Bargaining Order in Organizational Design*

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Abstract

This paper studies how the sequencing of supplier negotiations affects firm boundaries and global sourcing decisions in sequential production. In existing property-rights models of global value chains, the position of a supplier in the production process plays a central role in determining whether that supplier is integrated or outsourced. We add a distinct margin: the final-good producer chooses the order in which it bargains with suppliers. In the model, suppliers make relationship-specific investments, contracts are incomplete, and the final-good producer bargains bilaterally with suppliers using cash-offer contracts. We compare environments in which the final-good producer can commit to the bargaining order before suppliers invest with environments in which such commitment is not feasible. With commitment, sequencing provides an additional instrument for reallocating investment incentives and can substitute for vertical integration. Without commitment, the chosen order must satisfy an *ex post* credibility constraint, which restricts feasible organizational designs and can make vertical integration optimal. In an open economy, this credibility constraint creates a strategic motive for sourcing from a higher-cost location: a firm may choose a more costly sourcing location when doing so improves suppliers' investment incentives. The model therefore identifies a contractual channel through which bargaining-order credibility jointly shapes ownership and sourcing decisions in global value chains. It also offers a cautionary note for empirical work: observed ownership and sourcing patterns may depend not only on input importance, wages, and contractibility, but also on whether supplier-negotiation sequences are predetermined, chosen with commitment, or chosen without commitment.

Keywords: Global Value Chains; Global Sourcing; Firm Boundaries; Bargaining Order; Incomplete Contracts.

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1 Introduction

With globalization, the world has witnessed an unparalleled change in the way firms organize their operations. Production today spans multiple countries and there is an increasing reliance on foreign suppliers to source inputs. In organizing their operations, firms decide not only the sourcing location of inputs but also how much control they want to exercise over their relationships with their suppliers. The latter is the classic make-or-buy decision which determines whether a particular activity is undertaken in-house through vertical integration or is performed by an outside supplier through outsourcing. These two decisions regarding inputs — where to source and whether to make or buy — have been the main focus of the research on firm boundaries in international economics. We add a third margin: the sequencing of supplier negotiations. When sourcing engine components, for example, a car manufacturer must decide whether to negotiate first with a supplier of cylinder blocks or with a supplier of crankshafts. Similar sequencing issues arise in electronics, where a smartphone producer chooses whether to negotiate first with a supplier of customized processors or with a supplier of display modules. By affecting surplus shares and suppliers' investment incentives, this sequencing choice can shape both firm-boundary decisions and the geography of input sourcing.

We study the optimal organizational design within a property-rights model of firm boundaries. In our context, organizational design refers not only to the mode of organization (outsourcing vs. vertical integration) but also the sequencing of bilateral negotiations with input suppliers. We first analyze a closed-economy model in which inputs are sourced domestically to isolate the organizational mechanism linking bargaining order, investment incentives, and firm boundaries. We then embed the same mechanism in an open-economy environment in which inputs can also be sourced internationally. There is an industry with multiple varieties and each variety (final good) is produced in a market described by monopolistic competition. Our focus will be on a typical variety. A final good is produced using two intermediate inputs with a Cobb-Douglas technology. Each input requires relationship-specific investment and contracts for procuring these inputs are incomplete. Therefore, there is a hold-up problem

of underinvestment. Three agents are taking part in this production: suppliers of the two inputs and a final-good producer. In its dealings with each supplier, the final-good producer decides how to operate — either within firm boundaries through vertical integration or outside the firm through arm's length transactions. So far, this is a standard make-or-buy problem. The key additional feature is sequential bargaining with suppliers. Since suppliers' payoffs depend on their position in the bargaining sequence, the order of negotiations affects their expected surplus shares and hence their investment incentives. Our setup has four additional elements that separate the input structure of production from the strategic sequence of supplier bargaining: (1) When sourcing inputs from suppliers, final-good producers bargain with one supplier at a time. This assumption is natural because negotiations over relationship-specific inputs may require direct involvement by the final-good producer, and it can be costly to communicate with all suppliers at the same time, especially when some suppliers are located abroad. We model each of these bilateral negotiations as a generalized Nash bargaining problem. (2) We consider a pay-as-you-go scheme in which payments for inputs are immediately made after reaching an agreement with a supplier, before starting negotiations with another supplier. Such pay-as-you-go arrangements are common in electronics (see Xiao, 2018). (3) Most importantly, final-good producers have discretion over the sequence of input procurement, that is, the order of input-sourcing negotiations is endogenously determined. Thus, the bargaining order is not mechanically pinned down by the technological order of production.[1] (4) The two input suppliers that contribute to the final output may differ in terms of their *ex ante* outside options. In a standard property-rights model of firm boundaries (see Antràs, 2003), *ex ante* outside options of parties are often normalized to zero since this normalization does not affect the main ownership results in that setting. We show that in a setting in which the order of bargaining is endogenous and not contractible, this normalization becomes consequential.

The distinction between the input structure of production and the strategic bargaining

[1] We abstract from storage, coordination, or delivery-lag costs that may arise when the bargaining sequence differs from the timing of physical delivery or assembly. Such frictions could make some procurement sequences more costly or infeasible, but they would add a direct sequencing cost rather than eliminate the contractual incentive channel studied here.

sequence is especially relevant in global value chains, where firms often deal with specialized suppliers located in different markets and subject to different contractual environments. In such settings, the physical order in which inputs enter production need not coincide with the order in which payment terms, surplus splits, or procurement agreements are negotiated. The bargaining sequence is therefore a strategic variable that can affect suppliers' investment incentives and, ultimately, firms' ownership and sourcing decisions.[2]

We consider two scenarios regarding the sequencing of negotiations. First, similar to the choice of organizational mode (outsourcing vs. vertical integration), we assume that the order of input procurement is also contractible at the beginning of the game. This means there is a commitment to the bargaining order and suppliers know this order before making their investments. Under such a commitment, we show that the flexibility in choosing the order of negotiations enables the final-good producer to better adjust its organizational design. This also affects the optimal organizational mode. If the sequence of negotiations were fixed or tied to the input sequence, as in much of the sequential global value-chain literature (see Antràs and Chor, 2013; Alfaro *et al.*, 2019; Karabay, 2022; 2024), then vertical integration *in our setup* would serve to reallocate investment incentives between suppliers. Yet, when the bargaining order is endogenous and contractible, this reallocation of incentives can also be achieved by changing the sequence of negotiations, and thus vertical integration is less likely to occur. Next, we investigate the alternative scenario in which the bargaining order is not contractible. This implies that once input investments are made and potential revenue is revealed, the final-good producer may have an incentive to change the *ex ante* order of negotiations *ex post*. Nevertheless, suppliers have perfect foresight and hence they would anticipate any such opportunistic behavior and make their investments accordingly. This in turn restricts the final-good producer's choices of organizational design. The dis-

[2]The sequencing of negotiations is also relevant in other one-to-many bargaining environments, such as a real-estate developer negotiating with several landowners, a labor union negotiating with multiple firms over wages (see Marshall and Merlo, 2004), or a homeowner dealing with multiple contractors for related parts of a large project. These settings share two features with our framework: one principal negotiates with several agents, and negotiations generally occur one at a time, possibly because of coordination costs or proprietary information (see Krasteva and Yildirim, 2012).

tinction between commitment and no commitment should be interpreted as a reduced-form representation of the enforceability of the procurement sequence. In practice, firms may use framework agreements, procurement schedules, tender rules, or platform-based sourcing systems to make a chosen order harder to revise. While our commitment case captures environments in which these devices are sufficiently strong to make the sequence credible before suppliers invest, the no-commitment case captures environments where such devices are absent or too weak to prevent *ex post* changes to the bargaining order. The analysis also has empirical implications. Observed patterns of vertical integration may depend not only on input characteristics and contractual frictions, but also on whether the bargaining order is predetermined or endogenously chosen, and, in the latter case, whether firms can commit to that order.

To analyze the open-economy implications of our framework, we consider a stylized North-South model of trade in intermediate inputs. Final-good producers are located in the North and apart from organizational design, they decide whether to source their inputs domestically from the North or internationally from the South. We assume that in the South, the wage rate is lower, yet the contractual breach is also more costly to final-good producers. This creates a trade-off between labor-cost savings and the use of sourcing location as an incentive-allocation device. Using this setup, we examine how sourcing patterns and organizational design change with international sourcing under the two scenarios described above. We show that international sourcing improves profits in both scenarios, yet the gains are more limited when final-good producers cannot commit to the bargaining order. Moreover, under no commitment, a firm may choose a higher-cost sourcing location when doing so improves suppliers' investment incentives.

The paper's main contribution is to show that the bargaining order is a distinct organizational margin with direct implications for global sourcing. In standard property-rights models, ownership reallocates surplus shares and thereby affects suppliers' investment incentives. In our setting, the sequence of negotiations can accomplish a similar task, not because suppliers have different bargaining power in *ex post* bilateral negotiations with the

final-good producer, but because suppliers receive different shares depending on their position in the bargaining sequence. This has important implications: when commitment is feasible, optimally choosing the order of negotiations can partially substitute for vertical integration. By contrast, in the absence of commitment, an ideal bargaining order may not be credible *ex post*, and vertical integration may become optimal even though it would not arise under commitment. In the open-economy analysis, the same credibility constraint also affects sourcing locations, showing that the credibility of supplier-negotiation sequences can shape not only firm boundaries but also the geography of input sourcing.

Prior Work. Our work builds on the property-rights model of firm boundaries with simultaneous input production, as in Antràs (2003), and incorporates sequential input negotiations in the spirit of Antràs and Chor (2013) and Karabay (2022; 2024). This line of work links incomplete contracts, supplier position, and ownership choices in global value chains, and Alfaro *et al.* (2019) provide firm-level evidence on the internalization of such value chains. Unlike these papers, however, we endogenize the bargaining order within this framework and distinguish between environments with and without commitment to that order.

In the context of firms' organizational choice, Du *et al.* (2009) also endogenize the bargaining order but within a substantially different setting. They study bi-sourcing of a single input that can be supplied either internally through vertical integration or externally through outsourcing, so the inputs subject to sequential bargaining are perfect substitutes and the organizational mode of each supplier is fixed. Endogenous sequencing therefore determines which organizational mode appears in each bargaining stage, but not the ownership structure attached to each supplier. In our model, by contrast, suppliers provide distinct inputs, and the final-good producer separately chooses both the ownership structure of each supplier relationship and the order of negotiations. Moreover, Du *et al.* (2009) study endogenous bargaining order under commitment: the order is announced before investment and then taken as given in the subsequent bargaining game. By contrast, we analyze both commitment and no-commitment regimes, revealing how the absence of commitment generates an *ex post* credibility constraint.

A related set of papers analyzes the effects of vertical integration between upstream and downstream firms. For instance, Koulayev (2009) looks at the relationship between vertical integration and bargaining power in a model in which an upstream monopolist bargains sequentially with two downstream firms to sell its input. He adopts Atakan (2008)'s non-cooperative, random-proposer bargaining game with delay to model bilateral negotiations and allows the upstream monopolist to choose the bargaining order. In his model, vertically integrating one of the downstream firms gives the upstream monopolist a claim on financial assets without any control over the asset. Hence, aside from his bargaining protocol, the definition of vertical integration differs from ours. In another study, de Fontenay and Gans (2005) analyze the competitive effects of vertical integration using a model based on the property rights approach to firm boundaries. In contrast to our paper, they utilize the non-cooperative bargaining protocol of Stole and Zwiebel (1996), in which the order of negotiations is predetermined.

There is a large literature on games in which one principal engages in bilateral sequential negotiations with multiple agents. For example, Cai (2000) considers an infinite-horizon game in which the principal needs to strike a deal with all suppliers to obtain a positive gain and Bagwell and Staiger (2010) analyze trade negotiations in the presence of the most-favored-nation clause. In both papers, the bargaining order is fixed and agents are symmetric. More recently, Xiao (2018) extends Cai (2000) by introducing asymmetry among agents and an endogenous sequence of negotiations. The analysis of our model in the absence of commitment to the bargaining order closely follows Xiao (2018). Nonetheless, his paper does not study either underinvestment or organizational mode choice. Building on the model of Cai (2000), Li (2010) shows that in the context of complementary goods, any sequencing of negotiations is sustainable in equilibrium. Münster and Reisinger (2021) study bilateral negotiations between a principal and two agents in the presence of externalities between agents. They show that the asymmetry in the agents' bargaining power determines the sequencing of bilateral negotiations chosen by the principal. Unlike our paper, both Li (2010) and Münster and Reisinger (2021) use a non-cooperative, random-proposer bargaining

protocol. In a different context, Krasteva and Yildirim (2012) consider a setup where a buyer bargains with two sellers providing complementary goods and the buyer's valuation for a single good is uncertain. Using a non-cooperative, random-proposer bargaining protocol, they show that the optimal sequencing depends on the extent of complementarity and the difference in bargaining strength.

Relative to the literature discussed above, our contribution is to combine incomplete contracts with relationship-specific investment, endogenous bargaining order, and the firm's ownership and sourcing decisions. Existing property-rights models emphasize how ownership affects investment incentives, but typically take the bargaining sequence as fixed (predetermined). Papers on endogenous sequencing study how a principal chooses the order of negotiations, but generally abstract from relationship-specific investment and the make-or-buy decision. Our framework shows that once these elements are combined, bargaining order becomes a distinct instrument of organizational design: under commitment, it can substitute for vertical integration; under no commitment, it can restrict the set of credible organizational designs; and in an open economy, it can affect the geography of input sourcing.

The rest of the paper is organized as follows. Section 2 lays out the model in a closed economy with domestic sourcing only. The main focus in this section is on organizational design. Section 3 embeds the mechanism in an open-economy environment with North-South sourcing and studies the joint choice of sourcing location and ownership. In Section 4, we discuss some of the modeling assumptions underlying the analysis. The last section concludes. Proofs not included in the main text are relegated to the appendix.

2 The Model

Consider an economy that is populated by identical consumers with preferences represented by the following CES utility function

$$U = \left(\int q(s)^{\rho} ds \right)^{\frac{1}{\rho}} \text{ for } 0 < \rho < 1,$$

where $q(s)$ represents the consumption of variety s and ρ controls the elasticity of substitution, $\frac{1}{1-\rho}$, between varieties. We will focus on a typical variety for the rest of the analysis. Denoting $p(s)$ as the price of variety s, the inverse demand function is

$$p(s) = \Omega^{1-\rho} q(s)^{\rho-1}, \tag{1}$$

where Ω measures the demand level that is common to all varieties. As a result, the revenue can be written as

$$R(s) = p(s)q(s) = \Omega^{1-\rho} q(s)^{\rho}. \tag{2}$$

Production of a variety requires two variety-specific inputs, x_A and x_B. Three types of agents are involved in production: a final-good producer (firm), a supplier of x_A and a supplier of x_B. Suppliers of each input are available in large numbers and as in Antràs (2003), we allow for *ex ante* lump-sum transfers from selected suppliers to secure their participation before the project commences. Let $\mu_j > 0$ represent the *ex ante* outside option of any supplier $j \in \{A, B\}$.[3] For simplicity, the final-good producer's *ex ante* outside option is set to zero.[4] The project is assumed to generate sufficiently large surplus to ensure participation by all agents.

For successful completion of output, both inputs must be of high quality. Low-quality inputs can be produced at negligible cost but are worthless. A high-quality input $x_A(s)$ is produced by supplier A using $L_A(s)$ units of labor under a one-to-one technology: $x_A(s) = L_A(s)$. Similarly, $x_B(s) = L_B(s)$ for supplier B. Here, $L_A(s)$ and $L_B(s)$ represent the labor investments made by suppliers. To produce the output of a variety, the final-good producer combines these inputs via a Cobb-Douglas technology:

$$q(s) = \left(\frac{x_A(s)}{\beta}\right)^{\beta} \left(\frac{x_B(s)}{1-\beta}\right)^{1-\beta},$$

[3] These outside options, which represent suppliers' expected payoffs from alternative projects, may differ across inputs given that suppliers operate in different input markets or face different capacity constraints. The asymmetry in outside options is inconsequential for the commitment case, yet it becomes relevant when there is no commitment, since the final-good producer's *ex post* sequencing decision depends on suppliers' outside options and can therefore differ from the *ex ante* preferred order.

[4] It is possible to allow the final-good producer to have a positive *ex ante* outside option, but this does not affect our results.

where $\beta \in (0,1)$ captures the relative importance of $x_A(s)$ in producing variety s.[5] There is also a fixed operating cost, measured as f units of labor. Letting the wage rate be $\omega > 0$, the corresponding cost is ωf.

The final-good producer bargains sequentially with the selected suppliers according to a generalized Nash bargaining protocol[6] and makes two organizational design choices: (1) the ownership rights over each input by deciding whether to integrate the supplier of a given input, and (2) the order of negotiations—whether to negotiate first with supplier A or supplier B. For the latter choice, we will consider two scenarios. First, we assume that the bargaining order is contractible (hence, there is commitment), implying that suppliers know the order of negotiations before making any investment. Next, we consider the case in which the bargaining order is not contractible, implying that there is no commitment to the *ex ante* chosen order of negotiations, and the final-good producer can change it *ex post*, after suppliers make their investments.

We consider an incomplete contracting setting and as in Antràs (2003), assume that: (1) contracts specifying delivery of high-quality inputs cannot be enforced since input quality is not third-party verifiable, and (2) outsiders cannot verify *ex post* revenue. We take the existence of contract incompleteness as a fact of life without further complicating the model. As a result, there is a standard hold-up problem of underinvestment and any credible exchange for inputs can be done *ex post* once investments are made and inputs are produced. Under these conditions, the only contractibles are *ex ante* transfers, organizational modes, and if commitment is possible, the bargaining order. A few observations are in order. First, final-good producers collect lump-sum transfers from suppliers before any investment is made and competition among a large number of suppliers drives these transfers to a level at which each supplier ends up with its *ex ante* outside option, μ_j for $j \in \{A, B\}$. The presence of *ex ante*

[5] Although the model assumes $\beta \in (0,1)$, we occasionally refer to $\beta = 0$ and $\beta = 1$ as limiting cases.

[6] One could instead consider simultaneous multilateral bargaining and divide surplus according to the Shapley value, as in Acemoglu *et al.* (2007). When the final-good producer and both suppliers are essential for production, this protocol assigns equal surplus shares to all three parties. Such a benchmark abstracts from the sequencing mechanism studied here, since surplus shares do not depend on the order of negotiations. We therefore focus on sequential bilateral bargaining.

transfers does not eliminate the hold-up problem but rather alters the final-good producer's objective function. In deciding whether or not to integrate a supplier, the final-good producer has no rent-extraction motive as *ex ante* transfers allow the final-good producer to capture these rents. Instead, she selects the organizational mode for each stage of production to maximize the project's overall profits. Second, the supplier whose input is procured first is paid immediately, implying that any payment made to this supplier is sunk. Thus, we consider cash-offer contracts, which are prevalent in practice (see Xiao, 2018). Third, determining the organizational mode involves deciding on the optimal ownership rights for each input, which is a choice between outsourcing (O) and vertical integration (V). If outsourcing is chosen, the supplier is independent and not part of the firm, so the final-good producer does not have residual rights of control over the supplier's input. In contrast, under vertical integration, the supplier becomes part of the firm, which makes the final-good producer the residual claimant over the input. This improves the outside option of the final-good producer at the expense of the integrated supplier.

Let ϕ denote the bargaining power of the final-good producer with respect to any supplier $j \in \{A, B\}$. As stated above, the choice of organizational mode affects the outside option of the final-good producer and hence, changes the surplus sharing between the final-good producer and suppliers. Denote ϕ_{k_j} as the fraction of the surplus the final-good producer captures with respect to supplier $j \in \{A, B\}$ under organizational mode $k_j \in \{O, V\}$. If negotiations fail under outsourcing, then both the final-good producer and supplier obtain their outside options, implying that $\phi_{k_j} = \phi_O = \phi$, $\forall j$. By contrast, if negotiations fail under vertical integration, it is assumed that the final-good producer can still obtain a fraction, $\gamma \in (0, 1)$, of the bilateral joint surplus. This in turn increases the final-good producer's share at the expense of the supplier, *i.e.*, $\phi_{k_j} = \phi_V > \phi$, $\forall j$.[7] Therefore, an integrated supplier has a lower incentive to invest than an independent supplier.

[Insert Figure 1 here]

[7]The larger γ is, the more surplus the final-good producer captures under vertical integration, *i.e.*, ϕ_V is increasing in γ.

The timing of events is summarized in Figure 1: (i) The fixed operating cost, ωf, is paid, the organizational mode for each input is chosen, and the order of negotiations is decided. This is the stage where suppliers of each input bid for the production of the corresponding components and make lump-sum transfers. (ii) Suppliers A and B then choose simultaneously and noncooperatively their investments in $L_A(s)$ and $L_B(s)$, respectively, and produce $x_A(s)$ and $x_B(s)$ based on the specification provided by the final-good producer. (iii) Provided that both components are of high quality, bilateral negotiations between the final-good producer and suppliers take place. If the order of negotiations is contractible, then these negotiations follow the order determined in the first step. Otherwise, the final-good producer can change this order. Once the first bargaining is over, the relevant supplier is paid before the negotiations with the other supplier begin. (iv) After input procurement, the final-good variety is produced, sold and the revenue is realized.

2.1 Subgame Perfect Equilibrium

There are two stages: the final-good producer bargains with one supplier in the first stage, which we refer to as supplier 1 and then bargains with the remaining supplier in the second stage, which we refer to as supplier 2. These labels indicate the bargaining order, not supplier identities: depending on the chosen sequence, supplier 1 may be either A or B, and supplier 2 is the remaining supplier. The corresponding *ex ante* outside options of suppliers are denoted by μ_1 and μ_2 with $\mu_1, \mu_2 \in \{\mu_A, \mu_B\}$, where the mapping depends on the bargaining order. There is no discounting between stages for simplicity. The critical thing to note here is that suppliers are forward looking (perfect foresight) and there is no information asymmetry, implying that even if there is no commitment to a bargaining order, suppliers can correctly anticipate the order of negotiations that would be realized in equilibrium and invest accordingly.

The game is solved backwards. Recall that the equation for revenue, $R(s)$, is given by equation (2) and consider the second stage in which the final-good producer bargains with

supplier 2. Supplier 2 solves

$$\left\{ \begin{array}{l} \max\limits_{L_2(s)} \quad \mu_2 + (1-\phi_{k_2})\left(R(s)-\mu_2\right) - \omega L_2(s), \\ \\ \text{subject to } x_2(s) = L_2(s) \text{ and } \phi_{k_2} \in \{\phi, \phi_V\}. \end{array} \right\}$$

In the first stage, the final-good producer bargains with supplier 1. Since supplier 2 claims a fraction $1-\phi_{k_2}$ of $R(s)-\mu_2$, the residual surplus available in the first-stage negotiation, net of supplier 1's *ex ante* outside option, is $\phi_{k_2}\left(R(s)-\mu_2\right)-\mu_1$. Thus, supplier 1 solves

$$\left\{ \begin{array}{l} \max\limits_{L_1(s)} \quad \mu_1 + (1-\phi_{k_1})\left[\phi_{k_2}\left(R(s)-\mu_2\right)-\mu_1\right] - \omega L_1(s), \\ \\ \quad \text{subject to } x_1(s) = L_1(s) \text{ and } \phi_{k_1}, \phi_{k_2} \in \{\phi, \phi_V\}. \end{array} \right\} \tag{3}$$

At the beginning of the game, due to the competitive nature of both of the intermediate input markets, the final-good producer asks for *ex ante* transfers from suppliers 1 and 2 in the amounts $(1-\phi_{k_1})\left[\phi_{k_2}\left(R(s)-\mu_2\right)-\mu_1\right] - \omega L_1(s)$ and $(1-\phi_{k_2})\left(R(s)-\mu_2\right) - \omega L_2(s)$, respectively, and leaves each supplier with its *ex ante* outside option μ_j for $j \in \{A, B\}$ (no rents net of *ex ante* transfers).

2.2 Bargaining order with commitment

Here, we assume that the order of negotiations is contractible, so suppliers know this order before making any investment. We have our first result.

Lemma 1 *It is always optimal to choose outsourcing in the first stage of negotiations, i.e.,* $\phi_{k_1} = \phi_O = \phi$.

Proof. *In choosing the organizational mode, the final-good producer has no rent-extraction motive since it can capture the project's entire surplus thanks to ex ante transfers. We also know that, unlike suppliers, the final-good producer does not make any investment toward production. Hence, the only reason to integrate a particular supplier and lower that supplier's investment incentive is to provide stronger investment incentives (a larger surplus share) to*

the other supplier. Due to the sequential order of bargaining, this surplus reallocation is possible only from the second-stage supplier (supplier 2*) to the first-stage supplier (supplier* 1*), see expression (3). Therefore, integrating supplier* 1 *in the first stage causes supplier* 1 *to invest less without any offsetting benefit and thus lowers profits.* ■

Hereafter, when we talk about organizational mode, we refer to the second stage, *i.e.*, the choice of $\phi_{k_2} \in \{\phi, \phi_V\}$ given that $\phi_{k_1} = \phi_O = \phi$ due to Lemma 1. We are now ready to analyze the choice of *organizational design*, which entails determining the optimal organizational mode as well as the bargaining order. We know that outsourcing is chosen in the first stage due to Lemma 1, whereas either organizational mode is possible in the second stage. Consequently, there are 4 organizational-design possibilities, k_2^{ij}, where $k_2 \in \{O, V\}$, $i \neq j$ and $i, j \in \{A, B\}$:

1. The final-good producer negotiates with supplier A in the first stage and supplier B in the second stage and chooses outsourcing in the second stage. Denote this as O^{AB}, where O stands for outsourcing and superscript AB indicates that negotiations take place first with supplier A and then with supplier B.

2. The final-good producer negotiates with supplier A in the first stage and supplier B in the second stage and chooses vertical integration in the second stage. Denote this as V^{AB}, where V stands for vertical integration and superscript AB indicates that negotiations take place first with supplier A and then with supplier B.

3. The final-good producer negotiates with supplier B in the first stage and supplier A in the second stage and chooses outsourcing in the second stage. Denote this as O^{BA}, where O stands for outsourcing and superscript BA indicates that negotiations take place first with supplier B and then with supplier A.

4. The final-good producer negotiates with supplier B in the first stage and supplier A in the second stage and chooses vertical integration in the second stage. Denote this

as V^{BA}, where V stands for vertical integration and superscript BA indicates that negotiations take place first with supplier B and then with supplier A.

[Insert Table 1 here]

The revenue shares of suppliers, $\phi_A(k_2^{ij})$ and $\phi_B(k_2^{ij})$, in each organizational design k_2^{ij} are summarized in Table 1. Note that under vertical integration (either V^{AB} or V^{BA}), the relative size of each supplier's revenue share is *a priori* unclear: $1-\phi_V \lesseqgtr \phi_V(1-\phi) \Leftrightarrow \phi_V \gtreqless \frac{1}{2-\phi}$. To provide more structure and simplify the taxonomy of cases, we will assume the following for the rest of the paper.[8]

Assumption 1. We assume that $\phi_V < \frac{1}{2-\phi}$ so that $1-\phi_V > \phi_V(1-\phi)$.

The next lemma gives us operating profits for a given organizational design.

Lemma 2 *For a given organizational design k_2^{ij} in Table 1, where $k_2 \in \{O, V\}$, $i \neq j$ and $i, j \in \{A, B\}$, we can state profits $\pi_{k_2^{ij}}(\beta)$ as*

$$\pi_{k_2^{ij}}(\beta) = \Omega\Theta_{k_2^{ij}}(\beta) - \mu_A - \mu_B - \omega f, \tag{4}$$

where $\Theta_{k_2^{ij}}(\beta) = \dfrac{1-\rho\left[(1-\beta)\phi_B(k_2^{ij})+\beta\phi_A(k_2^{ij})\right]}{\left[\frac{1}{\rho}\left(\frac{\omega}{\phi_A(k_2^{ij})}\right)^{\beta}\left(\frac{\omega}{\phi_B(k_2^{ij})}\right)^{1-\beta}\right]^{\frac{\rho}{1-\rho}}}$.

Proof. *See Appendix.*

We know that choosing the organizational design involves choosing: (1) the organizational mode in the second stage, and (2) the order of negotiations. We now have a closer look at each option one at a time in the following two lemmas. To proceed further, define

[8] Assumption 1 is not essential for the existence of the incentive-reallocation mechanism, but it allows us to focus on the case in which vertical integration does not fully overturn the revenue-share advantage of the second-stage supplier. Without this restriction, the ranking of supplier revenue shares under vertical integration can reverse, which generates additional cases without changing the main economic force: the bargaining sequence reallocates investment incentives across suppliers, and commitment determines whether this reallocation is credible. This assumption also satisfies the necessary condition for vertical integration to occur under commitment, see Lemma 5 below.

$\Gamma_{k_2}^{AB-BA}(\beta) \equiv \frac{\pi_{k_2^{AB}}(\beta)+\mu_A+\mu_B+\omega f}{\pi_{k_2^{BA}}(\beta)+\mu_A+\mu_B+\omega f}$ for $k_2 \in \{O, V\}$ as the ratio of variable profits when negotiations are done first with supplier A and then with supplier B to those when negotiations are done first with supplier B and then with supplier A under organizational mode k_2.

Lemma 3 *We have:*

(i) $\Gamma_O^{AB-BA}(\beta)$ *is decreasing in* β*, where* $\Gamma_O^{AB-BA}(\frac{1}{2}) = 1$.

(ii) $\Gamma_V^{AB-BA}(\beta)$ *is decreasing in* β*, where* $\Gamma_V^{AB-BA}(\frac{1}{2}) = 1$.

Proof. *See Appendix.*

Lemma 3 states that for any organizational mode $k_2 \in \{O, V\}$, as the relative importance of supplier A's input (β) increases, negotiating with supplier A in the second stage after negotiating with supplier B in the first stage becomes relatively more appealing. This is intuitive since for a given organizational mode k_2, sequential bargaining allocates a larger revenue share to the supplier in the second stage of negotiations, *i.e.*, $1-\phi_{k_2} > (1-\phi_{k_1})\phi_{k_2}$.[9]

In Lemma 3, we have fixed the mode of organization and examined the relative attractiveness of a particular bargaining order with respect to β. The next lemma does the reverse by analyzing, for a given bargaining order, how the relative attractiveness of vertical integration changes with β. To do so, define $\Psi_{V-O}^{ij}(\beta) \equiv \frac{\pi_{V^{ij}}(\beta)+\mu_A+\mu_B+\omega f}{\pi_{O^{ij}}(\beta)+\mu_A+\mu_B+\omega f}$ for $i \neq j$ and $i, j \in \{A, B\}$ as the ratio of variable profits under vertical integration to those under outsourcing when negotiations are done first with supplier i and then with supplier j.

Lemma 4 *We have:*

(i) $\Psi_{V-O}^{AB}(\beta)$ *is increasing in* β*, where* $\Psi_{V-O}^{AB}(0) < 1$ *and* $\Psi_{V-O}^{AB}(1) > 1$.

(ii) $\Psi_{V-O}^{BA}(\beta)$ *is decreasing in* β*, where* $\Psi_{V-O}^{BA}(0) > 1$ *and* $\Psi_{V-O}^{BA}(1) < 1$.

Proof. *See Appendix.*

Lemma 4 highlights the role of the supplier's position in the bargaining sequence. This depends on whether supplier A negotiates with the final-good producer in the first or second

[9] We know that $\phi_{k_1} = \phi$ under Lemma 1. If $\phi_{k_2} = \phi$, the inequality holds for any $\phi < 1$, whereas if $\phi_{k_2} = \phi_V$, the inequality holds under Assumption 1.

stage. First, suppose that the final-good producer negotiates with supplier A in the first stage (refer to O^{AB} and V^{AB} in Table 1). In this case, supplier A's investment incentive is lower under outsourcing than under vertical integration, *i.e.*, $\phi(1-\phi) < \phi_V(1-\phi)$ given that $\phi < \phi_V$. As supplier A's contribution to production, β, increases, it becomes more important to encourage supplier A to invest more, which makes vertical integration *more* attractive. Next, suppose that the final-good producer negotiates with supplier A in the second stage (refer to O^{BA} and V^{BA} in Table 1). This time, supplier A's investment incentive is higher under outsourcing than under vertical integration, *i.e.*, $1-\phi > 1-\phi_V$ given that $\phi < \phi_V$. As β increases, it becomes relatively more important to incentivize supplier A, which now makes vertical integration *less* attractive.

The preceding lemmas identify two distinct incentive-reallocation channels. First, for a fixed organizational mode, changing the bargaining order changes which supplier receives the larger investment incentive. Second, for a fixed bargaining order, changing the organizational mode reallocates surplus shares between the first- and second-stage suppliers. Under commitment, the final-good producer can use both, whereas under no commitment, while organizational-mode choices remain contractible, the use of bargaining order as an incentive-reallocation instrument is constrained by *ex post* credibility.

We now provide a necessary (but not sufficient) condition for vertical integration to occur in equilibrium.

Lemma 5 *When the order of negotiations is contractible, we must have $\phi_V < 1-\phi(1-\phi)$ for vertical integration to be viable.*

Proof. *The larger are the suppliers' revenue shares, $\phi_A(k_2^{ij})$ and $\phi_B(k_2^{ij})$, the more they invest, generating higher output and profits. Refer to Table 1 and first compare the two organizational structures, V^{AB} and O^{BA}. Since $\phi_V < 1$, we have $\phi_A(V^{AB}) < \phi_A(O^{BA})$. If it is also true that $\phi_B(V^{AB}) \leqslant \phi_B(O^{BA})$, that is, $1-\phi_V \leqslant \phi(1-\phi)$, then for any value of $\beta \in (0,1)$, it is possible to generate more surplus under O^{BA} than under V^{AB}. Next, compare organizational structures V^{BA} and O^{AB}. We have $\phi_B(V^{BA}) < \phi_B(O^{AB})$* given that

$\phi_V < 1$. *If it is also true that* $\phi_A(V^{BA}) \leqslant \phi_A(O^{AB})$, *that is,* $1 - \phi_V \leqslant \phi\,(1-\phi)$, *then for any value of* $\beta \in (0,1)$, *it is possible to generate more surplus under* O^{AB} *than under* V^{BA}. *These two comparisons imply that, for either* V^{AB} *or* V^{BA} *to occur, it is necessary to have* $\phi_V < 1 - \phi\,(1-\phi)$. ■

Notice that this necessary condition is satisfied under Assumption 1.

Utilizing Assumption 1, Lemma 3 and Lemma 4, we can state our first proposition.[10]

Proposition 1 *There exists a critical value of* ϕ, ϕ^{crit}, *such that*

(1) If $\phi > \phi^{crit}$, *then vertical integration cannot occur in equilibrium and*

(i) for $\beta \in (0, \frac{1}{2})$, O^{AB} *is optimal.*

(ii) for $\beta \in (\frac{1}{2}, 1)$, O^{BA} *is optimal.*

(2) In contrast, if $\phi < \phi^{crit}$, *then it is possible to observe both organizational modes in equilibrium. There exists a unique value of* β, $\beta^{\dagger}$, *where* $0 < \beta^{\dagger} < \frac{1}{2}$, *such that*

(i) for $\beta \in (0, \beta^{\dagger})$, O^{AB} *is optimal.*

(ii) for $\beta \in (\beta^{\dagger}, \frac{1}{2})$, V^{AB} *is optimal.*

(iii) for $\beta \in (\frac{1}{2}, 1 - \beta^{\dagger})$, V^{BA} *is optimal.*

(iv) for $\beta \in (1 - \beta^{\dagger}, 1)$, O^{BA} *is optimal.*

Proof. *See Appendix.*

[Insert Figure 2 here]

[Insert Figure 3 here]

When supplier A's contribution is minimal, *i.e.*, $\beta \to 0$, it is important to incentivize supplier B as much as possible. We can see from Table 1 that this can be best achieved through negotiating first with supplier A and second with supplier B under outsourcing, O^{AB}. In contrast, when supplier A's contribution is very large, *i.e.*, $\beta \to 1$, it is critical to incentivize

[10] We omit the knife-edge cases, in which multiple organizational designs yield the same profit, for expositional simplicity.

supplier A as much as possible, which can be done through negotiating first with supplier B and second with supplier A under outsourcing, O^{BA}. By continuity, for β slightly above zero (β slightly below one), O^{AB} (O^{BA}) is still the optimal organizational design. Combining these observations with Lemmas 3 and 4 allows us to conclude that if vertical integration ever occurs, it will do so for the intermediate range of β values, under which balanced contributions from suppliers are required. Figure 2 and Figure 3 show the division of the parameter space as indicated, respectively, in part (1) and part (2) of Proposition 1. Notice that the realization of vertical integration in equilibrium critically depends on the value of ϕ. We know from the proof of Lemma 1 that the only motivation to choose vertical integration is to reallocate revenue shares between suppliers to maximize profits. As ϕ increases, ϕ_A and ϕ_B approach each other, which is what is required to encourage balanced contributions from suppliers (*i.e.*, intermediate β values) and once a high enough ϕ is reached, namely, ϕ^{crit}, these shares are sufficiently balanced that there is no need to reallocate them via vertical integration.

2.3 Bargaining order without commitment

When the bargaining order is not contractible, although the final-good producer may prefer a given bargaining order *ex ante*, this order may not be enforceable *ex post* after suppliers have invested. The equilibrium concept is subgame perfect equilibrium with perfect foresight. Suppliers correctly anticipate the bargaining order that the final-good producer will choose *ex post*, taking as given the organizational modes and the suppliers' outside options. A bargaining order is credible if, after investments have been made and the potential revenue is realized, the final-good producer has no incentive to change to an alternative order. Hence, under no commitment, the choices of organizational design that are feasible are those whose bargaining order satisfies the *ex post* credibility condition derived below.

To derive this condition, we need to look at the behavior of the final-good producer *ex post*, once investments are made and inputs are produced (thus, the prospective revenue is revealed). To this end, let ϕ_{k_1} and ϕ_{k_2} denote the fraction of the surplus the final-good

producer obtains in bargaining with the first- and second-stage suppliers, respectively, under organizational modes $k_1, k_2 \in \{O, V\}$. Recall that unlike bargaining order, organizational mode choices are contractible (see Figure 1) and suppliers know them before making their investments. Given each supplier's input investment, denote the potential revenue that can be realized as R^*. We know that the payment to the first-stage supplier, supplier 1, is a sunk cost for the final-good producer. Given the outside option of the supplier in the second stage, μ_2, the surplus that is shared between the final-good producer and supplier 2 is $R^* - \mu_2$, of which the final-good producer captures $\phi_{k_2}(R^* - \mu_2)$. Thus, the residual surplus available in the first-stage negotiation is $\phi_{k_2}(R^* - \mu_2) - \mu_1$, of which the final-good producer ends up with an *ex post* payoff of $\phi_{k_1}[\phi_{k_2}(R^* - \mu_2) - \mu_1]$.

Now consider suppliers i and j and their corresponding *ex ante* outside options, μ_i and μ_j, for $i, j \in \{A, B\}$ and $i \neq j$. If the supplier in the first stage is supplier i, then the final-good producer obtains an *ex post* payoff of $\phi_{k_i}\left[\phi_{k_j}(R^* - \mu_j) - \mu_i\right]$. Alternatively, if the supplier in the first stage is supplier j, then the final-good producer ends up with an *ex post* payoff of $\phi_{k_j}[\phi_{k_i}(R^* - \mu_i) - \mu_j]$. Comparing the two payoffs, we can see that the final-good producer does not negotiate first with supplier i if

$$\phi_{k_i}\left[\phi_{k_j}(R^* - \mu_j) - \mu_i\right] < \phi_{k_j}[\phi_{k_i}(R^* - \mu_i) - \mu_j], \text{ or}$$

$$\frac{\mu_i}{\mu_j} > \frac{\phi_{k_j}}{\phi_{k_i}}\left(\frac{1 - \phi_{k_i}}{1 - \phi_{k_j}}\right). \tag{5}$$

Notice that R^* cancels out, so the *ex post* bargaining order depends on suppliers' outside options and organizational modes, not directly on the realized revenue. Therefore, in the no-commitment regime, an organizational design is feasible only if the bargaining order associated with that design is *ex post* optimal for the final-good producer.

Our first task is to show that Lemma 1 continues to hold.

Lemma 6 *When the order of negotiations is not contractible, it is still optimal to choose outsourcing in the first stage of negotiations, i.e.,* $\phi_{k_1} = \phi_O = \phi$.

Proof. *See Appendix.*

To understand the intuition behind Lemma 6 better, consider the *ex post* payments to suppliers: supplier 1 receives $\mu_1 + (1 - \phi_{k_1}) [\phi_{k_2} (R^* - \mu_2) - \mu_1]$ and supplier 2 receives $\mu_2 + (1 - \phi_{k_2}) (R^* - \mu_2)$. The potential *ex post* incentive of the final-good producer in changing the bargaining order is to lower these payments. In the negotiations, suppliers must receive at least their *ex ante* outside options, namely, μ_1 and μ_2. That means, any potential reduction can come from each supplier's reward from their bilateral joint surpluses, *i.e.*, $(1 - \phi_{k_1}) [\phi_{k_2} (R^* - \mu_2) - \mu_1]$ and $(1 - \phi_{k_2}) (R^* - \mu_2)$, which depend on: (1) suppliers' *ex ante* outside options and (2) the fraction of the bilateral surplus each supplier captures, which in turn hinges on organizational mode chosen in dealing with each supplier. A decrease in either one lowers the total *ex post* payment the final-good producer needs to make. One might then think, besides changing the bargaining order *ex post*, the final-good producer can integrate suppliers to lower its total *ex post* payment. However, this intuition is incorrect since forward-looking suppliers will adjust their investments accordingly. This means, the total surplus, R^*, will be lower and the final-good producer will be worse off. Instead, the correct way to look at this problem is as follows. Consider the first-best organizational design that maximizes the *ex ante* profits, under which vertical integration is not optimal in the first stage due to Lemma 1. When there is no commitment, the final-good producer's *ex post* incentive to change the bargaining order might prevent it from implementing the first-best organizational design. The question we need to ask is whether the second-best organizational design might have vertical integration in the first stage. Since integration in the first stage lowers the investment incentive of the first supplier without providing any benefit to the second supplier, for this to be true, it must be the case that a particular bargaining order cannot be credible without integrating the first supplier. However, integrating a supplier makes that supplier *less likely* to be the first supplier. This is true since supplier 1 shares the residual surplus of the final-good producer that is left from the negotiations with supplier 2. It is easy to see this from inequality (5) since for given values of μ_i and μ_j, supplier i is less likely to be the first supplier when $\phi_{k_i} = \phi_V$ than when $\phi_{k_i} = \phi$. As a result, if the final-good producer wants to make negotiating with supplier i in the first stage credible, integrating

supplier i does not work.

By Lemma 6, we can restrict our attention to the four organizational-design possibilities, k_2^{ij}, where $k_2 \in \{O, V\}$, $i \neq j$ and $i, j \in \{A, B\}$ described on p. 13. Nevertheless, the final-good producer has a commitment problem, which might lower profits by constraining the choices of organizational design further. Thus, unlike in the commitment case, suppliers' outside options affect not only participation but also the credibility of the bargaining order.

Lemma 7 *Consider suppliers i and j and their corresponding ex ante outside options, μ_i and μ_j, for $i, j \in \{A, B\}$ and $i \neq j$. Without loss of generality, assume that $\mu_i > \mu_j$.*[11]

(i) Negotiating first with supplier i and then with supplier j under outsourcing, O^{ij}, cannot occur in equilibrium.

(ii) If it is also true that $\frac{\mu_i}{\mu_j} > \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$, where $\frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V} > 1$ since $\phi_V > \phi$, then negotiating first with supplier i and then with supplier j under vertical integration, V^{ij}, cannot occur in equilibrium.

Proof. *We know from the proof of Lemma 6 that the final-good producer never negotiates first with supplier i if $\phi_{k_i}\left[\phi_{k_j}\left(R^* - \mu_j\right) - \mu_i\right] < \phi_{k_j}\left[\phi_{k_i}\left(R^* - \mu_i\right) - \mu_j\right]$ or $\frac{\mu_i}{\mu_j} > \frac{\phi_{k_j}}{\phi_{k_i}}\frac{1-\phi_{k_i}}{1-\phi_{k_j}}$. Under O^{ij}, we have $\phi_{k_i} = \phi_{k_j} = \phi$ and the inequality becomes $\frac{\mu_i}{\mu_j} > 1$,* which is true *given our initial assumption $\mu_i > \mu_j$. This means O^{ij} cannot occur in equilibrium. Under V^{ij}, we have $\phi_{k_i} = \phi$, $\phi_{k_j} = \phi_V$ and the inequality becomes $\frac{\mu_i}{\mu_j} > \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$. If it is satisfied, then not only O^{ij} but also V^{ij} cannot occur in equilibrium.*[12] ■

To see the effect of suppliers' *ex ante* outside options on the final-good producer's *ex post* payment, assume first that $\phi_{k_i} = \phi_{k_j}$ but $\mu_i > \mu_j$. In this case, the final-good producer is

[11] When $\mu_A = \mu_B$, the final-good producer is indifferent between the two bargaining orders under outsourcing, generating multiple subgame perfect equilibria. To avoid this non-generic multiplicity, we assume that $\mu_A \neq \mu_B$ in the no-commitment analysis.

[12] In this latter case, we have outsourcing when dealing with supplier i, whereas we have vertical integration when dealing with supplier j. We show that if $\frac{\mu_i}{\mu_j} > \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$ holds, then the final-good producer will not negotiate with supplier i first. This implies that, *ex post*, the final-good producer would negotiate first with the integrated supplier. This might initially seem contrary to Lemma 6, yet it is not. Anticipating this bargaining order, the final-good producer would not integrate supplier j at the beginning of the game (*ex ante*). For example, choosing outsourcing for both suppliers keeps the bargaining order the same but improves profits by giving supplier j stronger investment incentives without decreasing the investment incentive of supplier i.

better off negotiating with supplier i in the second stage. The reason is that the outside option of the first-stage supplier enters the final-good producer's payoff directly, whereas the outside option of the second-stage supplier enters only through the residual surplus available after the second-stage negotiation. Thus, the larger outside option is less costly to the final-good producer when it belongs to the second-stage supplier. Now suppose instead that $\phi_{k_i} < \phi_{k_j}$ but $\mu_i > \mu_j$, implying that supplier j is integrated (since $\phi_{k_i} < \phi_{k_j}$ implies $\phi_{k_i} = \phi$ and $\phi_{k_j} = \phi_V$) but has a lower *ex ante* outside option. In this case, two opposing forces arise. The former, *i.e.*, $\phi_{k_i} < \phi_{k_j}$, favors negotiating with supplier i in the first stage, since doing so leaves supplier j for the second stage, where the final-good producer captures the larger share of the bilateral surplus. In contrast, the latter, *i.e.*, $\mu_i > \mu_j$, favors negotiating with supplier i in the second stage as explained earlier. The relative strength of these two effects determines the credible bargaining order. If $\frac{\mu_i}{\mu_j} > \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$, then the latter effect is stronger and the final-good producer negotiates with supplier i in the second stage, that is, V^{ij}, cannot occur. If $\frac{\mu_i}{\mu_j} < \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$, then the former effect is stronger and the final-good producer negotiates with supplier i in the first stage, that is, V^{ij} can occur.

Under no commitment to the bargaining order, Lemmas 1–4 derived earlier are still valid, while Lemma 5 is replaced by Lemma 7. Accordingly, Proposition 1 changes as follows.[13]

Proposition 2 *Consider suppliers' ex ante outside options, μ_A and μ_B, and recall the critical values ϕ^{crit} and $\beta^\dagger < \frac{1}{2}$ defined in Proposition 1.*

(1) If $1 < \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V} < \frac{\mu_B}{\mu_A}$, then neither O^{BA} nor V^{BA} can occur in equilibrium. There exists a unique value of β, $\widetilde{\beta}$, where $\widetilde{\beta} > \frac{1}{2}$ for $\phi > \phi^{crit}$ and $\widetilde{\beta} < \frac{1}{2}$ for $\phi < \phi^{crit}$, such that

(i) for $\beta \in (0, \widetilde{\beta})$, O^{AB} is optimal.

(ii) for $\beta \in (\widetilde{\beta}, 1)$, V^{AB} is optimal.

(2) If $1 < \frac{\mu_B}{\mu_A} < \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$, then O^{BA} cannot occur in equilibrium. There exists a unique value of β, $\beta^\blacktriangleright$, where $\beta^\blacktriangleright > \frac{1}{2}$ for $\phi > \phi^{crit}$ and $\beta^\blacktriangleright < \frac{1}{2}$ for $\phi < \phi^{crit}$, such that

[13] We again omit knife-edge cases, in which multiple organizational designs may be sustained or yield the same profit, for expositional simplicity.

(2a) If $\phi > \phi^{crit}$, then V^{AB} cannot be optimal and

(i) for $\beta \in (0, \beta^{\blacktriangleright})$, O^{AB} is optimal.

(ii) for $\beta \in (\beta^{\blacktriangleright}, 1)$, V^{BA} is optimal.

(2b) If instead, $\phi < \phi^{crit}$, then

(i) for $\beta \in (0, \beta^{\blacktriangleright})$, O^{AB} is optimal.

(ii) for $\beta \in (\beta^{\blacktriangleright}, \frac{1}{2})$, V^{AB} is optimal.

(iii) for $\beta \in (\frac{1}{2}, 1)$, V^{BA} is optimal.

(3) If $\frac{\phi}{\phi_V}\frac{1-\phi_V}{1-\phi} < \frac{\mu_B}{\mu_A} < 1$, then O^{AB} cannot occur in equilibrium. There exists a unique value of β, $\beta^{\blacktriangleleft}$, where $\beta^{\blacktriangleleft} < \frac{1}{2}$ for $\phi > \phi^{crit}$ and $\beta^{\blacktriangleleft} > \frac{1}{2}$ for $\phi < \phi^{crit}$, such that

(3a) If $\phi > \phi^{crit}$, then V^{BA} cannot be optimal and

(i) for $\beta \in (0, \beta^{\blacktriangleleft})$, V^{AB} is optimal.

(ii) for $\beta \in (\beta^{\blacktriangleleft}, 1)$, O^{BA} is optimal.

(3b) If instead, $\phi < \phi^{crit}$, then

(i) for $\beta \in (0, \frac{1}{2})$, V^{AB} is optimal.

(ii) for $\beta \in (\frac{1}{2}, \beta^{\blacktriangleleft})$, V^{BA} is optimal.

(iii) for $\beta \in (\beta^{\blacktriangleleft}, 1)$, O^{BA} is optimal.

(4) If $\frac{\mu_B}{\mu_A} < \frac{\phi}{\phi_V}\frac{1-\phi_V}{1-\phi} < 1$, then neither O^{AB} nor V^{AB} can occur in equilibrium. There exists a unique value of β, $\widehat{\beta}$, where $\widehat{\beta} < \frac{1}{2}$ for $\phi > \phi^{crit}$ and $\widehat{\beta} > \frac{1}{2}$ for $\phi < \phi^{crit}$, such that

(i) for $\beta \in (0, \widehat{\beta})$, V^{BA} is optimal.

(ii) for $\beta \in (\widehat{\beta}, 1)$, O^{BA} is optimal.

Proof. *The proof follows from Lemma 3, Lemma 4, Lemma 7, Proposition 1 and the fact that the production function is symmetric around $\beta = \frac{1}{2}$.*

This proposition characterizes how no commitment reshapes the organizational-design regions. Across cases, the only differences are which supplier has the larger outside option

and whether the credibility constraint eliminates outsourcing alone or both outsourcing and vertical integration for a given bargaining order. The underlying logic is the same: no commitment removes some bargaining sequences from the feasible set, and the final-good producer chooses the best remaining organizational design. Comparison of Propositions 1 and 2 reveals that when there is no commitment to the order of negotiations, each organizational mode (outsourcing and vertical integration) is guaranteed to exist for some parameter space. This occurs since the *ex post* opportunism of the final-good producer might prevent it from choosing the negotiation order that maximizes the project's value. For example, consider a scenario in which $\phi > \phi^{crit}$, $\frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V} < \frac{\mu_B}{\mu_A}$ and β is very large (close to 1). When the bargaining order is contractible, we know from Proposition 1 that vertical integration is not optimal in equilibrium (since $\phi > \phi^{crit}$). Also, given that supplier A's input is relatively more important (β is close to 1), supplier A needs stronger investment incentives than supplier B and the best way to achieve this is to choose the organizational design O^{BA}, to wit, negotiating first with supplier B and then with supplier A under outsourcing. However, in the absence of commitment, the final-good producer will change this order *ex post*. Suppliers anticipate this and invest accordingly, which makes O^{BA} infeasible. The second-best option, V^{BA}, is also infeasible for the same reason (see part (1) of Proposition 2). The third-best alternative to incentivize supplier A under a credible bargaining order (negotiating first with supplier A and then with supplier B) is to choose V^{AB}, which is feasible. By choosing V^{AB}, the final-good producer can allocate a larger revenue share to supplier A at supplier B's expense. In this example, while vertical integration can never be observed in equilibrium when there is commitment to the bargaining order, this is not the case in the absence of commitment.

This comparison suggests that empirical studies of firm boundaries should distinguish among three procurement environments: (i) the bargaining order is predetermined, (ii) firms choose and commit to the bargaining order before suppliers invest, and (iii) firms choose a preferred order but cannot commit to it *ex ante*. This distinction matters given that endogenous sequencing with commitment can substitute for vertical integration as a way to

reallocate investment incentives across suppliers, whereas endogenous sequencing without commitment may restrict the choices of credible organizational design and make vertical integration optimal. Ignoring these margins may cause empirical work to conflate ownership incentives with sequencing and commitment constraints. A possible empirical approach would first identify cases in which the procurement order is likely predetermined, using proxies such as technological sequencing requirements, regulatory certification steps, or modularity constraints. For the remaining cases, variation in procurement orders across comparable projects, products, or firms could be used to assess whether the bargaining order is endogenously chosen. Conditional on such evidence, commitment to the chosen order could be proxied by prior long-term supply agreements, framework agreements, formal procurement schedules, or other institutional features that make the procurement sequence more enforceable. This classification would allow empirical work to estimate the probability of vertical integration across procurement regimes while controlling for input importance, relationship specificity, contractual frictions, and firm- or product-level characteristics.[14]

3 The Open Economy: Global Sourcing

We now embed the bargaining-order mechanism in an open-economy environment. The purpose is to study how the credibility of the bargaining sequence affects not only the ownership decision but also the location from which inputs are sourced. The production process is the same as before but now there are two countries, North (N) and South (S) with corresponding fixed wage rates ω^N and ω^S. The fixed operating cost requires f units of Northern labor, and thus amounts to $\omega^N f$. Final-good varieties are completed in the North, so all final-good producers are located there. Suppliers of each input operate in both countries and their *ex ante* outside options do not change between countries: $\mu_A^N = \mu_A^S = \mu_A$ and $\mu_B^N = \mu_B^S = \mu_B$. Let $\phi_{k_1}^{l_1} \in (0,1)$ denote the fraction of the surplus the final-good producer obtains in *ex post* bilateral negotiations with the first-stage supplier, supplier 1, who may

[14] The model predicts that a chosen bargaining order with commitment should be associated with less vertical integration relative to settings in which the bargaining order is predetermined, whereas lack of commitment should weaken this substitution effect and may increase the likelihood of vertical integration.

be either A or B, when that supplier is located in country $l_1 \in \{N, S\}$. We have $k_1 = O$ by Lemmas 1 and 6. Similarly, let $\phi_{k_2}^{l_2} \in (0,1)$ denote the fraction of the surplus the final-good producer obtains in *ex post* bilateral negotiations with the second-stage supplier, supplier 2, who is the remaining supplier, when that supplier is located in country $l_2 \in \{N, S\}$ and $k_2 \in \{O, V\}$. We assume that labor is cheaper in the South ($\omega^S < \omega^N$), whereas contractual breach is more costly for final-good producers when sourcing inputs from the South. We model the latter in the spirit of Antràs and Helpman (2004) such that if negotiations fail under vertical integration, the fraction of the surplus that final-good producers capture is lower in the South, *i.e.*, $\gamma^S < \gamma^N$, implying that $\phi_V^S < \phi_V^N$ (recall Footnote 7).[15] In contrast, we have symmetry between countries under outsourcing, *i.e.*, $\phi_O^N = \phi_O^S = \phi$.

The open-economy environment introduces a trade-off that is absent in the closed-economy model. Sourcing from the South lowers input costs, but it may also weaken the incentive effects of vertical integration since contractual breach is more costly for final-good producers when suppliers are located in the South. Hence, sourcing location and organizational design interact such that the final-good producer must balance labor-cost savings against the allocation of investment incentives across suppliers. When the bargaining order is not contractible, this trade-off is further shaped by the credibility of the chosen negotiation sequence.

We can now write down the profit function when international sourcing is available. To this purpose, under organizational design k_2^{ij}, let $\phi_A^{l_A}(k_2^{ij})$ denote the revenue share of supplier A from country $l_A \in \{N, S\}$ and let $\phi_B^{l_B}(k_2^{ij})$ denote the revenue share of supplier B from country $l_B \in \{N, S\}$. Using equation (4), we get

$$\pi_{k_2^{ij}}^{l_A, l_B}(\beta) = \Omega \Theta_{k_2^{ij}}^{l_A, l_B}(\beta) - \mu_A - \mu_B - \omega^N f, \tag{6}$$

where

$$\Theta_{k_2^{ij}}^{l_A, l_B}(\beta) = \frac{1 - \rho \left[(1-\beta)\, \phi_B^{l_B}(k_2^{ij}) + \beta \phi_A^{l_A}(k_2^{ij}) \right]}{\left[\frac{1}{\rho} \left(\frac{\omega^{l_A}}{\phi_A^{l_A}(k_2^{ij})} \right)^{\beta} \left(\frac{\omega^{l_B}}{\phi_B^{l_B}(k_2^{ij})} \right)^{1-\beta} \right]^{\frac{\rho}{1-\rho}}}. \tag{7}$$

[15] This assumption can also be interpreted as reflecting lower corruption and stronger legal protection in the North (see Antràs and Helpman, 2004).

The following lemma is in order.

Lemma 8 *Our open-economy setup implies that:*

(i) Given that $\phi_O^N = \phi_O^S = \phi$ *but* $\omega^S < \omega^N$*, it is always optimal to do first-stage negotiations with a supplier from the South.*

(ii) Given that $\phi_V^N > \phi_V^S$*, the critical value of* ϕ*,* ϕ^{crit}*, stated in Proposition 1 is lower in the North, i.e.,* $(\phi^{crit})^N < (\phi^{crit})^S$*.*

Proof. *See Appendix.*

Part (i) of Lemma 8 implies that it is always optimal to procure the first input from the South. Part (ii) of Lemma 8 implies that for a given value of ϕ, vertical integration is more likely to occur if the second input is procured from the South. To make the analysis easy to follow, we will make two more assumptions.

Assumption 2. $(\phi^{crit})^N < \phi$

Assumption 2 allows us to isolate the role of international sourcing in shaping organizational design. Under this assumption, when the bargaining order is contractible, vertical integration cannot occur with domestic sourcing, *i.e.*, when both inputs are sourced from the North (see part (1) of Proposition 1). Therefore, if vertical integration occurs once Southern suppliers are available, this is not because the closed-economy benchmark already favors integration, but because international sourcing changes the incentive-reallocation trade-off.

Assumption 3. $\frac{\phi_V^N}{\phi}\frac{1-\phi}{1-\phi_V^N} < \frac{\mu_B}{\mu_A}$.

First, since the expression $\frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V}$ is increasing in ϕ_V and $\phi_V^S < \phi_V^N$, Assumption 3 also implies $\frac{\phi_V^S}{\phi}\frac{1-\phi}{1-\phi_V^S} < \frac{\mu_B}{\mu_A}$. Therefore, by Lemma 7, when the bargaining order is not contractible, the final-good producer's *ex post* opportunism implies that neither O^{BA} nor V^{BA} can occur in equilibrium, regardless of whether the second-stage supplier is located in the North or the

South. Hence, for high values of β, the final-good producer cannot credibly implement the sequence that would give supplier A the larger second-stage surplus share.[16]

For comparison with international sourcing, assume first that only domestic sourcing from the North is possible. When the bargaining order is contractible, vertical integration cannot occur in equilibrium due to Assumption 2. Using part (1) of Proposition 1, we can conclude that O^{AB} is optimal for $\beta < \frac{1}{2}$, whereas O^{BA} is optimal for $\beta > \frac{1}{2}$. On the other hand, when the bargaining order is not contractible, O^{BA} and V^{BA} cannot occur in equilibrium due to Assumption 3. Using part (1) of Proposition 2, we can state that there is a unique value of $\widetilde{\beta}$, where $\widetilde{\beta} > \frac{1}{2}$ due to Assumption 2, such that O^{AB} is optimal for $\beta < \widetilde{\beta}$, whereas V^{AB} is optimal for $\beta > \widetilde{\beta}$.

[Insert Table 2 here]

Now we are ready to analyze the model implications when international sourcing is viable. To clarify our notation further, consider the organizational design choices defined earlier (refer to p. 13): O^{AB}, V^{AB}, O^{BA} and V^{BA}. We know that the first-stage supplier, supplier 1, is always from the South due to part (i) of Lemma 8. Hence, let $(O^{AB})^{l_2}$, $(V^{AB})^{l_2}$, $\left(O^{BA}\right)^{l_2}$ and $\left(V^{BA}\right)^{l_2}$ denote the organizational design choices when supplier 2 is from country $l_2 \in \{N, S\}$. The revenue shares of suppliers, ϕ_A and ϕ_B, in each organizational design $(k_2^{ij})^{l_2}$ with international sourcing are summarized in Table 2. We also denote the corresponding profits in each organizational design as $\pi_{(k_2^{ij})^{l_2}}(\beta)$.

3.1 Open Economy with Commitment

Due to part (ii) of Lemma 8, we know that $(\phi^{crit})^N < (\phi^{crit})^S$. Accordingly, there are two possibilities:

Case 1 $(\phi^{crit})^N < (\phi^{crit})^S < \phi$

[16] The opposite restriction on outside options would rule out O^{AB} and V^{AB} instead, generating the mirror case for low values of β. We impose Assumption 3 to focus on one side of the no-commitment constraint and keep the open-economy taxonomy tractable.

Under this case, vertical integration cannot arise with international sourcing. Therefore, four organizational-design choices are available: $(O^{AB})^N$, $(O^{AB})^S$, $(O^{BA})^N$ and $(O^{BA})^S$. If it were the case that $\omega^S = \omega^N$, then it would not make any difference whether to procure the second input from the North or South in either organizational design (O^{AB} or O^{BA}) given that $\phi_O^N = \phi_O^S = \phi$ (refer to Table 2). However, since $\omega^S < \omega^N$, procuring the second input from the South is more beneficial. In other words, $\pi_{(O^{ij})^S}(\beta) > \pi_{(O^{ij})^N}(\beta)$ for $i \neq j$ and $i, j \in \{A, B\}$. Using part (1) of Proposition 1, we can state that $\left(O^{AB}\right)^S$ is optimal for $\beta < \frac{1}{2}$, whereas $\left(O^{BA}\right)^S$ is optimal for $\beta > \frac{1}{2}$. In this scenario, while the organizational design choice does not change with international sourcing, the sourcing location of both inputs changes from the North to the South.

Case 2 $(\phi^{crit})^N < \phi < (\phi^{crit})^S$

This time, vertical integration can arise with international sourcing. Hence, available choices of organizational design are: $(O^{AB})^N$, $(O^{AB})^S$, $(V^{AB})^S$, $(O^{BA})^N$, $(O^{BA})^S$ and $(V^{BA})^S$. As before, if outsourcing is optimal, it is more beneficial to procure the second input from the South given that $\omega^S < \omega^N$, that is $\pi_{(O^{ij})^S}(\beta) > \pi_{(O^{ij})^N}(\beta)$ for $i \neq j$ and $i, j \in \{A, B\}$. This means $(O^{AB})^N$ and $(O^{BA})^N$ cannot occur in equilibrium and both inputs will be procured from the South. Regarding organizational design, we can use part (2) of Proposition 1 to state that there are two critical values of β, β_1 and β_2, with $0 < \beta_1 < \frac{1}{2} < \beta_2 < 1$, such that $\left(O^{AB}\right)^S$ is optimal for low values of β, *i.e.*, $\beta < \beta_1$, whereas $\left(O^{BA}\right)^S$ is optimal for high values of β, *i.e.*, $\beta > \beta_2$. On the other hand, we can observe vertical integration for intermediate values of β, such that $\left(V^{AB}\right)^S$ is optimal for $\beta \in (\beta_1, \frac{1}{2})$ and $\left(V^{BA}\right)^S$ is optimal for $\beta \in (\frac{1}{2}, \beta_2)$. As a result, with international sourcing, not only are both inputs now sourced from the South, but also for some parameter space $\beta \in (\beta_1, \beta_2)$, we can also observe vertical integration as the optimal organizational mode.

Summarizing our results for international sourcing under commitment, both inputs are sourced from the South in both cases and given that the wage rate is lower in the South, international sourcing definitely improves firm profits. While organizational design choice in

Case 1 does not change with international sourcing, it does change in Case 2, which manifests itself through a change in organizational mode from outsourcing to vertical integration for intermediate values of β, while keeping the bargaining order with suppliers intact.[17]

3.2 Open Economy without Commitment

The no-commitment case delivers a distinct open-economy implication: sourcing location can be used not only to reduce labor costs but also to adjust the investment incentives generated under vertical integration. The relative magnitude of suppliers' outside options becomes important. Under Assumption 3, $(O^{BA})^N$, $(O^{BA})^S$, $(V^{BA})^N$ and $(V^{BA})^S$ are infeasible as indicated by Lemma 7 due to the final-good producer's *ex post* incentive to change the bargaining order. Furthermore, since $\phi_O^N = \phi_O^S = \phi$ but $\omega^S < \omega^N$, under *outsourcing*, it is beneficial to procure the second input from the South, *i.e.*, $\pi_{(O^{AB})^S}(\beta) > \pi_{(O^{AB})^N}(\beta)$. Thus, $(O^{AB})^N$ also cannot occur in equilibrium and the feasible organizational design choices are limited to: $(O^{AB})^S$, $(V^{AB})^N$ and $(V^{AB})^S$. As $\beta \to 0$, supplier B's input is very important for the production of the final output and Table 2 indicates that the investment incentive of supplier B is the strongest under $(O^{AB})^S$, *i.e.*, $1-\phi > 1-\phi_V^S > 1-\phi_V^N$. In addition, there is also a labor-cost advantage firms enjoy due to sourcing both inputs from the South under $(O^{AB})^S$. Both of these observations imply that for $\beta \to 0$, $(O^{AB})^S$ is the optimal organizational design. This is also true for β values that are slightly above zero by continuity. In contrast, as $\beta \to 1$, supplier A's input is very important for production and as Table 2 makes clear, supplier A's investment incentive is the strongest under $(V^{AB})^N$, *i.e.*, $\phi_V^N(1-\phi) > \phi_V^S(1-\phi) > \phi(1-\phi)$. However, this incentive advantage under $(V^{AB})^N$ must be weighed against the labor-cost disadvantage as the North has a higher wage rate. Using equation (7), we can see that the labor-cost disadvantage of sourcing the second input from the North vanishes as $\beta \to 1$, *i.e.*, $\left(\frac{\omega^N}{\omega^S}\right)^{1-\beta} \to 1$. This means, in the limiting case in which supplier A's input is overwhelmingly important, only the investment-incentive effect is present and thus, $(V^{AB})^N$ generates the highest profits. The intuition is that, under the

[17] This latter result is due to Assumption 1. Alternatively, if we were to assume $\phi_V > \frac{1}{2-\phi}$, then in addition to organizational mode, the order of negotiations would change with international sourcing for $\beta \in (\beta_1, \beta_2)$.

credible bargaining order AB, the final-good producer cannot negotiate with supplier A in the second stage, where supplier A would receive the largest surplus share. Sourcing the second-stage input from the North under vertical integration partially substitutes for this constraint. Given that $\phi_V^N > \phi_V^S$, sourcing the second-stage supplier from the North lowers supplier B's surplus share, $1 - \phi_V^N$, and raises the first-stage supplier's effective share, $\phi_V^N(1 - \phi)$. Thus, when supplier A's input is sufficiently important, the final-good producer may optimally source the second-stage input from the North despite the higher cost of Northern labor in order to shift investment incentives toward supplier A. By continuity, this must still be true for β slightly below 1, implying that there is a part of the parameter space where $(V^{AB})^N$ is the optimal organizational design. This discussion implies that if $(V^{AB})^S$ ever occurs, it will do so for an intermediate range of β values. The no-commitment case in the open economy is therefore useful since it separates two effects of international sourcing. First, sourcing from the South reduces labor costs. Second, the location of the second-stage supplier changes the investment incentives generated by vertical integration. The optimal design depends on which of these two forces dominates, and this dominance changes with β. We can now state the following.

Proposition 3 *Recall the critical value of β, $\widetilde{\beta}$, when only domestic sourcing is viable under no commitment (see p. 28). With international sourcing, there are two critical values of β, $\widetilde{\beta}_1$ and $\widetilde{\beta}_2$, with $0 < \widetilde{\beta}_1 < \widetilde{\beta} < \widetilde{\beta}_2 < 1$, where $\widetilde{\beta}_1 > \frac{1}{2}$ for $\phi > (\phi^{crit})^S$ and $\widetilde{\beta}_1 < \frac{1}{2} < \widetilde{\beta}_2$ for $\phi < (\phi^{crit})^S$, such that*

(i) for $\beta \in (0, \widetilde{\beta}_1)$, $(O^{AB})^S$ is optimal.

(ii) for $\beta \in (\widetilde{\beta}_1, \widetilde{\beta}_2)$, $(V^{AB})^S$ is optimal.

(iii) for $\beta \in (\widetilde{\beta}_2, 1)$, $(V^{AB})^N$ is optimal.

Proof. *See Appendix.*

Consequently, the parameter space is divided into three regions. When input x_B is very important (low value of β), the optimal organizational design is $(O^{AB})^S$, where both inputs are sourced from the South under outsourcing and negotiations are done first with supplier

A and then with supplier B. Notice that for this range of β values, the failure to commit to a bargaining order does not affect the optimal organizational design. On the other hand, when input x_A is very important (high value of β), the optimal organizational design is $(V^{AB})^N$, where the first input is sourced from the South but the second input is sourced from the North under vertical integration and negotiations are done first with supplier A and then with supplier B. For this range of β, the failure to commit to a bargaining order hurts the most given that neither O^{BA} (first best) nor V^{BA} (second best) is feasible (recall the discussion on p. 24). For $\beta \in (\widetilde{\beta}_1, \widetilde{\beta}_2)$, the optimal organizational design is $(V^{AB})^S$, where both inputs are sourced from the South under vertical integration and negotiations are done first with supplier A and then with supplier B. For this intermediate range of β values, the failure to commit to a particular bargaining order does not affect the optimal organizational design if $\beta < \frac{1}{2}$, but it does so if $\beta > \frac{1}{2}$.[18]

In addition, as discussed before, when there is no commitment to the bargaining order, each organizational mode (outsourcing and vertical integration) is guaranteed to exist for some parameter space. This is independent of the sourcing location of inputs. With international sourcing, however, we see that the parameter range where vertical integration is optimal expands given that $\widetilde{\beta}_1 < \widetilde{\beta}$, and unless supplier A's contribution to production is very important, *i.e.*, $\beta > \widetilde{\beta}_2$, both inputs will be sourced internationally from the South.

Lastly, in the absence of commitment, compared to domestic sourcing, firm profits increase with international sourcing. To be specific, for any $\beta < \widetilde{\beta}_1$, while organizational mode does not change, both inputs are sourced from the South, where the wage rate is lower. In this parameter range, the benefit to firm profits arises from labor cost reduction in obtaining each input. A similar benefit arises for any $\beta > \widetilde{\beta}_2$, although to a more limited extent, since only the initially procured input is sourced from the South. On the other hand, for any $\beta \in (\widetilde{\beta}_1, \widetilde{\beta}_2)$, the improvement in firm profits occurs not only due to lower labor cost in the South but also higher revenue due to more efficient allocation of revenue shares between

[18]Notice that having $\beta \in (\widetilde{\beta}_1, \widetilde{\beta}_2)$ and $\beta < \frac{1}{2}$ at the same time implies that $\widetilde{\beta}_1 < \frac{1}{2} < \widetilde{\beta}_2$, which requires $\phi < \left(\phi^{crit}\right)^S$, see Proposition 3.

suppliers. In other words, for this range of β values, even if there were no wage rate difference between the two countries, there would still be improvement in firm profits due to this latter effect.

4 Discussion

This section discusses several modeling assumptions underlying the analysis and how alternative formulations would affect the results. First, we assume that suppliers' outside options are exogenous. In the presence of commitment, these exogenous outside options enter the final-good producer's profit function as additive constants given that *ex ante* lump-sum transfers collected from suppliers drive suppliers' payoffs down to their participation constraints. Consequently, their exact values do not alter the firm's optimal choice of organizational design or bargaining sequence. In contrast, in the absence of commitment, these outside options become relevant as they affect the final-good producer's *ex post* incentive to revise the bargaining order. In the no-commitment analysis, we impose asymmetry in suppliers' outside options across input lines to avoid multiplicity of equilibria. This tie-breaking condition enables the credibility constraint to select a unique bargaining order and makes the role of outside options transparent.

There are different ways to extend this assumption. One way is to allow outside options to vary with the sourcing environment. For instance, suppliers' outside options could remain exogenous but differ not only across input lines but also across countries. This would be a meaningful extension, especially in the open-economy setting. We introduce asymmetry across input lines in the baseline model because the no-commitment mechanism is first developed in the closed economy, where there is no sourcing-location margin. If outside-option asymmetry arose only across countries, the role of outside options in the credibility constraint would appear only in the open-economy analysis. However, it would introduce an additional source of variation in the no-commitment credibility constraints. In that case, changes in the feasible organizational-design choices would reflect both the sequencing mechanism emphasized in the paper and cross-country differences in suppliers' outside options.

As a result, we keep outside options independent of sourcing location in order to isolate the role of bargaining order and maintain a tractable characterization of the equilibrium regions. Another possibility is to make outside options endogenous by allowing suppliers to invest in their outside opportunities. In that case, outside options would introduce an additional investment margin and could affect the commitment case as well, since suppliers' investments in outside opportunities would respond to the surplus shares associated with the chosen organizational design. We do not pursue this extension as it would change the nature of the incentive problem: suppliers would then choose not only relationship-specific investments, which increase the value of the current project, but also investments in outside opportunities, which improve their bargaining positions. The final-good producer's organizational-design problem would therefore involve balancing incentives for two distinct types of investment. Since the objective of the paper is to highlight how bargaining order affects incentives for relationship-specific investment, we leave endogenous outside options for future work.

Second, suppliers are assumed to have common bargaining power in *ex post* bilateral negotiations. This assumption is not meant to rule out supplier heterogeneity, but rather to ensure that differences in suppliers' surplus shares arise from their position in the bargaining sequence and from the ownership structure, not from primitive differences in bargaining power. If suppliers differed in bargaining power in *ex post* bilateral negotiations, the final-good producer's organizational-design problem would reflect both sequencing effects and supplier-specific bargaining-power asymmetries. Such asymmetries could generate additional variation in ownership choices, but they would also make it harder to focus on the paper's main mechanism.

Third, the model assumes a pay-as-you-go scheme: once the final-good producer reaches an agreement with the first supplier, the relevant supplier is paid before negotiations with the remaining supplier begin. Thus, the first payment is sunk at the time of the second negotiation. This assumption captures sourcing environments in which suppliers are paid upon delivery, at production milestones, or before subsequent procurement steps are completed. It also keeps the bargaining protocol sequential in an economically meaningful sense. If

all payments were instead deferred until the end of the production chain, the first supplier's compensation would no longer be sunk during the second negotiation, and the problem would move closer to a multilateral bargaining environment over the total surplus. We therefore use cash-offer contracts in order to focus on how sequential procurement and the timing of payments affect surplus shares and investment incentives.

Fourth, the model considers two suppliers. This is the minimal environment in which bargaining order is meaningful and can interact with ownership and sourcing decisions. It can be interpreted as a local segment of a longer global value chain, focusing on two adjacent or technologically related inputs whose suppliers must both be induced to invest. With more than two suppliers, the final-good producer would choose a full sequence of negotiations rather than deciding which of two suppliers to bargain with first. This would create a richer ordering problem, but the basic incentive channel would remain: a supplier's position in the bargaining sequence affects its surplus share and therefore its investment incentive. The two-supplier model therefore provides the simplest setting in which to study bargaining order as an instrument of organizational design.

5 Conclusion

This paper studies how the credibility of bargaining order shapes firm boundaries and global sourcing decisions in sequential production. In standard property-rights models of global value chains, the position of a supplier along the production line affects the firm's incentive to integrate or outsource that supplier. We add a distinct margin: the final-good producer's ability to choose and commit to the order of supplier negotiations. This margin matters since the bargaining order affects suppliers' surplus shares and therefore their relationship-specific investment incentives.

We first consider the ramifications of endogenizing the bargaining order with suppliers in the closed economy. The presence of incomplete contracts causes underinvestment in inputs as suppliers cannot capture the full marginal return on their investments. Firms can alleviate this by optimally choosing the ownership rights through their choice of organiza-

tional mode. We show that this organizational mode choice is very much affected by the sequencing of negotiations. We consider two scenarios. In the first scenario, we assume that bargaining order with suppliers is contractible. In this case, the final-good producer can use the sequence of negotiations as an additional instrument for allocating investment incentives across suppliers. As a result, endogenous bargaining order can partially substitute for vertical integration. The second scenario assumes that bargaining order is not contractible, implying that the final-good producer might change the order of negotiations *ex post* once suppliers make their investments. This *ex post* opportunism in turn restricts the organizational design options firms can choose and potentially lowers profits.

We then analyze how things unfold in the open economy. We assume that firms producing the final output are located in the North, whereas input suppliers are located in both the North and the South. In addition to choosing their organizational mode and the sequencing of negotiations with suppliers, firms also decide where to source their inputs, either domestically from the North or internationally from the South. In the South, wages are lower, but contractual breach is more costly when sourcing inputs from Southern suppliers under vertical integration. This creates a trade-off between labor-cost savings and the use of sourcing location as an incentive-allocation device. The open-economy analysis shows that access to international sourcing raises profits, but the gains are more limited when final-good producers cannot commit to the bargaining order. Moreover, under no commitment, a firm may choose a higher-cost sourcing location when doing so improves suppliers' investment incentives.

The model therefore identifies a contractual channel linking the credibility of supplier-negotiation sequences to both ownership choices and sourcing locations in global value chains. The analysis also has implications for empirical work. Observed patterns of vertical integration and global sourcing may depend not only on input characteristics, wages, and contractual frictions, but also on whether supplier-negotiation sequences are predetermined, chosen with commitment, or chosen without commitment. Overlooking these distinctions may cause empirical studies to conflate ownership incentives with sequencing and commitment constraints.

Appendix

Proof of Lemma 2. We can write profits for a given organizational design k_2^{ij} as

$$\pi_{k_2^{ij}}(\beta) = p_{k_2^{ij}}(s) q_{k_2^{ij}}(s) - \omega \left(L_{A_{k_2^{ij}}}(s) + L_{B_{k_2^{ij}}}(s) \right) - (\mu_A + \mu_B) - \omega f, \tag{A1}$$

To simplify notation, we will drop the subscript k_2^{ij} in the rest of the proof while keeping in mind that all variables of interest are functions of a given organizational design k_2^{ij}. We will solve for $q(s)$, $p(s)$, L_A and L_B to derive the expression given in equation (4). The maximization problems of suppliers A and B are given by[19]

$$\max_{L_A(s)} \ \phi_A R(s) - \omega L_A(s),$$

$$\max_{L_B(s)} \ \phi_B R(s) - \omega L_B(s),$$

where $R(s)$ is given by equation (2) and ϕ_A and ϕ_B values under each organizational design are provided in Table 1. We know that $x_A(s) = L_A(s)$ and $x_B(s) = L_B(s)$, so we have $q(s) = \left(\frac{L_A(s)}{\beta}\right)^{\beta} \left(\frac{L_B(s)}{1-\beta}\right)^{1-\beta}$. Thus, the first-order conditions with respect to $L_A(s)$ and $L_B(s)$ are

$$\phi_A \rho \Omega^{1-\rho} q(s)^{\rho} \frac{\beta}{L_A(s)} - \omega = 0, \tag{A2}$$

$$\phi_B \rho \Omega^{1-\rho} q(s)^{\rho} \frac{1-\beta}{L_B(s)} - \omega = 0. \tag{A3}$$

With a little manipulation, we can rewrite equations (A2) and (A3) as

$$\left(\frac{\phi_A \rho \Omega^{1-\rho} q(s)^{\rho}}{\omega} \right)^{\beta} = \left(\frac{L_A(s)}{\beta} \right)^{\beta},$$

$$\left(\frac{\phi_B \rho \Omega^{1-\rho} q(s)^{\rho}}{\omega} \right)^{1-\beta} = \left(\frac{L_B(s)}{1-\beta} \right)^{1-\beta},$$

so pairwise multiplication of the two equations leads to

$$\rho \Omega^{1-\rho} q(s)^{\rho} \left(\frac{\phi_A}{\omega} \right)^{\beta} \left(\frac{\phi_B}{\omega} \right)^{1-\beta} = q(s).$$

[19] The outside options μ_A and μ_B do not depend on input investments. They therefore enter each supplier's maximization problem as constants and can be omitted when deriving the first-order conditions.

Solving for $q(s)$, we obtain

$$q(s) = \Omega \left[\rho \left(\frac{\phi_A}{\omega} \right)^{\beta} \left(\frac{\phi_B}{\omega} \right)^{1-\beta} \right]^{\frac{1}{1-\rho}}.$$

Plugging the above value into equations (1), (A2) and (A3), we obtain

$$p(s) = \frac{1}{\rho} \left(\frac{\omega}{\phi_A} \right)^{\beta} \left(\frac{\omega}{\phi_B} \right)^{1-\beta},$$

$$L_A(s) = \phi_A \frac{\rho\beta\Omega}{\omega} \left[\rho \left(\frac{\phi_A}{\omega} \right)^{\beta} \left(\frac{\phi_B}{\omega} \right)^{1-\beta} \right]^{\frac{\rho}{1-\rho}},$$

$$L_B(s) = \phi_B \frac{\rho\left(1-\beta\right)\Omega}{\omega} \left[\rho \left(\frac{\phi_A}{\omega} \right)^{\beta} \left(\frac{\phi_B}{\omega} \right)^{1-\beta} \right]^{\frac{\rho}{1-\rho}}.$$

Plugging the values of $q(s)$, $p(s)$, $L_A(s)$ and $L_B(s)$ into equation (A1) gives the result. ■

Proof of Lemma 3.

(i) We start by writing $\Gamma_O^{AB-BA}(\beta)$ explicitly. Using equation (4) and Table 1, we have

$$\Gamma_O^{AB-BA}(\beta) = \left(\phi^{2\beta-1}\right)^{\frac{\rho}{1-\rho}} \frac{1-\rho\left(1-\phi\right)\left[1-\beta+\beta\phi\right]}{1-\rho\left(1-\phi\right)\left[\left(1-\beta\right)\phi+\beta\right]}. \tag{A4}$$

Taking the logarithm of equation (A4) and differentiating with respect to β yields

$$\frac{\partial \ln \Gamma_O^{AB-BA}(\beta)}{\partial\beta} = \rho m(\beta),$$

where

$$m(\beta) = \frac{2}{1-\rho}\ln\phi + \left(\frac{\left(1-\phi\right)^2\left[2-\rho(1-\phi^2)\right]}{\left\{1-\rho\left(1-\phi\right)\left[1-\beta\left(1-\phi\right)\right]\right\}\left\{1-\rho\left(1-\phi\right)\left[1-\left(1-\beta\right)\left(1-\phi\right)\right]\right\}} \right).$$

We need to show that $m(\beta) < 0$. Since $\phi < 1$, the first term is negative, whereas the second term in parentheses is positive. In addition, the second term is convex symmetric around $\beta = \frac{1}{2}$ and takes its maximum value at $\beta = 0$ and $\beta = 1$. Thus, if we set $\beta = 0$ (or $\beta = 1$) and show that $m(0) = m(1) < 0$, it will be sufficient. Doing so yields

$$m(0) = m(1) = \frac{2}{1-\rho}\ln\phi + \left(\frac{\left(1-\phi\right)^2\left[2-\rho(1-\phi^2)\right]}{\left[1-\rho\left(1-\phi\right)\right]\left[1-\rho\left(1-\phi\right)\phi\right]} \right),$$

where $m(0) = m(1) < 0$ requires

$$\underbrace{\frac{(1-\rho)\left[2-\rho(1-\phi^2)\right]}{\left[1-\rho(1-\phi)\right]\left[1-\rho(1-\phi)\phi\right]}}_{\text{Denote by } \chi(\rho)} < -\frac{2}{(1-\phi)^2}\ln\phi. \tag{A5}$$

Notice that the right-hand side of the expression in inequality (A5) is independent of ρ. If we denote the left-hand side as $\chi(\rho)$, we have

$$\frac{\partial\chi(\rho)}{\partial\rho} = \frac{-\left[\begin{array}{l}(1-\phi)^3(1-\rho)^2 + (1-\phi)^2\phi^2(1+\phi)\rho^2 \\ +\phi(1-\rho) + \phi^3(1+\rho) + \phi(1-\phi)\left[2-\rho(1+\phi)\right]\end{array}\right]}{\left[1-\rho(1-\phi)\right]^2\left[1-\rho(1-\phi)\phi\right]^2} < 0.$$

Therefore, if we can show that inequality (A5) holds for $\rho = 0$, it will be sufficient. Setting $\rho = 0$ and simplifying, we obtain

$$(1-\phi)^2 + \ln\phi < 0. \tag{A6}$$

At $\phi = 1$, the above inequality holds as an equality. Thus, if the left-hand side of inequality (A6) is increasing in ϕ, we are done. This derivative is given by

$$\frac{d\left[(1-\phi)^2 + \ln\phi\right]}{d\phi} = \frac{(1-\phi)^2}{\phi} + \phi > 0.$$

Thus, $\Gamma_O^{AB-BA}(\beta)$ is decreasing in β. Moreover, evaluating equation (A4) at $\beta = \frac{1}{2}$ yields $\Gamma_O^{AB-BA}(\frac{1}{2}) = 1$.

(ii) Using equation (4) and Table 1, we can write $\Gamma_V^{AB-BA}(\beta)$ as

$$\Gamma_V^{AB-BA}(\beta) = \left(\left(\frac{\phi_V(1-\phi)}{1-\phi_V}\right)^{2\beta-1}\right)^{\frac{\rho}{1-\rho}} \frac{1-\rho\left[(1-\beta)(1-\phi_V) + \beta\phi_V(1-\phi)\right]}{1-\rho\left[(1-\beta)\phi_V(1-\phi) + \beta(1-\phi_V)\right]}. \tag{A7}$$

Taking the logarithm of equation (A7) and differentiating with respect to β yields

$$\frac{\partial\ln\Gamma_V^{AB-BA}(\beta)}{\partial\beta} = \rho h(\beta),$$

where

$$h(\beta) = \tfrac{2}{1-\rho}\ln\left(\tfrac{\phi_V(1-\phi)}{1-\phi_V}\right) + \left(\tfrac{[(1-\phi_V)-\phi_V(1-\phi)][2-\rho(1-\phi_V\phi)]}{\{1-\rho[(1-\beta)(1-\phi_V)+\beta\phi_V(1-\phi)]\}\{1-\rho[(1-\beta)\phi_V(1-\phi)+\beta(1-\phi_V)]\}}\right).$$

We need to show that $h(\beta) < 0$. Since $1 - \phi_V > \phi_V(1-\phi)$ due to Assumption 1, the first term is negative, whereas the second term in parentheses is positive. In addition, the second term is convex and symmetric around $\beta = \frac{1}{2}$ and takes its maximum value at $\beta = 0$ and $\beta = 1$. Thus, if we set $\beta = 0$ (or $\beta = 1$) and show that $h(0) = h(1) < 0$, it will be sufficient. Doing so yields

$$h(0) = h(1) = \tfrac{2}{1-\rho} \ln\left(\tfrac{\phi_V(1-\phi)}{1-\phi_V}\right) + \tfrac{[(1-\phi_V)-\phi_V(1-\phi)][2-\rho(1-\phi_V\phi)]}{[1-\rho(1-\phi_V)][1-\rho\phi_V(1-\phi)]},$$

where $h(0) = h(1) < 0$ requires

$$\underbrace{\frac{(1-\rho)\left[2-\rho\left(1-\phi_V\phi\right)\right]}{\left[1-\rho\left(1-\phi_V\right)\right]\left[1-\rho\phi_V\left(1-\phi\right)\right]}}_{\text{Denote by } \Upsilon(\rho)} < -\frac{2}{\left[\left(1-\phi_V\right)-\phi_V\left(1-\phi\right)\right]} \ln\left(\frac{\phi_V\left(1-\phi\right)}{1-\phi_V}\right). \tag{A8}$$

Notice that the right-hand side of the expression in inequality (A8) is independent of ρ. If we denote the left-hand side as $\Upsilon(\rho)$, we have

$$\frac{\partial \Upsilon(\rho)}{\partial \rho} = \frac{-\left[\begin{array}{l}(1-\rho)^2\left(1+\phi\phi_V\right)\left(1-\phi_V\right)^2 + 4\rho(1-\rho)\phi\phi_V^3 \\ +(1+\phi\phi_V)\phi_V\left\{\left(1-\phi_V\right)\left[1-\rho^2\left(1-\phi_V\right)\right] + \left(1-\rho\phi_V\right)^2 + \rho^2\phi\phi_V\right\}\end{array}\right]}{\left[1-\rho\left(1-\phi_V\right)\right]^2\left[1-\rho\phi_V\left(1-\phi\right)\right]^2} < 0.$$

Therefore, if we can show that inequality (A8) holds for $\rho = 0$, it will be sufficient. Setting $\rho = 0$ and simplifying, we obtain

$$\left[\left(1-\phi_V\right)-\phi_V\left(1-\phi\right)\right] + \ln\left(\frac{\phi_V\left(1-\phi\right)}{1-\phi_V}\right) < 0. \tag{A9}$$

At $\phi_V = \frac{1}{2-\phi}$ (which is its upper bound due to Assumption 1), the above inequality holds as an equality. Thus, if the left-hand side of inequality (A9) is increasing in ϕ_V, we are done. This derivative is given by

$$\frac{d\left[\left(1-\phi_V\right)-\phi_V\left(1-\phi\right)+\ln\left(\frac{\phi_V(1-\phi)}{1-\phi_V}\right)\right]}{d\phi_V} = -(2-\phi) + \frac{1}{\phi_V\left(1-\phi_V\right)}.$$

This equation takes its minimum value when $\phi = 0$ and $\phi_V = \frac{1}{2}$, yet at this minimum, it is still positive. Thus, $\Gamma_V^{AB-BA}(\beta)$ is decreasing in β. Moreover, evaluating equation (A7) at $\beta = \frac{1}{2}$ yields $\Gamma_V^{AB-BA}(\frac{1}{2}) = 1$. ■

Proof of Lemma 4.

(i) We start by explicitly writing $\Psi_{V-O}^{AB}(\beta)$. Using equation (4) and Table 1, we have

$$\Psi_{V-O}^{AB}(\beta) = \left(\left(\frac{\phi_V}{\phi} \right)^{\beta} \left(\frac{1-\phi_V}{1-\phi} \right)^{1-\beta} \right)^{\frac{\rho}{1-\rho}} \frac{1-\rho\left[(1-\beta)(1-\phi_V)+\beta\phi_V(1-\phi)\right]}{1-\rho\left[(1-\beta)(1-\phi)+\beta\phi(1-\phi)\right]}. \quad \text{(A10)}$$

Taking the logarithm of equation (A10) and differentiating with respect to β yields

$$\frac{\partial \ln \Psi_{V-O}^{AB}(\beta)}{\partial \beta} = \rho v(\phi, \phi_V),$$

where

$$v(\phi, \phi_V) = \left\{ \begin{array}{l} \frac{1}{1-\rho}\left[\ln\left(\frac{\phi_V}{\phi}\right) - \ln\left(\frac{1-\phi_V}{1-\phi}\right)\right] \\ \\ +\frac{(1-\phi_V)^2-\phi_V(\phi_V-\phi)}{1-\rho[(1-\beta)(1-\phi_V)+\beta\phi_V(1-\phi)]} - \frac{(1-\phi)^2}{1-\rho[(1-\beta)(1-\phi)+\beta\phi(1-\phi)]}. \end{array} \right\}$$

Notice that $v(\phi, \phi) = 0$. Hence, if $v_{\phi_V}(\phi, \phi_V) > 0$, then we can conclude that $v(\phi, \phi_V) > 0$ since $\phi_V > \phi$ by definition. This will then mean that $\frac{\partial \ln \Psi_{V-O}^{AB}(\beta)}{\partial \beta} > 0$. By taking the derivative of $v(\phi, \phi_V)$ with respect to ϕ_V and simplifying, we obtain

$$v_{\phi_V}(\phi, \phi_V) = \frac{1}{1-\rho}\left(\frac{1}{\phi_V(1-\phi_V)}\right) - \frac{1+(1-\rho)(1-\phi)}{\left\{1-\rho\left[(1-\beta)(1-\phi_V)+\beta\phi_V(1-\phi)\right]\right\}^2}.$$

This implies that $v_{\phi_V}(\phi, \phi_V) > 0$ if and only if

$$g(\phi_V) > (1-\rho)\left[1+(1-\rho)(1-\phi)\right], \quad \text{(A11)}$$

where

$$g(\phi_V) = \frac{\left\{1-\rho[(1-\beta)(1-\phi_V)+\beta\phi_V(1-\phi)]\right\}^2}{\phi_V(1-\phi_V)}.$$

Notice that the right-hand side of the expression in inequality (A11) is independent of ϕ_V. Hence, if the inequality is satisfied at the minimum value of $g(\phi_V)$, then it will be satisfied for all ϕ_V. Taking logs and differentiating

$$\frac{\partial \ln g(\phi_V)}{\partial \phi_V} = \frac{2\rho[(1-\beta)-\beta(1-\phi)]}{1-\rho[(1-\beta)(1-\phi_V)+\beta\phi_V(1-\phi)]} - \frac{1}{\phi_V} + \frac{1}{1-\phi_V}.$$

Setting this equal to 0 yields a value of ϕ_V:

$$\phi_V^* = \frac{1-\rho(1-\beta)}{2-\rho(1-\beta\phi)},$$

where $0 < \phi_V^* < 1$. Note that $g(\phi_V) \to \infty$ when $\phi_V \to 0$ as well as when $\phi_V \to 1$. In addition, we have $g''(\phi_V^*) > 0$. Thus, $g(\phi_V^*)$ is a local minimum. Since $0 < \phi_V < 1$ and ϕ_V^* is the only root within this range such that $g'(\phi_V^*) = 0$, it is also the global minimum for this range. By evaluating the function at this point and simplifying, we obtain

$$g(\phi_V^*) = 4(1 - \rho(1-\beta))(1 - \rho\beta(1-\phi)).$$

The final task is to establish that (A11) holds. This is satisfied if and only if

$$\begin{gathered} 4(1-\rho(1-\beta))(1-\rho\beta(1-\phi)) \\ > \\ (1-\rho)[1+(1-\rho)(1-\phi)] \\ \Leftrightarrow \\ (1-\rho)[2+\phi+\rho(1-\phi)] + 4\rho\beta[\phi+\rho(1-\phi)(1-\beta)] > 0, \end{gathered}$$

which is true. Hence, $\Psi_{V-O}^{AB}(\beta)$ is increasing in β.

In addition, evaluating equation (A10) at $\beta = 0$ and $\beta = 1$, we obtain

$$\begin{aligned} \Psi_{V-O}^{AB}(0) &= \left(\frac{1-\rho(1-\phi_V)}{1-\rho(1-\phi)}\right)\left(\frac{1-\phi_V}{1-\phi}\right)^{\frac{\rho}{1-\rho}} < 1, \text{ and} \\ \Psi_{V-O}^{AB}(1) &= \left(\frac{1-\rho\phi_V(1-\phi)}{1-\rho\phi(1-\phi)}\right)\left(\frac{\phi_V(1-\phi)}{\phi(1-\phi)}\right)^{\frac{\rho}{1-\rho}} > 1, \end{aligned}$$

where the inequalities follow from $\phi_V > \phi$ and the fact that $(1-\rho x)x^{\frac{\rho}{1-\rho}}$ is an increasing function of x for $\rho \in (0,1)$ and $x \in (0,1)$. This completes part (i) of the proof.

(ii) Using equation (4) and Table 1, we can write $\Psi_{V-O}^{BA}(\beta)$ as

$$\Psi_{V-O}^{BA}(\beta) = \left(\left(\frac{1-\phi_V}{1-\phi}\right)^{\beta}\left(\frac{\phi_V}{\phi}\right)^{1-\beta}\right)^{\frac{\rho}{1-\rho}} \frac{1-\rho[(1-\beta)\phi_V(1-\phi)+\beta(1-\phi_V)]}{1-\rho[(1-\beta)\phi(1-\phi)+\beta(1-\phi)]}. \quad \text{(A12)}$$

Comparing equations (A10) and (A12), we can see that $\Psi_{V-O}^{AB}(\beta) = \Psi_{V-O}^{BA}(1-\beta)$. This automatically implies that $\frac{\partial \ln \Psi_{V-O}^{BA}(\beta)}{\partial \beta} < 0$, $\Psi_{V-O}^{BA}(0) > 1$ and $\Psi_{V-O}^{BA}(1) < 1$. ■

Proof of Proposition 1. We will first establish the existence of a critical value of ϕ, ϕ^{crit}, stated in the proposition. Lemma 3 indicates that for a given organizational mode $k_2 \in \{O, V\}$, negotiating first with supplier A and then with supplier B is more appealing

for $\beta < \frac{1}{2}$, whereas negotiating first with supplier B and then with supplier A is more appealing for $\beta > \frac{1}{2}$. On the other hand, Lemma 4 states that when negotiations take place first with supplier A and then with supplier B (which is the case when $\beta < \frac{1}{2}$ according to Lemma 3), the relative appeal of vertical integration increases with β, whereas when negotiations take place first with supplier B and then with supplier A (which is the case when $\beta > \frac{1}{2}$ according to Lemma 3), the relative appeal of vertical integration decreases with β. These observations imply that if vertical integration is optimal for some β, then it must be optimal at $\beta = \frac{1}{2}$. Notice that when analyzing the relative appeal of vertical integration with respect to outsourcing at $\beta = \frac{1}{2}$, the bargaining order does not matter, *i.e.*, $\Psi_{V-O}^{AB}\left(\beta = \frac{1}{2}\right) = \Psi_{V-O}^{BA}\left(\beta = \frac{1}{2}\right) = \Psi_{V-O}\left(\beta = \frac{1}{2}\right)$. If vertical integration is optimal at some range of β, then this range must include $\beta = \frac{1}{2}$, which means

$$\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right) = \left(\frac{\phi_V\left(1-\phi_V\right)}{\phi\left(1-\phi\right)}\right)^{\frac{\rho}{2(1-\rho)}} \frac{2-\rho\left(1-\phi_V\phi\right)}{2-\rho\left(1-\phi^2\right)} > 1. \tag{A13}$$

We will now consider a thought experiment in which we find the value of ϕ_V that maximizes $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right)$. One can easily verify that $\ln \Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right)$ is strictly concave in $\phi_V \in (0,1)$. Therefore, $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right)$ is strictly log-concave and its first-order condition has at most one interior solution. Taking the derivative with respect to ϕ_V and setting it equal to 0, we can find $\phi_V^{opt}\left(\beta = \frac{1}{2}, \phi\right)$ as

$$\phi_V^{opt}\left(\beta = \frac{1}{2}, \phi\right) = \frac{\sqrt{(2-\rho)^2(2-\phi)^2 + 8\phi\left(2-\rho\right)} - (2-\rho)(2-\phi)}{4\phi}. \tag{A14}$$

When $\phi_V = \phi$, we have $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V = \phi\right) = 1$, as can be seen from the expression (A13). Moreover, as $\phi_V \to 1$, we have $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right) \to 0$. Given the strict log-concavity of $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right)$ with respect to $\phi_V \in (0,1)$, for any $\phi_V^{opt}(\beta = \frac{1}{2}, \phi) > \phi$, there exists another value of ϕ_V, say $\overline{\phi}_V(\phi)$, such that $\phi_V^{opt}(\beta = \frac{1}{2}, \phi) < \overline{\phi}_V(\phi)$ and $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V = \overline{\phi}_V(\phi)\right) = 1$. Therefore, for any $\phi_V^{opt}(\beta = \frac{1}{2}, \phi) > \phi$, there must be a range of $\phi_V \in \left(\phi, \overline{\phi}_V(\phi)\right)$ for which $\Psi_{V-O}\left(\beta = \frac{1}{2}, \phi_V\right) > 1$.

Next, we will state the required condition for $\phi_V^{opt}(\beta = \frac{1}{2}, \phi) > \phi$. The first step is to

show that $\frac{\partial \phi_V^{opt}(\beta=\frac{1}{2},\phi)}{\partial \rho} < 0$. We have

$$\frac{\partial \phi_V^{opt}\left(\beta=\frac{1}{2},\phi\right)}{\partial \rho} = \frac{(2-\phi)\left(\sqrt{(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho)}-(2-\rho)(2-\phi)\right)-4\phi}{4\phi\sqrt{(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho)}}.$$

The above derivative is negative if and only if the numerator is negative, that is,

$$\frac{\partial \phi_V^{opt}\left(\beta=\frac{1}{2},\phi\right)}{\partial \rho} < 0 \Leftrightarrow (2-\phi)\left(\sqrt{(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho)}-(2-\rho)(2-\phi)\right)-4\phi < 0,$$

where the latter condition implies that

$$\sqrt{(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho)} < \frac{4\phi}{2-\phi}+(2-\rho)(2-\phi).$$

Taking squares of both sides, we obtain

$$\left(\sqrt{(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho)}\right)^2 < \left(\tfrac{4\phi}{2-\phi}+(2-\rho)(2-\phi)\right)^2,$$

$$(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho) < \tfrac{16\phi^2}{(2-\phi)^2}+(2-\rho)^2(2-\phi)^2+8\phi\,(2-\rho),$$

$$0 < \tfrac{16\phi^2}{(2-\phi)^2}, \text{ which is true since } \phi > 0.$$

Therefore, $\frac{\partial \phi_V^{opt}\left(\beta=\frac{1}{2},\phi\right)}{\partial \rho} < 0$. Notice that $\phi_V^{opt}\left(\beta=\frac{1}{2},\phi\right) = \phi$ when $\rho = 2\left(1-\frac{\phi^3}{(1-\phi)^2}\right)$. Combining these two observations, we can conclude that

$$\phi_V^{opt}\left(\beta=\frac{1}{2},\phi\right) > \phi \text{ for } \rho < 2\left(1-\frac{\phi^3}{(1-\phi)^2}\right).$$

Therefore, provided that $\rho < 2\left(1-\frac{\phi^3}{(1-\phi)^2}\right)$, there is a range of $\phi_V \in \left(\phi, \overline{\phi}_V(\phi)\right)$ for which $\Psi_{V-O}\left(\beta=\frac{1}{2},\phi_V\right) > 1$.[20] This condition is not sufficient for vertical integration to be optimal for every value of $\phi_V > \phi$; it only ensures that the interval $\left(\phi, \overline{\phi}_V(\phi)\right)$ is non-empty. For the actual value of ϕ_V, vertical integration is optimal at $\beta = \frac{1}{2}$ only if $\phi_V < \overline{\phi}_V(\phi)$.

Next, we look at what happens to this range as ϕ changes. In particular, we want to show that as ϕ increases, this range gets smaller. For this to occur, we must have

$$\frac{d\left(\overline{\phi}_V(\phi)-\phi\right)}{d\phi} = \frac{d\overline{\phi}_V(\phi)}{d\phi} - 1 < 0. \tag{A15}$$

[20] Note that for any $\phi \leqslant \frac{1}{2}$, we necessarily have $\rho < 2\left(1-\frac{\phi^3}{(1-\phi)^2}\right)$ given that $\rho < 1$.

To do that, we first need to determine the change in the upper bound, *i.e.*, $\overline{\phi}_V(\phi)$. We know that $\Psi_{V-O}\left(\beta=\frac{1}{2},\phi_V=\overline{\phi}_V(\phi)\right)=1$. If we differentiate this function with respect to ϕ, we get

$$\frac{d\Psi_{V-O}\left(\beta=\frac{1}{2},\phi_V=\overline{\phi}_V(\phi)\right)}{d\phi}=\frac{\partial\Psi_{V-O}}{\partial\phi}+\frac{\partial\Psi_{V-O}}{\partial\phi_V}\frac{d\overline{\phi}_V(\phi)}{d\phi}=0,$$

implying that

$$\frac{d\overline{\phi}_V(\phi)}{d\phi}=-\frac{\frac{\partial\Psi_{V-O}}{\partial\phi}}{\frac{\partial\Psi_{V-O}}{\partial\phi_V}}.$$

The calculation of the above derivative gives us

$$\frac{d\overline{\phi}_V(\phi)}{d\phi}=-\frac{\frac{\partial\Psi_{V-O}}{\partial\phi}}{\frac{\partial\Psi_{V-O}}{\partial\phi_V}}=-\frac{\frac{(\phi_V-\phi)(2-\rho)-\phi(2-\rho(1-\phi_V\phi))}{2-\rho(1-\phi^2)}-\frac{1-2\phi}{\phi(1-\phi)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}}{\frac{1-2\phi_V}{\phi_V(1-\phi_V)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}+\phi}$$

Notice that for any $\phi_V>\phi_V^{opt}(\beta=\frac{1}{2},\phi)$, the denominator must be negative:

$$\frac{1-2\phi_V}{\phi_V(1-\phi_V)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}+\phi<0 \tag{A16}$$

Therefore, the condition (A15) becomes

$$-\frac{\frac{(\phi_V-\phi)(2-\rho)-\phi(2-\rho(1-\phi_V\phi))}{2-\rho(1-\phi^2)}-\frac{1-2\phi}{\phi(1-\phi)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}}{\frac{1-2\phi_V}{\phi_V(1-\phi_V)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}+\phi}-1<0,$$

or using the inequality (A16)

$$\frac{1-2\phi}{\phi(1-\phi)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}-\frac{(\phi_V-\phi)(2-\rho)-\phi(2-\rho(1-\phi_V\phi))}{2-\rho(1-\phi^2)}>\frac{1-2\phi_V}{\phi_V(1-\phi_V)}\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}+\phi.$$

After some simplification, the above inequality becomes

$$\left(\frac{1-2\phi}{\phi(1-\phi)}-\frac{1-2\phi_V}{\phi_V(1-\phi_V)}\right)\left(\frac{2-\rho(1-\phi_V\phi)}{2(1-\rho)}\right)>(\phi_V-\phi)\left(\frac{2-\rho(1+\phi^2)}{2-\rho(1-\phi^2)}\right).$$

Given that $\phi_V>\phi$, the first term in parentheses on the left-hand side of the above inequality is positive. Further, while the left-hand side of the above inequality is increasing in ρ, the right-hand side is decreasing in ρ. Therefore, it will be sufficient to show that the above inequality holds at $\rho=0$. Setting $\rho=0$, we obtain

$$2\left(\frac{1-2\phi}{\phi(1-\phi)}-\frac{1-2\phi_V}{\phi_V(1-\phi_V)}\right)>2(\phi_V-\phi).$$

With a bit of manipulation, we get

$$(\phi_V - \phi)\left(\frac{1}{\phi_V \phi} + \frac{1-(1-\phi_V)(1-\phi)}{(1-\phi_V)(1-\phi)}\right) > 0,$$

which is true since $\phi < \phi_V < 1$. Hence, as ϕ increases, the range $\left(\phi, \overline{\phi}_V(\phi)\right)$ gets smaller. At the same time, for a given value of γ (recall Footnote 7), as ϕ increases, ϕ_V also increases (so $\phi < \phi_V$ still holds). Consequently, once we reach a critical value of ϕ, $\phi^{crit}(\gamma)$, the (new) value of ϕ_V will be outside this (new smaller) range and vertical integration will not be optimal.

The above discussion establishes the existence of ϕ^{crit}. Then, the first part of the proposition directly follows from part (i) of Lemma 3. The second part follows from both Lemma 3 and Lemma 4. ■

Proof of Lemma 6. We know that the first-best organizational design is the one that maximizes the *ex ante* profits. We also know from Lemma 1 that the organizational design that maximizes *ex ante* profits, *i.e.*, the first best, cannot have vertical integration in the first-stage negotiations. When there is no commitment to the bargaining order, the final-good producer might have an incentive to change the bargaining order *ex post*. Under perfect foresight, suppliers would foresee any *ex post* opportunistic behavior of the final-good producer and make their investments accordingly. Therefore, sometimes the first-best organizational design is not attainable due to this *ex post* commitment problem. When this is the case, we need to choose an organizational design that maximizes *ex ante* profits subject to the constraint that it is credible, *i.e.*, there would be no incentive to change the bargaining order *ex post*. In this second-best organizational design, we then need to check whether integration in the first stage of negotiations can be optimal.

To do so, consider a scenario in which negotiating with supplier i first and supplier j second generates the highest *ex ante* profits but cannot occur due to *ex post* opportunistic behavior of the final-good producer, *i.e.*, $\frac{\mu_i}{\mu_j} > \frac{\phi^*_{k_j}}{\phi^*_{k_i}} \frac{1-\phi^*_{k_i}}{1-\phi^*_{k_j}}$ (see inequality (5)), where $\phi^*_{k_i}$ and $\phi^*_{k_j}$ denote the optimal organizational mode for suppliers i and j that maximizes *ex ante* profits. As explained above, under commitment there is no benefit from integrating the first

supplier, supplier i. Therefore, we must have $\phi^*_{k_i} = \phi$. There are two possibilities regarding the organizational mode chosen with respect to supplier j: $\phi^*_{k_j} = \phi$ or $\phi^*_{k_j} = \phi_V$, and in either case, the initial condition $\frac{\mu_i}{\mu_j} > \frac{\phi^*_{k_j}}{\phi^*_{k_i}} \frac{1-\phi^*_{k_i}}{1-\phi^*_{k_j}}$ implies that $\frac{\mu_i}{\mu_j} > 1$ must hold. We are now ready to examine whether vertical integration can be optimal in the first stage under the second-best organizational design.

First, assume that the second-best organizational design involves negotiating with supplier i first and supplier j second. In this case, $\frac{\mu_i}{\mu_j} \leqslant \frac{\phi_{k_j}}{\phi_{k_i}} \frac{1-\phi_{k_i}}{1-\phi_{k_j}}$ must hold for the assumed bargaining order *not to change ex post* as required by the second-best organizational design. Given that $\frac{\mu_i}{\mu_j} > 1$, this inequality is violated for $\phi_{k_i} \geqslant \phi_{k_j}$. Thus, neither outsourcing both suppliers, integrating supplier i alone, nor integrating both suppliers can support the assumed bargaining order. Therefore, consider $\phi_{k_i} < \phi_{k_j}$, that is, integrating supplier j alone ($\phi_{k_i} = \phi < \phi_V = \phi_{k_j}$). In this case, given the assumed bargaining order in the second-best organizational design, vertical integration does not occur in the first stage of negotiations.

Second, assume instead that the second-best organizational design involves negotiating with supplier j first and supplier i second. This time, $\frac{\mu_i}{\mu_j} \geqslant \frac{\phi_{k_j}}{\phi_{k_i}} \frac{1-\phi_{k_i}}{1-\phi_{k_j}}$ must hold for the assumed bargaining order *not to change ex post* as required by the second-best organizational design. This inequality is satisfied for $\phi_{k_i} \geqslant \phi_{k_j}$, and there are three possibilities. If both suppliers are outsourced ($\phi_{k_i} = \phi = \phi_{k_j}$), then vertical integration does not take place in the first stage of negotiations. Instead, if supplier i alone is integrated ($\phi_{k_i} = \phi_V > \phi = \phi_{k_j}$), then for the assumed bargaining order, the first-stage negotiations are with supplier j under outsourcing, in line with our claim that integration does not take place in the first-stage negotiations. Finally, if both suppliers are integrated ($\phi_{k_i} = \phi_V = \phi_{k_j}$), then the first-stage negotiations are with supplier j under vertical integration. Yet, integrating both suppliers cannot be optimal in the second-best organizational design as integrating supplier i alone also keeps the bargaining order intact *ex post* but achieves higher profits given that the investment incentive of supplier j is higher. On the other hand, for $\phi_{k_i} < \phi_{k_j}$, that is, integrating supplier j alone ($\phi_{k_i} = \phi < \phi_V = \phi_{k_j}$), there are two cases to consider. If $1 < \frac{\mu_i}{\mu_j} < \frac{\phi_V}{\phi} \frac{1-\phi}{1-\phi_V}$, the inequality at the beginning of this paragraph is violated and we are

done. In contrast, if $1 < \frac{\phi_V}{\phi}\frac{1-\phi}{1-\phi_V} \leqslant \frac{\mu_i}{\mu_j}$, then the first-stage negotiations are done with supplier j under vertical integration. Yet, this cannot be optimal in the second-best organizational design since choosing outsourcing for both suppliers also keeps the bargaining order intact *ex post* but achieves higher profits given that the investment incentive of supplier j is higher. Therefore, integration cannot occur in the first stage of negotiations. ■

Proof of Lemma 8. First consider part (i). We know from Lemma 1 and Lemma 6 that regardless of whether the bargaining order is contractible, it is always optimal to choose outsourcing in the first stage. Given that $\phi_O^N = \phi_O^S = \phi$, the sourcing location of the first input depends solely on wage-rate differences. The fact that the South has a lower wage rate than the North gives us the result.

Next, consider part (ii). In the proof of Proposition 1, we have shown that for $\rho < 2\left(1 - \frac{\phi^3}{(1-\phi)^2}\right)$, there exists a range $\phi_V \in \left(\phi, \overline{\phi}_V(\phi)\right)$ for which vertical integration is optimal for intermediate values of β (including $\beta = \frac{1}{2}$). Also, we have proved that as ϕ increases, this range gets smaller, *i.e.*, the lower bound increases whereas the upper bound decreases. Using this observation, we have established the existence of a critical value of ϕ, $\phi^{crit}(\gamma)$, for a given value of γ. Now consider two values of ϕ_V given in the lemma, $\phi_V^N > \phi_V^S > \phi > 0$, implying that $\gamma^N > \gamma^S$. Initially assume that both ϕ_V^N and ϕ_V^S lie in $\left(\phi, \overline{\phi}_V(\phi)\right)$. If we increase ϕ, both ϕ_V^N and ϕ_V^S also increase for given γ^N and γ^S, while the viable range $\left(\phi, \overline{\phi}_V(\phi)\right)$ gets smaller. We can easily see that ϕ_V^N reaches the upper boundary of the viable range before ϕ_V^S. This means that there is more room for ϕ to increase before ϕ_V^S falls outside the viable range, implying that $(\phi^{crit})^N < (\phi^{crit})^S$. ■

Proof of Proposition 3. The discussion just prior to Proposition 3 establishes that there are three potential design choices available: $(O^{AB})^S$, $(V^{AB})^N$ and $(V^{AB})^S$. We know from Lemma 1 and Lemma 6 that outsourcing is the optimal organizational mode choice in the first stage of negotiations: $\phi_{k_1} = \phi_O = \phi$. First, abstract from cross-country wage differences and consider the profit function with a common wage rate ω. To understand the dynamics of the selection of organizational mode in the second-stage negotiations, we will consider a

thought experiment in which the final-good producer could freely choose the optimal ϕ_{k_2}, say $\phi_{k_2}^{opt} \in (0,1)$, that maximizes profits. While a higher value of ϕ_{k_2} reduces the investment incentive of the supplier in the second-stage negotiation, it incentivizes the first-stage supplier by allocating a larger fraction of the surplus. The optimal $\phi_{k_2}^{opt}$ takes this trade-off into account. Given that in all three potential design choices, the final-good producer negotiates first with supplier A and second with supplier B, we have $\phi_B = (1-\phi_{k_2})$ and $\phi_A = \phi_{k_2}(1-\phi)$. Therefore, we can rewrite profits given in equation (4) as

$$\pi(\beta) = \Omega \left(\frac{1-\rho\left[(1-\beta)(1-\phi_{k_2}) + \beta\phi_{k_2}(1-\phi)\right]}{\left[\frac{1}{\rho}\left(\frac{\omega}{\phi_{k_2}(1-\phi)}\right)^{\beta}\left(\frac{\omega}{1-\phi_{k_2}}\right)^{1-\beta}\right]^{\frac{\rho}{1-\rho}}} \right) - \mu_A - \mu_B - \omega f. \tag{A17}$$

Taking the derivative of equation (A17) with respect to ϕ_{k_2} and equating to zero gives us an expression that is proportional to the polynomial

$$\left.\begin{aligned} &-\left[1-\beta(2-\phi)\right]\phi_{k_2}^2 \\ -&\left[\beta(2-\phi)(1-\rho(1-\beta))\right]\phi_{k_2} \\ &+\beta(1-\rho(1-\beta)) \end{aligned}\right\} = 0.$$

Solving this expression for ϕ_{k_2} gives us

$$\phi_{k_2}^{opt}(\beta) = \frac{\sqrt{\{\beta[1-\rho(1-\beta)](2-\phi)\}^2 + 4\beta[1-\rho(1-\beta)][1-\beta(2-\phi)]} - \beta[1-\rho(1-\beta)](2-\phi)}{2[1-\beta(2-\phi)]}.$$

It is easy to see that $\phi_{k_2}^{opt}(\beta) \in (0,1)$ with $\phi_{k_2}^{opt}(\beta) \to 0$ as $\beta \to 0$ and $\phi_{k_2}^{opt}(\beta) \to 1$ as $\beta \to 1$.[21] It is also the only root in the relevant range $\phi_{k_2} \in (0,1)$.[22] It is easy to verify that $\phi_{k_2}^{opt}(\beta)$ is increasing in β, that is, as supplier A's contribution becomes more important, more incentives

[21] At $\beta = \frac{1}{2-\phi}$, the closed-form expression above for $\phi_{k_2}^{opt}(\beta)$ takes the indeterminate form $\frac{0}{0}$. Applying L'Hôpital's rule gives $\lim_{\beta \to \frac{1}{2-\phi}} \phi_{k_2}^{opt}(\beta) = \frac{1}{2-\phi}$. Thus, at $\beta = \frac{1}{2-\phi}$, we define $\phi_{k_2}^{opt}$ by its limit, which equals $\frac{1}{2-\phi}$.

[22] For $\beta \neq \frac{1}{2-\phi}$, the other root is given by

$$\phi_{k_2}^{opt_other}(\beta) = -\frac{\sqrt{\{\beta[1-\rho(1-\beta)](2-\phi)\}^2 + 4\beta[1-\rho(1-\beta)][1-\beta(2-\phi)]} + \beta[1-\rho(1-\beta)](2-\phi)}{2[1-\beta(2-\phi)]},$$

which is either larger than 1 or negative (hence outside the allowed bounds of ϕ_{k_2}) depending on whether the denominator is negative or positive, respectively.

need to be given to supplier A, which implies a higher value of $\phi_{k_2}^{opt}$. Furthermore, taking the second derivative of equation (A17) with respect to ϕ_{k_2} and evaluating it at $\phi_{k_2} = \phi_{k_2}^{opt}$ gives us a negative value, hence $\phi_{k_2}^{opt}$ is a local maximum. Since $\phi_{k_2}^{opt}$ is the only interior root of the first-order condition and the variable-profit component approaches zero as $\phi_{k_2} \to 0$ or $\phi_{k_2} \to 1$, this local maximum is also the global maximum on the relevant range. These observations imply that for a given β, profits are increasing in ϕ_{k_2} for $0 < \phi_{k_2} < \phi_{k_2}^{opt}(\beta)$ and decreasing in ϕ_{k_2} for $\phi_{k_2}^{opt}(\beta) < \phi_{k_2} < 1$.

[Insert Figure 4 here]

We plot $\phi_{k_2}^{opt}$ as a function of β in Figure 4. For each β, $\phi_{k_2}^{opt}(\beta)$ guarantees that the revenue shares allocated to suppliers maximize profits. It has a positive slope, implying that as the relative importance of supplier A's input increases, the revenue share that must be allocated to supplier A, $\phi_A^{opt} = (1-\phi)\,\phi_{k_2}^{opt}(\beta)$, increases at the expense of supplier B's revenue share, $\phi_B^{opt} = 1 - \phi_{k_2}^{opt}(\beta)$. The key point is that ϕ_{k_2} governs a one-dimensional trade-off between the suppliers' revenue shares: increasing ϕ_{k_2} raises supplier A's share, $\phi_A = \phi_{k_2}(1-\phi)$, while lowering supplier B's share, $\phi_B = 1 - \phi_{k_2}$. Equivalently, the feasible revenue-share combinations satisfy $\frac{1}{1-\phi}\phi_A + \phi_B = 1$. In our actual scenario with three potential design choices, the final-good producer is allowed to choose $\phi_{k_2} \in \{\phi, \phi_V^S, \phi_V^N\}$. Given that $\phi < \phi_V^S < \phi_V^N$, we must have $\beta_{(O^{AB})^S} < \beta_{(V^{AB})^S} < \beta_{(V^{AB})^N}$, where $\phi_{k_2}^{opt}(\beta_{(O^{AB})^S}) = \phi$, $\phi_{k_2}^{opt}(\beta_{(V^{AB})^S}) = \phi_V^S$ and $\phi_{k_2}^{opt}(\beta_{(V^{AB})^N}) = \phi_V^N$.

Next, part (i) of Lemma 4 establishes the unique domestic cutoff, $\widetilde{\beta}$, such that $\Psi_{V-O}^{AB}(\widetilde{\beta}) = 1$. Now consider $\beta_{(O^{AB})^S}$ and $\beta_{(V^{AB})^S}$ defined above. There exists a critical value of β, $\widetilde{\beta}_1$ with $\beta_{(O^{AB})^S} < \widetilde{\beta}_1 < \beta_{(V^{AB})^S}$ that generates the same profits under $(O^{AB})^S$ and $(V^{AB})^S$. For any $\beta < \widetilde{\beta}_1$, $(O^{AB})^S$ generates more profits than $(V^{AB})^S$, whereas for $\beta > \widetilde{\beta}_1$, the opposite is true. Since vertical integration is more likely when the second input is sourced from the South than under domestic sourcing, we have $\widetilde{\beta}_1 < \widetilde{\beta}$.

Similarly, consider $\beta_{(V^{AB})^S}$ and $\beta_{(V^{AB})^N}$. In the *common-wage benchmark*, with a change of variables in Ψ_{V-O}^{AB}, one can show that there exists a critical value of β, $\overline{\beta}_2$ with $\beta_{(V^{AB})^S} <$

$\overline{\beta}_2 < \beta_{(V^{AB})^N}$ that generates the same profits under $(V^{AB})^S$ and $(V^{AB})^N$. For any $\beta < \overline{\beta}_2$, $(V^{AB})^S$ generates more profits than $(V^{AB})^N$, whereas for $\beta > \overline{\beta}_2$, the opposite is true. Since $\phi_{k_2}^{opt}(\beta)$ is increasing in β and profits are increasing in ϕ_{k_2} below $\phi_{k_2}^{opt}(\beta)$ and decreasing above $\phi_{k_2}^{opt}(\beta)$, the preferred discrete choice of ϕ_{k_2} moves monotonically from lower to higher values as β increases. Given $\phi < \phi_V^S < \phi_V^N$, the cutoff between ϕ and ϕ_V^N, namely the domestic cutoff $\widetilde{\beta}$, must lie between the cutoff between ϕ and ϕ_V^S, namely $\widetilde{\beta}_1$, and the common-wage cutoff between ϕ_V^S and ϕ_V^N, namely $\overline{\beta}_2$. Hence, $\widetilde{\beta}_1 < \widetilde{\beta} < \overline{\beta}_2$. *The wage disadvantage of the North then implies that the actual cutoff*, denoted by $\widetilde{\beta}_2$, *must be larger than the common-wage cutoff* $\overline{\beta}_2$, *i.e.,* $(V^{AB})^S$ *is optimal over a larger part of the parameter space than in the common-wage benchmark.* In particular, as the North's wage disadvantage becomes more severe, $\widetilde{\beta}_2$ can go beyond $\beta_{(V^{AB})^N}$. However, as explained on p. 30, there exists a parameter space in which $(V^{AB})^N$ generates more profit than $(V^{AB})^S$. Since $(V^{AB})^N$ dominates as $\beta \to 1$, we have $\widetilde{\beta}_2 < 1$.

These observations imply $0 < \widetilde{\beta}_1 < \widetilde{\beta} < \widetilde{\beta}_2 < 1$. Thus, for any $\beta \in (0, \widetilde{\beta}_1)$, $(O^{AB})^S$ is the optimal organizational design, for any $\beta \in (\widetilde{\beta}_1, \widetilde{\beta}_2)$, $(V^{AB})^S$ is the optimal organizational design, and for any $\beta \in (\widetilde{\beta}_2, 1)$, $(V^{AB})^N$ is the optimal organizational design. ■

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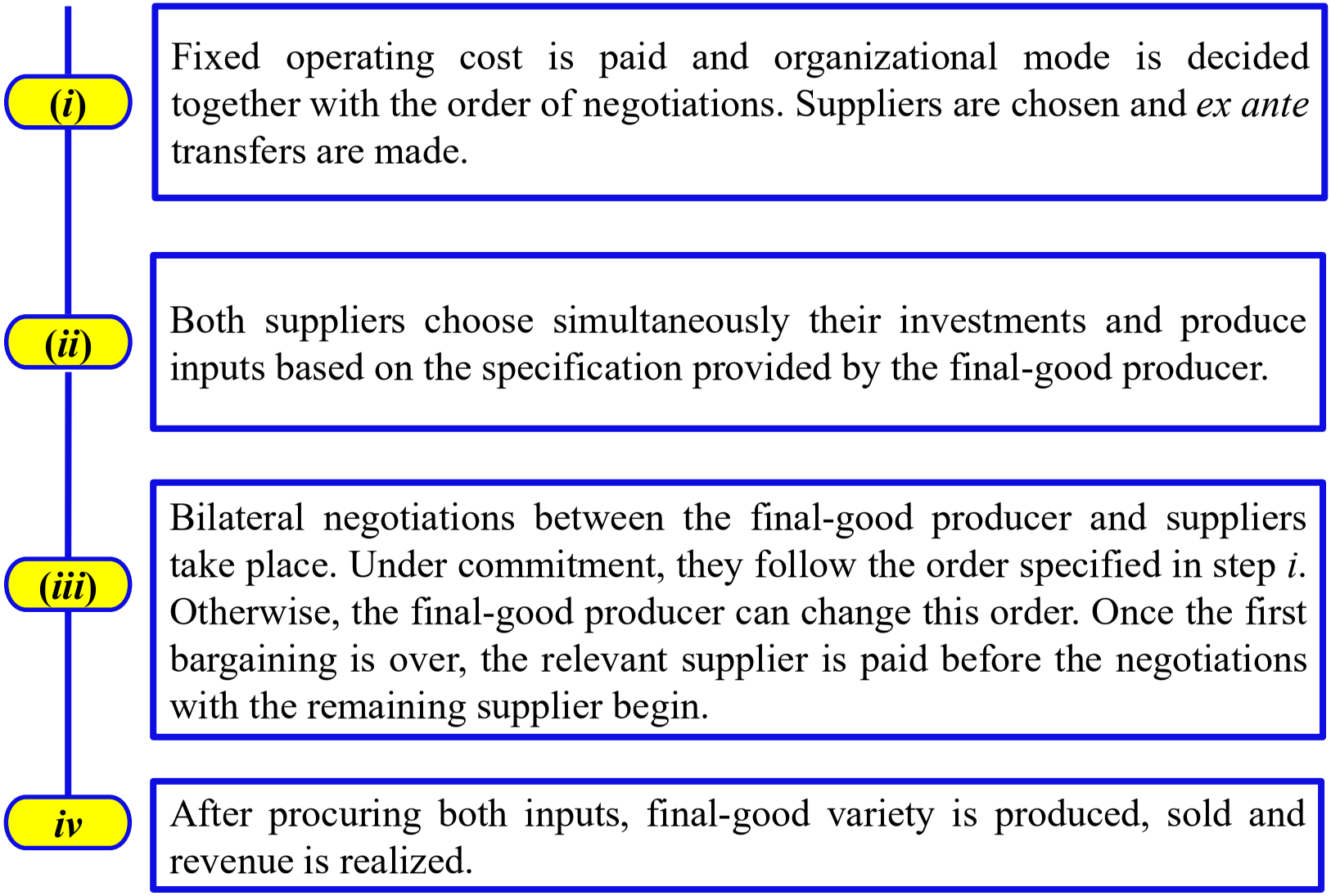


Figure 1. Timing of Events

Organizational Design, k_2^{ij}	**Revenue Share**	
	$\boldsymbol{\phi_A}$	$\boldsymbol{\phi_B}$
O^{AB}	$\phi(1-\phi)$	$1-\phi$
V^{AB}	$\phi_V(1-\phi)$	$1-\phi_V$
O^{BA}	$1-\phi$	$\phi(1-\phi)$
V^{BA}	$1-\phi_V$	$\phi_V(1-\phi)$

Table 1. Revenue shares

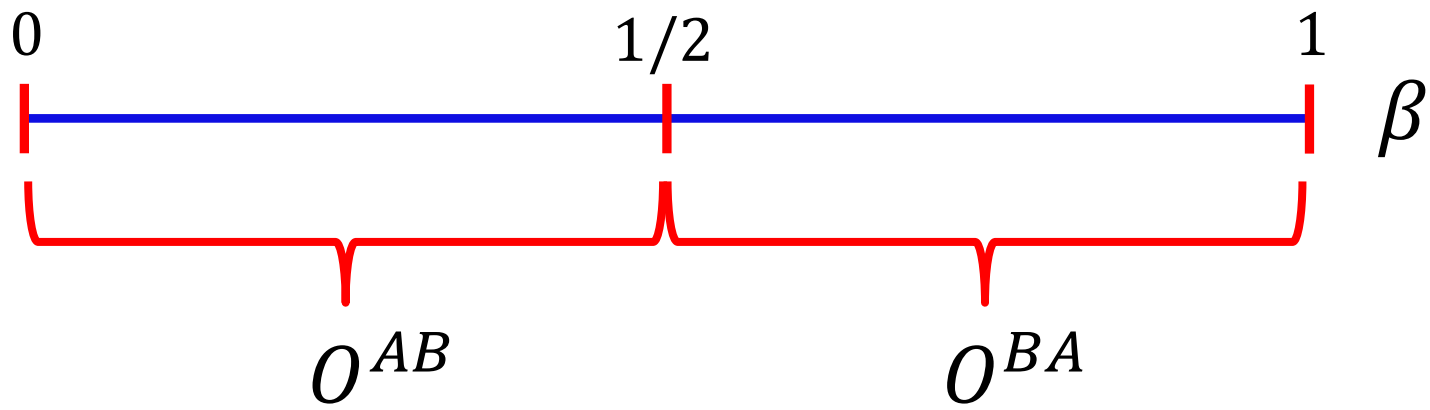


Figure 2. Commitment when $\phi > \phi^{crit}$

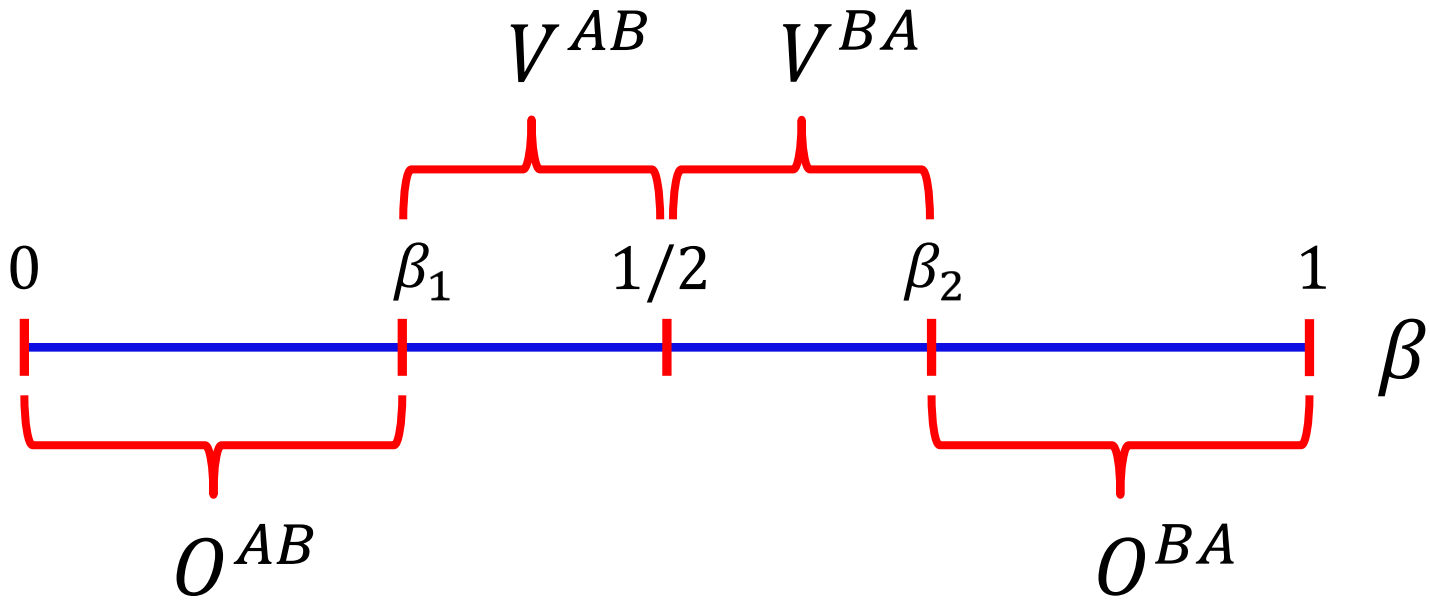


Figure 3. Commitment when $\phi < \phi^{crit}$

Organizational Design, $(k_2^{ij})^{l_2}$	Revenue Share	
	ϕ_A	ϕ_B
$(O^{AB})^{N} = (O^{AB})^{S}$	$\phi(1-\phi)$	$1-\phi$
$(V^{AB})^{N}$	$\phi_V^N(1-\phi)$	$1-\phi_V^N$
$(V^{AB})^{S}$	$\phi_V^S(1-\phi)$	$1-\phi_V^S$
$(O^{BA})^{N} = (O^{BA})^{S}$	$1-\phi$	$\phi(1-\phi)$
$(V^{BA})^{N}$	$1-\phi_V^N$	$\phi_V^N(1-\phi)$
$(V^{BA})^{S}$	$1-\phi_V^S$	$\phi_V^S(1-\phi)$

Table 2. Revenue shares with international sourcing

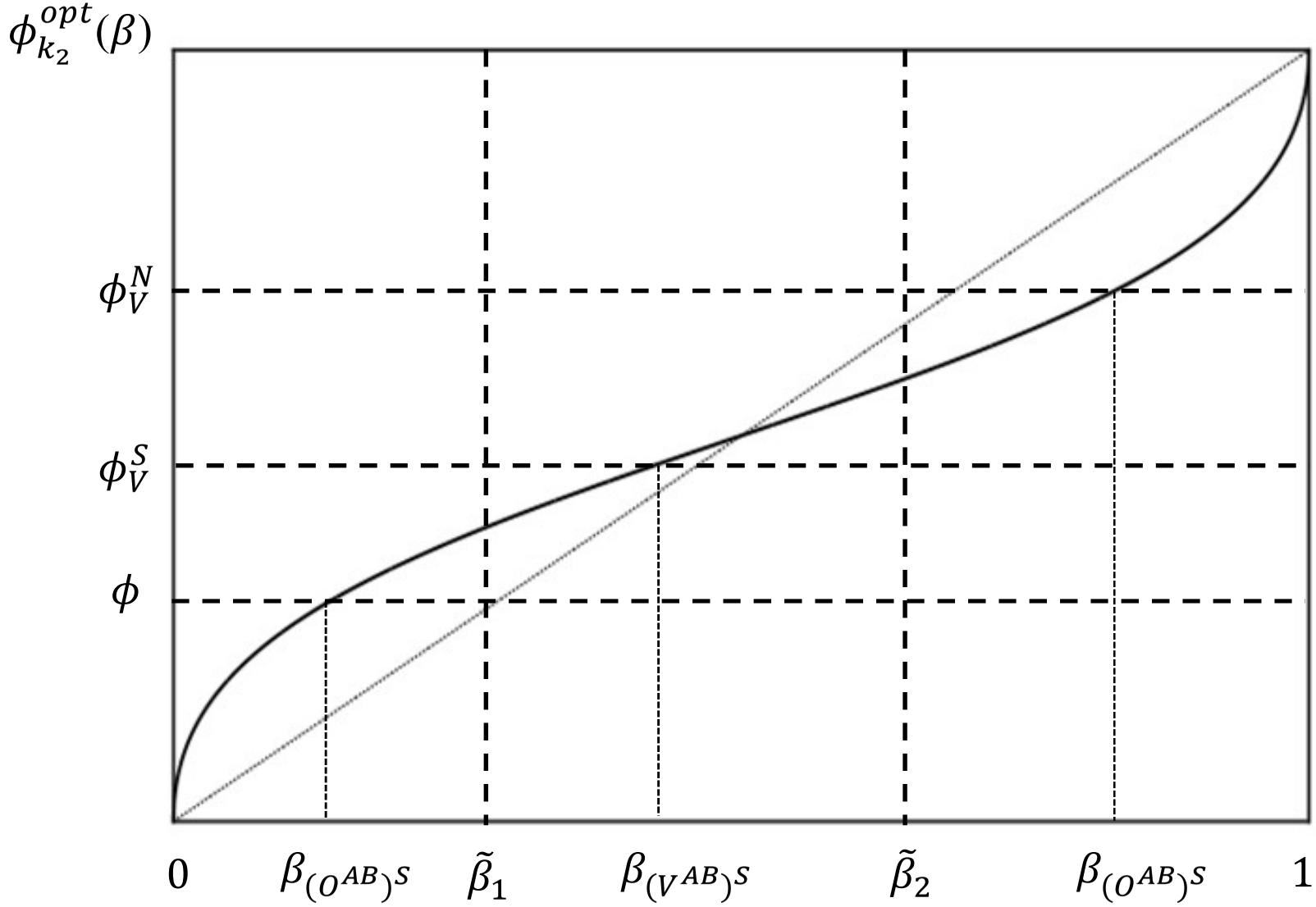


Figure 4. Optimal Revenue Share, $\phi_{k_2}^{opt}(\beta)$