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ABSTRACT

We study the determinants of the extent of outsourcing and of direct foreign investment in an industry in which producers need specialized components. Potential suppliers must make a relationship-specific investment in order to serve each prospective customer. Such investments are governed by imperfect contracts. A final-good producer can manufacture components for itself, but the per-unit cost is higher than for specialized suppliers. We consider how the size of the cost differential, the extent of contractual incompleteness, the size of the industry, and the relative wage rate affect the organization of industry production.

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1 Introduction

International outsourcing and foreign direct investment (FDI) have been growing in leaps and bounds. As Audet (1996), Campa and Goldberg (1997), Feenstra (1998), Hummels et al. (2001) and Yeats (2001) have documented, firms in many countries are sub-contracting abroad an expanding range of activities, from product design and the production of intermediate inputs to assembly, marketing, and after-sales service. Meanwhile, the same and other firms have been engaging in ever more foreign investment. Although a debate continues about whether the preponderance of FDI is horizontal or vertical in nature, there can be no doubt that the production of intermediate inputs is an important activity in foreign subsidiaries, and increasingly so. Hanson et al. (2001) provide evidence on the global expansion of U.S.-based firms.

A burgeoning literature is seeking to identify the sources of these trends. For example, Jones (2000) has modified the traditional models of international trade to deal more fully with trade in intermediate inputs, while Grossman and Helpman (2002a) have developed a model of monopolistic competition in which global outsourcing of components competes with domestic outsourcing. More generally, researchers have been trying to understand better how production is organized; see Aghion and Tirole (1995), Marin and Verdier (2001), Grossman and Helpman (2002b), and Puga and Trefler (2002) for just a few of the many recent examples.

In this paper, we combine elements from Grossman and Helpman (2002a) and (2002b) in order to shed light on the trade-off between FDI and international outsourcing. We develop a model of an industry that produces differentiated consumer goods. Each producer needs a specialized component to serve as an input into the production of its final goods. We assume that it is cheapest to produce these components in the South, where wages are low.[1] Specialized suppliers are more efficient

[1] Thus, to keep things simple, we limit the choice of organizational mode to two alternatives. Similarly, in Grossman and Helpman (2002a) we studied the determinants of the location of outsourcing in a setting where outsourcing was assumed superior to integrated production, while in Grossman and Helpman (2002b) we examined the relative advantages of integrated production and

producers of the inputs, but the bilateral relationships between suppliers and final producers are plagued by contractual incompleteness. Final producers are distinguished by the characteristics of the components they need, while suppliers differ in their expertise. In equilibrium, some producers choose to negotiate subcontracting arrangements while others opt to serve as their own suppliers. Our analysis focuses on the relative prevalence of these alternative modes of organization.

After developing the model in the next section, we characterize an industry equilibrium in section 3. The industry equilibrium takes account of the effects of the numbers of final and intermediate good producers on the profitability of entry and exit. But we assume that the industry faces an infinitely elastic supply of labor, thereby abstracting from the general-equilibrium feedbacks to relative wages. In section 4, we use the model to examine the prevalence of each mode of organization. In particular, we investigate the effects of: (a) productivity differences between specialized and integrated producers of inputs; (b) industry size; (c) the degree of contractual incompleteness; and (d) relative wages in the two regions, on market share of firms that outsource the production of components relative to those that produce their own components in foreign subsidiaries.

2 The Model

We consider the organization of firms in industry equilibrium. The industry that we study produces an endogenous number of differentiated consumer goods. These goods are designed in the North at a cost of wf_n per variety, where w is the wage rate in the North and f_n is the amount of Northern labor needed to design a product. We assume that the industry is small in relation to the size of the Northern labor market, so that it can hire as much labor as it wishes at the fixed wage w.

The production of a unit of any variety requires one unit of a specialized component. In the analysis here, we assume that it is cost-effective to produce these components in the South, where the wage is substantially lower than in the North.

outsourcing in a closed economy.

We thus neglect the determination of the location of component production (which was the subject of Grossman and Helpman, 2002) in order to focus on the relative prevalence of outsourcing versus direct foreign investment. We normalize the Southern wage to equal one, and assume that it too is not affected by demand from the industry under consideration.

Consumers spend a constant fraction β of their income on output from the industry.[2] They view the varieties produced by the industry as symmetrically differentiated and perceive a constant elasticity of substitution between every pair of goods. World income is $I = wL_N + L_S$, where L_i is the fixed labor supply in country i. Thus, the demand for any differentiated product is given by

$$y = Ap^{-\varepsilon}, \tag{1}$$

where

$$A = \frac{\beta I}{\int p(j)^{1-\varepsilon} dj} \tag{2}$$

is a measure of industry demand, $p(j)$ is the price of variety j, and $\varepsilon > 1$ is the elasticity of demand. The integral in the denominator of (2) is taken over all available brands. As is well known, with CES preferences, the elasticity of demand is equal to the elasticity of substitution between varieties.

On the supply side, a consumer good is distinguished by the characteristics of the component that is used in its production. We represent the characteristics of the component needed to produce a good by a point on the circumference of the unit circle. Final producers do not choose their locations on the circle; rather, this is a matter of technology. When a firm designs a consumer good, it receives a draw from a uniform distribution of locations. Thus, with a continuum of entrants, the final producers are spread evenly around the circle. We take n to be the measure of entrants, which represents as well the density of final goods at each location on the circle.

An integrated producer can manufacture the component it needs with $\lambda > 1$ units of labor per unit of output. An integrated producer need not pay any fixed cost to

[2] It would be straightforward to extend the model to allow for a constant elasticity of demand for industry output different from one.

design or manufacture its own components beyond what it has already incurred to enter the industry.[3] Inasmuch as $w > 1$, an integrated producer will always choose to manufacture components in a subsidiary located in the low-wage South. Thus, the marginal cost of production for an integrated producer is λ.

A producer might alternatively purchase its components from a specialized supplier. The number of suppliers m is finite and endogenous. Each supplier chooses its expertise, which we also represent by a point on the circumference of the unit circle. To develop such expertise, a potential supplier must deploy f_m units of labor. Since we shall focus on an equilibrium in which all outsourcing takes place in the South, the cost of entry for suppliers is f_m, the product of the input requirement for entry and the Southern wage rate. A supplier must also incur an additional fixed cost in order to develop a prototype for a particular end user. The size of the requisite investment is proportional to the distance along the circumference of the circle between the location of the final-good producer and the expertise of the supplier. If a supplier has an expertise in producing components that are very close (in characteristics space) to what the producer needs, then the cost of customization will be modest. If, however, the supplier has expertise in components that are quite different from what the producer needs, then the required investment will be larger. We assume that customization requires μx units of labor when the supplier and final producer are separated by a distance x. In the equilibria that we study, this investment is undertaken in the South, so μx is also the cost of customization. If a supplier invests in the prototype for a particular final producer, it can thereafter manufacture such components with one unit of (Southern) labor per unit of output.

A final producer can approach any supplier in an attempt to arrange for the outsourcing of components.[4] However, the producer only has enough time to negotiate

[3] We could introduce an extra fixed cost for firms that produce their own components in foreign subsidiaries without any qualitative effect on our conclusions.

[4] In Grossman and Helpman (2002), we modelled a process of costly search by final producers for suitable outsourcing partners. Final producers were assumed not to know the exact locations of the m suppliers along the circle, although they were assumed to know the number of such suppliers (the "thickness" of the market) and that such suppliers are equally spaced in equilibrium. We assumed

with a single potential supplier. Moreover, should the negotiation between a final producer and a potential supplier fail, the producer no longer will have sufficient time to prepare for self supply. Thus, each firm makes an initial decision whether to conduct negotiations or to open a subsidiary. Should it decide to seek outside supply, it chooses a potential supplier. If the negotiations with that supplier ultimately fail, the final producer has no choice but to exit the market.

The outsourcing relationships that are formed are governed by incomplete contracts. That is, we assume that a third party cannot verify all of the tasks required to customize a component. The final producer and supplier can write a contract that covers the performance of at most a fraction $\gamma < 1/2$ of the requisite investment in the prototype. We take γ to a a parameter reflecting the state of the legal system in the host country, as well as the technological characteristics of the customization technology.

We assume that negotiations between a producer of consumer goods and a potential supplier take place in two stages. First, the parties negotiate an *investment contract* that governs the investment in a prototype. Such a contract stipulates the tasks that the supplier must successfully complete in order to qualify for a first-stage payment, and the size of the payment P that must be made by the producer in the event that the supplier fulfills its end of the deal. Of course, the contractible tasks can include only those that can be verified by an outside party; i.e., at most a fraction γ of the total requisite investment cost. In the event that the supplier develops a workable prototype (i.e., makes the full investment necessary to render its expertise useful in producing the necessary components), the two parties meet again to negotiate an *order contract.* The order contract governs the production and exchange of components. It stipulates a volume of output and a price.[5] At each stage, the par-

that by conducting a search of intensity x, requiring ηx^2 units of labor, a producer could identify all suppliers within an arc length of $2x$ along the circle. The simplier model described here can be seen as the limiting case of a model with costly search, as the cost parameter η goes to zero.

[5] The parties do not negotiate the quantity and price at the outset, because the supplier might then produce a volume of components to deliver without making the necessary investment in customization. In other words, we assume that third parties can verify the quantity of components but

ties share equally in any surplus they would derive from continuing their relationship relative to their outside options.

3 The Equilibrium

In this section, we characterize an equilibrium in which some final producers outsource the production of components and others manufacture their own components in foreign subsidiaries. We begin by discussing the outsourcing relationships that are formed. We then describe the behavior of integrated firms. Next, we discuss the entry of suppliers and final producers. Finally, we develop a diagram that we use to solve for equilibrium values of the endogenous variables.

3.1 Outsourcing Partnerships

Consider a final producer that chooses to seek an outsourcing partner. In equilibrium, we will find that such a producer either is indifferent between alternative suppliers, or it prefers to negotiate with the one whose expertise is in producing components that are closer to its own input requirements. We thus assume provisionally that each producer desiring an outsourcing partner negotiates with the input supplier whose expertise is closest in input characteristics space to the location of its own component needs.

Let the supplier that is closest to a particular final producer be at a distance x. Once a prototype exists (if ever it does exist), this supplier will be able to produce components at a marginal cost of one. Since this cost is independent of the distance x, so too will be the maximal profits that the two parties can share by subsequently agreeing to an order contract. Denote these joint profits by S^o. The final producer and potential supplier anticipate that they will share equally in any surplus that derives from an order contract between them, in the event that a workable prototype exists. Moreover, the input supplier will have no alternative use for the prototype should the talks break down at the time that the order contract is being discussed,

not whether the characteristics of the components match producer's needs.

nor will the final producer have any alternative source of supply for its inputs. Accordingly, both firms will face outside options of zero in the second stage. It follows that each side expects to earn $S^o/2$ in the event that an investment contract is signed and if the supplier subsequently opts to make the full investment μx necessary for the development of a workable prototype.

The supplier will make the full investment in customization if and only if what it stands to earn from an order contract matches or exceeds the cost of the discretionary (non-contracted) investment tasks. Thus, the two sides can expect the development of a workable prototype if and only if $\mu x(1-\gamma) \leq S^o/2$ or $x \leq S^o/2\mu(1-\gamma)$. In other words, if the expertise of the supplier is close enough to the needs of the producer, then there is the possibility of a gainful outsourcing relationship; otherwise, not.

What about the up-front payment that would be agreed in an investment contract? In Grossman and Helpman (2002) we show that this payment as a function of the distance x is given by

$$P(x) = \begin{cases} \frac{1}{2}\mu x & \text{for} \quad \frac{S^o}{2\mu} < x \leq \frac{S^o}{2\mu(1-\gamma)} \\ 0 & \text{otherwise} \end{cases} ; \tag{3}$$

that is, no payment is made when the expertise of the supplier is very close to the needs of the producer, whereas the two sides share the total investment cost equally when the the distant between the two is in an intermediate range. This outcome reflects the fact that the supplier stands ready to make the full investment in customization even without any formal investment contract payment when $\mu x \leq S^o/2$.

Should the input supplier make the full investment in customization, the parties will meet again to discuss an order contract. At that stage, their interests will coincide regarding the production and marketing of the final good. Therefore, they will write an efficient (joint profit maximizing) contract to govern the manufacture of components. The profit maximizing price of consumer good with a marginal cost of one is $p_o = 1/\alpha$, where $\alpha = 1 - 1/\varepsilon$. The maximal joint profits are given by

$$S^o = (1-\alpha)A\left(\frac{1}{\alpha}\right)^{1-\varepsilon} . \tag{4}$$

3.2 FDI and the Choice of Organizational Form

If a final producer chooses to manufacture its own components in a foreign subsidiary, the marginal cost of those components will be $\lambda > 1$. Such a vertically integrated firm sets a profit maximizing price of $p_v = \lambda/\alpha$, and achieves an operating profit of

$$S^v = \lambda^{1-\varepsilon} S^o. \tag{5}$$

Each final producer faces a choice between manufacturing its own components and approaching an external supplier. Firms that are located at a distance $x > S^o/2\mu(1-\gamma)$ from the nearest supplier certainly will choose to produce their own components, because no existing suppliers would be willing to make the relationship-specific investment necessary to serve their needs. As for the firms that have a potential supplier with expertise closer to what they need, they face a choice between the profits S^v that they can reap by manufacturing their own components and the profits $S^o/2 - P(x)$ that they can expect in a negotiated agreement with a supplier. Here, we assume that

$$\lambda^{1-\varepsilon} < \frac{1}{2}\left[1 - \frac{1}{2(1-\gamma)}\right],$$

which means that every final-good producer that has a potential supplier willing to invest in customization prefers outsourcing to integrated production.[6] Then all firms that are located within a distance x^o from their nearest supplier engage in outsourcing, where

$$x^o = \frac{S^o}{2\mu(1-\gamma)} . \tag{6}$$

Notice that the cut-off point depends on the industry equilibrium, because S^o does.

[6] The assumption ensures that $S^v < S^o/2 - P(x)$ for $x \leq S^o/2\mu(1-\gamma)$. If, in contrast to our assumption, $\lambda^{1-\varepsilon} > 1/2$, then all final producers prefer direct foreign investment to outsourcing. Alternatively, if $[1 - \frac{1}{2(1-\gamma)}]/2 < \lambda^{1-\varepsilon} < 1/2$, then some firms that could find outsourcing partners willing to undertake the necessary investment will opt nonetheless to produce their own components. We leave the analysis of this intermediate case to the interested reader.

3.3 Entry by Suppliers and Final Producers

Suppliers enter until profit opportunities vanish. Each entrant maximizes its sales and profits, in view of the uniform distribution of final producers along the unit circle, by locating halfway between the two most distant competing suppliers. This means that, in equilibrium, the suppliers locate symmetrically at a distance $1/m$ from one another, where m is the number of such suppliers.[7] Each supplier serves all final producers located within a distance x^o from itself, which constitutes a measure $2nx^o$ of customers. Its marginal profits from a customer at distance x is $P(x) + S^o/2 - \mu x$, the sum of the payment from the investment contract and the supplier's share of profits from the order contract net of its investment cost. Total operating profits for the typical component producer are[8]

$$\begin{aligned}\pi_m &= 2n \int_0^{x^o} \left[P(x) + \frac{1}{2} S^o - \mu x \right] dx \\ &= \mu (x^o)^2 n \left(1 - \gamma - \frac{1}{2}\gamma^2 \right) ,\end{aligned} \tag{7}$$

which, in equilibrium, are equal to the fixed cost of developing the expertise, f_m.

A final producer that pays wf_n to design a product receives a random draw of location in the component characteristics space. If its distance from the nearest supplier in the market happens to be less than x^o — which happens with probability $2mx^o$ — then the firm will engage in outsourcing and realize profits of $S^o/2 - P(x)$, where x is the distance to the nearest supplier. Otherwise, it will produce its own components in a foreign subsidiary and realize profits of S^v. The expected operating profits of a potential entrant are

$$\pi_n = (1 - 2mx_o) S^v + 2mx_o \int_0^{x_o} \frac{1}{x_o} \left[\frac{S^o}{2} - P(x) \right] dx \ .$$

Equating these profits to the fixed cost of product design, and using (3), (5), and (6), we can write

$$x_o = \left(\frac{wf_n}{2\mu} \right) \frac{1}{(1-\rho)\, \lambda^{1-\varepsilon} \, (1-\gamma) + \rho \left(\frac{1}{2} - \frac{3}{4}\gamma + \frac{1}{8}\gamma^2 \right)}, \tag{8}$$

[7] For simplicity, we neglect the integer constraint on the (finite) number of suppliers, and treat m as if it were a continuous variable.

[8] The second line of the equation is derived using (3) and (6).

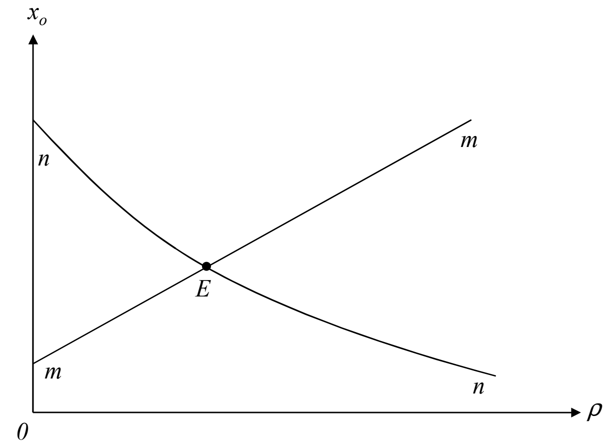

Figure 1: Equilibrium values

where $\rho = 2mx_o$ is the fraction of final producers that engage in outsourcing.

3.4 Solving for the Equilibrium

We can now illustrate the equilibrium in a simple diagram. In Figure 1, the nn curve depicts equation (8), showing the combinations of x_o and ρ for which final producers earn zero expected profits. A second relationship between these variables is derived as follows. From (2) and the expressions for the prices p_o and p_v, we find an expression for A in terms of the endogenous variables n and ρ. We substitute this expression into (4), and use (6) and $\pi_m = f_m$ to derive

$$x_o = \frac{2f_m (1-\gamma)}{(1-\alpha)\beta (wL_N + L_S)\left(1-\gamma-\frac{1}{2}\gamma^2\right)}\left[(1-\rho)\lambda^{1-\varepsilon}+\rho\right] . \tag{9}$$

We depict this relationship, which is essentially a zero-profit condition for component suppliers, by the line mm in the figure. The equilibrium values of x_o and ρ can be found at point E. Since the mm line slopes upward and the nn curve slopes downward, the intersection (if it exists) is unique. We can find the equilibrium number of suppliers using $m = \rho/2x_o$. Other variables of interest are readily computed.

4 Determinants of Organizational Form

We are now ready to examine the determinants of organizational form. We could measure the prevalence of outsourcing either as the fraction of final producers that choose to outsource their components ρ or as the market share of final producers that engage in outsourcing. To calculate market shares, we weight the revenues of firms that select a given organizational firm by the fraction of firms in each category. Using the equilibrium prices and the demand function in (1), we find that the market share of firms that outsource their components is

$$\sigma^o = \frac{\rho}{\rho + (1-\rho)\lambda^{1-\varepsilon}} \ . \tag{10}$$

Consider first a rather obvious determinant of the extent of outsourcing, which is the productivity advantage of firms that specialize in producing components. This advantage is reflected in the size of the parameter λ. An increase in λ causes the mm line to shift down and the nn curve to shift up. The result is an increase in ρ, the fraction of firms that engage in outsourcing and an increase in σ^o, the market share of such firms.

Next consider the effect of industry size, which we measure by the fraction β of aggregate spending that is devoted to the industry. An increase in β shifts the mm line down. At the new equilibrium, the fraction ρ of firms that outsource is higher, as is the market share of these firms. An increase in industry size favors outsourcing, because it increases the spending on final products relative to prices and costs. One effect of this is to increase the number of final producers and thus the derived demand for the services of any specialized producer of components. With greater demand and given costs, there is entry by outsourcing firms. This creates a "thicker" market, and allows more final producers to find suppliers with expertise relatively close to their needs.

The contracting environment is another determinant of the equilibrium prevalence of outsourcing. Recall that γ denotes the fraction of investment tasks that can be verified by third parties. The greater is γ, the more complete are the contracts that can be written to govern the relationship-specific investments. As γ increases, both the the mm line and the nn curve shift upward, but the latter shifts by proportionately more.[9] As a result, the fraction of firms that engage in outsourcing increases. So does the market share of such firms. When the contracting environment improves, there are fewer investment tasks that are left to the discretion of a potential supplier. Thus, it is more likely to be the case that the supplier's share of the prospective surplus will cover the cost of these non-contractible tasks. Given the number of suppliers in the market, a final producer is more likely to be able to find one that is willing to undertake the investment in customization. Thus, a greater fraction of such producers are able to turn to such suppliers to fill their demand for components.

Finally, consider the relative wage in the country that exports components. An increase in the relative wage of the South is captured by a fall in w. This shifts the nn curve downward and the mm curve upward, causing a decline in ρ and a decline in σ^o. A fall in w spells a decline in world income relative to the cost of entry by intermediate producers. It also spells an increase in the cost of product design, which tends to reduce the measure of final producers. Both of these effects exert downward pressure on the profitability of component produces, causing the number of such producers to fall. Finally, with a smaller number of suppliers, there are greater gaps between the expertise of neighboring firms, and a smaller fraction of final producers are able to find suppliers that will invest in a bilateral relationship.

[9] This can be seen by noting that *both* $\left(1-\gamma-\frac{1}{2}\gamma^2\right)/\left(1-\gamma\right)^2$ and $\left(1-\gamma-\frac{1}{2}\gamma^2\right)/\left(1-\gamma\right)\left(1/2-3\gamma/4+\gamma^2/8\right)$ are increasing functions of γ for $0<\gamma<1/2$.

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