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GLOBAL SOURCING

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ABSTRACT

We present a North—South model of international trade in which differentiated products are developed in the North. Sectors are populated by final-good producers who differ in productivity levels. Based on productivity and sectoral characteristics, firms decide whether to integrate into the production of intermediate inputs or outsource them. In either case they have to decide from which country to source the inputs. Final-good producers and their suppliers must make relationship-specific investments, both in an integrated firm and in an arm's-length relationship. We describe an equilibrium in which firms with different productivity levels choose different ownership structures and supplier locations, i.e., they choose different organizational forms. We then study the effects of within-sectoral heterogeneity and variations in industry characteristics on the relative prevalence of these organizational forms. The analysis sheds light on the structure of foreign trade within and across industries.

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1 Introduction

A firm that chooses to keep the production of an intermediate input within its boundaries can produce it at home or in a foreign country. When it keeps it at home, it engages in standard vertical integration. And when it makes it abroad, it engages in foreign direct investment (FDI) and intra-firm trade. Alternatively, a firm may choose to outsource an input in the home country or in a foreign country. When it buys the input at home, it engages in domestic outsourcing. And when it buys it abroad, it engages in foreign outsourcing, or arm's-length trade. Intel Corporation provides an example of the FDI strategy; it assembles most of its microchips in wholly-owned subsidiaries in China, Costa Rica, Malaysia, and the Philippines. On the other hand, Nike provides an example of the arm's-length import strategy; it subcontracts most of its manufacturing to independent producers in Thailand, Indonesia, Cambodia, and Vietnam.

Growth of international specialization has been a dominant feature of the international economy. Amongst the many examples that illustrate this trend, two are particularly telling. Citing Tempest (1996), Feenstra (1998) illustrates Mattel's global sourcing strategy in the production of its star product, the Barbie doll. "Of the $2 export value for the dolls when they leave Hong Kong for the United States," he writes, "about 35 cents covers Chinese labor, 65 cents covers the cost of materials," — which are imported from Taiwan, Japan, and the United States — "and the remainder covers transportation and overheads, including profits earned in Hong Kong" (pp.35-36). The World Trade Organization provides another example in its 1998 annual report. In the production of an "American" car, 30 percent of the car's value originates in Korea, 17.5 percent in Japan, 7.5 percent in Germany, 4 percent in Taiwan and Singapore, 2.5 percent in the U.K., and 1.5 percent in Ireland and Barbados. That is, "...only 37 percent of the production value... is generated in the United States" (p.36).

The increasing international disintegration of production is large enough to be noticed in aggregate statistics. Feenstra and Hanson (1996) use U.S. input–output tables to infer U.S. imports of intermediate inputs. They find that the share of imported intermediates increased from 5.3% of total U.S. intermediate purchases in 1972 to 11.6% in 1990. Campa and Goldberg (1997) find similar evidence for Canada and the U.K. (but not for Japan). And Hummels, Ishii and Yi (2001) and Yeats (2001) show that international trade has grown faster in components than in final goods.

But how important is intra-firm relative to arm's-length trade in intermediate in-

puts? A firm-level data analysis is needed to answer this question, and no such analysis is available at this point in time. And despite the fact that the business press has stressed the spectacular growth of foreign outsourcing, Hanson, Mataloni and Slaughter (2002) document an equally impressive growth of trade within multinational firms. Nevertheless, the fact that according to BEA data imports from foreign affiliates of U.S.-based firms has fallen from 23.9% of total U.S. imports in 1977 to 16.1% in 1982, and remained roughly at this level until 1999, suggests that the growth of foreign outsourcing by U.S. firms might have outpaced the growth of their foreign intra-firm sourcing.

Other studies have documented a rise in the prevalence of *domestic* outsourcing by U.S. firms. *The Economist* (1991), Bamford (1994) and Abraham and Taylor (1996), all report rising subcontracting in particular industries or activities. A systematic analysis of this trend is not available. Nevertheless, Fan and Lang (2000) provide indirect evidence of a decline in vertical integration. According to their data, the average number of four-digit SIC segments in which a U.S. publicly-traded manufacturing company operates, declined steadily from 2.72 in 1979 to 1.81 in 1997. This suggests that U.S. manufacturing firms have become more specialized over time.

To address issues that arise from the choice of outsourcing versus integration and home versus foreign production, we need a theoretical framework in which companies make endogenous organizational choices. We propose such a framework in this paper by integrating two recent strands of the literature.

Melitz (2003) and Helpman, Melitz and Yeaple (2003) have studied the effects of within sectoral heterogeneity on the decisions of firms to serve foreign markets. By allowing productivity to differ across firms, they show that low-productivity firms serve only the domestic market while high-productivity firms also serve foreign markets. Allowing for horizontal foreign direct investment, Helpman, Melitz and Yeaple also show that, amongst the firms that serve foreign markets, the more productive ones engage in foreign direct investment while the less productive firms export, and affiliate sales relative to exports are larger in sectors with more productivity dispersion. Their approach emphasizes variations across firms within industries, without addressing the organizational choices of firms that need to acquire intermediate inputs.

Grossman and Helpman (2002) address the choice between outsourcing and integration in a one-input general equilibrium framework, assuming that all firms of a given type are equally productive. Their firms face the friction of incomplete contracts in arm's-length relationships, which they weigh against the less-efficient production of in-

puts in integrated companies. As a result, some sectors have only vertically integrated firms while others have only disintegrated firms. Grossman and Helpman identify sectoral characteristics that lead to one or the other equilibrium structure. This approach has been extended by Antràs (2003a) to a trading environment, by introducing two new features. First, the friction of incomplete contracts also exists within integrated firms, and — as in Grossman and Hart (1986) — integration provides well defined property rights. However, these property rights may or may not give integration an advantage over outsourcing. Second, there are two inputs, one controlled by the final-good producer, the other by another supplier, inside or outside the firm. The relative intensity of these inputs turns out to be an important determinant of the choice between integration and outsourcing.

By embodying this structure in a Helpman and Krugman (1985) style two-sector general equilibrium model of trading countries, Antràs shows that the sector that is relatively intensive in the input controlled by the final-good producer integrates, while the sector that is relatively intensive in the other input outsources. As a result, in the former sector there is intra-firm trade in inputs, while in the latter sector there is arm's-length trade.

Building on this literature, we develop a theoretical model that combines the within-sectoral heterogeneity of Melitz (2003) with the structure of firms in Antràs (2003a). The final-good producer controls the supply of headquarter services while a supplier of intermediate goods controls the quality and quantity of the intermediates. This allows us to study the impact of variations in productivity within sectors and in differences in technological and organizational characteristics across sectors on international trade, foreign direct investment, and the organizational choices of firms. In this framework trade, investment and organization are interdependent. The incentives created by different organizations, differences in their fixed costs, and wage differentials across countries shape the equilibrium organizational structure.

We show that in a world of two countries, North and South, in which final-good producers are based in the North, final-good producers who operate in the same sector but differ by productivity sort into integrated companies that produce inputs in the North (do not engage in foreign trade in inputs), integrated companies that produce inputs in the South (engage in FDI and intra-firm trade), disintegrated companies that outsource in the North (do not engage in foreign trade in inputs), and disintegrated companies that outsource in the South (import inputs at arm's length). Moreover, we show that in sectors with low headquarter intensive firms do not integrate; low-productivity firms

outsource in the North while high-productivity firms outsource in the South. In sectors with high headquarter intensity all four organizational forms may exist in equilibrium, and, as in sectors with low headquarter intensity, high-productivity firms import inputs while low-productivity firms acquire them in the North. However, amongst the firms that acquire inputs in the same country, the low-productivity firms outsource while the high-productivity firms insource. This implies that the least-productive firms outsource in the North while the most productive firms insource in the South via foreign direct investment.

We use the model to study the relative prevalence of different organizational forms. We show how prevalence depends on the wage gap between the North and the South, the trading costs of intermediate inputs, the degree of productivity dispersion within a sector, the distribution of bargaining power, the size of the ownership advantage (which may be different in the two countries), and the intensity of headquarter services. Our model predicts that relatively more final-good producers rely on imported intermediates in sectors with higher productivity dispersion or lower headquarter intensity. And in sectors with integration and outsourcing, which are the sectors with high headquarter intensity, industries with higher productivity dispersion have relatively more final-good producers who integrate. This is true for a comparison of integration versus outsourcing in each of the countries. As a result, such sectors have more intra-firm trade relative to arm's-length trade. These results illustrate the types of issues that can be addressed with our model.

Our model is developed in the next section. In section 3 we characterize an industry's equilibrium. Then, in section 4, we describe the equilibrium sorting of firms into different organizational forms, and we study in section 5 the prevalence of each mode of organization. This is also the section that examines the effects of variations within and across sectors on the relative prevalence of organizational forms. Section 6 offers a short summary with concluding comments.

2 The Model

Consider a world with two countries, the North and the South, and a unique factor of production, labor. The world is populated by a unit measure of consumers with

identical preferences represented by:

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

where x_0 is consumption of a homogeneous good, X_j is an index of aggregate consumption in sector j, and μ is a parameter. Aggregate consumption in sector j is a CES function

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

of the consumption of different varieties $x_j(i)$, where the range of i will be endogenously determined. The elasticity of substitution between any two varieties in a given sector is $1/(1-\alpha)$. We assume that $\alpha > \mu$, so that varieties within a sector are more substitutable for each other than they are substitutable for x_0 or for varieties from a different sector. This leads to the inverse demand function for each variety i in sector j:

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

Producers of differentiated products face a perfectly elastic supply of labor in each one of the countries. We denote by w^N the wage rate in the North and by w^S the wage rate in the South. These wage rates are fixed and $w^N > w^S$. The assumption of fixed wage rates and a higher wage rate in the North can be justified in general equilibrium by assuming that w^{ℓ} is the productivity of labor in producing x_0 in country ℓ, $\ell = N, S$, and that labor supply is large enough in every country so that both countries produce x_0.

The demand parameters μ and α are the same in every industry, which helps to focus attention on cross-sectoral differences in technology and organizational costs. Our aim is to explore how differences in technology interact with organizational choices in shaping industrial structure, trade flows and FDI.

Only the North knows how to produce final-good varieties. To start producing a variety in sector j a firm needs to bear a fixed cost of entry consisting of f_E units of Northern labor. Upon paying this fixed cost, the unique producer of variety i in sector j draws a productivity level θ from a known distribution $G(\theta)$.[1] After observing this

[1] To be more precise, the unique producer of variety i draws a particular realization $\theta(i)$ from the distribution $G(\theta)$. However, we drop the variety index i from $\theta(i)$ in order to simplify the notation. For the same reason we drop the sectoral index j from the fixed cost variable f_E and the distribution function $G(\cdot)$.

productivity level, the final-good producer decides whether to exit the market or start producing; in the latter case an additional fixed cost of organizing production needs to be incurred. As discussed below, this additional fixed cost is a function of the structure of ownership and the location of production.

Production of any final-good variety requires a combination of two variety-specific inputs, $h_j(i)$ and $m_j(i)$, which we associate with headquarter services and manufactured components, respectively. Output of every variety is a sector-specific Cobb-Douglas function of the inputs,

$$x_j(i) = \theta \left(\frac{h_j(i)}{\eta_j} \right)^{\eta_j} \left(\frac{m_j(i)}{1-\eta_j} \right)^{1-\eta_j}, \quad 0 < \eta_j < 1, \tag{2}$$

where the productivity parameter θ is firm specific while the parameter η_j is sector specific. The larger is η_j the more intensive is the sector in headquarter services. Headquarter services $h_j(i)$ can be produced only in the North, with one unit of labor per unit output, while intermediate inputs $m_j(i)$ can be produced in the North and in the South, with one unit of labor per unit output in each one of the countries.

There are two types of agents engaged in production: final-good producers who supply headquarter-services and operators of manufacturing plants who supply intermediate inputs. We use H to denote a final-good producer and M to denote a supplier of intermediate inputs. Every final-good producer H needs to contract with a manufacturing-plant operator M for the provision of components. We allow international fragmentation of the production process, so that H can choose to transact with a manufacturing-plant operator M in the North or in the South.

It follows from our assumptions that all final-good producers locate in the North. Upon paying the fixed cost of entry $w^N f_E$ and observing the productivity level θ, the unique final-good producer H of variety i in sector j seeks out a supplier of components M in the North or in the South. Simultaneously, H chooses whether to insource or outsource intermediate inputs. The joint management costs of final and intermediate goods production, such as supervision, quality control, accounting and marketing, depend on the organizational form and the location of M. All these costs, the sum of which we term *fixed organizational costs*, are in terms of Northern labor. We denote them by $w^N f_k^\ell$, where k is an index of the ownership structure and ℓ is an index of the country in which M is located and the manufacturing of components takes place.

The ownership structure takes one of two forms: vertical integration V or outsourcing O. The location of M is in one of two sites: in the North N or in the South S.

Therefore $k \in \{V, O\}$ and $\ell \in \{N, S\}$. An *organizational form* consists of an ownership structure and a location of M.

We assume that the fixed organizational costs are higher when M is located in the South regardless of ownership structure, because the fixed costs of search, monitoring, and communication are significantly higher in the foreign country. Namely, $f_k^S > f_V^N$ and $f_k^S > f_O^N$ for $k = V, O$. We also assume that, given the location of M, the fixed organizational costs of a V-firm are higher than the fixed organizational costs of an O-firm. Namely, $f_V^\ell > f_O^\ell$ for $\ell = N, S$. We make this assumption in order to avoid a taxonomy of cases. There exists a tension between two considerations that affect the ranking of f_V^ℓ and f_O^ℓ. On the one hand, the need to supervise the production of intermediate inputs in addition to other managerial tasks raises managerial overload and the fixed organizational costs of a V-firm relative to an O-firm. On the other hand, economies of scope in the management of diverse activities reduce the fixed organizational costs of a V-firm relative to an O-firm. Our ordering amounts to assuming that managerial overload is more important than managerial economies of scope. Although we believe this assumption to be appropriate in many instances, and we therefore maintain it in the main analysis, we shall point out how some of the results change when $f_V^\ell < f_O^\ell$. As a result of these assumptions the fixed organizational costs are ranked as follows:

$$f_V^S > f_O^S > f_V^N > f_O^N. \tag{3}$$

The setting is one of incomplete contracts. Final-good producers and manufacturing-plant operators cannot sign ex-ante enforceable contracts specifying the purchase of specialized intermediate inputs for a certain price. In addition, the parties cannot write enforceable contracts contingent on the amount of labor hired or on the volume of sales revenues obtained when the final good is sold. One can use arguments of the type developed by Hart and Moore (1999) and Segal (1999) to justify this specification. Namely, that the parties cannot commit not to renegotiate an initial contract and that the precise nature of the required input is revealed only ex-post, and it is not verifiable by a third party. To simplify the analysis, we just impose these constraints on the contracting environment.

Because no enforceable contract can be signed ex-ante, final-good producers and manufacturing-plant operators bargain over the surplus from the relationship after the inputs have been produced. We model this ex-post bargaining as a Generalized Nash Bargaining game in which the final-good producer obtains a fraction $\beta \in (0, 1)$ of the

ex-post gains from the relationship.[2]

Following the property-rights approach to the theory of the firm, we assume that ex-post bargaining takes place both under outsourcing and under integration. The distribution of surplus is sensitive, however, to the mode of organization. More specifically, the outside option of H is assumed to be different when it owns the manufacturing plant than when it does not. In the latter case, a failure to reach an agreement on the distribution of the surplus leaves both parties with no income, because the inputs are tailored specifically to the other party in the transaction. However, by vertically integrating the production of components, H is effectively buying the right to fire M and seize the inputs $m_j(i)$. If there were no costs associated with firing the operator of the manufacturing plant, the final-good producer would always have an incentive to seize the inputs $m_j(i)$ ex-post, and M would have an incentive to choose $m_j(i) = 0$ ex-ante (which of course would imply $x_j(i) = 0$). In this case integration would never be chosen. We therefore assume that firing M results in a loss of a fraction $1 - \delta^\ell$ of final-good production, because H cannot use the intermediate inputs without M as effectively as it can with the cooperation of M.[3] We also assume that $\delta^N \geq \delta^S$. This captures the notion that a contractual breach is likely to be more costly to H when M is in the South. More figuratively, we think of this assumption as reflecting less corruption and better legal protection in the North. As is clear from the weak inequality, however, our results still hold when $\delta^N = \delta^S$.[4]

The location of M and the mode of ownership are chosen ex-ante by H to maximize its profits. There is an infinitely elastic supply of M agents in each one of the countries. H offers a contract that seeks to attract a plant operator M. The contract includes an upfront fee for participation in the relationship that has to be paid by M. This fee can be positive or negative, i.e., the operator can make a payment to the final good producer or vice versa. The purpose of the fee is to secure the participation of M in the relationship at minimum cost to H. When the supply of M is infinitely elastic, M's profits from the relationship net of the participation fee are equal in equilibrium to its ex-ante outside option. For simplicity, we set M's ex-ante outside option equal to zero in both countries. It is, however, easy to extend the analysis to cases in which these outside options are positive and different in the North and in the South.

[2] This specification is similar to Grossman and Helpman (2002) and Antràs (2003a,b).

[3] The fact that the fraction of final-good production lost is independent of η_j greatly simplifies the analysis, but it is not necessary for the qualitative results discussed below.

[4] We maintain a distinction between δ^N and δ^S in order to show in Section 5 that these two parameters affect the relative prevalence of different organizational forms in distinct ways.

3 Equilibrium

Consider the payoffs in the bargaining game for a pair of agents H and M in sector j. Since from now on we discuss a particular sector, we drop for simplicity the index j from all the variables. If the parties agree in the bargaining, the potential revenue from the sale of the final goods is $R(i) = p(i)x(i)$, which, using (1) and (2), can be written as

$$R(i) = X^{\mu-\alpha}\theta^{\alpha}\left(\frac{h(i)}{\eta}\right)^{\alpha\eta}\left(\frac{m(i)}{1-\eta}\right)^{\alpha(1-\eta)}. \tag{4}$$

If they fail to agree, however, the outside option of M is always 0 while that of H varies with the ownership structure and the location of components manufacturing.

When H outsources components, its outside option is also 0 regardless of the location of the manufacturing plant. In this event H gets $\beta R(i)$ while M gets $(1-\beta)R(i)$.

Following Grossman and Hart (1986), we assume that the final-good producer has more leverage under vertical integration. When the parties fail to reach an agreement, H can sell an amount $\delta^{\ell}x(i)$ of output when its manufacturing plant is in country ℓ, which yields the revenue $\left(\delta^{\ell}\right)^{\alpha}R(i)$. The ex-post gains from trade are in this case $\left[1-\left(\delta^{\ell}\right)^{\alpha}\right]R(i)$. In the bargaining, H receives its outside option plus a fraction β of the quasi-rents, i.e., $\left(\delta^{\ell}\right)^{\alpha}R(i)+\beta\left[1-\left(\delta^{\ell}\right)^{\alpha}\right]R(i)$, while M obtains $(1-\beta)\left[1-\left(\delta^{\ell}\right)^{\alpha}\right]R(i)$.

Notice that the payoffs in the bargaining game are proportional to the revenue. Denoting by $\beta_k^{\ell}R(i)$ the payoff of H under ownership structure k and the location of M in country ℓ, the assumption $\delta^N \geq \delta^S$ implies that

$$\beta_V^N = \left(\delta^N\right)^{\alpha}+\beta\left[1-\left(\delta^N\right)^{\alpha}\right] \geq \beta_V^S = \left(\delta^S\right)^{\alpha}+\beta\left[1-\left(\delta^S\right)^{\alpha}\right] > \beta_O^N = \beta_O^S = \beta. \tag{5}$$

That is, final-good producers are able to appropriate higher fractions of revenue under integration than under outsourcing, with this fraction being higher when integration takes place in the North. As in Grossman and Hart (1986), integration gives H residual rights of control that allow it ex-post to use the inputs produced by M, which in turn enhances H's bargaining position. As a result, H gets a higher fraction of the revenue under integration.

Since the delivery of the inputs $h(i)$ and $m(i)$ is not contractible ex-ante, the parties choose their quantities noncooperatively; every supplier maximizes its own payoff. In particular, H provides an amount of headquarter services that maximizes $\beta_k^{\ell}R(i) - w^N h(i)$ while M provides an amount of components that maximizes $\left(1-\beta_k^{\ell}\right)R(i) -$

$w^{\ell}m(i)$. Combining the first-order conditions of these two programs, using (4), the total value of the relationship, as measured by total operating profits, can be expressed as:

$$\pi_k^{\ell}(\theta, X, \eta) = X^{(\mu-\alpha)/(1-\alpha)}\theta^{\alpha/(1-\alpha)}\psi_k^{\ell}(\eta) - w^N f_k^{\ell} \tag{6}$$

where

$$\psi_k^{\ell}(\eta) = \frac{1-\alpha\left[\beta_k^{\ell}\eta + \left(1-\beta_k^{\ell}\right)(1-\eta)\right]}{\left[\frac{1}{\alpha}\left(\frac{w^N}{\beta_k^{\ell}}\right)^{\eta}\left(\frac{w^{\ell}}{1-\beta_k^{\ell}}\right)^{1-\eta}\right]^{\alpha/(1-\alpha)}}. \tag{7}$$

Note that among the arguments of the profit function $\pi_k^{\ell}(\theta, X, \eta)$, the first one is firm-specific while the others are industry-specific. Moreover, while η is a parameter measuring the intensity of headquarter services, the consumption index X is endogenous to the industry but exogenous to the producer of a specific variety of the final good.

Our assumptions imply that the final-good producer chooses the organizational form that maximizes $\pi_k^{\ell}(\theta, X, \eta)$. To see why, recall that ex-ante, before a relationship between H and M has been formed, H offers a contract designed to attract an M agent whose ex-ante outside option is zero, and the contract includes a participation fee, say $t \gtrless 0$, that has to be paid by M. Under these circumstances the final-good producer of brand i expects to earn operating profits $\pi_{Hk}^{\ell} = \beta_k^{\ell}R(i) + t - w^N h(i) - w^N f_{Hk}^{\ell}$, where f_{Hk}^{ℓ} represents the component of the fixed costs that H has to bear when M is located in ℓ and the ownership structure is k. On the other hand, M expects to earn operating profits $\pi_{Mk}^{\ell} = \left(1-\beta_k^{\ell}\right)R(i) - t - w^{\ell}m(i) - w^N f_{Mk}^{\ell}$ from the relationship with H, where f_{Mk}^{ℓ} represents the component of the fixed costs that M has to bear. By definition, $f_{Hk}^{\ell} + f_{Mk}^{\ell} = f_k^{\ell}$. Next note that H has an incentive to raise t as much as possible, as long as the participation constraint $\pi_{Mk}^{\ell} \geq 0$ is satisfied, because once a relationship between H and M is formed, the participation fee has no further effects on the outcomes. As a result, the equilibrium value of t satisfies $\pi_{Mk}^{\ell} = 0$, which implies that $\pi_{Hk}^{\ell} = R(i) - w^N h(i) - w^{\ell}m(i) - w^N f_k^{\ell}$. It follows that in a subgame perfect equilibrium $\pi_{Hk}^{\ell} = \pi_k^{\ell}(\theta, X, \eta)$.

Upon observing its productivity level θ, a final-good producer H chooses the ownership structure and the location of manufacturing that maximizes (6), or exits the industry and forfeits the fixed cost of entry $w^N f_E$. It is clear from (6) that the latter occurs whenever θ is below a threshold θ, denoted by $\underline{\theta} \in (0, \infty)$, at which the operating profits

$$\pi(\theta, X, \eta) = \max_{k\in\{V,O\},\ell\in\{N,S\}} \pi_k^{\ell}(\theta, X, \eta) \tag{8}$$

equal zero. Namely, $\underline{\theta}$ is implicitly defined by

$$\pi\left(\underline{\theta}, X, \eta\right) = 0. \tag{9}$$

This threshold productivity level depends on the sector's aggregate consumption index X, i.e., $\underline{\theta}\left(X\right)$.

In solving the problem on the right-hand-side of (8), a final-good producer effectively chooses the triplet $\left(\beta_k^\ell, w^\ell, f_k^\ell\right)$ that maximizes (6). It is straightforward to see that $\pi_k^\ell\left(\theta, X, \eta\right)$ is decreasing in both w^ℓ and f_k^ℓ. For this reason final-good producers prefer to organize production so as to minimize both variable and fixed costs. On account of variable costs, Southern manufacturing is preferred to Northern manufacturing regardless of the ownership structure (because $w^N > w^S$). On account of fixed costs, however, the ranking of profit levels is the reverse of the ranking of fixed cost levels in (3).

Next note that if the final-good producer could freely choose its fraction of revenue β_k^ℓ, it would choose $\beta^* \in [0,1]$ that maximizes $\psi_k^\ell\left(\eta\right)$. This fraction is

$$\beta^*\left(\eta\right) = \frac{\eta\left(\alpha\eta + 1 - \alpha\right) - \sqrt{\eta\left(1-\eta\right)\left(1-\alpha\eta\right)\left(\alpha\eta + 1 - \alpha\right)}}{2\eta - 1}. \tag{10}$$

Although a higher β_k^ℓ gives H a larger fraction of the revenue, it also induces M to produce fewer components. As a result, the final-good producer trades the choice of a larger fraction of the revenue for a smaller revenue level.

The function $\beta^*\left(\eta\right)$ is depicted by the solid curve in Figure 1. It rises in η; $\beta^*\left(0\right) = 0$ and $\beta^*\left(1\right) = 1$.[5] To understand these properties, notice that in the ex-post bargaining neither H nor M appropriate the full marginal return to their investments in the supply of headquarter services and components, respectively. This leads them to underinvest in the provision of these inputs. Each party's severity of underinvestment is inversely related to the fraction of the surplus that it appropriates. Ex-ante efficiency then requires giving a larger share of the revenue to the party undertaking the relatively more important investment. As a result, the higher the intensity of headquarter services (the larger is η), the higher is the profit-maximizing fraction of the surplus accruing to the final-good producer (the higher is β^*).

Following Grossman and Hart (1986), we do not allow a free ex-ante choice of the division rule of the surplus. The choice of ownership structure and the location of

[5] Notice also that it does not depend on factor prices and that it is less nonlinear the higher is α.

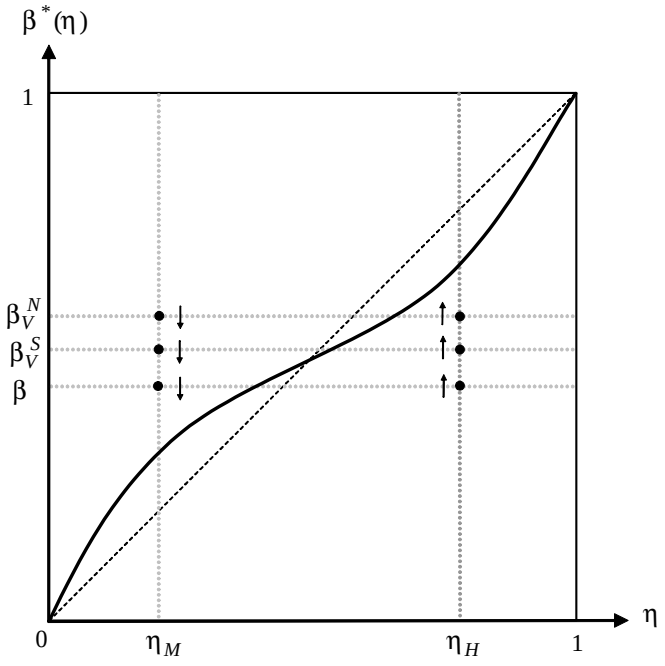

Figure 1: Distribution of Revenue that Maximizes Joint Profits

the manufacturing of components are the only instruments for affecting the division rule, in the sense that the final-good producer is constrained to choose a β_k^ℓ in the set $\left\{\beta_V^N, \beta_O^N, \beta_V^S, \beta_O^S\right\}$. When η is close to 1, higher values of β_k^ℓ yield higher profits. Given the ordering in (5), this implies that H would have chosen domestic integration if there were no other differences in the costs and benefits of the competing organizational forms. Conversely, when η is close to 0, lower values of β_k^ℓ yield higher profits, and H would have chosen outsourcing in the absence of other differences in the costs and benefits of the organizational forms. Naturally, there are other differences in the costs and benefits of various organizational forms. As a result, the profit-maximizing choice of an ownership structure and the location of the manufacturing of components depends on a firm's productivity level.

Free entry ensures that, in equilibrium, the expected operating profits of a potential entrant equal the fixed cost of entry. From the discussion above, a firm that draws a productivity level below $\underline{\theta}(X)$ chooses to exit, because its operating profits are negative. On the other hand, firms with $\theta \geq \underline{\theta}(X)$ stay in the industry, and they choose organizational forms that maximize their profits. Under the circumstances the

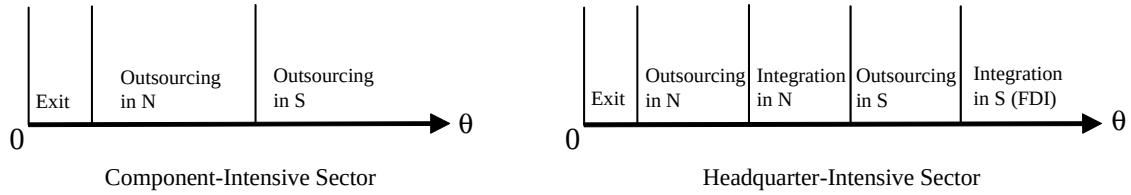

Figure 2: Organizational Forms

free-entry condition can be expressed as

$$\int_{\underline{\theta}(X)}^{\infty} \pi\left(\theta, X, \eta\right) dG\left(\theta\right) = w^N f_E. \tag{11}$$

This condition provides an implicit solution to the sector's real consumption index X. Using the sector's consumption index, it is then possible to calculate all other variables of interest, such as the threshold productivity level of surviving entrants, the organizational forms of final-good producers with different productivity levels, and the number of entrants.

4 Organizational Forms

The choice of an organizational form faces two types of tensions. First, variable costs are lower in the South, but fixed costs are higher there. Second, insourcing gives H a larger fraction of the revenue, but it has higher fixed costs. And moreover, because giving H a higher fraction of the revenue raises its incentive to supply headquarter services but reduces M's incentive to supply components, H does not always benefit from a higher fraction of the revenue. These tradeoffs are the central considerations in the choice of an organizational form.

To simplify the discussion, we examine in this section organizational forms in only two types of sectors: those with relatively high headquarter intensity and those with relatively low headquarter intensity. Intermediate cases can be similarly analyzed. We show below that firms sort into organizational forms according to the patterns depicted in Figure 2. First, in component-intensive sectors (i.e., low η) firms do not integrate; high-productivity firms outsource components in the South, low-productivity firms outsource them in the North, and the least productive firms exit. On the other

hand, integration takes place in headquarter-intensive sectors (i.e., high η). The most productive firms integrate in the South while somewhat less productive firms outsource in the South. Firms with even lower productivity acquire components in the North, and amongst them the more productive integrate while the less productive outsource. The least productivity firms exit. Note that surviving firms with the lowest productivity outsource in the North in all sectors. And more generally, less productive firms acquire components in the North while more productive firms acquire them in the South.

We now derive these results. First consider a sector with low headquarter intensity η, such that $\beta^*(\eta) < \beta_O^N = \beta_O^S = \beta$; we refer to it as a component-intensive sector. This case is depicted in Figure 1 by $\eta = \eta_M$, where the arrows indicate the direction in which profits rise with changes in β_k^ℓ, i.e., the profit function $\pi_k^\ell(\cdot)$ is decreasing in β_k^ℓ. In this type of sector H prefers outsourcing to insourcing in every country ℓ, because outsourcing has lower fixed costs and it gives H a lower fraction of the revenue. Under these circumstances integration is not an optimal strategy. In choosing between domestic and foreign outsourcing, however, H trades-off the lower variable costs of Southern manufacturing against the lower fixed organizational costs in the North. Depending on whether the cross-country difference in the wage rate is small or large relative to the cross-country difference in the fixed organizational costs, the resulting equilibrium can have outsourcing in both countries or outsourcing in the South only.

Figure 3 depicts the first case, in which the wage differential is small relative to the fixed-cost differential, i.e., $w^N/w^S < \left(f_O^S/f_O^N\right)^{(1-\alpha)/\alpha(1-\eta)}$. The variable $\theta^{\alpha/(1-\alpha)}$ is measured along the horizontal axis while operating profits are measured along the vertical axis. It is evident from (6) that the operating profit function $\pi_k^\ell(\cdot)$ is linear in $\theta^{\alpha/(1-\alpha)}$ and it has the intercept $-w^N f_k^\ell$. The slope of this function is proportional to $\psi_k^\ell(\eta)$. It follows that the profit line π_O^S in Figure 3 is steeper than the profit line π_O^N, because wages are lower in the South.

Firms with productivity below $\underline{\theta}_M$ expect negative profits under all organizational forms. Therefore they exit the industry. Firms with productivity between $\underline{\theta}_M$ and θ_{MO}^N attain the highest profits by outsourcing in the North while firms with productivity above θ_{MO}^N attain the highest profits by outsourcing in the South. The cutoffs $\underline{\theta}_M$ and θ_{MO}^N are given by

$$\left.\begin{aligned} \underline{\theta}_M &= X^{(\alpha-\mu)/\alpha}\left[\frac{w^N f_O^N}{\psi_O^N(\eta)}\right]^{(1-\alpha)/\alpha}, \\ \theta_{MO}^N &= X^{(\alpha-\mu)/\alpha}\left[\frac{w^N\left(f_O^S-f_O^N\right)}{\psi_O^S(\eta)-\psi_O^N(\eta)}\right]^{(1-\alpha)/\alpha}. \end{aligned}\right\} \tag{12}$$

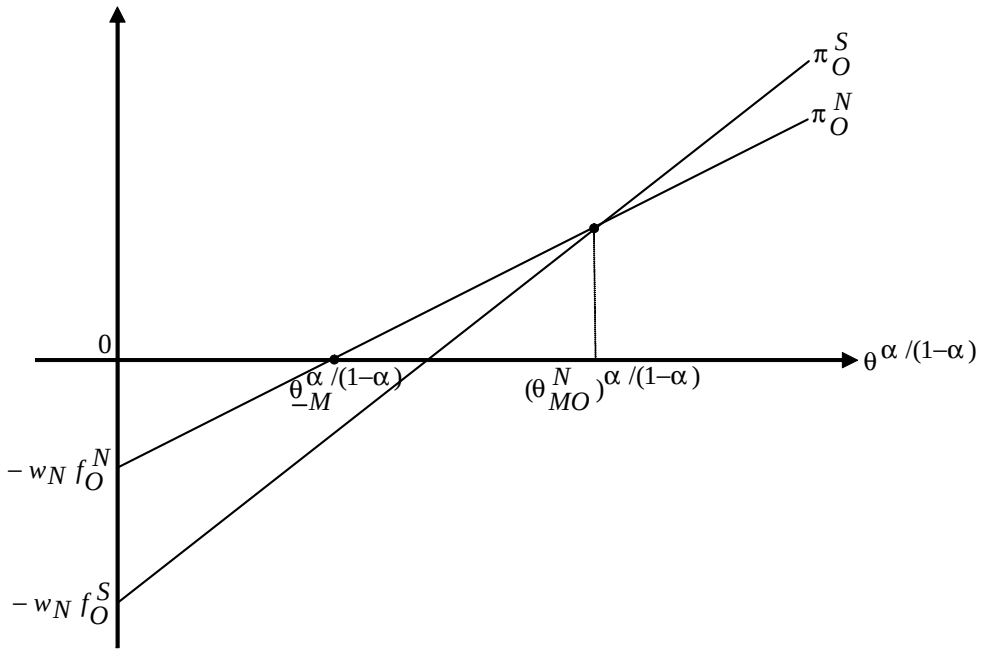

Figure 3: Equilibrium in the Component-Intensive Sector

It also is clear from Figure 3 that the intersection point of the two profit lines takes place at a negative profit level when the fixed organizational costs of outsourcing in the South are close to the fixed organizational costs of outsourcing in the North, i.e., when $w^N/w^S > \left(f_O^S/f_O^N\right)^{(1-\alpha)/\alpha(1-\eta)}$. In this case the threshold productivity level $\underline{\theta}_M$ is defined by the point of intersection of the profit line π_O^S with the horizontal axis. As a result, all firms with productivity below this threshold exit while all firms with higher productivity levels outsource in the South. This describes the second type of equilibrium, in which no firm outsources in the North.

We shall treat the equilibrium with outsourcing in both countries — depicted in Figure 3 — as the benchmark case. In this event the free entry condition (11), together with (6) and (8), imply

$$w^N X^{(\alpha-\mu)/(1-\alpha)} = \frac{\psi_O^N(\eta)\left[V\left(\theta_{MO}^N\right) - V\left(\underline{\theta}_M\right)\right] + \psi_O^S(\eta)\left[1 - V\left(\theta_{MO}^N\right)\right]}{f_E + f_O^N\left[G\left(\theta_{MO}^N\right) - G\left(\underline{\theta}_M\right)\right] + f_O^S\left[1 - G\left(\theta_{MO}^N\right)\right]}, \tag{13}$$

where

$$V(\theta) = \int_0^{\theta} y^{\alpha/(1-\alpha)} dG(y).$$

Equations (12) and (13) provide implicit solutions for the cutoffs $\underline{\theta}_M$ and θ_{MO}^N and for

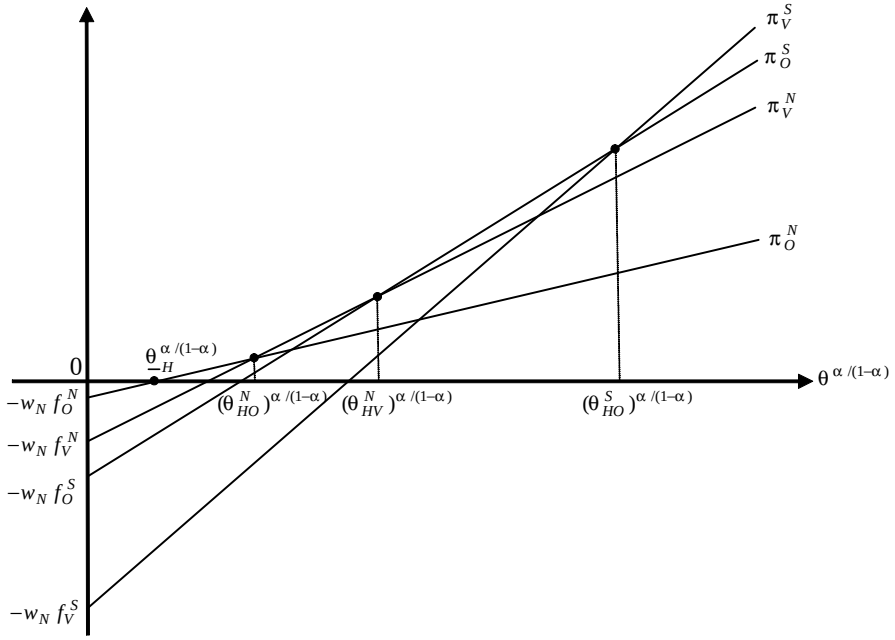

Figure 4: Equilibrium in the Headquarter-Intensive Sector

the aggregate consumption index X.

We next consider a sector with high headquarter intensity η, such that $\beta^*(\eta) > \beta_V^N$. We refer to it as a headquarter-intensive sector. A sector of this type is represented by $\eta = \eta_H$ in Figure 1. In this sector profits are increasing in β_k^ℓ, as shown by the arrows in the figure. In a headquarter-intensive sector the marginal product of headquarter services is high, making underinvestment in h especially costly and integration especially attractive. This is reflected in the slopes of the profit lines in Figure 4; π_V^ℓ is steeper than π_O^ℓ for $\ell = N, S$, because $\psi_V^\ell(\eta) > \psi_O^\ell(\eta)$.

Next compare the slopes of π_V^N and π_O^S. On the one hand, integration gives the final-good producer a larger fraction of the revenue, making π_V^N steeper. On the other hand, variable production costs are lower in the South, making π_O^S steeper. For these reasons the profit line of outsourcing in the South can be steeper or flatter than the profit line of integration in the North. That is, $\psi_O^S(\eta)$ can be larger or smaller than $\psi_V^N(\eta)$. In particular, $\psi_O^S(\eta) > \psi_V^N(\eta)$ if and only if $\left(w^N/w^S\right)^{1-\eta} > \phi\left(\beta_V^N, \eta\right)/\phi(\beta, \eta)$,

where[6]

$$\phi(\zeta,\eta) \equiv \{1-\alpha[\zeta\eta+(1-\zeta)(1-\eta)]\}^{(1-\alpha)/\alpha}\zeta^{\eta}(1-\zeta)^{1-\eta}.$$

First consider the case in which the wage differential is large relative to the difference between β_V^N and β, so that $\psi_O^S(\eta) > \psi_V^N(\eta)$. Under these circumstances

$$\psi_V^S(\eta) > \psi_O^S(\eta) > \psi_V^N(\eta) > \psi_O^N(\eta). \tag{14}$$

Given the orderings in (3) and (14), the orders of the intercepts and the slopes of the profit functions are as depicted in Figure 4. Moreover, the figure depicts our benchmark case for headquarter-intensive sectors, in which all four organizational forms exist in equilibrium, with outsourcing and insourcing taking place in both countries. Firms with productivity below $\underline{\theta}_H$ exit the industry, those with productivity between $\underline{\theta}_H$ and θ_{HO}^N outsource in the North, those with productivity between θ_{HO}^N and θ_{HV}^N integrate in the North, those with productivity between θ_{HV}^N and θ_{HO}^S outsource in the South, and those with productivity above θ_{HO}^S integrate in the South (engage in vertical FDI).

It is easy to see that either one of the first three organizational forms may not exist in equilibrium, but that the last one always exists in the absence of an upper bound on the support of $G(\theta)$. That is, there always exist high-productivity final-good producers who choose to insource components in the South. And more generally, the organizational forms that survive in equilibrium attract firms according to the sorting pattern described in Figure 4. If, for example, integration in the North and outsourcing in the South are viable, firms that outsource in the South have higher productivity than firms that insource in the North. But insourcing in the North would not be viable if its fixed organizational costs were too high.

In the next section, where we study variations in the relative prevalence of different organizational forms, we focus on the benchmark case depicted in Figure 4, for which

[6] In component-intensive sectors the inequality $\left(w^N/w^S\right)^{1-\eta} > \phi\left(\beta_V^N,\eta\right)/\phi(\beta,\eta)$ always holds, because in these sectors $\phi(\zeta,\eta)$ is declining in ζ, and therefore the right-hand side is smaller than one (recall that $\beta_V^N > \beta$). On the other hand, in headquarter-intensive sectors the right-hand side is larger than one, because in such sectors $\phi(\zeta,\eta)$ is increasing in ζ. Therefore the inequality holds only if the wage rate is sufficiently higher in the North.

the cutoffs are given by

$$\left.\begin{aligned}
\underline{\theta}_H &= X^{(\alpha-\mu)/\alpha}\left[\frac{w^N f_O^N}{\psi_O^N(\eta)}\right]^{(1-\alpha)/\alpha}, \\
\theta_{HO}^N &= X^{(\alpha-\mu)/\alpha}\left[\frac{w^N\left(f_V^N-f_O^N\right)}{\psi_V^N(\eta)-\psi_O^N(\eta)}\right]^{(1-\alpha)/\alpha}, \\
\theta_{HV}^N &= X^{(\alpha-\mu)/\alpha}\left[\frac{w^N\left(f_O^S-f_V^N\right)}{\psi_O^S(\eta)-\psi_V^N(\eta)}\right]^{(1-\alpha)/\alpha} \\
\theta_{HO}^S &= X^{(\alpha-\mu)/\alpha}\left[\frac{w^N\left(f_V^S-f_O^S\right)}{\psi_V^S(\eta)-\psi_O^S(\eta)}\right]^{(1-\alpha)/\alpha}.
\end{aligned}\right\} \tag{15}$$

We can also use the free entry condition (11) to derive an equation that is analogous to (13). This equation together with (15) can then be used to solve for the cutoffs and the consumption index X.

Next consider the case in which the wage differential is small, so that $\left(w^N/w^S\right)^{1-\eta} < \phi\left(\beta_V^N,\eta\right)/\phi\left(\beta,\eta\right)$ in the headquarter-intensive sector. In this event π_V^N is steeper than π_O^S and the ordering in (14) is not preserved. In this case there are two possibilities only: either $\psi_V^S(\eta) > \psi_V^N(\eta) > \psi_O^S(\eta) > \psi_O^N(\eta)$ or $\psi_V^N(\eta) > \psi_V^S(\eta) > \psi_O^S(\eta) > \psi_O^N(\eta)$ (because $\psi_O^S(\eta) > \psi_O^N(\eta)$).

When $\psi_V^S(\eta) > \psi_V^N(\eta) > \psi_O^S(\eta) > \psi_O^N(\eta)$, integration in the North dominates outsourcing in the South, because the profit line π_V^N in Figure 4 has a higher intercept and a larger slope than π_O^S. As a result, at most three organizational forms exist in equilibrium: outsourcing in the North, chosen by low-productivity firms; insourcing in the North, chosen by intermediate-productivity firms; and insourcing in the South, chosen by high-productivity firms. On the other hand, when $\psi_V^N(\eta) > \psi_V^S(\eta) > \psi_O^S(\eta) > \psi_O^N(\eta)$, integration in the North dominates outsourcing and insourcing in the South, in which case there is no international trade in intermediate inputs. As a result, at most two organizational forms can exist in equilibrium: outsourcing in the North, chosen by low-productivity firms, and insourcing in the North, chosen by high-productivity firms.[7]

[7] Our analysis has so far assumed that the ordering of the fixed costs (3) is satisfied. Now suppose instead that the fixed costs of outsourcing are higher than the fixed costs of integration in each one of the countries, but that the fixed costs of integration in the South are higher than the fixed costs of outsourcing in the North, i.e., $f_O^S > f_V^S > f_O^N > f_V^N$. In addition, suppose that the ranking of the slopes of the profit functions (14) holds. Then, in a headquarter-intensive sector integration dominates outsourcing in both countries, because the fixed costs of integration are lower than the fixed costs of outsourcing and the profit line of an integrated firm is steeper than the profit line of an outsourcing firm. As a result, no firm outsources and at most two organizational forms exist in equilibrium: low-productivity firms insource in the North while high-productivity firms insource in the South. On the other hand, in a component-intensive sector all four organizational forms can exist in equilibrium. In such an equilibrium the least productive firms insource in the North, some more

We have shown that in our benchmark cases the equilibrium organizational forms follow the patterns depicted in Figure 2. This sorting pattern differs from the sorting pattern derived by Grossman and Helpman (2003) for organizational structures that use managerial incentives à la Holmstrom and Milgrom (1994).[8] Contrary to our results, in their model surviving low-productivity firms acquire components in the South. Within this group less-productive firms outsource while more-productivity firms insource. While no one outsources inputs in the North, there exist modestly-high productive firms that integrate in the North. However, the most-productive firms, like the least-productive firms, outsource in the South. Evidently, these alternative theories of the firm predict different sorting patterns. Empirical evidence is needed to discriminate between them, but no such evidence is available for the time being.[9]

5 Prevalence of Organizational Forms

Our model predicts variations in organizational forms across firms and industries. In the previous section we examined variations across firms. Now we ask, How does the prevalence of organizational forms vary across industries? To answer this questions, we use the fraction of firms that choose a particular organizational form as the measure of prevalence. We show in the appendix, however, that using instead the market share of these firms as a measure of prevalence yields similar results.

Following Melitz (2003) and Helpman, Melitz and Yeaple (2003), we choose $G(\theta)$ to be a Pareto distribution with shape k, i.e.,

$$G(\theta) = 1 - \left(\frac{b}{\theta}\right)^k \text{ for } \theta \geq b > 0, \tag{16}$$

where k is large enough to ensure a finite variance of the size distribution of firms. In

productive firms outsource in the North, still higher-productivity firms insource in the South, and the most productive firms outsource in the South. These results illustrate the influence of fixed costs on the sorting patterns. Note, however, that independently of whether the fixed organizational costs of insourcing are higher than the fixed organizational costs of outsourcing, integration is more prevalent in headquarter-intensive sectors.

[8] They did not distinguish between component- and headquarter-intensive sectors, however, although one can interpret their production technology as having $\eta = 0$, i.e., a zero output elasticity with respect to headquarter services. For this reason a comparison of the cross-section variation of organizational forms that is based on the component-intensive and headquarter-intensive distinction cannot be made with their work.

[9] The empowerment of workers may also be an important determinant of the structure of firms. Puga and Trefler (2002) and Marin and Verdier (2003) have developed general equilibrium frameworks in which every firm chooses endogenously the structure of authority within the organization.

this event the distribution of sales is also Pareto, which is consistent with the evidence (see Axtell (2001) and Helpman, Melitz and Yeaple (2003)). For concreteness we discuss only the benchmark cases of component- and headquarter-intensive sectors as defined in Section 4.

5.1 Component-intensive sector

Recall that in a component-intensive sector no firm integrates. In the benchmark case depicted in Figure 3, firms with productivity below $\underline{\theta}_M$ exit the industry, those with productivity between $\underline{\theta}_M$ and θ_{MO}^N outsource in the North, and higher-productivity firms outsource in the South.

Denote by σ_{MO}^ℓ the fraction of active firms that outsource in country ℓ. Then $\sigma_{MO}^S = \left[1 - G\left(\theta_{MO}^N\right)\right] / \left[1 - G\left(\underline{\theta}_M\right)\right]$ and $\sigma_{MO}^N = 1 - \sigma_{MO}^S$. The Pareto distribution (16) then implies that $\sigma_{MO}^S = \left(\underline{\theta}_M / \theta_{MO}^N\right)^k$. Substituting (12) into this expression yields

$$\sigma_{MO}^S = \left[\frac{\psi_O^S(\eta) - \psi_O^N(\eta)}{\psi_O^N(\eta)} \frac{f_O^N}{f_O^S - f_O^N}\right]^{k(1-\alpha)/\alpha}. \tag{17}$$

As is clear from equation (17), σ_{MO}^S is only a function of the ratio of slopes $\psi_O^S(\eta)/\psi_O^N(\eta)$ and the ratio of fixed costs f_O^S/f_O^N. In order to study how the different parameters of the model affect the relative prevalence of foreign outsourcing it is therefore sufficient to analyze their effect on these ratios.

First consider the Southern wage rate. A lower wage in the South raises the profitability of outsourcing in the South, i.e., raises $\psi_O^S(\eta)/\psi_O^N(\eta)$. As a result, outsourcing in the South becomes more prevalent, i.e., σ_{MO}^S increases. In addition, it can be shown that $\underline{\theta}_M$ rises in the industry equilibrium, leading to exit of a larger fraction of firms.

The model can easily be extended to incorporate transport costs for intermediate inputs. If the shipment of components is subjected to melting-iceberg-type transport costs, then a fall in transport costs is very similar to a decline in the Southern wage rate. It follows that, as in Melitz (2003), lower transport costs lead to more exit of low-productivity firms, and to more prevalence of foreign outsourcing.

Second, consider an increase in the dispersion of productivity, which is represented by a decline of k. Since the expression in the brackets on the right hand side of (17) represents the ratio of the cutoffs $\underline{\theta}_M/\theta_{MO}^N$ and this ratio is smaller than one, a rise in dispersion raises the fraction of firms that outsource in the South.[10]

[10] This is similar, in terms of the mechanism at work, to the finding in Melitz (2003) that more

Third, note that the headquarter intensity also affects the prevalence of outsourcing in the two countries. Since $\psi_O^S(\eta)/\psi_O^N(\eta) = \left(w^N/w^S\right)^{(1-\eta)\alpha/(1-\alpha)}$, it follows that foreign outsourcing is less prevalent in sectors with higher headquarter intensity, because the less important are components in production the less important are the cost savings from outsourcing in the South compared to the higher fixed organizational costs of foreign outsourcing.

Finally, we have assumed for simplicity that an outsourcing final-good producer H appropriates a fraction β of the surplus from its relationship with an input supplier M, irrespective of whether M is in the North or in the South. Imagine, however, a situation in which this fraction can differ across countries, and that H now gets a smaller fraction of the surplus from outsourcing in the South, but still higher than $\beta^*(\eta)$, so that the sector remains component-intensive. This decline in H's bargaining power raises the profitability of outsourcing in the South, making foreign outsourcing more prevalent.

5.2 Headquarter-intensive sector

Four organizational forms exist in the benchmark case of a headquarter-intensive sector. Ordered from low- to high-productivity, these are: outsourcing in the North, insourcing in the North, outsourcing in the South and insourcing in the South (see Figures 2 and 4). We denote by σ_{Hk}^{ℓ} the fraction of firms that choose the organizational form (k,ℓ), where k is the ownership structure and ℓ is the location of M. Using the Pareto distribution (16) and the cutoffs (15), these fractions are

$$\left.\begin{aligned}
\sigma_{HO}^N &= 1 - \left[\frac{\psi_V^N(\eta)-\psi_O^N(\eta)}{\psi_O^N(\eta)}\ \frac{f_O^N}{f_V^N-f_O^N}\right]^{k(1-\alpha)/\alpha}, \\
\sigma_{HV}^N &= \left[\frac{\psi_V^N(\eta)-\psi_O^N(\eta)}{\psi_O^N(\eta)}\ \frac{f_O^N}{f_V^N-f_O^N}\right]^{k(1-\alpha)/\alpha} - \left[\frac{\psi_O^S(\eta)-\psi_V^N(\eta)}{\psi_O^N(\eta)}\ \frac{f_O^N}{f_O^S-f_V^N}\right]^{k(1-\alpha)/\alpha}, \\
\sigma_{HO}^S &= \left[\frac{\psi_O^S(\eta)-\psi_V^N(\eta)}{\psi_O^N(\eta)}\ \frac{f_O^N}{f_O^S-f_V^N}\right]^{k(1-\alpha)/\alpha} - \left[\frac{\psi_V^S(\eta)-\psi_O^S(\eta)}{\psi_O^N(\eta)}\ \frac{f_O^N}{f_V^S-f_O^S}\right]^{k(1-\alpha)/\alpha}, \\
\sigma_{HV}^S &= \left[\frac{\psi_V^S(\eta)-\psi_O^S(\eta)}{\psi_O^N(\eta)}\ \frac{f_O^N}{f_V^S-f_O^S}\right]^{k(1-\alpha)/\alpha}.
\end{aligned}\right\} \tag{18}$$

We again first consider a lowering of the wage rate in the South. Lower wages in the South raise the profitability of foreign sourcing. In particular, (7) implies that $\psi_V^S(\eta)$ and $\psi_O^S(\eta)$ increase while $\psi_V^N(\eta)$ and $\psi_O^N(\eta)$ do not change. It then follows from (18) that σ_{HO}^N does not change while σ_{HV}^N declines. The reason is that low-productivity

dispersion raises the share of exporting firms in domestic output, and the finding in Helpman, Melitz and Yeaple (2003) that more dispersion raises horizontal FDI relative to exports.

firms that outsource in the North are too far from productivity levels that make foreign sourcing profitable. As a result, small changes in the profitability of foreign sourcing do not make the acquisition of inputs in the South attractive to these firms. On the other hand, amongst the integrated producers in the North the most productive are indifferent between integration in the North and outsourcing in the South. Therefore, for these firms a decline in the South's wage rate tilts the balance in favor of foreign outsourcing. As a result, σ_{HV}^N declines and σ_{HO}^S rises.[11] Finally, σ_{HV}^S rises. Naturally, a decline in the cost of Southern labor induces a reorganization that favors foreign sourcing. But the model also predicts that the effect is disproportionately large on foreign outsourcing relative to FDI. At the same time the unfavorable effect on the acquisition of inputs in the North falls disproportionately on integration. It follows that outsourcing rises overall relative to integration.

A fall in transport costs of intermediate inputs has the same effects as a fall in w^S. It is interesting to note that the recent trends described in the introduction are in line with the model's predictions about falling costs of doing business in the South. Feenstra and Hanson (1996) point out that transport costs have declined and foreign assembly has increased both in-house and at arm's length. Furthermore, the BEA data suggest that the growth of foreign outsourcing might have outpaced that of foreign direct investment. Finally, as predicted by the model, U.S. domestic outsourcing seems to have increased relative to U.S. domestic insourcing.[12]

Second, we examine a decline in k, which represents an increase in the dispersion of productivity across firms. It is evident from (18) that a decline in k reduces the fraction of firms that outsource in the North and increases the fraction of firms that insource in the South. The effect on the share of firms that insource in the North or outsource in the South is ambiguous, however. Yet the share of final-good producers who import components from the South rises, and so does the prevalence of FDI relative to outsourcing in the South (i.e., the ratio $\sigma_{HV}^S/\sigma_{HO}^S$) and the prevalence of integration relative to outsourcing in the North (i.e., the ratio $\sigma_{HV}^N/\sigma_{HO}^N$).

Third, we consider variations in headquarter intensity. In sectors with higher headquarter intensity domestic outsourcing is favored relative to foreign outsourcing and integration is favored relative to outsourcing. That is, the ratios $\psi_O^N(\eta)/\psi_O^S(\eta)$ and

[11] This is easy to see from (18) by noting that the ratio $\psi_V^S(\eta)/\psi_O^S(\eta)$ is independent of the wage rate w^S.

[12] As in the a component-intensive sector, lower labor costs in the South or lower transport costs of intermediates increase the cutoff productivity level below which final-good producers exit the industry in a headquarter-intensive sector. This implies a higher proportion of exiting firms.

$\psi_V^\ell(\eta)/\psi_O^\ell(\eta)$ are higher in both countries in sectors with higher values of η (see Antràs (2003a)). Equations (18) then imply that the fraction of firms that outsource in the North falls with η while the fraction of firms that insource in the North rises. Moreover, the sum of these two shares goes up, implying that a larger η reduces the fraction of firms that import components. As for the composition of imported inputs, we cannot sign the effects of η on the fraction of firms that insource in the South. Nevertheless, (18) implies that the ratio $\sigma_{HV}^S/\sigma_{HO}^S$ rises and, hence, that σ_{HO}^S falls. Namely, FDI becomes more prevalent relative to arm's-length imports. It follows that in a cross-section of headquarter-intensive sectors integration is more prevalent and outsourcing is less prevalent the more headquarter-intensive is the sector. This prediction is in line with the findings of Antràs (2003a), who shows that in a panel of 23 manufacturing industries and four years of data, the share of intra-firm imports in total U.S. imports is significantly higher, the higher the R&D intensity of the industry.

Fourth, consider the revenue shares β_V^ℓ, $\ell = N, S$. An increase in β_V^S, which can result from a reduction in corruption or an improvement in the legal system in the South, raises the slope of the profit line π_V^S without affecting the slopes of other profit lines. Equations (18) then imply that the shares of firms that source components in the North, σ_{HO}^N and σ_{HV}^N, do not change. In this event, the fraction of firms that source components in the South does not change, except that amongst them the fraction of outsourcing firms declines while the fraction of insourcing firms rises.

An increase in β_V^N makes integration in the North more profitable, thereby raising the slope of the profit line π_V^N. It then follows from (18) that the fraction of firms that outsource in the North declines, the fraction of firms that insource in the North rises, the fraction of firms that outsource in the South declines, and the fraction of firms that insource in the South does not change. Here the interesting implication is that a shift that makes integration more attractive in the North changes the composition of foreign sourcing in favor of FDI.

Finally, consider an increase in the primitive bargaining-power parameter β. It can be shown that it reduces the ratios $\psi_V^S(\eta)/\psi_O^\ell(\eta)$ and $\psi_V^N(\eta)/\psi_O^\ell(\eta)$ for $\ell = N, S$ as well as $\psi_V^N(\eta)/\psi_V^S(\eta)$. The reason is that an increase in β shifts the bargaining power in favor of H, regardless of ownership structure. As a result, outsourcing becomes more attractive to H. In this event the fraction of firms that outsource components rises in each one of the countries. On the other hand, the share of firms that insource components declines in each one of the countries. Moreover, the fraction of firms that import components rises. That is, the fraction of firms that outsource components

in the South rises more than the fraction of firms that insource components in the South declines. It follows that an increase in β biases the acquisition of inputs towards imports on the one hand and towards outsourcing as opposed to integration on the other.

6 Concluding Comments

We have developed a theoretical framework for studying global sourcing strategies. In our model, heterogeneous final-good producers choose organizational forms. That is, they choose ownership structures and locations for the production of intermediate inputs. Headquarter services are always produced in the home country (the North). Intermediate inputs can be produced at home or in the low-wage South, and the production of intermediates can be owned by the final-good producer or by an independent supplier.

Final-good producers and suppliers of components make relationship-specific investments, which are governed by imperfect contracts. In choosing between a domestic and a foreign supplier of parts, a final-good producer trades off the benefits of lower variable costs in the South against the benefits of lower fixed costs in the North. On the other hand, in choosing between vertical integration and outsourcing, the final-good producer trades off the benefits of ownership advantage from vertical integration against the benefits of better incentives for the independent supplier of parts. These tradeoffs induce firms with different productivity levels to sort by organizational form. We show that the equilibrium sorting patterns depend on the wage differential between the North and the South, on the ownership advantage in each one of the countries, on the distribution of the bargaining power between final-good producers and suppliers of components, and on the headquarter intensity of the technology.

A key result is that high-productivity firms acquire intermediate inputs in the South while low-productivity firms acquire them in the North. Amongst firms that source their inputs in the same country, the low-productivity firms outsource while the high-productivity firms insource. In sectors with a very low intensity of headquarter services no firm integrates; low-productivity firms outsource at home while high-productivity firms outsource abroad.

We also show how the prevalence of organizational forms, measured by the fraction of firms that organize in the same way, depends on industry characteristics that shape the sorting pattern and on the degree of productivity dispersion across firms.

Two results stand out. First, sectors with more productivity dispersion rely more on imported inputs, and within the group of headquarter-intensive sectors integration is more prevalent in sectors with more productivity dispersion. Second, the higher a sector's headquarter intensity the less it relies on imported inputs, and within the group of headquarter-intensive sectors integration is more prevalent in sectors with higher headquarter intensity.

Our model has also interesting implications for a widening of the wage gap between the North and the South, or a reduction of the trading costs of intermediate inputs (both changes produce similar results). As one would expect, reducing the costs of foreign sourcing raises the fraction of firms that import intermediate inputs. In addition, however, it raises the fraction of firms that outsource in each one of the countries. As a result, arm's-length trade rises relative to intra-firm trade.

As is evident from these results, our model provides rich predictions about patterns of foreign trade and investment. Since we laid out the empirical motivation for this study in the introduction, it suffices to point out in these concluding comments that our approach helps to better appreciate the complexity of trade and investment in a world in which firms choose endogenously their organizational forms. It also should help in designing empirical studies of the ever evolving world trading system.

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A Appendix

In the main text, we measured the relative prevalence of different organizational forms with the fraction of final-good varieties produced under each type of organization. In this appendix we show that the use of other measures yields similar results.

First consider the case of market shares, i.e., the fraction of industry sales captured by each organizational form. It is straightforward to show that firm revenues can be expressed as:

$$R_k^\ell(\theta, X, \eta) = \frac{X^{(\mu-\alpha)/(1-\alpha)}\theta^{\alpha/(1-\alpha)}\psi_k^\ell(\eta)}{1-\alpha\left[\beta_k^\ell\eta + \left(1-\beta_k^\ell\right)(1-\eta)\right]}.$$

Therefore in the benchmark component-intensive sector, the market share of foreign outsourcing is

$$\xi_{MO}^S = \frac{\left[1-V\left(\theta_{MO}^N\right)\right]\rho_O^S(\eta)}{\left[1-V\left(\theta_{MO}^N\right)\right]\rho_O^S(\eta) + \left[V\left(\theta_{MO}^N\right) - V\left(\underline{\theta}_M\right)\right]\rho_O^N(\eta)}. \tag{19}$$

where

$$\rho_k^\ell(\eta) = \frac{\psi_k^\ell(\eta)}{1-\alpha\left[\beta_k^\ell\eta + \left(1-\beta_k^\ell\right)(1-\eta)\right]} = \left[\frac{1}{\alpha}\left(\frac{w^N}{\beta_k^\ell}\right)^\eta\left(\frac{w^\ell}{1-\beta_k^\ell}\right)^{1-\eta}\right]^{-\alpha/(1-\alpha)}. \tag{20}$$

When the productivity index θ is drawn from a Pareto distribution with the shape parameter k, the distribution of firm sales is also Pareto with the shape parameter $k-\alpha/(1-\alpha)$. Making use of the properties of the Pareto distribution, (19) can be expressed as:

$$\xi_{MO}^S = \frac{1}{1+\left[\left(\frac{\psi_O^N(\eta)\left(f_O^S-f_O^N\right)}{\left[\psi_O^S(\eta)-\psi_O^N(\eta)\right]f_O^N}\right)^{k(1-\alpha)/\alpha-1} - 1\right]\frac{\rho_O^N(\eta)}{\rho_O^S(\eta)}}.$$

Because $\beta_O^N = \beta_O^S = \beta$, it follows that $\rho_O^N(\eta)/\rho_O^S(\eta) = \psi_O^N(\eta)/\psi_O^S(\eta)$, and ξ_{MO}^S is increasing in $\psi_O^S(\eta)/\psi_O^N(\eta)$. This implies that, as in the main text, the prevalence of Southern outsourcing is decreasing in the Southern wage rate, in transport costs, and in the importance of headquarter services as measured by η. Furthermore, because $\theta_{MO}^N > \underline{\theta}_M$, it is straightforward to show that an increase in dispersion (a fall in k) raises the market share of final-good producers outsourcing in the South. Finally, a fall in the South's bargaining power increases $\psi_O^S(\eta)$ and $\rho_O^S(\eta)$ when $\eta < \beta$, a condition that may or may not be more restrictive than the condition that defines the component-intensive sector (i.e., $\beta^*(\eta) < \beta$).[13] When $\eta < \beta$, a fall in the bargaining power in the South raises the market share of Southern outsourcing. When, instead, $\eta > \beta$, the effect is ambiguous.

In the benchmark headquarter-intensive sector, sale revenues are $X^{(\mu-\alpha)/(1-\alpha)}\theta^{\alpha/(1-\alpha)}\widehat{R}(\eta)$,

[13] The inequality $\eta < \beta$ holds true in the low-tech sector when $\beta < 1/2$. This follows from $\beta^*(\eta) > \eta$ if and only if $\beta^*(\eta) < 1/2$ (see equation (10)).

where $\widehat{R}(\eta)$ is given by:

$$\begin{aligned}\widehat{R}(\eta) &= \left[V\left(\theta_{HO}^{N}\right)-V\left(\underline{\theta}_{H}\right)\right]\rho_{O}^{N}(\eta)+\left[V\left(\theta_{HV}^{N}\right)-V\left(\theta_{HO}^{N}\right)\right]\rho_{V}^{N}(\eta)+\\ &\quad+\left[V\left(\theta_{HO}^{S}\right)-V\left(\theta_{HV}^{N}\right)\right]\rho_{O}^{S}(\eta)+\left[1-V\left(\theta_{HO}^{S}\right)\right]\rho_{V}^{S}(\eta),\end{aligned} \tag{21}$$

and $\rho_{k}^{\ell}(\eta)$ is defined in (20). The market share of each type of organizational form is then:

$$\left.\begin{aligned}\xi_{HO}^{N}&=\left[V\left(\theta_{HO}^{N}\right)-V\left(\underline{\theta}_{H}\right)\right]\rho_{O}^{N}(\eta)/\widehat{R}(\eta),\\ \xi_{HV}^{N}&=\left[V\left(\theta_{HV}^{N}\right)-V\left(\theta_{HO}^{N}\right)\right]\rho_{V}^{N}(\eta)/\widehat{R}(\eta),\\ \xi_{HO}^{S}&=\left[V\left(\theta_{HO}^{S}\right)-V\left(\theta_{HV}^{N}\right)\right]\rho_{O}^{S}(\eta)/\widehat{R}(\eta)\\ \xi_{HV}^{S}&=\left[1-V\left(\theta_{HO}^{S}\right)\right]\rho_{V}^{S}(\eta)/\widehat{R}(\eta).\end{aligned}\right\} \tag{22}$$

As is clear from equations (21) and (22), each market share is now a function of all four cutoffs $\underline{\theta}_{H}$, θ_{HO}^{N}, θ_{HV}^{N}, and θ_{HO}^{S}. This complicates the analysis relative to the main text, but the results are similar.

First, a fall in the Southern wage or in transport costs increases $\psi_{O}^{S}(\eta)$, $\psi_{V}^{S}(\eta)$, $\rho_{O}^{S}(\eta)$, and $\rho_{V}^{S}(\eta)$, while leaving the ratios $\psi_{O}^{S}(\eta)/\psi_{V}^{S}(\eta)$ and $\rho_{O}^{S}(\eta)/\rho_{V}^{S}(\eta)$ unaffected. It is straightforward to check that, as in the main text, the ratios $\xi_{HO}^{S}/\xi_{HV}^{S}$, $\xi_{HV}^{S}/\xi_{HO}^{N}$, and $\xi_{HO}^{N}/\xi_{HV}^{N}$ all increase. It follows that global production sharing, as measured by the sum $\xi_{HO}^{S}+\xi_{HV}^{S}$, increases, as does outsourcing relative to integration in each one of the countries. This implies that ξ_{HO}^{S} rises and ξ_{HV}^{N} falls. The overall effect on ξ_{HO}^{N} and ξ_{HV}^{S} depends on whether $\widehat{R}(\eta)$ increases or decreases. If $\eta>\beta$ and w^{N}/w^{S} is high enough, it can be shown that not only $\psi_{V}^{S}(\eta)>\psi_{O}^{S}(\eta)>\psi_{V}^{N}(\eta)>\psi_{O}^{N}(\eta)$, but also $\rho_{V}^{S}(\eta)>\rho_{O}^{S}(\eta)>\rho_{V}^{N}(\eta)>\rho_{O}^{N}(\eta)$.[14] In this case $\widehat{R}(\eta)$ rises when Southern wages or transport costs fall. As a result, ξ_{HO}^{N} falls, whereas the effect on ξ_{HV}^{S} remains ambiguous. If instead η, β, and w^{N}/w^{S} are such that $\widehat{R}(\eta)$ falls, then both ξ_{HO}^{N} and ξ_{HV}^{S} rise when Southern wages or transport costs decline.

Second, it is straightforward to show that an increase in the degree of dispersion reduces the market share of firms outsourcing in the North and increases the market share of firms integrating in the South. Furthermore, as in the main text, $\xi_{HO}^{S}+\xi_{HV}^{S}$, $\xi_{HV}^{S}/\xi_{HO}^{S}$, and $\xi_{HV}^{N}/\xi_{HO}^{N}$ are decreasing in k.

Third, an increase in the output elasticity of headquarter services, η, increases $\psi_{O}^{N}(\eta)/\psi_{O}^{S}(\eta)$ and $\psi_{V}^{\ell}(\eta)/\psi_{O}^{\ell}(\eta)$ for $\ell=N,S$, as well as $\rho_{O}^{N}(\eta)/\rho_{O}^{S}(\eta)$ and $\rho_{V}^{\ell}(\eta)/\rho_{O}^{\ell}(\eta)$ for $\ell=N,S$. As in the main text, the relative prevalence of domestic integration increases, both in absolute terms and relative to domestic outsourcing, while the relative prevalence of foreign outsourcing falls, both in absolute terms and relative to foreign integration. Furthermore, under mild assumptions, the market share of firms that import components falls.

[14] In particular, $\eta>\beta$ ensures that $\rho_{V}^{S}(\eta)>\rho_{O}^{S}(\eta)$ and $\rho_{V}^{N}(\eta)>\rho_{O}^{N}(\eta)$, while $\rho_{O}^{S}(\eta)>\rho_{V}^{N}(\eta)$ holds true as long as:

$$\left(\frac{w^{N}}{w^{S}}\right)^{1-\eta}>\left(\frac{\beta_{V}^{N}}{\beta}\right)^{\eta}\left(\frac{1-\beta_{V}^{N}}{1-\beta}\right)^{1-\eta}.$$

Fourth, consider the effect of β_V^ℓ, $\ell = N, S$. An increase in β_V^S raises $\psi_V^S(\eta)$ without affecting the slopes of the other profits functions. Furthermore, if η is high enough, namely $\eta > \beta_V^S$, this also increases $\rho_V^S(\eta)$ relative to $\rho_O^S(\eta)$, $\rho_V^N(\eta)$, and $\rho_O^N(\eta)$. In this case ξ_{HV}^S increases and ξ_{HO}^S declines, while the ratio ξ_{HO}^N/ξ_{HV}^N does not change. The only difference with the main text is that the market share of final-good producers who use imported components is now affected by β_V^S. The effect depends again on whether $\widehat{R}(\eta)$ increases or decreases with β_V^S. As before, if $\eta > \beta$ and w^N/w^S is high enough, then $\rho_V^S(\eta) > \rho_O^S(\eta) > \rho_V^N(\eta) > \rho_O^N(\eta)$, and $\widehat{R}(\eta)$ is raised by an increase in β_V^S. In this case the market share of importers is increasing in β_V^S.

An increase in β_V^N affects prevalence similarly to the the main text when $\eta > \beta_V^N$. In this case domestic integration gains market share relative to both domestic outsourcing and foreign outsourcing. As a result, the prevalence of vertical integration relative to outsourcing rises in both countries. As in the main text, ξ_{HV}^N is increasing in β_V^N, whereas the effect on the other market shares depends on whether $\widehat{R}(\eta)$ is increasing or decreasing in β_V^N.

Finally, as in the main text, an increase in the primitive bargaining power β reduces the ratios $\psi_V^S(\eta)/\psi_O^\ell(\eta)$, $\psi_V^N(\eta)/\psi_O^\ell(\eta)$, and $\psi_V^N(\eta)/\psi_V^S(\eta)$ for $\ell = N, S$. Moreover, it also reduces the ratios $\rho_V^S(\eta)/\rho_O^\ell(\eta)$, $\rho_V^N(\eta)/\rho_O^\ell(\eta)$, and $\rho_V^N(\eta)/\rho_V^S(\eta)$ for $\ell = N, S$. As a result, the market share of firms outsourcing in each country increases relative to the market share of firms integrating in the same country, just as in the main text. The effect on the market share of firms that import components $(\xi_{HO}^S + \xi_{HV}^S)$ is, however, ambiguous.

Using output of each organizational form as a measure of relative prevalence also yields similar results. In particular, it can be shown that equations (19)-(22) apply to this case, with $\widetilde{\rho}_k^\ell(\eta) = \left[\rho_k^\ell(\eta)\right]^{1/\alpha}$ replacing $\rho_k^\ell(\eta)$. The comparative statics are therefore similar to those for market shares.