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Make and Buy: Balancing Bargaining Power

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Make and Buy: Balancing Bargaining Power

Abstract

We analyze the optimal procurement of labor. The input can be supplied either internally, based on wage negotiations, or can be acquired at terms negotiated with an external subcontractor. We demonstrate analytically how multiple sourcing emerges as an organizational mechanism to balance cost advantages associated with outsourcing against a subcontractor's increased bargaining power. We characterize the relationship between the bargaining structure and the optimal production mode and find that the optimal proportion of outsourcing is lower with sequential negotiations than with simultaneous negotiations.

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1. Introduction

Many view in-house production and outsourced production as the main alternative production modes available to a firm. In line with such a viewpoint, discussions about the border of the firm often distinguish those circumstances when an activity or component is produced in-house from those when an external supplier acquires it as a market transaction (for example, Williamson (1979), Grossman and Hart (1986), and Holmström and Roberts (1998)). However, firms frequently source inputs externally from independent suppliers as well as within the boundaries of the firm. In the literature, scholars refer to such a practice as multiple sourcing, tapered integration, or partial outsourcing. For example, Nickerson and Silverman (2003) report that 35% of interstate carriers in the trucking industry procure driving services from in-house as well as external sources.³ In another industry example, Nokia Siemens Networks (NSN) outsources approximately 20% of its production; NSN “generally prefers to have multiple sources for its components, but sources some components from a single or a small number of selected suppliers” (Nokia Annual Report 2008, Form 20-F).

Researchers often argue that extreme production modes focusing exclusively either on in-house production or subcontracting mean that the firm loses bargaining power to the exclusive input supplier. Under such circumstances, multiple sourcing might be a mechanism to overcome this problem. According to this view, outsourcing may serve as a disciplining device to counteract union power and thereby foster competitiveness of in-house production. Similarly, in-house production provides a benchmark against which the firm can evaluate the competitiveness of external suppliers. Balancing the power of internal and external suppliers is, in fact, a delicate problem for managers. An important approach in the strategic management literature, dating back to Porter (1980), has viewed multiple sourcing as a mechanism whereby the firm can affect its bargaining power relative to both inside and outside suppliers.⁴ According to this argument, a balancing of bargaining power relative to both inside and outside suppliers determines the

³ He and Nickerson (2006) analyze certain justifications for the mixed use of these organization modes in the trucking industry.

⁴ Porter (1980) says: “If a firm is dealing with suppliers or customers who wield significant bargaining power and reap returns on investment in excess of the opportunity cost of capital, it pays for the firm to integrate even if there are no other savings from integration” (p. 307).

optimal organization mode for the firm. Michael (2000), Simester and Knez (2002), and Rothaermel, Hitt, and Jobe (2006) are interesting empirical studies following this tradition.

In the present study, we design a model to analyze a firm's procurement of labor input. The labor input can be supplied either internally with the wage negotiated between the trade union and the firm or alternatively can be acquired based on an external contract at terms negotiated with a subcontractor. We assume that bargaining within the context of a labor market where the firm cannot control its own bargaining power determines the wage for in-house production. Furthermore, we assume that outsourcing provides an option for the firm to potentially exploit a marginal cost advantage. However, an increased fraction of outsourcing can be realized only at the expense of the subcontractor's increased bargaining power. In this way, our model formalizes the idea that the optimal organizational mode balances a potential cost advantage against the subcontractor's increased bargaining power. Within such a framework, we investigate two bargaining regimes distinguished by the relative timing of negotiations: 1) negotiations where the firm simultaneously bargains with the labor union and subcontractor, and 2) negotiations where the firm sequentially bargains with these parties. We assume these negotiations take place conditional on the firm's sourcing decision.

In the present analysis, multiple sourcing emerges as the optimal organizational mode, because the allocation of how to procure the labor input balances the potential cost advantage against the subcontractor's increased bargaining power. This mechanism for multiple sourcing complements those we know from the existing literature. Inderst (2008) shows that single sourcing is not optimal for a buyer facing suppliers with convex costs unless the buyer has sufficiently strong market power. Du, Lu and Tao (2006) analyze a production function which separates headquarter services and component inputs and they assume that the headquarter has stronger bargaining power with respect to internal than to external component suppliers. However, contrary to our study they focus exclusively on exogenous bargaining power and demonstrate how the headquarter can benefit from bi-sourcing, because it generates a cross threat effect when negotiating with the two different input suppliers. Furthermore, Du, Lu and Tao (2006) compare the profit associated with bi-sourcing with that associated with single sourcing, but they do not structurally characterize the optimal production mode.⁵ Shy and Stenbacka (2005) characterize

⁵ Du, Lu, and Tao (2009) explore this mechanism within the framework of a model of international trade.

the equilibrium fraction of outsourced inputs within a framework where the production of the final good requires a large number of potentially heterogeneous inputs and where outsourcing generates monitoring costs, which increase as a convex function of the number of production lines managed by external suppliers. However, they assume that each component has to be completely outsourced or produced entirely in-house. Another approach, developed by van Mieghem (1999) and Alvarez and Stenbacka (2007), focuses on an environment with uncertainty and characterizes the production mode which under such circumstances maximize the option value associated with outsourcing. Finally, our study also relates to the literature on second sourcing by multinationals. In this literature stream, the objective is to explain why multinationals simultaneously export and engage in foreign direct investments (FDI), and for that purpose scholars have developed both strategic approaches (see Choi and Davidson (2004)) and real options approaches (see Kogut and Kulatilaka (1994)).

We design our model in such a way that the firm's choice of organizational mode, more precisely the proportion of inputs outsourced, serves as a commitment relative to the stage of interrelated bargaining. At this bargaining stage, the firm negotiates the factor prices for the internally and externally sourced inputs either simultaneously or sequentially. Formally, we model these negotiations through Nash bargaining, with the particular methodological novelty that the subcontractor's bargaining power is an increasing function of the proportion of production outsourced to this subcontractor. This way the organizational mode serves as a strategic device whereby the firm can influence the negotiated input prices since it determines the subcontractor's bargaining power.

An extensive literature focuses on the analysis of bargaining as well as on various aspects of the Nash bargaining solution in particular. In standard versions of the Nash bargaining games (as surveyed by, for example, Muthoo (1999)), the bargaining power is simply an exogenous feature of the negotiation. In some more elaborate versions of bargaining, for example the model of strategic bargaining developed by Shaked and Sutton (1984), the outside option is endogenized. However, we are not aware of any model of bargaining with the feature that the bargaining

power coefficient is endogenous.⁶ In our model, the optimal production mode balances cost advantages achievable through outsourcing against the increased bargaining power of the subcontractor associated with outsourcing. There is also a recent literature on the pattern of bargaining where exogenous bargaining power strategically determines the sequence of related negotiations. For example, Marshall and Merlo (2004) examine the case where one labor supplier (the union) chooses the sequence in which it negotiates with firms. Marx and Shaffer (2007) consider sequential negotiations with two sellers and one buyer and examine configurations where the buyer engages in multi-sourcing.

We demonstrate analytically how multiple sourcing emerges as an organizational mechanism to balance cost advantages associated with outsourcing against the subcontractor's increased bargaining power. In particular, our model predicts single sourcing, that is, either complete in-house production or complete outsourcing, if the bargaining power of the external supplier is independent of the proportion of outsourced production. We also explore the effects of the bargaining structure on the optimal production mode. In this respect, we find that the optimal proportion of outsourcing is lower with sequential negotiations than with simultaneous negotiations. Furthermore, we characterize the relationship between the optimal production modes and the order in which the firm conducts sequential negotiations.

Our study proceeds as follows. Section 2 presents the model. In Section 3, we characterize the optimal production mode with simultaneous bargaining. In Section 4, we explore the implications of the order of negotiations with sequential bargaining. Section 5 concludes. The Appendix provides formal proofs for the analytical results.

2. The Model

We design a model to analyze a firm's procurement of labor input. The labor input can be supplied either internally with the wage negotiated between the trade union and the firm or alternatively can be acquired based on a contract at terms negotiated with an external

⁶ For an extensive and general discussion of the sources of bargaining power in wage negotiations, we refer to Manzini and Snower (2002), and for a general perspective on bargaining considerations relevant for outsourcing, we refer to de Fontenay and Gans (2008).

subcontractor. We assume that bargaining within the context of a labor market where the firm cannot control its own bargaining power determines the wage for in-house production. Furthermore, we assume that outsourcing provides an option for the firm to potentially exploit a marginal cost advantage.

We model the formation of wages and subcontractor unit prices as a two-stage game where in the first stage the firm commits itself to the production mode, that is, the proportion of production that is conducted in-house $(1-x)$ and the proportion supplied by the subcontractor (x) . Conditional on the production mode, in the second stage, the firm engages in two Nash bargaining games (NBGs): 1) the firm negotiates with the trade union regarding the wage in order to produce the proportion $(1-x)$ of its output, and 2) the firm negotiates with the subcontractor in order to establish the unit price, ϕ , which applies to the proportion x of its output.

Formally, we model the bargaining game between the firm and the trade union according to:

$$\max_w \Omega_e(x, w, \phi) = [(w - w_o)(1 - x)]^{\beta_e} [(1 - x)(P - w)]^{(1-\beta_e)}, \quad (1)$$

where P is the price the firm obtains for its output, $(1 - x)(P - w)$ is the surplus to the firm attributable to the portion of output produced in-house, w_o is the outside option of the firm's workforce, and β_e is the (constant) bargaining power of the trade union. If the wage negotiations fail, we assume that the associated proportion of output will not be produced. In other words, the firm commits the proportion $(1-x)$ of its output for in-house production, and if the wage negotiations fail, that proportion of the production is not realized.

We determine the price of the input supplied by the subcontractor as the solution to the Nash bargaining game:

$$\max_\phi \Omega_c(x, w, \phi) = [(\phi - \phi_o)x]^{\beta(x)} [x(P - \phi)]^{(1-\beta(x))}, \quad (2)$$

where ϕ_o denotes the outside option of the subcontractor, that is, the price it could obtain for the alternative use of its capacity. The factor $P - \phi$ denotes the surplus to the firm and applies to the proportion x of output committed to the subcontractor. Again, we assume that if negotiations fail with the subcontractor, then that proportion of output will not be produced.

We assume two qualitatively important differences between the bargaining problems (1) and (2). First, we assume that the reservation price associated with in-house supply of labor is higher than that associated with external supply of labor, that is, $w_0 > \phi_0$. This means that outsourcing offers an option for the firm to exploit a potential cost advantage. Second, we assume a crucial difference in the nature of the firm's bargaining power between the two sourcing modes. With in-house sourcing of labor, the wage formation takes place within the framework of negotiations between the firm and the trade union. These negotiations take place with boundary conditions determined by labor laws and labor market institutions that are largely beyond the control of the firm. We capture this feature by assuming that the bargaining power coefficient is constant and independent of the proportion of in-house production. The contractual freedom is significantly larger for the negotiations between the firm and the external supplier. We assume that the subcontractor's bargaining power is an increasing function of the proportion of output supplied by the subcontractor. Formally, we assume that the subcontractor's bargaining power is a continuous, differentiable, and strictly increasing function ($\beta'(x) > 0$), with the additional boundary conditions that $\beta(0) = \beta_0 > 0$ and $\beta(1) = \bar{\beta} < 1$.

Prior to the negotiations regarding the input prices, the firm commits to its profit-maximizing production mode, that is, the proportion of production that is outsourced. When determining its production mode, the firm anticipates the outcome of the bargaining games. Overall, the firm's optimal procurement strategy balances potential cost advantages associated with outsourcing against the subcontractor's increased bargaining power. In our detailed analysis, incorporated in Sections 3 and 4, we investigate two bargaining regimes distinguished by the sequences of negotiations: 1) negotiations where the firm bargains with the trade union and subcontractor simultaneously, and 2) negotiations where the firm bargains with these parties sequentially.

The feature that the bargaining power is a *function* of the production volume allocated to one of the suppliers is an interesting and novel property from a methodological point. Earlier studies have modeled endogeneous bargaining power through the reservation values (see Muthoo (1999)). In our model, the optimal production mode determines the bargaining power of the subcontractor (and the firm). Multiple sourcing is derived as a result of the bargaining power being an increasing function of the proportion of the production being subcontracted. Another

interesting feature of our study is that we are able to characterize the consequences of the relative timing of negotiations by comparing simultaneous bargaining with sequential bargaining.

3. Simultaneous Bargaining

In this section, we analyze the configuration where the firm engages in simultaneous negotiations with the trade union in order to determine wages and with the subcontractor in order to determine the price of external supply. Formally, we find this Nash bargaining solution by solving the optimization problems (1) and (2) simultaneously. The necessary first-order conditions associated with (1) and (2) show that the negotiated wage is a downward sloping function of the external supply price and vice versa. In other words, the negotiated input prices associated with the two alternative production modes are strategic substitutes. Solving the system of equations determined by the first-order conditions, we can give the simultaneous Nash bargaining solution by:⁷

$$\phi^N = \phi_o + \beta(x)(P - \phi_o)$$

and

$$w^N = w_o + \beta_e(P - w_o).$$

The negotiated price for the external supplier incorporates a markup over its reservation price. This markup is proportional to the gains from trade $P - \phi_o$ with the subcontractor's bargaining power $\beta(x)$ as the proportionality factor. The negotiated price for the outsourced input depends on the firm's production mode through the bargaining power of the subcontractor. Analogously, the negotiated wage incorporates a markup over the outside option available to unionized workers. Also, for internal labor this markup is proportional to the gains from trade $P - w_o$ with the union's bargaining power β_e as the proportionality factor. Within the framework of this model, the negotiated wage does not depend on the firm's production mode.

The profit associated with the simultaneous Nash bargaining solution is:

⁷ We can easily show that the second-order conditions for optimality are satisfied.

$$\pi(x, w^N, \phi^N) = \pi_o(x) - (1-x)\beta_e(P-w_o) - x\beta(x)(P-\phi_o),$$

where $\pi_o(x) = P - (1-x)w_o - x\phi_o$ is the total surplus available. In this profit, we subtract the markups to the subcontractor and the unionized workers from the total surplus. This is the profit that is relevant for the firm when it determines the production mode in anticipation of the negotiated input prices associated with in-house production and outsourcing.

We can express the optimal proportion (x^N) of outsourced production implicitly as the solution to the following differential equation:⁸

$$w_o - \phi_o - (x^N \beta'(x^N) + \beta(x^N))(P - \phi_o) + \beta_e(P - w_o) = 0. \quad (3)$$

The first-order condition (3) captures three effects associated with a marginal increase in outsourcing. The first component, $w_o - \phi_o$, captures the savings in marginal costs imposed by outsourcing. The second component, $(x^N \beta'(x^N) + \beta(x^N))(P - \phi_o)$, denotes the marginal cost increase associated with the subcontractor's increased bargaining power. The third component, $\beta_e(P - w_o)$, captures that increased outsourcing causes a marginal benefit to the firm by removing rents from the trade union. Overall, the first-order condition (3) requires that the profit-enhancing effects exactly balance the marginal costs at the optimal proportion of outsourcing.

Let us first characterize the optimal production mode if the bargaining power of the subcontractor is constant, say $\beta(x) = \beta_c$. Under such circumstances the firm would find single sourcing optimal according to the following:

Result 1: If the bargaining power of the subcontractor is constant, $\beta(x) = \beta_c$, we can characterize the optimal production mode by:

$$(a) \text{ complete in-house production } (x=0) \text{ when } \beta_c \geq \frac{w_o - \phi_o}{P - \phi_o} + \beta_e \frac{P - w_o}{P - \phi_o}$$

(b) complete outsourcing ($x=1$) otherwise.

⁸ The second-order condition for an internal production mode solution with multiple sourcing is satisfied if $2\beta'(x) + x\beta''(x) > 0$.

If there is no cost advantage to outsourcing ($w_o = \phi_o$), conditions for single sourcing in Result 1 would reduce to direct comparisons between the bargaining power coefficients β_c and β_e . In Result 1, we assume that the firm maintains in-house production when the bargaining powers satisfy the linear relationship $\beta_c = \frac{w_o - \phi_o}{P - \phi_o} + \beta_e \frac{P - w_o}{P - \phi_o}$.

So far, we have delineated circumstances under which single sourcing is optimal. Next we ask: Under which conditions is a production mode with multiple sourcing optimal? Formally, multiple sourcing is optimal if the optimal proportion of outsourced production, x^N , satisfies that $0 < x^N < 1$. For this purpose, we shift to the general case with the subcontractor's bargaining power as a continuous, differentiable, and strictly increasing function with the additional boundary conditions that $\beta(0) = \beta_0 > 0$ and $\beta(1) = \bar{\beta} < 1$. Contingent on these boundary conditions, we formulate the following sufficient condition for multiple sourcing to be optimal:

Result 2: Multiple sourcing is the optimal production mode if the boundary conditions of the subcontractor's bargaining power satisfy:

$$\beta_0 < \frac{w_o - \phi_o}{P - \phi_o} + \beta_e \frac{P - w_o}{P - \phi_o} \quad \text{and} \quad \beta'(1) + \bar{\beta} > \frac{w_o - \phi_o}{P - \phi_o} + \beta_e \frac{P - w_o}{P - \phi_o} . \quad (4)$$

The condition on β_0 in (4) guarantees that initially some outsourcing would occur. The second condition in (4) on $\beta'(1) + \bar{\beta}$ makes it too expensive to outsource all production.

In this model, multiple sourcing is an organizational mechanism to balance cost advantages associated with outsourcing against the subcontractor's increased bargaining power. As explained in the introduction, this mechanism for multiple sourcing complements those presented in the existing literature. The first-order condition (3) implies that the optimal production mode has the following interesting comparative statics properties:

Result 3: If the second-order condition $2\beta'(x) + x\beta''(x) > 0$ holds, the optimal proportion of outsourcing (x^N) is an increasing function of w_o and β_e and is a decreasing function of P and ϕ_o .

The comparative statics properties with respect to w_o , β_e , and ϕ_o are intuitive and straightforward. As one type of input becomes costlier, the firm diverts more resources towards the alternative production mode. Similarly, a higher bargaining power of the internal source makes outsourcing more attractive. An increased value of production (P) enhances the surplus for all negotiating partners. This makes the firm more sensitive to changes in the bargaining power that the degree of outsourcing affects.

4. Sequential Bargaining

So far we have analyzed a configuration where the firm negotiates with the trade union and the subcontractor simultaneously. In this section, we focus on a sequential pattern of bargaining, where the firm's negotiations with one party serve as a commitment relative to its negotiations with the other party.

4.1 Sequential Bargaining with the Negotiated Wage as a Commitment

In this section, we investigate a sequential pattern of bargaining with the feature that the negotiated wage serves as an irreversible commitment relative to the firm's negotiations with the external subcontractor. With such a timing structure, the firm conducts the wage negotiations in anticipation of its subsequent negotiation regarding the terms of outsourcing. Such a timing structure seems plausible if the negotiated outsourcing contracts have short horizons relative to the horizons of negotiated wage contracts. This may well be the case in industries where the production can be flexibly outsourced, that is, where the subcontractors have the knowhow and capacity to carry out the production without relationship-specific investments.

Given that the firm has reached a wage agreement, w , for producing the proportion $1-x$ in-house, we determine the price of the input supplied by the subcontractor as the solution to the Nash bargaining game:

$$\max_{\phi} \Omega_c(x, w, \phi) = [(\phi - \phi_o)x]^{\beta(x)} [x(P - \phi)]^{(1-\beta(x))} ,$$

which yields the Nash bargaining solution:

$$\phi^F = \phi_o + \beta(x)(P - \phi_o) .$$

In anticipation of this input price associated with outsourcing, we determine the wage as the solution to:

$$\max_w \Omega_e^L(x, w, \phi^F) = [(1-x)(w - w_o)]^{\beta_e} [P - (1-x)w - x\phi^F]^{1-\beta_e} . \quad (5)$$

The above optimization problem captures that the value to the firm of reaching a wage agreement is $(P - w)(1 - x) + x(P - \phi^F)$. This value incorporates as an embedded option the value to the firm of subsequently reaching an agreement with the external supplier at the negotiated price ϕ^F . Substituting ϕ^F into the above and solving for w , we find that the negotiated wage is:

$$w^L = w_o + \frac{\beta_e}{(1-x)} [\pi_o(x) - x\beta(x)(P - \phi_o)] ,$$

where, as earlier, $\pi_o(x) = P - (1-x)w_o - x\phi_o$. By substituting w^L and ϕ^F back into the profit function, we find that sequential bargaining implies the following profit to the firm:

$$\pi^L(x) = (1 - \beta_e) [\pi_o(x) - x\beta(x)(P - \phi_o)] . \quad (6)$$

From (6) we can characterize the optimal production mode with sequential negotiations x^L by:⁹

$$w_o - \phi_o - (x^L \beta'(x^L) + \beta(x^L))(P - \phi_o) = 0 . \quad (7)$$

⁹ As in the previous section, we assume the sufficient second-order condition to hold true.

If the bargaining power of the subcontractor were constant, $\beta(x) = \beta_c$, we can directly conclude that the optimal production mode would be full outsourcing as long as $w_0 > \phi_0$.

In the general case, we can make use of (3) and (7) to compare the optimal production mode with sequential negotiations with that associated with simultaneous negotiations. In this respect, we can report the following finding:

Result 4: Consider sequential negotiations such that the firm first reaches a wage agreement with the trade union. With such sequential negotiations, the optimal proportion of outsourced production is lower than that associated with simultaneous negotiations, that is, $x^L < x^N$.

The relationship between the optimal production modes under sequential and simultaneous negotiation is very interesting, particularly in light of the associated relationship between the factor prices. We can show that:

$$w^L(x^L) - w^N(x^N) = x^L(1 - \beta(x^L))[P - \phi_0] > 0,$$

meaning that the negotiated wage is higher with sequential than with simultaneous negotiations.

This finding is indeed consistent with Result 4, as the relationship $x^N > x^L$ also implies that:

$$\phi^N(x^N) - \phi^L(x^L) > 0.$$

The relationship $x^L < x^N$ implies that the trade union benefits from sequential bargaining compared with simultaneous bargaining, as $w^L(1 - x^L) > w^N(1 - x^N)$. Conversely, with sequential negotiations, where the firm determines wages prior to the terms of the contract for external supply, the surplus to the subcontractor is smaller than with simultaneous bargaining, as $\phi^L x^L < \phi^N x^N$. Consequently, we can conclude that the in-house supplier, who is part of the first-round negotiations, benefits at the expense of the subcontractor, who is part of the second-round negotiations.

In light of our assumption that the reservation price associated with in-house supply of labor is higher than that associated with external supply ($w_0 > \phi_0$), Result 4 has interesting implications

for total welfare. Suppose that we define total welfare as the unweighted sum of the firm's profit, the surplus to the labor union and to the subcontractor. Under such circumstances, outsourcing clearly promotes total welfare in a monotonic way such that total welfare would be maximized with complete outsourcing. Based on this argument, we can formulate the following:

Result 5: Simultaneous bargaining promotes total welfare as compared with sequential bargaining.

For a general function of the bargaining power, $\beta(x)$, we are unable to determine whether the firm benefits or not from sequential negotiations compared with simultaneous negotiations. In order to be able to compare the effects for the firm's profits of the two patterns of negotiation, we focus on a linear bargaining power function with $\beta(x) = ax$, $0 < a < 1$. This particular bargaining power function satisfies the general conditions we have imposed in the analysis so far. For this linear bargaining power function, it follows directly from (3) that we can give the optimal production mode with simultaneous bargaining by:

$$x^N = \frac{w_0 - \phi_0 + \beta_e (P - w_0)}{2a(P - \phi_0)}.$$

Similarly, from (7) we can give the optimal production mode with sequential bargaining by:

$$x^L = \frac{w_0 - \phi_0}{2a(P - \phi_0)}.$$

Substituting the optimal production modes for simultaneous and sequential bargaining into the profit function, we find after simplification that:

$$\begin{aligned} \pi^N(x^N, w^N, \phi^N) - \pi^L(x^L, w^L, \phi^L) = \\ \phi_0 + \frac{(w_0 - \phi_0)^2}{4a(P - \phi_0)}(1 - \beta_e) + \frac{\beta_e (P - w_0)}{2a(P - \phi_0)}[P - \phi_0 + (w_0 - \phi_0)] > 0. \end{aligned}$$

Consequently, we can draw the following conclusion for a linear bargaining power function with $\beta(x) = ax$, $0 < a < 1$:

Result 6: The firm prefers simultaneous bargaining to sequential bargaining such that the negotiated wage serves as an irreversible commitment relative to the firm's negotiations with the external subcontractor.

According to Result 6, the firm has an incentive to design a bargaining structure whereby it simultaneously negotiates with respect to the wages and the terms of external supply. By synchronizing the start and termination of these contracts, the firm could facilitate simultaneous bargaining. Alternatively, the firm could also facilitate this by keeping the terms of contracts undisclosed to either party.

4.2 Sequential Bargaining with the External Supplier Contract as a Commitment

In this subsection, we investigate a sequential pattern of bargaining with the order of negotiations reversed. This means that the terms of the contract with the external supplier serves as an irreversible commitment relative to the firm's wage negotiations associated with in-house supply. Such a timing structure applies to situations where the contracts with external suppliers have long horizons relative to those of negotiated wage contracts. This could very well capture industries where the external supplier has to make highly irreversible and firm-specific investments.

Conditional on a negotiated price, ϕ , for the proportion x of input supplied by the subcontractor, we determine the wage as the solution to the Nash bargaining game:

$$\max_w \Omega_e(x, w, \phi) = [(w - w_o)(1 - x)]^{\beta_e} [(1 - x)(P - w)]^{1 - \beta_e} ,$$

which yields the Nash bargaining solution:

$$w^F = w_o + \beta_e(P - w_o) .$$

In anticipation of this wage for in-house supply, we determine the price for external supply as the solution to:

$$\max_{\phi} \Omega_c^L(x, w^F, \phi^*) = [x(\phi - \phi_0)]^{\beta(x)} [P - (1-x)w^F - x\phi]^{1-\beta(x)}.$$

$P - (1-x)w^F - x\phi = x(P - \phi) + (1-x)(P - w^F)$ denotes the value to the firm of reaching an agreement with respect to ϕ . With this sequence of bargaining, the value incorporates as an embedded option the value to the firm of subsequently reaching a wage agreement at the negotiated wage of w^F . Not reaching an agreement in the first stage implies not being able to proceed, that is, all the production is required in order to satisfy existing sales agreements.

Based on the appropriate substitution of w^F , we can give the negotiated price for external supply by:

$$\phi^L = \phi_0 + \frac{\beta(x)}{x} \{ \pi_o(x) - (1-x)\beta_e(P - w_o) \}.$$

By substituting ϕ^L and w^F back into the profit function, we find that sequential bargaining with the subcontractor negotiating first implies the following profit to the firm:

$$\pi(x, \phi^L, w^F) = (1 - \beta(x)) [\pi_o(x) - (1-x)\beta_e(P - w_o)].$$

Differentiating this profit function with respect to x , we find the following necessary condition for the firm's optimal production mode, $x = x^C$, with this sequential pattern of bargaining:

$$- \beta'(x^C) [\pi_o(x^C) - (1-x^C)\beta_e(P - w_o)] + (1 - \beta(x^C)) [(w_o - \phi_0) + \beta_e(P - w_o)] = 0. \quad (8)$$

We can compare the optimal production modes of this pattern of bargaining (x^C) with that of the alternative order of negotiations (x^L) or with that associated with simultaneous bargaining (x^N). Formally, this involves an explicit comparison between (3), (7), and (8). At a general level, such a comparison yields results with fairly limited transparency. A comparison between (7) and (8) reveals that the characterization of the optimal production mode is significantly more complex for the bargaining sequence where the firm first negotiates with the external supplier. The reason

for this is that the bargaining power of the subcontractor depends on the production mode. For that reason, we again rely on a linear bargaining power function with $\beta(x) = ax$, $0 < a < 1$, as in Subsection 4.1.

For the purpose of facilitating more transparent comparisons in this subsection, we normalize by assuming that $\phi_0 = 0$. This imposes no loss of generality and essentially means that w_0 captures the extent to which the reservation price associated with in-house supply of labor is higher than that associated with external supply of labor. With this normalization, we can make use of (3), (7), and (8) to calculate that the optimal production modes associated with the three different bargaining patterns are:

$$x^N = \frac{\beta_e P + (1 - \beta_e) w_0}{2aP}, \quad x^L = \frac{w_0}{2aP}, \quad \text{and} \quad x^C = \frac{(\beta_e(1+a) - 1)P - \beta_e(1+a)w_0}{2a[\beta_e P + (1 - \beta_e)w_0]},$$

respectively.

We first compare x^C with x^N , for which we can report the following result:

Result 7: Consider sequential negotiations such that the firm first negotiates with the external subcontractor. With such sequential negotiations, the optimal proportion of outsourced production is lower than that associated with simultaneous negotiations, that is, $x^C < x^N$.

By combining Results 4 and 7, we can conclude that the optimal proportion of outsourcing is higher with simultaneous negotiations than with sequential negotiations independent of the order in which the firm conducts these sequential negotiations.

We must still compare the optimal production modes across the two patterns of bargaining with sequential negotiations. Based on a detailed comparison of x^C with x^L , we can formulate the following result:

Result 8: The relationship between the optimal production modes in the two patterns of bargaining with sequential negotiations is determined by the following conditions:

(a) Assume that $P < \frac{2+a}{a} w_0$. If the firm first negotiates with the external subcontractor, the optimal proportion of outsourcing is lower than if it first negotiates with the trade union, that is, $x^C < x^L$.

(b) Assume that $P \geq \frac{2+a}{a} w_0$ and define $\hat{\beta}_e$ as the solution to the equation $P[(\hat{\beta}_e(1+a) - 1)P - \hat{\beta}_e(1+a)w_0] = w_0[\hat{\beta}_e P + (1-\hat{\beta}_e)w_0]$. The optimal production modes satisfy that $x^C > x^L$ if and only if $\beta_e > \hat{\beta}_e$.

According to Result 8, the difference between P and w_0 as well as the exogenous bargaining power of the trade union determine the relationship between the optimal production modes associated with the two patterns of bargaining with sequential negotiations. According to Result 8 (a), when the difference between P and w_0 is sufficiently small, the optimal proportion of outsourcing is always lower if the firm first negotiates with the external subcontractor than if it first negotiates with the trade union. If the difference between P and w_0 is sufficiently large, Result 8 (b) specifies that we can determine the relationship between the optimal production modes for the two sequences of negotiations by the exogenous bargaining power of the trade union. More precisely, the optimal proportion of outsourcing is larger when the firm negotiates first with the external supplier if the trade union has sufficiently strong bargaining power.

Consistent with the argument presented in association with Result 5, the proportion of outsourcing determines the total welfare in a monotonic way. In light of this argument, Result 8 (a) and 8 (b) characterize the welfare effects of sequential bargaining with different sequences of negotiations. More precisely, sequential bargaining with wages negotiated first has welfare gains compared with the opposite sequence of negotiations if $P < \frac{2+a}{a} w_0$. This condition is likely satisfied if the prevailing technology has labor as the predominant production factor. However, the exogenous bargaining power of the trade union determines the welfare effects of the different

sequences of bargaining if $P \geq \frac{2+a}{a} w_0$, which would be more likely to hold when there are multiple production factors.

5. Conclusion

This analysis has characterized a firm's optimal production mode in a setting where labor is the only production factor. This input can be supplied either internally based on wage negotiations or acquired at terms negotiated with an external subcontractor. Within the framework of such a model, we establish analytically how multiple sourcing emerges as an organizational mechanism to balance cost advantages associated with outsourcing against the subcontractor's increased bargaining power. In particular, our model predicts single sourcing, that is, either complete in-house production or complete outsourcing, if the bargaining power of the external supplier is independent of the proportion of outsourced production. We also compare the effects of the bargaining structure on the optimal production mode. In this respect, we find that the optimal proportion of outsourcing is lower with sequential negotiations than with simultaneous negotiations. Furthermore, we also characterize the relationship between the optimal production modes and the order in which the firm conducts sequential negotiations.

Our analysis has focused on asymmetric input suppliers insofar as we assume that the insider, the trade union, has exogenous bargaining power, whereas the bargaining power of the external supplier is derived as a function of the production mode. In Section 2, we attempt to justify that such an asymmetry is plausible for an analysis of a firm's procurement of labor input. However, our model could very well be extended to investigate the problem of a firm facing multiple suppliers of an arbitrary input or multiple retailers in such a way that the bargaining power of each supplier (retailer) would be a function of the production volume to the supplier (retailer) in question. Such an extension would add significantly to our knowledge of optimal sourcing for a firm facing multiple suppliers (retailers).

When comparing different bargaining patterns, we primarily focus on the effect of the bargaining pattern on the optimal production mode. We have offered a very limited analysis of the optimal bargaining pattern from the firm's point of view. In that respect, we have only established that

the firm prefers simultaneous bargaining to sequential bargaining with such an order of negotiations that the wage serves as an irreversible commitment relative to the firm's negotiations with the external subcontractor. Clearly, our approach could be extended to yield a more systematic analysis of the optimal bargaining pattern for the firm.

Appendix: Proofs of Results

Proof of Result 2: Differentiating the profit associated with the simultaneous Nash bargaining solution with respect to x , we find that $\pi'(x) = w_0 - \phi_0 - (x\beta'(x) + \beta(x))(P - \phi_0) + \beta_e(P - w_0)$. In particular, it holds true that $\lim_{x \rightarrow 0^+} \pi'(x) > 0$ if:

$$\beta_0 < \frac{w_0 - \phi_0}{P - \phi_0} + \beta_e \frac{P - w_0}{P - \phi_0},$$

and that $\lim_{x \rightarrow 1^-} \pi'(x) < 0$ if:

$$\beta'(1) + \bar{\beta} > \frac{w_0 - \phi_0}{P - \phi_0} + \beta_e \frac{P - w_0}{P - \phi_0}.$$

Because the profit function $\pi(x)$ is continuous, differentiable, and strictly concave, these conditions imply a unique interior production mode $0 < x^N < 1$ with the property that $\pi'(x^N) = 0$. *QED*

Proof of Result 3: Rearranging (3), we have:

$$x^N \beta'(x^N) + \beta(x^N) = \frac{w_0 - \phi_0 + \beta_e(P - w_0)}{(P - \phi_0)} = K.$$

According to the second-order condition, the L.H.S. of the above equation is strictly increasing in x . The comparative statics results follow from the observations that $\frac{\partial K}{\partial w_0} > 0$ as $\beta_e < 1$,

$$\frac{\partial K}{\partial \beta_e} > 0, \quad \frac{\partial K}{\partial \phi_0} = -\frac{(1-\beta_e)(P-w_0)}{(P-\phi_0)^2} < 0, \quad \text{and} \quad \frac{\partial K}{\partial P} = -\frac{(1-\beta_e)(w_0-\phi_0)}{(P-\phi_0)^2} < 0. \quad Q.E.D.$$

Proof of Result 4: According to (3), the optimal proportion of outsourcing with simultaneous negotiations satisfies:

$$x^N \beta'(x^N) + \beta(x^N) = \frac{w_0 - \phi_0}{P - \phi_0} + \beta_e \frac{P - w_0}{P - \phi_0}.$$

According to (7), the optimal proportion of outsourcing with sequential negotiations is:

$$x^L \beta'(x^L) + \beta(x^L) = \frac{w_0 - \phi_0}{P - \phi_0}.$$

The second-order condition $2\beta'(x) + x\beta''(x) > 0$ implies that the common L.H.S. of these equations is increasing as a function of x . We can therefore conclude that $x^L < x^N$. *QED*

Proof of Result 7: By direct substitution, we find that the inequality $x^C < x^N$ is equivalent to:

$$P [(\beta_e (1+a) - 1)P - \beta_e (1+a)w_0] < [\beta_e P + (1-\beta_e)w_0]^2.$$

We define $g(\beta_e) = P[(\beta_e (1+a) - 1)P - \beta_e (1+a)w_0]$ and $h(\beta_e) = [\beta_e P + (1-\beta_e)w_0]^2$.

Clearly, both of these functions are strictly increasing with $g'(\beta_e) = P(1+a)(P-w_0) > 0$ and

$h'(\beta_e) = 2[\beta_e P + (1-\beta_e)w_0](P-w_0) > 0$. Furthermore, $g(0) = -P^2$, $h(0) = (w_0)^2$,

$g(1) = P[aP - (1+a)w_0]$, and $h(1) = P^2$. From these properties, we can directly conclude that

$g(\beta_e) < h(\beta_e) \forall \beta_e \in [0,1]$. Consequently, it holds true that $x^C < x^N$. *QED*

Proof of Result 8: By direct substitution, we find that the inequality $x^C < x^L$ is equivalent to:

$$P[(\beta_e (1+a) - 1)P - \beta_e (1+a) w_0] < w_0 [\beta_e P + (1-\beta_e) w_0].$$

We define $g(\beta_e) = P[(\beta_e (1+a) - 1)P - \beta_e (1+a) w_0]$ and $k(\beta_e) = w_0 [\beta_e P + (1-\beta_e) w_0]$.

Both of these functions are strictly increasing with $g'(\beta_e) = P(1+a)(P - w_0) > 0$ and

$k'(\beta_e) = w_0 (P - w_0) > 0$. Furthermore, we observe that $g(0) = -P^2$ and $k(0) = (w_0)^2$. By

substituting in $\beta_e = 1$, we find that:

$$g(1) = P[aP - (1+a)w_0] < w_0 P = k(1) \text{ if and only if } P < \frac{2+a}{a} w_0.$$

From these properties, we can directly conclude that $g(\beta_e) < k(\beta_e) \forall \beta_e \in [0,1]$ if $P < \frac{2+a}{a} w_0$.

This completes the proof of Result 8 (a).

If, on the other hand, $P \geq \frac{2+a}{a} w_0$, it holds true that $g(1) \geq k(1)$. From the established

properties of the functions $g(\beta_e)$ and $k(\beta_e)$, this implies that $g(\beta_e) \geq k(\beta_e)$ if and only if

$\beta_e \geq \hat{\beta}_e$, where we define $\hat{\beta}_e$ as the solution to the equation

$$P[(\hat{\beta}_e (1+a) - 1)P - \hat{\beta}_e (1+a) w_0] = w_0 [\hat{\beta}_e P + (1-\hat{\beta}_e) w_0].$$

This completes the proof of Result 8 (b).

QED

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