]	[0.060]
(Downstream Quin 5) X 1(Elas > Median)	**0.181*****	**0.352*****	**0.257*****	**0.171*****	**0.380*****	**0.300*****
	[0.048]	**[0.067]**	**[0.062]**	**[0.059]**	**[0.085]**	**[0.074]**
Industry controls for:	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer
Downstream quin and Elasticity dummies?	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	No	Yes	Yes	No
Country-Year fixed effects	No	No	Yes	No	No	Yes
Observations	2783	2783	207991	2783	2783	207991
R-squared	0.35	0.63	0.61	0.33	0.67	0.63

Selection into intrafirm trade (Heckman selection)

- Excluded variable in the second-stage: interaction of measure of country costs of entry and R&D intensity of the selling industry

	(1)	(2)	(3)	(4)	(5)	(6)
Downstreamness:	DUse_TUse	DUse_TUse	DUse_TUse	DownMeasure	DownMeasure	DownMeasure
	Probit	Weighted	Weighted	Probit	Weighted	Weighted
Downstream X 1(Elas < Median)	0.047	-0.073	-0.072	0.634**	-0.020	-0.011
	[0.310]	[0.074]	[0.074]	[0.317]	[0.097]	[0.088]
Downstream X 1(Elas > Median)	0.274	0.310***	0.314***	-0.291	0.353***	0.347***
	[0.252]	[0.106]	[0.102]	[0.246]	[0.078]	[0.084]
1(Elas > Median)	0.003	-0.268***	-0.268***	0.661***	-0.244***	-0.234***
	[0.231]	[0.075]	[0.075]	[0.233]	[0.076]	[0.073]
Seller Log (0.001+ R&D/Sales)	-0.028***			-0.028***		
X Country Entry Costs	[0.007]			[0.007]		
Seller Log (0.001+ R&D/Sales)	0.030			0.026		
	[0.045]			[0.041]		
Inverse Mills Ratio		-0.120			-0.082	
		[0.250]			[0.197]	
Industry controls for:	Buyer	Buyer	Buyer	Buyer	Buyer	Buyer
Country-year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes
Sample:	Total imports >=0	Total imports > 0	Total imports > 0	Total imports >=0	Total imports > 0	Total imports > 0
Observations	462990	186029	186029	462990	186029	186029
R-squared	-	0.63	0.63	-	0.64	0.64

Plan of Talk

1. Motivation and Introduction
2. Setup of the Core Model
3. Key Predictions
4. Extensions
5. Empirical Evidence
6. **Conclusion**

Concluding Remarks

- Developed a model of organizational decisions for a production function with a continuum of sequential stages
- For each stage, firm's make-or-buy decision depends on that stage's position in the value chain
  - When stage inputs are sequential complements: Outsource upstream and Integrate downstream
  - When stage inputs are sequential substitutes: Integrate upstream and Outsource downstream
  - Intuition driven by how effort choices of upstream stage suppliers affect effort levels downstream
- Can be readily embedded into existing global sourcing frameworks
- Evidence based on U.S. related-party trade shares is broadly consistent with the model's predictions

The Make-or-Buy Decision

Proof heuristic:

For a given stage m, adopt the solution approach in Antràs and Helpman (2004, 2008) and consider the hypothetical case in which $\beta(m)$ can be chosen from the continuum of values in $[0, 1]$

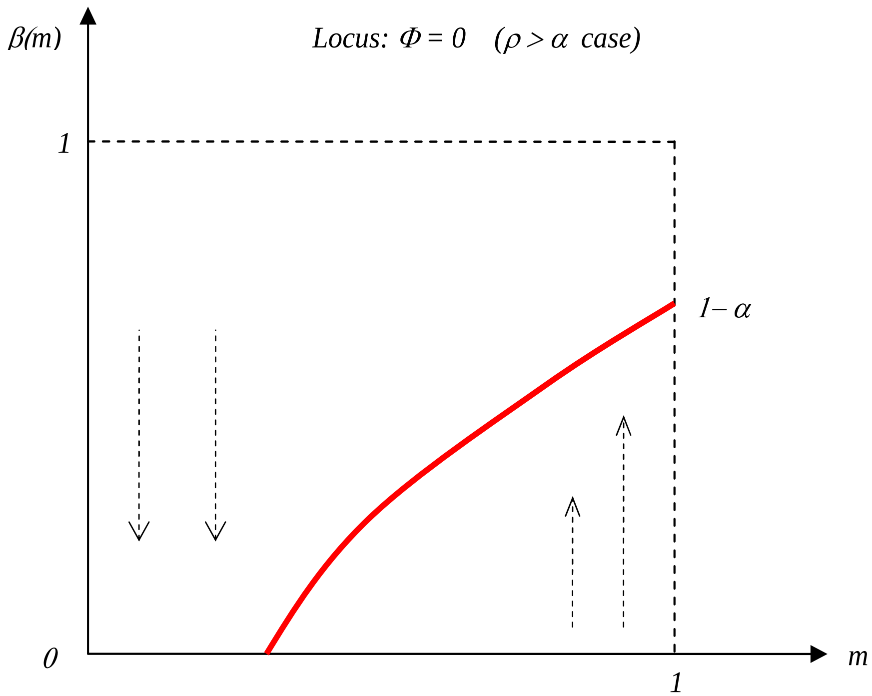
Let $\beta^*(m)$ denote the unconstrained bargaining share that solves $\frac{\partial \Pi_S}{\partial \beta(m)} = 0$

Consider the behavior of $\beta^*(m)$ in the two cases

Return

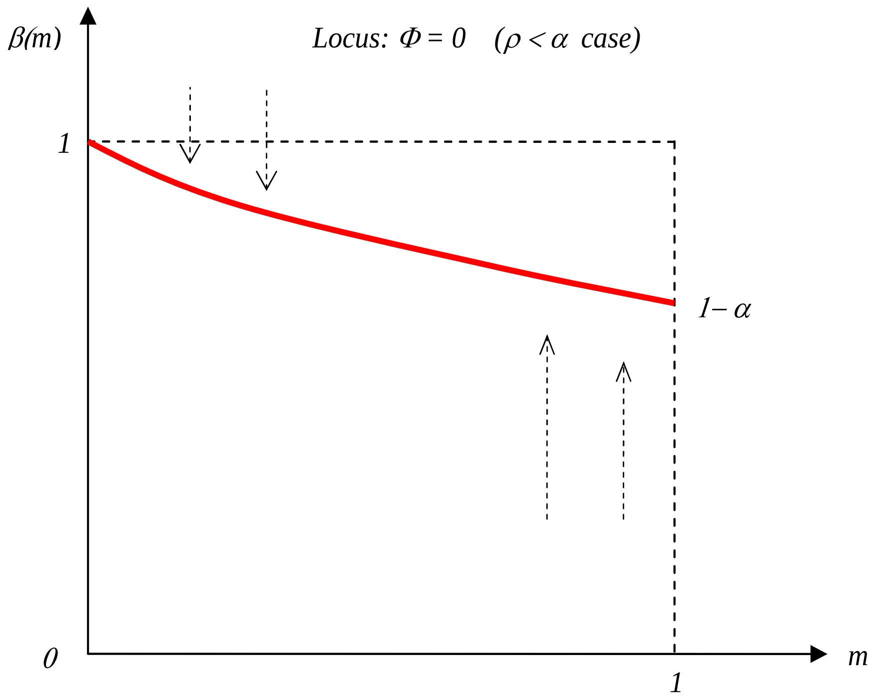
The Make-or-Buy Decision: Sequential Complements

For $\rho > \alpha$: Tend to choose β_O upstream, β_V downstream



The Make-or-Buy Decision: Sequential Substitutes

For $\rho < \alpha$: Tend to choose β_O downstream , β_V upstream



Extension 1: Headquarter Intensity

$$q = \theta \left(\frac{h}{\eta}\right)^{\eta} \left(\int_0^1 \left(\frac{x(j)}{1-\eta}\right)^{\alpha} I(j)dj \right)^{\frac{1-\eta}{\alpha}} \tag{9}$$

- Headquarter services, h, are fully noncontractible
- Provided by the firm before stage 0 commences
- All stage suppliers take h as given when they decide on $x(j)$
- $\eta \in (0,1)$: intensity of headquarter services

Return

Extension 1: Headquarter Intensity (cont.)

- With the same demand function as before, this yields:

$$r(m) = A^{1-\rho}\theta^{\rho}\left(\frac{h}{\eta}\right)^{\rho\eta}(1-\eta)^{-\tilde{\rho}}\left[\int_0^m x(j)^{\alpha}dj\right]^{\frac{\tilde{\rho}}{\alpha}}$$

- This turns out to behave like the core model, but with ρ replaced by $\tilde{\rho} \equiv (1-\eta)\rho$

Proposition

In the presence of headquarter services provided by the firm, the results in Propositions 1 and 2 continue to hold except for the fact that: (i) the complements and substitutes cases are now defined by $\tilde{\rho} \equiv (1-\eta)\,\rho > \alpha$ and $\tilde{\rho} \equiv (1-\eta)\,\rho < \alpha$, respectively, and (ii) the range of stages that are vertically integrated is now also (weakly) increasing in η.

Extension 1: Headquarter Intensity (cont.)

Remarks:

- Part (ii) of the proposition implies that the propensity to integrate rises as hq services become more important in production (η rises)
- Recovers the Antràs (2003) result, although the empirical implementation will call for a slight variation:

  If we interpret hq services as being capital- or R&D-intensive, then would expect the share of intrafirm trade for a given input to be increasing in the (average) capital or R&D intensity of industries that buy the input in question
- Also from part (i) of the proposition, note that the likelihood that we find ourselves in the sequential complements case is lower the higher is headquarter intensity
  - This is an auxiliary prediction of the model that we will test

Extension 2: Firm Heterogeneity

Introduce two new features:

1. Industry contains many other firms that differ only in their productivity, θ, which is drawn from a Pareto distribution:

$$G(\theta) = 1 - \left(\underline{\theta}/\theta\right)^z \quad \text{for } \theta \geq \underline{\theta} > 0$$

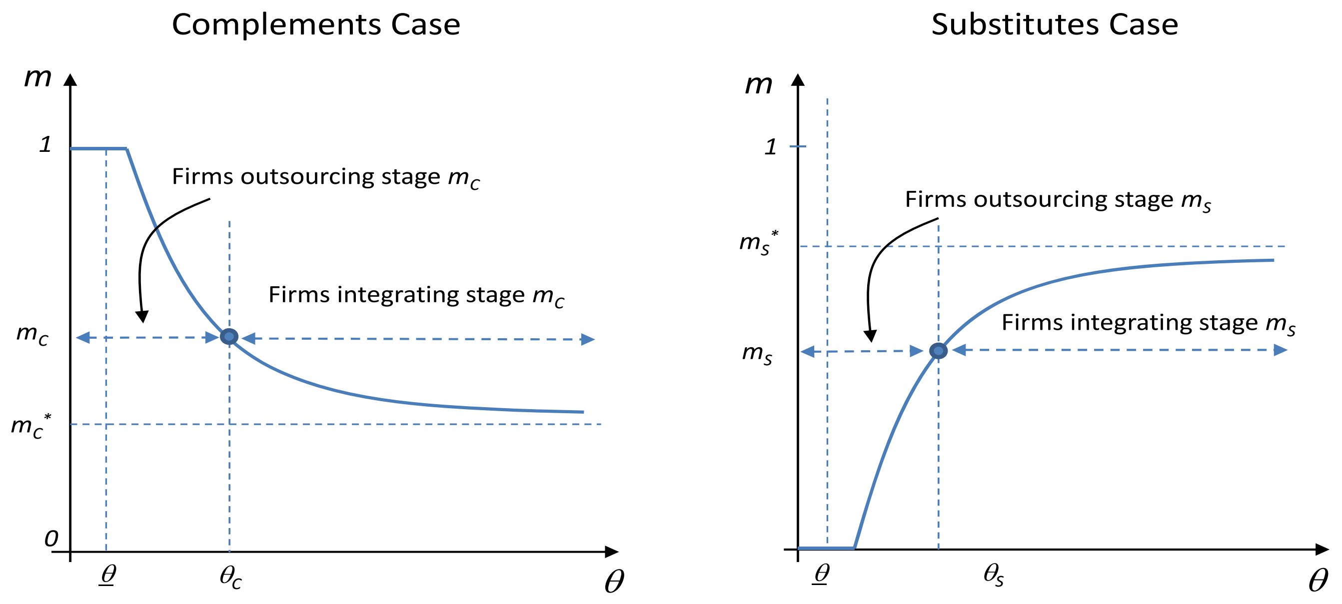
2. Each production stage m incurs fixed organizational costs. Specifically, assume that:

$$f_V > f_O$$

Firm's objective is thus to maximize revenues net of total fixed costs, $\int_{j=0}^{1} f(j)dj$

Return

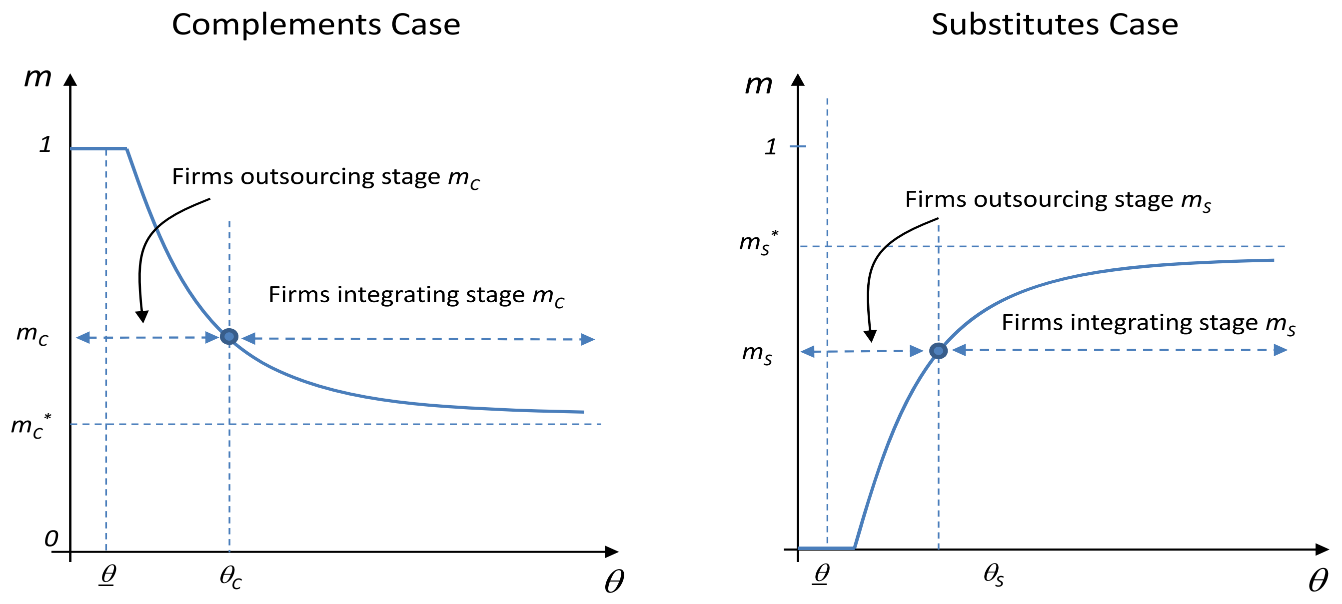
Extension 2: Firm Heterogeneity (cont.)



Complements case ($\rho > \alpha$):

- For each θ, there exists a cutoff stage $m_C(\theta)$ such that all stages before $m_C(\theta)$ are outsourced, and all stages after are integrated
- $m_C(\theta)$ is decreasing in θ

Extension 2: Firm Heterogeneity (cont.)



Conversely, in the substitutes case ($\rho < \alpha$):

- For each θ, there exists a cutoff stage $m_S(\theta)$ such that all stages before $m_S(\theta)$ are integrated, and all stages after are outsourced
- $m_S(\theta)$ is increasing in θ

Extension 2: Firm Heterogeneity (cont.)

Importantly, this generates smooth predictions for how the intrafirm trade share varies with production line position:

Proposition

The share of firms integrating a particular stage m is weakly increasing in the downstreamness of that stage in the complements case ($\rho > \alpha$), while it is decreasing in the downstreamness of the stage in the substitutes case ($\rho < \alpha$).

Furthermore, the share of firms integrating a particular stage m, is weakly increasing in the dispersion of productivity within the industry.

- This converts previous within-firm variation on the propensity to integrate different stages into predictions regarding the relative prevalence of integration of an input with a particular level of downstreamness
- If fixed costs of integration are relatively high, only most downstream (in complements case) or most upstream stages (in substitutes case) will be integrated

Extension 3: Input and Supplier Heterogeneity

Relaxing the symmetry in the production function:

$$q = \theta \left(\int_0^1 \left(\psi(j) \, x(j) \right)^{\alpha} I(j) dj \right)^{1/\alpha} \tag{10}$$

In practice:

- Production stages can have different weights
- Stage suppliers could defer in their productivity levels

Separately, production costs for stage j, $c(j)$, might depend on which country the stage is located in

Return

Extension 3: Input and Supplier Heterogeneity (cont.)

This more general model can be solved using a similar heuristic:

Proposition

Suppose that technology allows for input heterogeneity as in (10) and that marginal costs of production of inputs are also heterogeneous and given by $c(j)$ for $j \in [0, 1]$.

Then the share of firms integrating a particular stage m is weakly increasing in the downstreamness of that stage in the complements case ($\rho > \alpha$), while it is decreasing in the downstreamness of that stage in the substitutes case ($\rho < \alpha$).

Extension 3: Input and Supplier Heterogeneity (cont.)

Caveats:

- $c(m)$ is in principle endogenous, it being a function of location choice
- Marginal incentives for the Firm to reduce the marginal cost of a given stage are indeed generally affected by the index of the production stage m, but this dependence is complex and hinges on various aspects of the model in subtle ways
- Empirically: Control for country fixed effects, to ensure that effects of downstreamness are not being estimated off cross-country variation in production costs. Also, run a two-stage Heckman procedure to correct for selection bias

Property-Rights Approach

Luca David Opromolla

NC State, Spring 2024

Way forward

- Way forward:
  - In the real world, the challenge of incentivizing the agents involved in a production process does not disappear when those agents become employees of the firm.
  - Property-Rights Theory of the firm: explaining in a unified framework both the benefits as well as the costs of vertical integration.

Property-Rights Theory of the Firm

- Literature started with a seminal paper by Sanford Grossman and Oliver Hart—further developed in Hart and Moore (1990) and Hart (1995)—about the costs and benefits of ownership in an economy with incomplete contracting.
  - Opportunistic behavior and incentive provision are arguably just as important in within-firm transactions as they are in market transactions.
- Oliver Hart received, together with Bengt Holmström, the Nobel prize in economics in 2016 for their contributions to contract theory. Here a link to the press release.
- Many trade papers rely on the approach set forward by Grossman and Hart. For example, the way firms organize production on a global scale is often studied via incomplete contracting.

What are the limits of contracts?

- In early summer 1983, Sanford Grossman and Oliver Hart became interested in the following question:

  Why would one firm ever buy another firm rather than conduct business with that firm through a contract?

What are the limits of contracts?

- Ronald Coase and Oliver Williamson had already worked on this question: Transaction cost-based theory of integration.
  - Coase (1937). Why is it profitable to establish a firm? "The main reason why it is profitable to establish a firm would seem to be that there is a cost of using the price mechanism." Transactions will be organized in the firm when the cost of doing this is lower than the cost of using the market.
  - A contractual relationship will be plagued by opportunistic and inefficient behavior when there are large amounts of surplus to be divided ex post and the ex ante contract does not specify a clear division of this surplus. Such situations are likely to arise when investments are relationship-specific (Klein et al. 1978, Williamson, 1979).
- Grossman and Hart
  - identify two key elements: contractual incompleteness & the notion of residual control (or decision) rights
  - and develop a <u>formal</u> model of the differences between arms-length contracting and integration or a merger. They start by working hard for 10 days...

Let's stop for a minute: Methodology

What can we learn from this that can help us in being efficient when we do our own research?

1. A simple and well defined question: "*Why would one firm ever buy another firm rather than conduct business with that firm through a contract?*"
2. Focus and work intensively for a limited amount of days.
3. Look at the relevant literature (there is almost always one) but also think independently. This is a subtle balance.
4. Identify the key elements and understand if something that is important to answer the question is missing.

An Example

Consider a power plant that locates next to a coal mine with the purpose of burning coal to make electricity.

- It could sign a long-term contract with the coal mine, specifying the quantity, quality, and price of coal for many years to come.
- But any such contract will be incomplete. Events will occur that the parties could not fully foresee when they started out.
- For example, suppose that the power plant needs the coal to be pure but that it is hard to specify in advance what purity means given that there are many potential impurities.
- Imagine that ten years on, ash content is the relevant impurity and that high-ash-content coal is more expensive for the power plant to burn but cheaper for the coal mine to produce.

An Example (cont'd): - Hold up problem

- The power plant can, of course, offer to pay the coal mine to switch to low-ash-content coal, but the coal mine is in a very strong bargaining position. It can demand a very high price: it has the power plant "over a barrel."
- The owner of the coal mine has residual rights of control: the right to decide on uses of the coal mine about which the contract is silent. Grossman and Hart essentially define ownership to mean having residual rights of control.
- Anticipating the possibility of being "held-up", the power plant may be reluctant to become totally dependent on the coal mine for its source of coal, even though this is efficient.

An Example (cont'd) - Costs and Benefits of Integration

- Short of writing a better contract, one thing the power plant could do is to buy the coal mine in advance. The power plant can now order the coal mine manager to mine low-ash-content coal and be willing to become dependent on the coal mine. This is the benefit of integration.
- But the manager of the coal mine, who, say, previously owned it, is now MORE vulnerable.
- For example, suppose that the manager has an idea about how to mine coal more efficiently. If the manager owns the coal mine he can be confident about reaping the returns from this idea. Otherwise, the power plant could fire him and use his idea anyway. Anticipating this, the manager has a lower incentive to innovate.
- This is the cost of integration. Vertical integration entails endogenous (transactions) costs because it reduces the incentives of the integrated firm to make investments that are partially specific to the integrating firm, and this underinvestment lowers the overall surplus of the relationship.

A Property-Rights Model of Multinational Firm Boundaries

- The profitability of domestic outsourcing and offshore outsourcing are still represented by the profit functions $\pi_{DO}(\varphi)$ and $\pi_{OO}(\varphi)$

$$\pi_{DO}(\varphi) = (w_N)^{1-\sigma} \varphi^{\sigma-1} B\Gamma_{DO} - w_N f_{DO}$$

$$\pi_{OO}(\varphi) = \left((w_N)^{\eta} (w_S \tau)^{1-\eta}\right)^{1-\sigma} \varphi^{\sigma-1} B\Gamma_{OO} - w_N f_{OO}$$

  where Γ_{DO} and Γ_{OO} summarize the level of contractual inefficiencies associated with domestic and offshore oursourcing, respectively.

- We will assume that, for simplicity, contract governing domestic transactions are complete, while contract governing international transactions are totally incomplete.

- We will also assume that there is only one supplier, that investments are fully relationship specific, that bargaining power is symmetric, and that there are no constraints on ex-ante transfers.

- Overall,

$$\Gamma_{DO} = 1 \textit{ and } \Gamma_{OO} = (\sigma+1)\left(\frac{1}{2}\right)^{\sigma} < 1 \textit{ for } \sigma > 1.$$

A Property-Rights Model of Multinational Firm Boundaries

- Key innovation: intrafirm transactions are also governed by incomplete contracts.
  - When F decides its mode of organization at t_0, it anticipates playing an analogous game with a manufacturing operator M regardless of whether the operator is an employee or an independent contractor.
  - Both the outsourcing and integration branches of the game feature an ex-ante contracting stage t_0, an investment stage t_1, and an ex-post bargaining stage t_2.
  - The only difference between the two branches of the game is at t_2, where the outside options available to F and M will now be a function of the ownership decision at t_0.

- In the outsourcing branch of the game we assumed that, because of relationship-specific investments, both F's and M's outside options, in the event of no agreement at t_2, were zero.

- In the case of integration, the above formulation of the outside options is unrealistic.

A Property-Rights Model of Multinational Firm Boundaries

- We will assume that H will hold property rights over the input m produced by M, and thus F has the ability to fire a stubborn operator M that is refusing to agree on a transfer price, while still being able to capture part, say a fraction $\delta < 1$, **of the revenue** generated by combining h and m.

- The fact that δ is assumed to be lower than one reflects the intuitive idea that F cannot use the input m as effectively as it can with the cooperation of its producer, i.e., M.

A Property-Rights Model of Multinational Firm Boundaries

- Let R be the revenues from the relationship in case of an agreement. Given our assumptions, the final good producer is left with
  - a fraction $\frac{1}{2}$ of the ex-post gains from trade, which are equal to $(1-\delta)R$
  - an outside option equal to δR
- Then
$$\beta_V \equiv \frac{1}{2}(1+\delta) > \frac{1}{2} \equiv \beta_O$$
where β_V is the final good producer bargaining share in the case of vertical integration, while β_O is the share in the case of outsourcing.
- This difference captures the key property-rights idea that F holds more power under integration than under outsourcing.

A Property-Rights Model of Multinational Firm Boundaries

- Profitability of foreign integration will then be

$$\pi_{OV}(\varphi) = \left((w_N)^{\eta}(w_S\tau)^{1-\eta}\right)^{1-\sigma}\varphi^{\sigma-1}B\Gamma_{OV} - w_N f_{OV}$$

  where

$$\Gamma_{OV} = (\sigma - (\sigma-1)(\beta_V\eta + (1-\beta_V)(1-\eta)))\left(\beta_V^{\eta}(1-\beta_V)^{1-\eta}\right)^{\sigma-1}.$$

- Note that, under our assumptions, $\Gamma_{DV} = \Gamma_{DO} = 1$ so that $\pi_{DO}(\varphi) > \pi_{DV}(\varphi)$ for all φ and no firm in the industry integrates domestic suppliers.

The Choice Between Offshore Outsourcing and Foreign Integration

- Let us consider the choice between offshore outsourcing and foreign integration.
- We compare

$$\pi_{OV}(\varphi) = \left((w_N)^{\eta}(w_S\tau)^{1-\eta}\right)^{1-\sigma}\varphi^{\sigma-1}B\Gamma_{OV} - w_N f_{OV}$$

where

$$\Gamma_{OV} = (\sigma - (\sigma-1)(\beta_V\eta + (1-\beta_V)(1-\eta)))\left(\beta_V^{\eta}(1-\beta_V)^{1-\eta}\right)^{\sigma-1},$$

with

$$\pi_{OO}(\varphi) = \left((w_N)^{\eta}(w_S\tau)^{1-\eta}\right)^{1-\sigma}\varphi^{\sigma-1}B\Gamma_{OO} - w_N f_{OO}$$

where

$$\Gamma_{OO} = (\sigma+1)\left(\frac{1}{2}\right)^{\sigma}.$$

The Choice Between Offshore Outsourcing and Foreign Integration

- A key aspect of the property-rights model is the extent to which contractual efficiency is higher in integrated versus non-integrated transactions, as summarized in the relative size of Γ_{OV} and Γ_{OO}.

- In this model

$$\frac{\Gamma_{OV}}{\Gamma_{OO}} = \frac{\left(\sigma - \left(\sigma - 1\right)\left(\beta_V \eta + \left(1 - \beta_V\right)\left(1 - \eta\right)\right)\right)\left(\beta_V^{\eta}\left(1 - \beta_V\right)^{1-\eta}\right)^{\sigma - 1}}{\left(\sigma - \left(\sigma - 1\right)\left(\beta_O \eta + \left(1 - \beta_O\right)\left(1 - \eta\right)\right)\right)\left(\beta_O^{\eta}\left(1 - \beta_O\right)^{1-\eta}\right)^{\sigma - 1}}$$

- It is easily verified that $\frac{\Gamma_{OV}}{\Gamma_{OO}} > 1$ when $\eta \to 1$, while $\frac{\Gamma_{OV}}{\Gamma_{OO}} < 1$ when $\eta \to 0$.
    - In words, for sufficiently high level of headquarter intensity, the transaction costs of using the market mechanism are higher than those of transacting within firm boundaries, just as is assumed in the transaction-cost theory.
    - When headquarter intensity is sufficiently low, however, the converse is true and the contractual efficiency of outsourcing is actually higher than that of integration.

The Choice Between Offshore Outsourcing and Foreign Integration

- This result, which corresponds to Proposition 1 in Antras (2003), resonates with one of the central results in the property-rights theory: with incomplete contracting, ownership rights of assets should be allocated to parties undertaking noncontractible investments that contribute disproportionately to the value of the relationship.

Equilibrium Sorting in the Property-Rights Model

- Under the maintained assumption that $\Gamma_{DO} = \Gamma_{DV} = 1$, domestic integration is a dominated strategy.

- Whenever headquarter intensity is sufficiently low, foreign integration will also be a dominated strategy, since $\frac{\Gamma_{OV}}{\Gamma_{OO}} < 1$ and the fixed cost of foreign integration is higher than the one of foreign outsourcing.

- For higher levels of headquarter intensity, richer sorting patterns can emerge.
  - The effective marginal cost is now lower under integration than under outsourcing, but outsourcing continues to be a strategy associated with lower fixed costs.
  - Thus a subgroup of relatively unproductive firms might continue to prefer outsourcing over integration.

Equilibrium Sorting in the Property-Rights Model

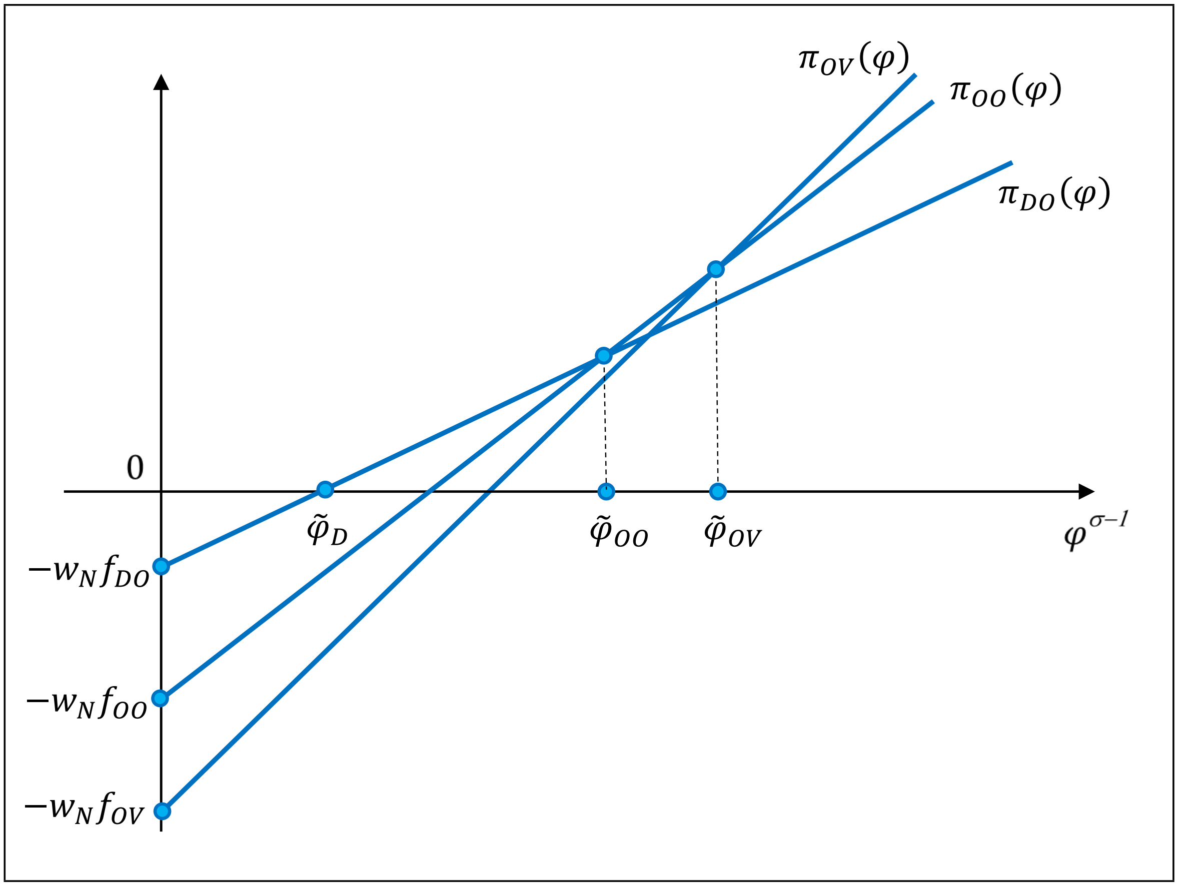


Figure 7.2: Equilibrium Sorting with High Headquarter Intensity

Implications for the Share of Intrafirm Trade

- We aggregate all firms' decisions within an industry and compute the share of intrafirm input imports over total input imports.
- Under a Pareto distribution for φ,

$$S = \frac{\Gamma_{OV}/\Gamma_{OO}}{\left[\left(\frac{\widetilde{\varphi}_{OV}}{\widetilde{\varphi}_{OO}}\right)^{\kappa-\sigma-1} - 1\right] + \Gamma_{OV}/\Gamma_{OO}}$$

  where

$$\frac{\widetilde{\varphi}_{OV}}{\widetilde{\varphi}_{OO}} = \left[\frac{f_{OV} - f_{OO}}{f_{OO} - f_{OD}} \frac{1 - (w_N/\tau w_S)^{-(1-\eta)(\sigma-1)}/\Gamma_{OO}}{\Gamma_{OV}/\Gamma_{OO} - 1}\right].$$

- The share of intrafirm imports is increasing in productivity dispersion, trade costs, and Southern labor costs (note that Γ_{OV} and Γ_{OO} are independent of κ and $w_N/w_S\tau$).
  - The effect of trade costs and wage difference stems from the fact that the extensive margin of offshoring affects outsourcing disproportionately. Intuitively, decreases in these parameters lead firms that were sourcing domestically to select into offshoring, but as observed in the figure, these new foreign input purchases necessarily occur at armís-length, hence decreasing the relative

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