CREI Lectures in Macroeconomics

Contracts and the Global Organization of Production

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Introduction

- In this lecture, I will begin to discuss simple ways to introduce contractual imperfections in the benchmark models developed at the end of Lecture 1
- I will start with a simple variant of the Melitz (2003) model of exporting
  - this will be developed in more detail in the Lectures' manuscript
- Later I will introduce contractual frictions into the model of global sourcing in Lecture 1
- At the end, I will discuss empirical evidence suggestive of the role of these frictions for the international organization of production

Contractual Frictions in the Melitz Model

- In the Melitz model, it is assumed that firms decide on the volume of output sold in each market in a profit-maximizing manner
- Remember that the profits that a firm from country i with productivity φ anticipates obtaining in country j are given by

$$\pi_{ij}(\varphi) = \max\left\{(\tau_{ij} w_i)^{1-\sigma} B_j \varphi^{\sigma-1} - w_i f_{ij}, 0\right\}$$

- But to realize those profits, we implicitly assume that the firm:
  1. has full information on all parameters of the model (including the level of demand implicit in the term B_j)
  2. can hire (efficiency units of) labor at a wage rate w_i (or inputs) without frictions
  3. can costlessly contract with a local distributor (an agent, employee, or a firm) that will collect the sales revenue in country j and will hand them over to the exporter in i in exchange for a fee

Contractual Frictions in the Melitz Model

- A lot of interesting recent work in Trade has been devoted to studying the implications of relaxing Assumptions #1 and #2
  - Segura-Cayuela and Vilarrubia (2008), Albornoz et al. (2012) on demand uncertainty
  - Helpman et al. (2010) on imperfect labor markets
  - Nunn (2007) and Levchenko (2007) on local inputs
- I will instead outline some implications of relaxing Assumption #3

▸ Jump to Global Sourcing

Complete-Contracting Benchmark

- Consider the complete-contracting assumption implicit in the Melitz (2003) model and its applications
- Take a firm in country i with productivity level φ
- For each market j for which $\pi_{ij}(\varphi) > 0$:
  - the firm agrees to ship an amount of goods equal to $q_{ij}(\varphi)$ at some initial date $t = 0$
  - the distributor agrees to pay an amount $s_{ij}(\varphi)$ at some later date (perhaps when the good has been sold and revenue has been collected)
- For simplicity, take the case in which the firm makes a take-it-or-leave it offer to the distributor in j and the latter's cost of distribution is equal to $w_i f_{ij}$
  - if the cost was in terms of country j's labor (not i's) not much would change

Complete-Contracting Benchmark

- The firm will then solves

$$\begin{aligned} \max_{q_{ij}(\varphi), s_{ij}(\varphi)} \quad & s_{ij}(\varphi) - \tau_{ij} w_i q_{ij}(\varphi) \\ \text{s.t.} \quad & p_{ij}(q_{ij}(\varphi)) q_{ij}(\varphi) - w_i f_{ij} - s_{ij} \geq 0 \end{aligned}$$

  where $p_{ij}(\cdot)$ is the inverse demand function faced by the distributor
- Quite naturally, the participation constraint will bind and we will revert to the expressions in the Melitz model

Imperfect Contracting

- Suppose, however, that this contract is **imperfectly enforceable**
- We discussed in Lecture 1 a variety of reasons why that might be the case
- For instance, if the distributor were to abscond with the sales revenue
  - the exporter would only be able to recoup a share of the expected proceeds via litigation
  - or it would anticipate recouping all the proceeds with lower-than-one probability
- For concreteness, suppose that absconding (or defaulting) would leave the distributor with an expected share χ_D of sales revenue minus the cost of distribution $w_i f_{ij}$

Optimal Imperfect Contract

- When signing the initial contract, the exporter then knows that any payment to the distributor lower than $\chi_D p_{ij}\left(q_{ij}\left(\varphi\right)\right) q_{ij}\left(\varphi\right) - w_i f_{ij}$ would lead the distributor to abscond and would thus trigger litigation
- The firm will then solve

$$\begin{aligned} \max_{q_{ij}(\varphi), s_{ij}(\varphi)} \quad & s_{ij}\left(\varphi\right) - \tau_{ij} w_i q_{ij}\left(\varphi\right) \\ \text{s.t.} \quad & p_{ij}\left(q_{ij}\left(\varphi\right)\right) q_{ij}\left(\varphi\right) - w_i f_{ij} - s_{ij} \geq 0 \\ & p_{ij}\left(q_{ij}\left(\varphi\right)\right) q_{ij}\left(\varphi\right) - s_{ij} \geq \chi_D p_{ij}\left(q_{ij}\left(\varphi\right)\right) q_{ij}\left(\varphi\right) \end{aligned}$$

- For a sufficiently high χ_D, the IC constraint is more binding than the PC constraint
- In such a case, imperfect contracting will reduce the profitability of selling in j and the more so, the larger is χ_D

Institutional Quality

- What does χ_D depend on? Makes sense to think of it as inversely related to the effective cost for the distributor of defaulting on the exporter
- One would imagine that countries with better contracting institutions and higher quality legal systems would tend to enforce lower levels of χ_D
- In sum, controlling for standard determinants of exporting, the extensive and intensive margins of exporting should respond positively to better contracting institutions of the importing country
  - see Araujo, Mion and Ornelas (2012) for a dynamic model and empirical evidence with Belgian firm-level dataset
- Related work: Manova (2012) emphasizes the role of financial institutions in the **exporting country**
  - firms need working capital to produce and to cover exporting costs and may be constrained in obtaining it

A Simple Solution?

- In the example above, it may seem that a simple solution to the problem is to have the distributor pay for the goods in advance
- In that case, the exporter can insist on a payment equal to $p_{ij}\left(q_{ij}\left(\varphi\right)\right)q_{ij}\left(\varphi\right) - w_i f_{ij}$, as implemented by the optimal complete (or fully enforceable) contract
- Why would this typically not work?
  1. The distributor might worry about moral hazard on the part of the exporter (quality of goods being shipped is difficult to contract upon)
  2. The distributor might face borrowing constraints which would limit the ability of the exporter to obtain the desired amount of revenue ex-ante

Choice of Mode of Trade Finance

- Antràs and Foley (2011) model the tradeoff between "cash in advance" versus "open account" export contracts
  - crucially shaped by the contracting environment of the importing country, but in subtle ways
  - higher risk of default makes CIA appealing, but high borrowing costs (due to weak institutions) make OA appealing
- Active literature: Ahn (2010), Olsen (2010), Schmidt-Eisenlohr (2009), Amiti and Weinstein (2011)
- Empirically, we analyze transaction level data from U.S. based exporter of frozen and refrigerated food products, particularly poultry
- Three robust stylized facts emerge from the data

Sylized Facts About Trade Finance Choice

- Most commonly used terms are cash in advance and open account terms; these do not involve direct intermediation by banks

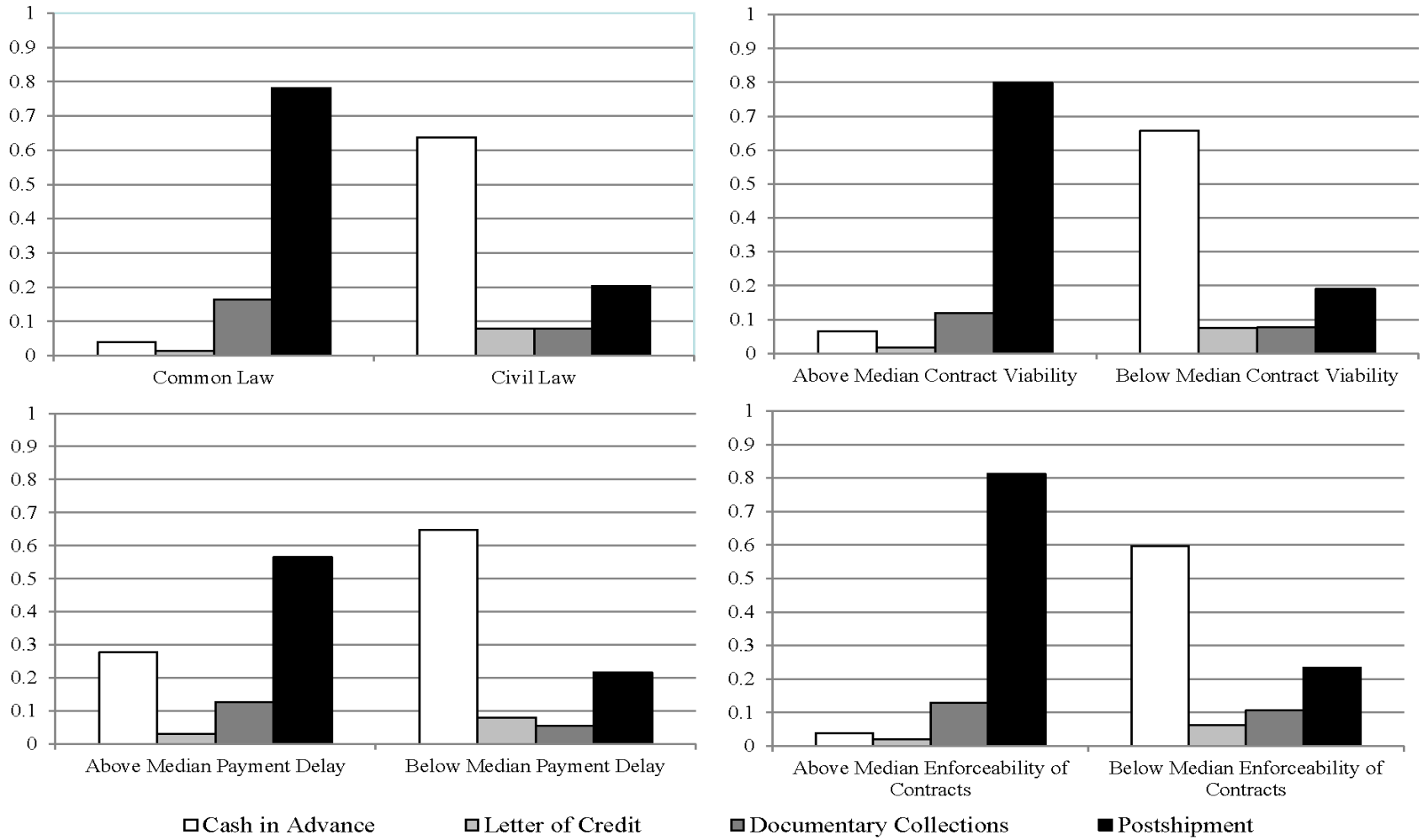
Categories of Financing Terms

Notes: This table diplays the twenty most commonly used financing terms

Cash In Advance	Letter of Credit	Documentary Collection	Open Account Terms
Wire transfer in advance	Letter of credit	Sight Draft	Net 7 days after arrival
Wire transfer upon receiving fax			Net 7 allow 21
20% deposit, 80% wire transfer in advance			Net 7 allow 30
10% wire transfer in advance, 90% prior to arrival			Net 14 days after arrival
10% wire transfer in advance, 90% 3 days prior to arrival			Net 15 days after arrival
30% deposit, 70% 7 days prior to arrival			Net 21 days after arrival
30% deposit, 70% estimated time of arrival			Net 21 days after delivery
15% deposit, 85% prior to arrival			Net 30 days after arrival
			Net 30 days after delivery
			Net 45 days from bill of lading date

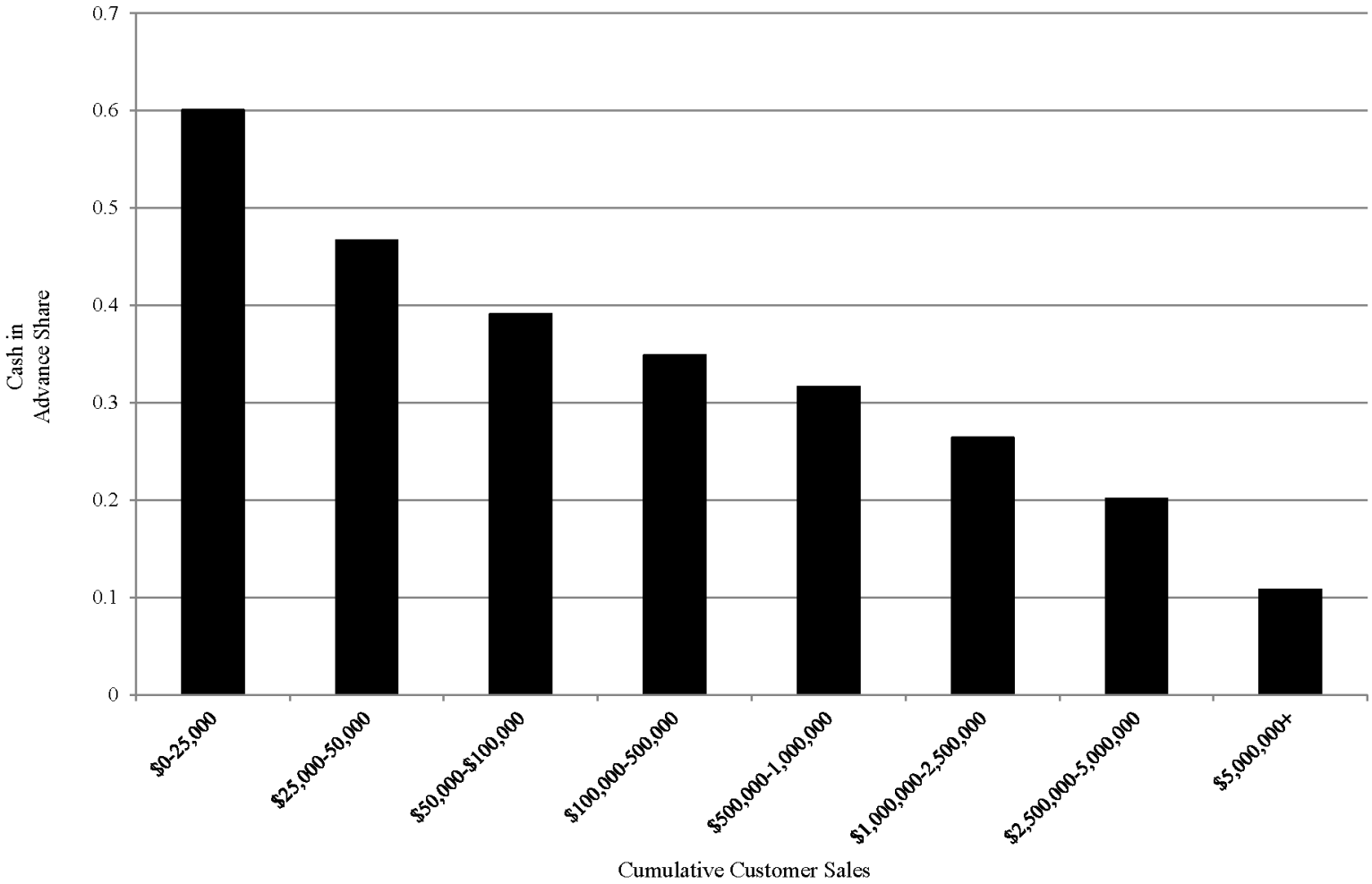
Sylized Facts About Trade Finance Choice

- Sales to locations with weak contractual enforcement are more likely to occur on cash in advance terms



Sylized Facts About Trade Finance Choice

- As the exporter establishes a relationship with an importer, transactions less likely to occur on cash in advance terms



Back to Global Sourcing Model

- Let us now go back to the model of global sourcing with heterogeneous firms introduced in Lecture 1
- Remember some key equations
- Cost functions:

$$\begin{aligned} C_D(q) &= \left(f_D + \frac{q}{\varphi}\right) w_N \\ C_O(q) &= f_O w_N + \frac{q}{\varphi} (w_N)^{\eta} (\tau w_S)^{1-\eta} \end{aligned}$$

- Underlying technology:

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

Back to Global Sourcing Model

- From this we argued that the profit levels of the firm's two alternatives (no offshoring vs. offshoring) were given by

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

and

$$\pi_O(\varphi) = \left((w_N)^{\eta} (\tau w_S)^{1-\eta}\right)^{1-\sigma} B \varphi^{\sigma-1} - w_N f_O \tag{2}$$

with

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

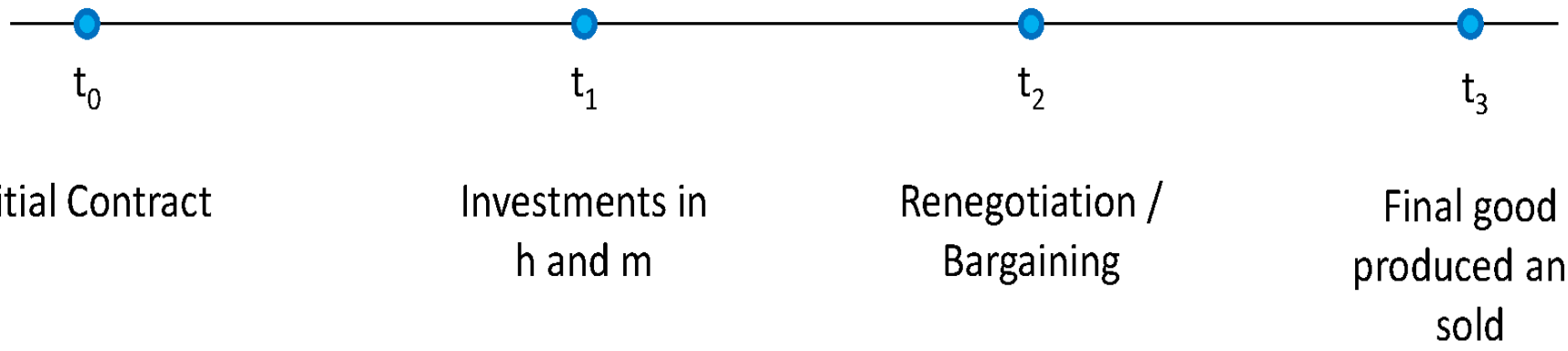
and P is the common price index in each country, given costless final-good trade

- Is it reasonable to assume that these 'first-best' (or joint-maximizing) profit levels will be attained?

Underlying Microeconomic Structure

- Headquarter services h are controlled by a final-good producer (agent F)
- Manufacturing or plant production m is controlled by an operator of the production facility (agent M)
- h and m produced one-to-one with labor
- Let us focus for now on the case in which M is not an employee of F and is thus an independent supplier
- How can the profit levels in (1) and (2) be attained?
- Let us first discuss the timing of events more formally

Timing of Events



A Simple Contract

- Consider the case of offshoring manufacturing to the South
- Suppose that F offers a Southern M a contract that stipulates a quantity m^C of manufacturing 'services' to be provided by M in exchange for a fee s^C received by M
- F will then choose $h^C(\varphi)$, $m^C(\varphi)$ and $s^C(\varphi)$ to solve

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

$$\text{s.t.} \quad s(\varphi) \geq \tau w_S m(\varphi)$$

- Naturally, $s^C(\varphi)$ will be set to make M's participation constraint bind, and the joint-profit maximizing level of investments and output delivering (2) will be attained
  - timing of events or payments is irrelevant here

Limitations of the Simple Contract

- For M to abide by the terms of the contract, it is important that a court of law be able to verify that m^C was indeed provided
- In practice, manufacturing 'services' are not only a function of the **quantity** of manufacturing provided (say the number of units of the input or finished good delivered)
- But they are also affected by their **quality or compatibility** with other parts of the production process
- Whether a given quantity was delivered may be easily verifiable, but their quality or compatibility might be much harder to verify
- Quality-contingent contracts (specifying the purchase of a given quantity of goods *m of a particular quality* for a certain price) would still deliver the 'first-best' profits in (2)
    - But it is much less reasonable to assume that courts of law will be able to enforce such contracts

Alternatives to the Simple Contract

- When quality or compatibility issues are important, contracts specifying *only* quantities and prices (regardless of quality) will tend to be unappealing to F
  - particularly when the independent supplier M can produce a useless, low-quality version of m at a negligible cost (or by heavily reducing production costs)
- In some cases, revenue-sharing contracts might be appealing, although they will not be able to attain the first-best when the provision of headquarter services is not verifiable either (see Holmstrom, 1982)
  - and they might be prone to manipulation thus making them unappealing in some settings
- I will discuss below several possible types of initial contract terms, with varying degrees of incompleteness
  - but I will abstract from mechanisms and other foundational issues

'Totally Incomplete' Contracts

- For now, however, let us focus on a stark example in which:
  1. either contracts are **complete**: quality-contingent contracts are perceived to be enforceable
  2. or they are **totally incomplete**: no aspect of the initial contract is perceived to be enforceable, except for an initial transfer occuring at the time of the agreement
- For reasons discussed in Lecture 1, it seems natural to assume that certain contracts that are feasible or enforceable in domestic transactions might not be feasible or enforceable in international transactions
- Again it is useful to start with a stark example in which:
  1. Contracting is complete or perfect in the absence of offshoring
  2. Contracting is totally incomplete in offshoring relationships

Implications of Incomplete Contracts

- What happens when the initial contract does not stipulate m nor a price for its purchase (in an enforceable manner)?
- F and M can still negotiate over the terms of exchange after m has been produced
  - i.e.: at t_2 in the timing of events chart above
- Does the lack of a complete contract necessarily lead to inefficiencies?
- Not always: only when a separation (or absence of a transaction between F and M) is costly to these parties
- In global sourcing environments, there are however two natural sources of 'lock in':
  - inputs (and also headquarter services) are often customized to their intended buyers and cannot easily be resold at full price to alternative buyers
  - even in the absence of customization, search frictions make separations costly for both F and M

Lock In and Hold Up

- In the presence of lock-in effects, incomplete contracting leads to a **two-sided hold-up problem** in offshoring relationships
- The exchange price for m will only be determined ex-post (at t_2), at which point the investments incurred by both agents are sunk and have a relatively lower value outside the relationship
- F will try to push the price of the input as low as possible (but not "too much" if separation is costly to him/her)
- Instead, M will try to raise the price of m as much as possible, knowing that it is also in F's best interest to go through with the transaction
- Even when bargaining is efficient and trade takes place in equilibrium, the possibility of a disagreement implies that F and M will tend to have lower incentives to invest in h and m than in the complete contracting case

More Structure on Bargaining Stage

- 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 (abstract from mechanisms)
- This leaves F and M with their outside options plus a share of the ex-post gains from trade (i.e., the difference between the sum of the agent's payoffs under trade and their sum under no trade)
- For the time being, I will assume that the outside options of both parties are 0
- In other words, I am assuming that m is fully specialized to F (and useless to other producers), while h is also fully tailored to M and useless to other agents
- I will also consider the case of symmetric Nash bargaining, so that F and M share equally the ex-post gains
- These are strong assumptions which I will relax below

Investment Stage

- Denote revenue by

$$r(h,m) = p(q(h,m))\, q(h,m)$$

- Then in the ex-post bargaining at t_2, F will obtain $\frac{1}{2} r(h,m)$ and, at t_1, will set h to solve

$$\max_h \quad \frac{1}{2} r(h,m) - w_N h \tag{3}$$

- M will in turn obtain $\frac{1}{2} r(h,m)$ at t_2 and will choose m at t_1 to solve

$$\max_m \quad \frac{1}{2} r(h,m) - \tau w_S m \tag{4}$$

Initial Contract

- For comparability with the complete-contracting case, I will assume that F has full bargaining power ex-ante, so it can make a take-it-or-leave-it offer to M
- Because the initial contract is allowed to include a lump-sum transfer between parties, F can set the transfer such that the PC constraint of M exactly binds
- So, as with complete contracts, F ends up with a payoff of

$$\pi_O = r(h, m) - w_N h - \tau w_S m - w_N f_O$$

Equilibrium Profitability of Offshoring

- Plugging the equilibrium values of h and m resulting from programs (3) and (4) delivers the following expression for the profits obtained by F:

$$\pi_O = \left((w_N)^{\eta} (\tau w_S)^{1-\eta} \right)^{1-\sigma} B \Gamma \varphi^{\sigma-1} - w_N f_O \tag{5}$$

where

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

- This is identical to the complete-contracting expression except for the term $\Gamma < 1$, which reflects the loss of efficiency due to incomplete contracting
- Γ is decreasing in σ reflecting the higher cost of incomplete-contracting frictions in more competitive environments

Choice of Location

- Note that we can write

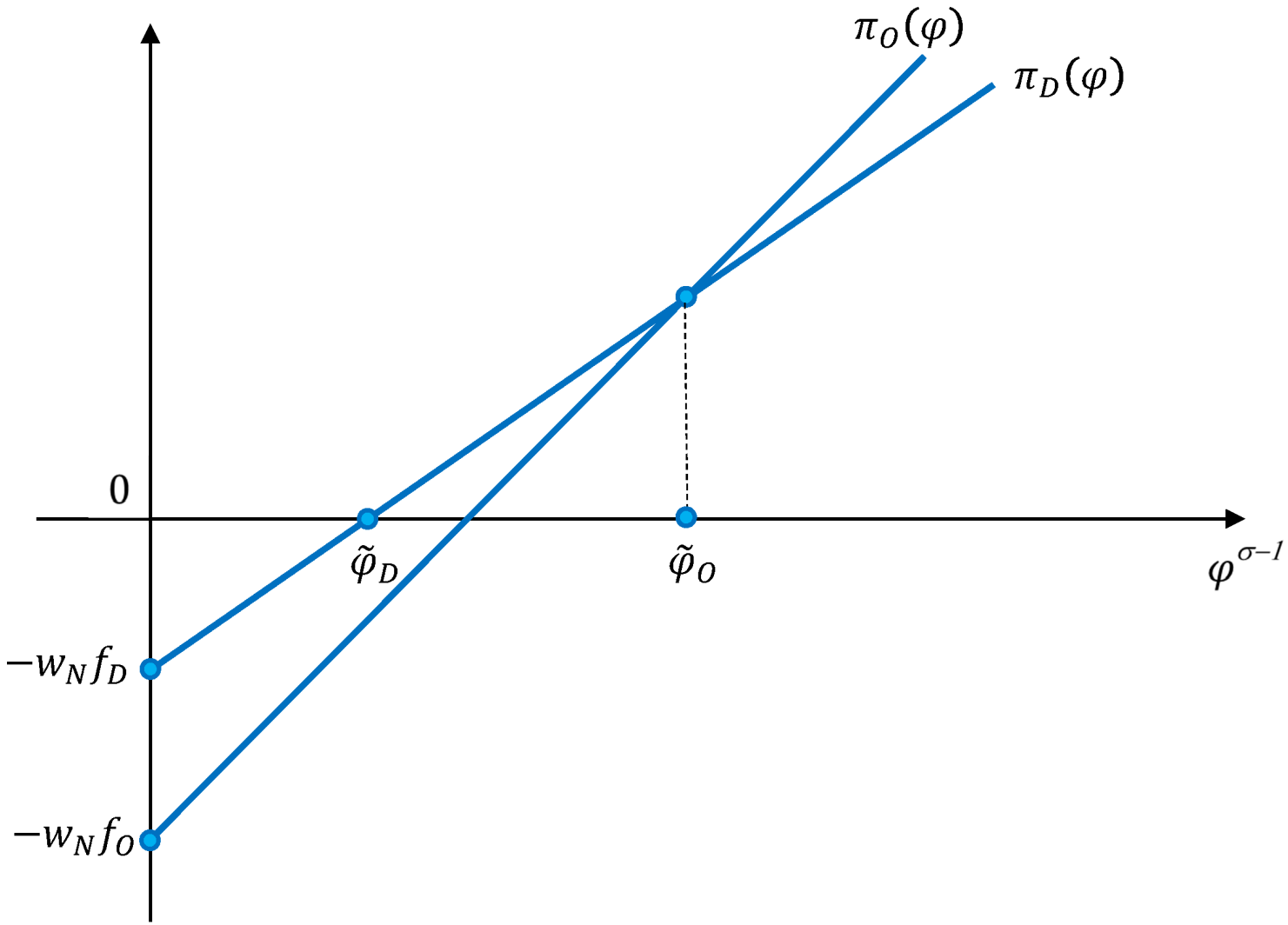
$$\pi_\ell(\varphi) = \psi_\ell B \varphi^{\sigma-1} - w_N f_\ell \quad \text{for } \ell = D, O$$

and that

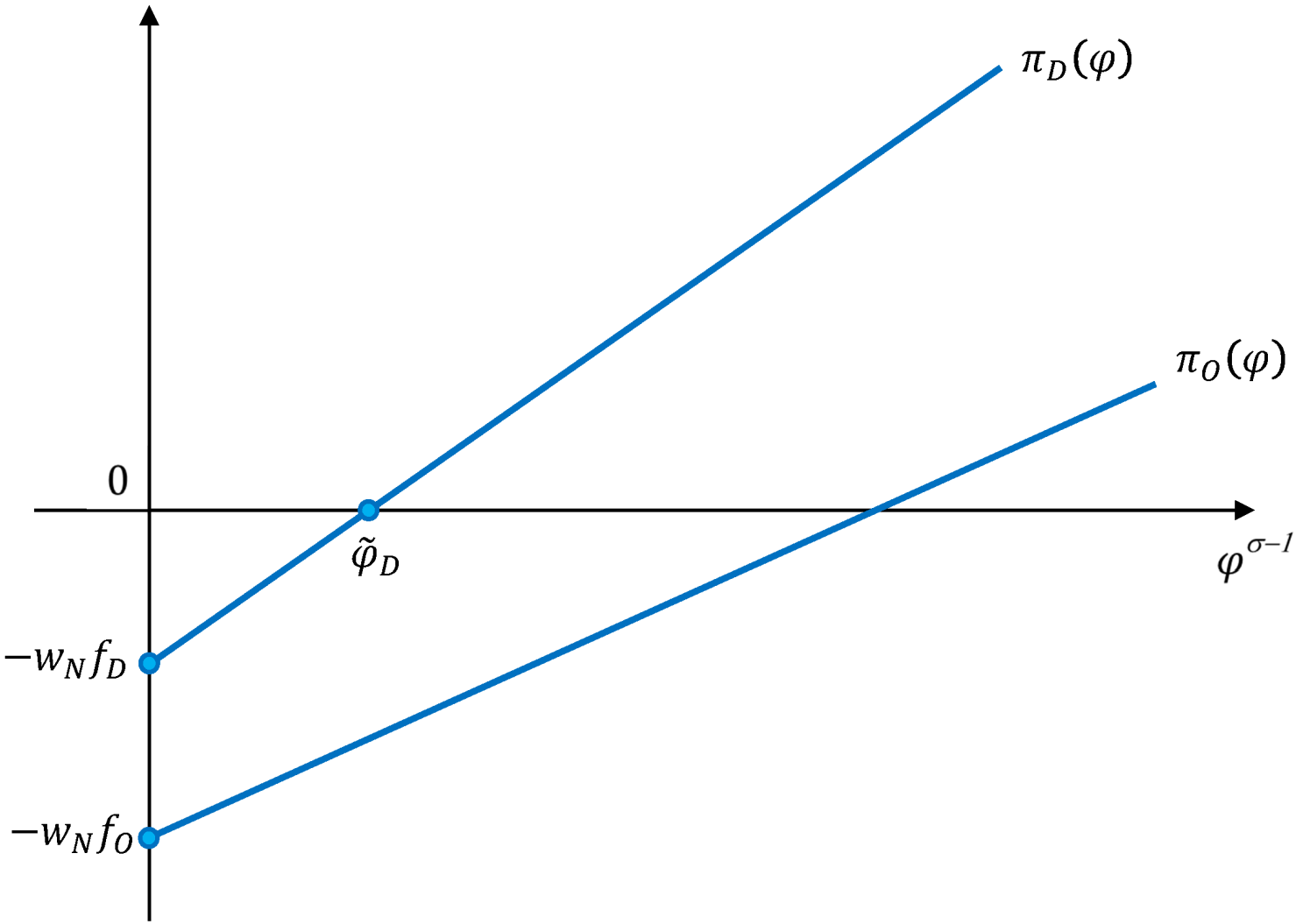
$$\frac{\psi_D}{\psi_O} = \frac{1}{\Gamma}\left(\frac{w_N}{\tau w_S}\right)^{-(1-\eta)(\sigma-1)}$$

- So when $w_N \approx \tau w_S$, we necessarily have $\psi_D/\psi_O > 1$ (because $\Gamma < 1$)
  - analogous to productivity in South being low (little cost advantage)
- But for sufficiently different wage levels, we restore $\psi_D/\psi_O < 1$ as long as $w_N > \tau w_S$ (as with perfect contracting)

Equilibrium Sorting with Large Wage Differences



Equilibrium Sorting with Small Wage Differences



Comparative Statics

- With a Pareto distribution of productivity, the share of active firms engaged in offshoring is given by

$$\frac{\int_{\tilde{\varphi}_O}^{\infty} \varphi^{\sigma-1} dG(\varphi)}{\int_{\tilde{\varphi}_D}^{\tilde{\varphi}_O} \varphi^{\sigma-1} d\varphi} = \frac{1}{\left(\frac{\tilde{\varphi}_O}{\tilde{\varphi}_D}\right)^{k-(\sigma-1)} - 1}$$

with

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

- This share is clearly increasing in $w_N/\tau w_S$ and decreasing in k and η as with complete contracts
- But because $\Gamma < 1$, this share is lower than with complete contracting

An Application: Product Cycles

- Vernon (1966)'s PC hypothesis: new goods are not only developed in high-wage countries, but they are also manufactured there for a while
- Theoretical perspectives:
  - Imitation (Krugman, 1979, Grossman and Helpman, 1991)
  - Vernon emphasized the role of multinational firms in the eventual production transfer to less developed countries
- Empirical evidence suggests that indeed it takes time for low-wage countries to start producing relatively unstandardized goods
- Antràs (2005) provides a theory where the decision to shift production to low-wage South is a profit-maximizing one from the point of view of firms in North

An Application: Product Cycles

- The time lag between the first appearance of the product and its manufacturing in the South is explained by appealing to incomplete contracts *in international transactions* (not exogenous or driven by imitation)
- Intuitively, if headquarter intensity η falls along the life cycle of a good, the model above would suggest that the incentives to offshore increase over time
- Production lag persists even in the absence of trade costs and even when wages in South remain lower with free trade (a feature of Antràs' 2005, general equilibrium)
- Antràs (2005) also shows that an improvement in contracting moves the terms of trade in favor of the South. This enhances welfare in the South, but has an ambiguous effect on Northern welfare

Robustness and Generalizations

- We have made a bunch of simplifying assumptions to illustrate the negative role of contractual frictions on the profitability of offshoring
- It is important to study more general environments for two reasons:
  - verify the robustness of the key comparative statics
  - generalize the framework to more realistic environments to better guide empirical work
- I will discuss five generalizations below
  1. Generalized Nash bargaining
  2. Restrictions on ex-ante transfers (financial constraints?)
  3. Partial contractibility ▸ Jump to Partial Contractibility
  4. Partial relationship-specificity
  5. Multiple-supplier environments

Generalized Nash Bargaining

- We have assumed that F and M share the ex-post gains from trade equally
- In some circumstances it may make sense to assume that the primitive bargaining power of F might be higher or lower than $1/2$
- Later we will develop models in which the effective ex-post bargaining power of F will be endogenous and shaped by competition across suppliers
- For now just assume that F gets a share β of the ex-post gains from trade

Generalized Nash Bargaining

- This amounts to replacing $\frac{1}{2}$ with β in (3) and with $1-\beta$ in (4), and equilibrium profits obtained by F can be written as:

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

where

$$\Gamma = (\sigma - (\sigma-1)(\beta\eta + (1-\beta)(1-\eta))) \left(\beta^{\eta} (1-\beta)^{1-\eta} \right)^{\sigma-1} < 1$$

- Hence, regardless of the primitive bargaining power β, incomplete contracting continues to reduce the profitability of offshoring
- The main comparative statics derived above continue to hold, except for some qualifications in the negative effect of η on offshoring (see Antràs, 2005)
- The effect of β on the profitability of offshoring will be studied in detail in Lecture 3

Financial Constraints

- So far, the choice of location has been assumed to be ex-ante efficient, in the sense that it maximizes joint profits of F and M
- For this it is important that F and M can freely exchange lump-sum transfers when signing the initial contract at t_0
- In practice, it is not clear that firms can easily resort to nondistortionary transfers in their initial negotiations
  - some firms might be financially constrained and might have difficulties raising the amount of cash needed for that efficient location to be individually rational for both agents
- What happens when constraints are set on ex-ante transfers?
- Consider the case in which M can pledge to external financiers at most a share ϕ of the net income it receives from transacting with F, which is $\frac{1}{2}r(h,m) - \tau w_S m$

Financial Constraints

- In such a case, F obtains a payoff of

$$\pi_{O,Fin} = \left((w_N)^{\eta} (\tau w_S)^{1-\eta} \right)^{1-\sigma} B \Gamma_{Fin} \varphi^{\sigma-1} - w_N f_O \qquad (6)$$

where

$$\Gamma_{Fin} = (\sigma + \phi - (\sigma - 1)(1 - \phi)\eta) \left(\frac{1}{2}\right)^{\sigma} < \Gamma < 1$$

- It is clear that, holding B constant, these profits are lower than in the case with ex-ante transfers provided that $\phi < 1$
- Intuitively, offshoring now not only entails distorted investments, but it is also associated with a loss of rents on the part of F
- But same comparative statics apply since Γ_{Fin} decreases in η
- **New prediction:** the higher is ϕ (the better financial contracting), the more appealing is offshoring, other things equal
  - note: positive effect of ϕ is increasing in headquarter intensity η

Partial Contractibility

- It is unrealistic to assume that contracts in international transactions are 'totally incomplete'
  - surely some aspects of production are contractible and enforceable
- It is also unrealistic to assume that contracts in domestic transactions are complete
  - surely some aspects of production are nonverifiable to (domestic) outsiders
- I next incorporate partial contractibility into the model following the approach in Antràs and Helpman (2008)

Modelling Partial Contractibility

- The main idea is that the production processes h and m now entail a continuum of relationship-specific *activities* or parts
- A fraction of these activities is ex-ante contractible while the rest cannot be verified by a court of law and therefore are noncontractible
- This fraction is allowed to vary across production processes reflecting technological aspects that make some inputs more contractible than others
- But fraction is also allowed to vary across countries reflecting variation in contracting institutions
  - certain types of contracts are perceived to be enforceable in some environments but not in others

Partial Contractibility: Specific Assumptions

- Same assumptions as before, but now let

$$h = \exp\left[\int_0^1 \log x_h(i)\, di\right]$$

and

$$m = \exp\left[\int_0^1 \log x_m(i)\, di\right]$$

- Only activities related to input $k = h, m$ in the range $\left[0, \mu_{kj}\right]$ (with $0 \leq \mu_{kj} \leq 1$) are contractible in country $j = N, S$
  - in the sense that the characteristics of these activities can be fully specified in advance in an *enforceable* ex-ante contract
- Initial contracts now stipulates a lump-sum transfer between F and M and the level of contractible activities (which are still carried out at t_1)
- Still, parties will bargain at t_2 about the division of the surplus generated from incorporating the noncontractible into production

Partial Contractibility: Equilibrium

- Solving for the subgame perfect equilibrium of the game, we have that F's profits under offshoring are given by

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

where

$$\Gamma_{O,Partial} = \left(\frac{\sigma}{\sigma - (\sigma-1)\gamma_O} + 1 \right)^{\sigma-(\sigma-1)\gamma_O} \left(\frac{1}{2} \right)^{\sigma}$$

and

$$\gamma_O \equiv \eta (1 - \mu_{hS}) + (1-\eta)(1 - \mu_{mS})$$

- $\Gamma_{O,Partial}$ is increasing in μ_{hS} and μ_{mS} and thus in the quality of contracting in South (interacts with η)

Choice of Location

- The expression for domestic sourcing is analogous (with w_N and μ_{mN} replacing w_S and μ_{mS}, respectively) so we can write:

$$\pi_\ell(\varphi) = \psi_\ell B \varphi^{\sigma-1} - w_N f_\ell \quad \text{for } \ell = D, O$$

with

$$\frac{\psi_D}{\psi_O} = \frac{\Gamma_{D,Partial}}{\Gamma_{O,Partial}} \left(\frac{w_N}{\tau w_S} \right)^{-(1-\eta)(\sigma-1)}$$

- Note that contracting institutions only matter when they differ across location decisions
- Improvements in enforcement of contracts in Southern transactions will increase the prevalence of foreign sourcing

Partial Relationship Specificity

- Although relationship-specific investments are pervasive, the assumption of full relationship-specificity is extreme
- Even when particular transactions end up not occuring, suppliers can generally recoup part of the cost of their investment, perhaps by reselling their goods to alternative buyers
- Similarly, contractual breaches by suppliers may reduce the overall profitability of headquarter services, but will generally not render these useless
- Proper modeling of partial-relationship-specificity is tricky (secondary markets, multiple rounds of negotiation,...)
- But mechanics are similar to partial contractibility
  - parties feel 'secure' or do not anticipate hold up when undertaking certain investments
- We expect foreign sourcing in weak contracting environments to feature relatively low levels of specificity (related to Nunn, 2007)

Many Suppliers

- In modern manufacturing processes final-good producers combine intermediate inputs provided by various suppliers
- Furthermore inputs provided by different suppliers are generally partially substitutable
  - think of (quality-adjusted) services from those inputs rather than physical units
- Implications for the (ex-post) negotiations between F and its suppliers and for the overall efficiency of production
- I next briefly outline a multiple-supplier extension of the global sourcing model above, following the approach in Acemoglu, Antràs and Helpman (2007)
- Degree of complementarity between inputs in production plays a crucial role in determining the profitability of production

Modelling Multiple Suppliers

- Production now combine headquarter services h and a large number (formally, a continuum) of inputs, each provided by a different supplier
- Some of these characteristics or parts of these inputs are contractible, but others are not, so again some aspects of production will need to be (re-) negotiated
- Ex-post bargaining is now multilateral, rather than bilateral, so adopt the Shapley value as the solution concept for multilateral bargaining (as in Hart and Moore, 1990)
    - technically, one needs to consider the limit of a finite-player game to obtain a well-defined expression for the Shapley value

Multiple Suppliers: Specific Assumptions

- Production combines headquarter services and a measure 1 of intermediate inputs:

$$q = \varphi \left(\frac{h}{\eta} \right)^{\eta} \left(\frac{\left[\int_0^1 m(j)^{\rho} \, dj \right]^{1/\rho}}{1-\eta} \right)^{1-\eta}$$

  where $m(j)$ is an input of type j
  - $\rho \in [0,1]$ governs the degree of substitutability between inputs
- Each input is performed by a different supplier, with whom the firm needs to contract
- For simplicity, assume for now that contracting is 'totally incomplete' under offshoring and complete under domestic sourcing

Benchmark: Complete Contracts

- With complete contracts, the firm makes offer $\{x(i,j)\}_{i\in[0,1],j\in[0,1]}, \{s(j)\}_{j\in[0,1]}$ to suppliers
- This ends up delivering the exact same profit levels as in the bilateral case
  - given the unit measure of identical suppliers
- Degree of substitutability ρ is irrelevant for efficiency and profitability

Equilibrium with Incomplete Contracting

- With incomplete contracting and bargaining, F ends with share

$$\beta \equiv \frac{\rho\sigma}{\rho\sigma + (\sigma - 1)(1 - \eta)}$$

of revenue, while suppliers jointly capture a share $1 - \beta$

  - The larger is input substitutability (ρ), the more surplus the firm captures

- F profits under offshoring are given by

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

where

$$\Gamma_{O,Multi} = \left(\frac{(\sigma - 1)(1 - \eta) + \rho}{\rho} \right) \left(\frac{\rho\sigma}{\rho\sigma + (\sigma - 1)(1 - \eta)} \right)^{\sigma}$$

Equilibrium with Incomplete Contracting

- It can be shown that $\Gamma_{O,Multi}$ is increasing in ρ and thus the contractual frictions associated with offshoring are lower, the more substitutable the inputs
- As a consequence, the relative prevalence of offshoring is expected to increase in ρ

Intuition

- A higher ρ is associated with a lower remuneration to suppliers...
- ... but also with a higher sensitivity of their payoff to their own investments
- Also, a high ρ enhances investments in headquarter services by F
- Given functional forms, these last two effects dominate and underinvestment inefficiencies are lower in environments with higher substitutability

Reintroducing Partial Contractibility

- One can also incorporate partial contractibility in the same manner as above
- **New prediction:** the inefficiencies associated with operating in a weak contractual environment are more severe whenever inputs feature greater complementarities
- Comparative advantage result: other things equal, foreign sourcing to countries with worse contracting institutions should be more prevalent in sectors with higher substitutability between inputs (less hold-up)

Empirics of Contracts and Specialization

1. Brief Overview of Key Empirical Contributions
    1. Gravity-style empirical evidence using bilateral aggregate level data
    2. Comparative-advantage-style evidence using country and sectoral data
2. Interpretation of the Results
3. Evidence Based on Recent U.S. Import Data

Gravity-Style Empirical Evidence

- Anderson and Marcoullier (2002) show that, controlling for standard gravity determinants of trade flows, countries with weak contracting institutions tend to import less from their trading partners (relative to the United States)
  - effect identified in the cross-section of importing countries
- Berkowitz, Moenius and Pistor (2006)
  - emphasize and demonstrate the importance of the institutions of the exporting country (related to the New York Convention)
  - show that the effects are concentrated in 'complex' goods (in the Rauch sense) rather than in 'simple' or homogeneous goods
  - estimation includes country fixed effects, so identification uses time series variation in quality of institutions (also timing of signing of New York convention)

Gravity-Style Empirical Evidence

TABLE 2.—IMPORT REGRESSIONS POOLED FOR 1982–1992 OVERALL TRADE

Regression column	1	2	3	4[t]
GDP importer	0.81 (39.07)	0.81 (38.53)	−0.10 (−0.43)	−0.15 (−0.52)
GDP exporter	0.77 (39.78)	0.76 (39.13)	−0.13 (−0.60)	−0.19 (−0.65)
GDP per capita importer	0.72 (23.30)	0.53 (11.16)	1.00 (3.80)	1.18 (4.00)
GDP per capita exporter	1.04 (32.09)	0.74 (13.96)	1.20 (4.50)	1.39 (4.63)
Distance	−1.12 (−27.30)	−1.16 (−27.97)	−1.02 (−27.09)	−1.03 (−27.11)
Adjacent	0.31 (2.33)	0.35 (2.43)	0.40 (2.64)	0.40 (2.65)
Links	0.51 (4.91)	0.42 (4.07)	0.45 (4.42)	0.45 (4.40)
Language similarities	−0.09 (−0.54)	0.09 (0.51)	0.99 (5.72)	1.00 (5.74)
Remoteness	0.37 (3.79)	0.58 (6.04)	1.46 (2.21)	1.79 (2.31)
Quality of importer legal institutions		0.61 (5.41)	0.17 (0.18)	0.05 (0.51)
Quality of exporter legal institutions		0.91 (7.12)	0.32 (3.07)	0.36 (3.26)
Probability that the quality-of-legal-institution coefficients are the same		0.076	0.035	0.035
Country dummies			Yes	Yes
Time dummies				Yes
Constant	−20.04 (−12.13)	−21.45 (−13.16)		
Number of clusters (country pairs)	2792	2792	2792	2792
R^2	0.69	0.70	0.77	0.77
Observations	26,577	23,564	23,564	23,564

t-statistics reported in parentheses are computed from robust standard errors that allow for within-group correlation.

Gravity-Style Empirical Evidence

TABLE 3.—IMPORT REGRESSIONS POOLED FOR 1982–1992, COMPLEX VERSUS SIMPLE GOODS

Regression column	1	2	3	4
Goods	Complex	Simple	Complex	Simple
GDP importer	0.34	−1.50	0.08	−1.06
	(1.65)	(−4.59)	(0.27)	(−2.52)
GDP exporter	0.58	−1.81	0.32	−1.38
	(2.82)	(−5.55)	(1.08)	(−3.26)
GDP per capita importer	0.77	2.35	1.17	2.03
	(3.16)	(6.05)	(4.05)	(4.70)
GDP per capita exporter	0.71	2.27	1.10	1.95
	(2.92)	(5.77)	(3.86)	(4.48)
Distance	−0.98	−1.26	−0.98	−1.26
	(−24.90)	(−22.76)	(−24.98)	(−22.72)
Adjacent	0.44	0.27	0.44	0.27
	(2.62)	(1.55)	(2.62)	(1.54)
Links	0.54	0.18	0.54	0.18
	(5.11)	(1.21)	(5.09)	(1.22)
Language similarities	1.27	0.11	1.28	0.11
	(6.73)	(0.41)	(6.77)	(0.40)
Remoteness	−0.81	7.83	0.74	6.69
	(−1.30)	(7.91)	(0.96)	(5.50)
Quality of importer institutions	−0.51	0.66	−0.44	0.66
	(−5.18)	(4.54)	(−4.24)	(4.42)
Quality of exporter institutions	0.85	−0.53	0.93	−0.53
	(7.92)	(−3.66)	(8.41)	(−3.45)
Probability that the absolute value of the quality of institutions coefficients are the same	0.02	0.54	0.00	0.53
Country dummies	Yes	Yes	Yes	Yes
Time dummies			Yes	Yes
Number of clusters (country pairs)	2755	2550	2755	2550
R^2	0.79	0.50	0.79	0.38
Observations	22,669	18,948	22,669	18,948

t-statistics reported in parentheses are computed from robust standard errors that allow for within-group correlation.

Comparative-Advantage-Style Evidence

- Recently, several authors have pointed out that the effect of weak contracting institutions should affect different sectors differently
  - some sectors are more 'contract dependent' than others
- This builds on the Berkowitz et al.'s (2006) results but considers finer differences across goods (not just complex vs. simple)
- Specifications are reminiscent of the 'identification' strategy in Rajan and Zingales (1997) in a finance context and Romalis (2004) in a trade context
- Different papers offer alternative measures of contract dependence at the industry level
  - Costinot (2009): complexity measured as average number of months necessary to be fully trained and qualified in that industry from PSID
  - Levchenko (2007): complexity measured as Herfindahl index of input use from I-O tables
  - Nunn (2007): relationship-specificity (see next slide) ▸ Skip Nunn's details

Nunn (2007): Data

- Trade data for 146 countries and 222 industries classified according to the BEA's I-O industry classification system (roughly NAICS 6-digit) in 1997
- Contract enforcement across countries
  - 'Rule of Law' variable from the Governance Matters III Database.
  - Weighted average of 17 measures of "judicial quality and contract enforcement"
  - **Examples of these measures**:
    - "Enforceability of Private Contracts Index" from Global Insight Inc.
    - "Enforceability of Contracts Index" from Economist Intelligence Unit
    - "Strength and Impartiality of the Legal System Index" from Political Risk Services.

Nunn (2007): Contract Intensity

- Nunn's measure of contract intensity is the proportion of an industry's intermediate inputs that are relationship-specific
- What does this mean? An investment is relationship-specific if its value inside the buyer-seller relationship is significantly higher than outside the relationship
- How is it constructed?
  1. Use the United States' Input-Output Accounts to identify the intermediate inputs used to produce each good and in what proportions
  2. Identify which inputs are relationship-specific (or rather, which are not)
     1. Sold on an organized exchange
     2. Reference priced in trade publications (ambiguous – constructs 2 measures)
     3. Neither
  3. Construct share of "non-standardized" inputs
- Data are from Rauch (1999)

Nunn (2007): Contract Intensity

Table 1: The least and most contract intense industries.

20 Least Contract Intense: lowest z_i^{rs1}		20 Most Contract Intense: highest z_i^{rs1}	
z_i^{rs1}	Industry Description	z_i^{rs1}	Industry Description
.024	Poultry processing	.810	Photographic & photocopying equip. manuf.
.024	Flour milling	.819	Air & gas compressor manuf.
.036	Petroleum refineries	.822	Analytical laboratory instr. manuf.
.036	Wet corn milling	.824	Other engine equipment manuf.
.053	Aluminum sheet, plate & foil manuf.	.826	Other electronic component manuf.
.058	Primary aluminum production	.831	Packaging machinery manuf.
.087	Nitrogenous fertilizer manufacturing	.840	Book publishers
.099	Rice milling	.851	Breweries
.111	Prim. nonferrous metal, ex. copper & alum.	.854	Musical instrument manufacturing
.132	Tobacco stemming & redrying	.872	Aircraft engine & engine parts manuf.
.144	Other oilseed processing	.873	Electricity & signal testing instr. manuf.
.171	Oil gas extraction	.880	Telephone apparatus manufacturing
.173	Coffee & tea manufacturing	.888	Search, detection, & navig. instr. manuf.
.180	Fiber, yarn, & thread mills	.891	Broadcast & wireless comm. equip. manuf.
.184	Synthetic dye & pigment manufacturing	.893	Aircraft manufacturing
.190	Synthetic rubber manufacturing	.901	Other computer peripheral equip. manuf.
.195	Plastics material & resin manuf.	.904	Audio & video equipment manuf.
.196	Phosphatic fertilizer manufacturing	.956	Electronic computer manufacturing
.200	Ferroalloy & related products manuf.	.977	Heavy duty truck manufacturing
.200	Frozen food manufacturing	.980	Automobile & light truck manuf.

Notes: The measures have been rounded from seven digits to three digits.

Nunn (2007): Examining the Raw Data

- Do countries with better contracting environments produce and export more contract intensive goods, on average?
- Compute average contract intensity of a country's exports or production
- In the case of production, this is constructed using data from UNIDO's Industrial Statistics Database
- The answer appears to be "yes"

Nunn (2007): Examining the Raw Data

TABLE III

JUDICIAL QUALITY AND THE AVERAGE CONTRACT INTENSITY OF PRODUCTION AND OF EXPORTS

	Output regressions		Export regressions	
	$\bar{Z}_c^{rs1}$	$\bar{Z}_c^{rs2}$	$\bar{Z}_c^{rs1}$	$\bar{Z}_c^{rs2}$
Judicial quality: Q_c	.392**	.465**	.290**	.291**
	(.109)	(.109)	(.081)	(.065)
Number of obs.	78	78	146	146
R^2	.15	.22	.08	.08

The dependent variables are the average contract intensity of production or exports. Standardized beta coefficients are reported, with robust standard errors in brackets. ** indicates significance at the 1 percent level.

Nunn (2007): Econometric Evidence

- Nunn runs

$$\ln(x_{ic}) = \alpha_i + \alpha_c + \beta_1 z_i Q_c + \beta_2 h_i H_c + \beta_3 k_i K_c + \varepsilon_{ic},$$

where

- x_{ic} denotes total exports in industry i from country c to all other countries in the world
- z_i is a measure of the importance of relationship-specific investments (i.e., contract intensity) in industry i
- Q_c is a measure of the quality of contract enforcement in country c
- H_c and K_c denote country c's endowments of skilled labor and capital, and h_i and k_i are the skill and capital intensities of production in industry i
- α_i and α_c denote industry fixed effects and country fixed effects
- Later in paper, robustness tests and endogeneity corrections

Nunn (2007): Econometric Evidence

TABLE IV
THE DETERMINANTS OF COMPARATIVE ADVANTAGE

	(1)	(2)	(3)	(4)	(5)
Judicial quality interaction: $z_i Q_c$	.289**	.318**	.326**	.235**	.296**
	(.013)	(.020)	(.023)	(.017)	(.024)
Skill interaction: $h_i H_c$			.085**		.063**
			(.017)		(.017)
Capital interaction: $k_i K_c$			.105**		.074
			(.031)		(.041)
Log income × value added: $va_i \ln y_c$				−.117*	−.137*
				(.047)	(.067)
Log income × intra-industry trade: $iit_i \ln y_c$				.576**	.546**
				(.041)	(.056)
Log income × TFP growth: $\Delta tfp_i \ln y_c$				.024	−.010
				(.033)	(.049)
Log credit/GDP × capital: $k_i CR_c$				.020	.021
				(.012)	(.018)
Log income × input variety: $(1 - hi_i) \ln y_c$				.446**	.522**
				(.075)	(.103)
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
R^2	.72	.76	.76	.77	.76
Number of observations	22,598	10,976	10,976	15,737	10,816

Dependent variable is $\ln x_{ic}$. The regressions are estimates of (1). The dependent variable is the natural log of exports in industry i by country c to all other countries. In all regressions the measure of contract intensity used is z_i^{rs1}. Standardized beta coefficients are reported, with robust standard errors in brackets. * and ** indicate significance at the 5 and 1 percent levels.

Interpretation of the Results

- Recent studies show that the quality of contract enforcement is important for the types of goods countries export
  - driven by variation in **within-country** contracting across producers
- The interpretation of the importance of the institutions of exporting countries is very different in Berkowitz et al. (2006)
  - they emphasize security of contracting **across countries** (effect of New York convention)
- When considering offshoring by US-based companies, again variation in the quality of the institutions of the countries from which they buy parts or contract manufacturing is likely to be important
- **Next:** simple adaptation of Nunn's approach to data on U.S. imports
  - I will replicate some of his results and test other predictions that emerged from the offshoring models earlier in this Lecture

Evidence Based on U.S. Imports: Basic NAICS Regressions

- Basic results illustrate role of contracting interactions

	Dependent Variable: Log U.S. imports (Average 2000-11)				
	I	II	III	IV	V
Capital Intensity x Capital Abundance	0.031	0.240***	-0.043	0.02	0.087*
	[0.047]	[0.048]	[0.047]	[0.048]	[0.049]
Skill Intensity x Years of Schooling	0.194***	0.136***	0.154***	0.196***	0.125***
	[0.020]	[0.020]	[0.020]	[0.020]	[0.020]
R&D Intensity x Years of Schooling	0.131***	0.105***	0.070***	0.132***	0.064***
	[0.016]	[0.017]	[0.016]	[0.016]	[0.016]
Nunn specificity x Rule of Law		0.150***			0.092***
		[0.012]			[0.013]
Intermediation x Rule of Law			-0.161***		-0.139***
			[0.008]		[0.009]
Broda-Weinstein Elasticity x Rule of Law				0.013**	0.008
				[0.006]	[0.006]
Observations	25716	25716	25693	25254	25254
R-squared	0.68	0.68	0.68	0.68	0.68

Robust standard errors in brackets (* significant at 10%; ** at 5%; *** at 1%)
Regressions include industry and country fixed effects

Evidence Based on U.S. Imports: Robustness

- Robust to other interactions (signs mostly consistent with theory)

	Dependent Variable: Log U.S. imports (Average 2000-11 or pooled)				
	I	II	III	IV	V
Capital Intensity x Capital Abundance	0.087*	0.027	-0.111**	-0.096*	-0.217***
	[0.049]	[0.052]	[0.054]	[0.054]	[0.069]
Skill Intensity x Years of Schooling	0.125***	0.095***	0.090***	0.075***	0.117***
	[0.020]	[0.022]	[0.023]	[0.023]	[0.027]
R&D Intensity x Years of Schooling	0.064***	0.023	0.006	0.012	0.045*
	[0.016]	[0.019]	[0.020]	[0.020]	[0.024]
Nunn specificity x Rule of Law	0.092***	0.084***	0.167***	0.160***	0.177***
	[0.013]	[0.013]	[0.022]	[0.022]	[0.025]
Intermediation x Rule of Law	-0.139***	-0.131***	-0.054***	-0.049***	-0.048**
	[0.009]	[0.009]	[0.016]	[0.016]	[0.019]
Broda-Weinstein Elasticity x Rule of Law	0.008	0.007	0.003	0	0.002
	[0.006]	[0.006]	[0.010]	[0.010]	[0.011]
Headquarter Intensity x Rule of Law		0.019***	0.022***	0.021***	0.039***
		[0.007]	[0.008]	[0.008]	[0.010]
Heaquarter Intensity x Private Credit/GDP		0.017**	0.017**	0.016**	0.023***
		[0.007]	[0.007]	[0.007]	[0.008]
Interactions with log GDP per capita	No	No	Yes	Yes	Yes
Dropping final goods (as in Wright, 2012)	No	No	No	Yes	Yes
Country-Year fixed effects	No	No	No	No	Yes
Observations	25254	24851	24851	23588	194151
R-squared	0.68	0.68	0.68	0.7	0.6

Standard errors (clustered at country/industry level) in brackets (* significant at 10%; ** at 5%; *** at 1%)
Regressions include industry and country (or country-year) fixed effects

Evidence Based on U.S. Imports: IO-2002 Regressions

- "Buyer" headquarter intensity (effect of ρ now consistent with theory)

	Dependent Variable: Log U.S. imports (pooled 2000-11)				
	I	II	III	IV	V
Capital Intensity x Capital Abundance	-0.077	-0.149**	-0.364***	-0.358***	-0.241***
	[0.065]	[0.068]	[0.074]	[0.073]	[0.073]
Skill Intensity x Years of Schooling	0.165***	0.112***	0.101***	0.106***	-0.011
	[0.024]	[0.026]	[0.027]	[0.027]	[0.031]
R&D Intensity x Years of Schooling	0.100***	0.042	0.013	0.005	0.107***
	[0.023]	[0.026]	[0.027]	[0.027]	[0.032]
Nunn specificity x Rule of Law	0.124***	0.110***	0.202***	0.196***	0.192***
	[0.014]	[0.015]	[0.024]	[0.024]	[0.024]
Intermediation x Rule of Law	-0.229***	-0.190***	-0.167***	-0.148***	-0.142***
	[0.016]	[0.017]	[0.030]	[0.030]	[0.030]
Broda-Weinstein Elasticity x Rule of Law	-0.005	-0.002	-0.024**	-0.025**	-0.021*
	[0.007]	[0.007]	[0.012]	[0.012]	[0.012]
Headquarter Intensity x Rule of Law		0.034***	0.023**	0.025**	0.032***
		[0.008]	[0.010]	[0.010]	[0.010]
Heaquarter Intensity x Private Credit/GDP		0.016*	0.017**	0.017**	0.011
		[0.008]	[0.008]	[0.008]	[0.008]
Interactions with log GDP per capita	No	No	Yes	Yes	Yes
Dropping final goods (as in Wright, 2012)	No	No	No	Yes	Yes
Headquarter Intensity of	Seller	Seller	Seller	Seller	Buyer
Observations	195964	192687	192687	188655	188655
R-squared	0.6	0.6	0.6	0.61	0.61

Standard errors (clustered at country/industry level) in brackets (* significant at 10%; ** at 5%; *** at 1%)
Regressions include industry and country-year fixed effects

Preview of Next Time

- Study of the control or internalization decision
- Brief overview of main theories of the firm
- Exposition of transaction-cost and property-rights theories and their application to the study of offshoring
- Overview of empirical work in the area