Make and buy: Balancing bargaining power

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A B S T R A C T

We analyze the optimal procurement of labor, which can be supplied either internally, based on wage negotiations, or acquired at terms negotiated with an external subcontractor. The novel feature of our model is that the subcontractor’s bargaining power is a function of the proportion of output outsourced. 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 find that the optimal proportion of outsourcing is lower with sequential negotiations than with simultaneous negotiations, if the supplier to first negotiate can foreclose subsequent negotiations.

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1. Introduction

In-house production and outsourced production are often viewed as the main alternative production modes available to a firm. As such, 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 Holmstrom 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 percent of interstate carriers in the U.S. trucking industry procure driving services from in-house as well as external sources. As another example, Nokia Siemens Networks (NSN) outsources approximately 20 percent 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). Bas and Carluccio (2009) conclude from their empirical study of French multinationals how the balance of bargaining power between firms and trade unions (or other input suppliers) shape firms’ organizational choices.

Economists, and managers alike, often argue that extreme production modes focusing exclusively either on in-house production or subcontracting implies that the firm loses bargaining power to the exclusive input supplier. Multiple sourcing...
can 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 issue identified 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. According to this argument, a balancing of bargaining power relative to both inside and outside suppliers determines the optimal organization mode for the firm. Michael (2000), Simester and Knez (2002), and Rothaermel et al. (2006) are interesting empirical studies on such issues.

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. Thereby the sourcing decision makes the bargaining power of the firm relative to subcontractors an endogenous feature of the model. 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, partial integration 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 et al. (2006) analyze a production function that separates headquarters services and component inputs and assume that the headquarters have a stronger but exogenously given bargaining power with respect to internal rather than external component suppliers. They demonstrate how the headquarters can benefit from bi-sourcing, which generates a cross-threat effect when negotiating with the two different input suppliers. Shy and Stenbacka (2005) characterize 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 Gans (2003), models wage formation as a series of pairwise bargaining games between a representative firm and its employees. This approach is different from ours, because we make a distinction between internal suppliers (which, in our context, collectively bargain) of labor and subcontractors. Shaked and Sutton (1984) make the distinction between insiders and outsiders in their analysis of wage bargaining, but they do not study how to optimally allocate production between in-house production and 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, and in particular on various aspects of the Nash bargaining solution. In standard versions of the Nash bargaining games (as surveyed by, for example, Muthoo, 1999), the bargaining power is 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 bargaining model with the feature that the bargaining power coefficient is endogenous.4 In our model, the optimal

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2 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). However, Porter did not formally analyze this matter.

3 Du et al. (2009) explore this mechanism within the framework of a model of international trade.

4 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). Grennan (2011) emphasizes that
production mode balances cost advantages achievable through outsourcing against the increased bargaining power of the subcontractor associated with outsourcing. There is also a related literature on the pattern of bargaining where either firms or unions strategically determine the sequence of negotiations under circumstances with exogenously given bargaining power measures (for example, Dobson, 1984 and Marshall and Merlo, 2004). 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 performance of sequential bargaining depends crucially on whether the input supplier with which the firm negotiates first has the ability to block subsequent negotiations with alternative input suppliers. We find that the optimal proportion of outsourcing is lower with sequential negotiations than with simultaneous negotiations if the input supplier engaged in first-round negotiations has foreclosing power. Furthermore, we characterize the relationship between the optimal production modes and the order in which the firm conducts sequential negotiations. If the input supplier engaged in first-round negotiations cannot foreclose subsequent negotiations it does not matter whether the negotiations are conducted simultaneously or sequentially as long as these negotiations take place conditional on the firm’s commitment with respect to the proportion of outsourced production.

Our study proceeds as follows. Section 2 presents the bargaining framework. In Section 3, we characterize the optimal production mode with simultaneous bargaining. In Section 4, we explore the implications of the order of negotiations under sequential bargaining, where the input supplier with which the firm negotiates first has the ability to foreclose subsequent negotiations with alternative input suppliers. Section 5 studies the implications of the bargaining structure without foreclosing power. Section 6 concludes and discusses possible extensions. The Appendix A 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 subcontractor. We assume that wages associated with in-house production are determined within the context of a labor market where the firm cannot control its own bargaining power. 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 \((v)\) 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, \(\phi\), which applies to the proportion \(x\) of its output.

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

\[
\max_v \Omega_v(x, w, \phi) = [\{w - w_0\} (1-x)]^{\beta_x} [(1-x)(P-w)]^{1 - \beta_x},
\]

where \(P\) is the price the firm obtains for its output, \(w_0\) is the outside option of the firm’s workforce, and \(\beta_x\) is the (constant) bargaining power of the trade union. 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. The surplus to the firm attributable to the portion of output produced in-house is \((P - x\phi - (1-x)w) - x(P - \phi) = (1-x)P - w\).

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

\[
\max_h \Omega_h(x, w, \phi) = [(\phi - \phi_0)x]^{\beta_h} [x(P - \phi)]^{1 - \beta_h},
\]

where \(\phi_0\) 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. Formally, the surplus to the firm attributable to the portion of output produced based on outsourcing is \((P - x\phi - (1-x)w) - (1-x)(P-w) = x(P - \phi)\).

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

bargaining power is also importantly affected by bargaining ability. Draganska et al. (2010) empirically estimate bargaining power parameters between manufacturers and retailers in the German coffee market.
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 will find that the subcontractor’s bargaining power is an increasing function of the proportion of output supplied by the subcontractor in order for partial integration to occur. We will then adopt the feature 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 \( \beta(1) = \beta < 1 \). Supplier Relationship News (2007) presents a case example relating the volume supplied by a subcontractor to bargaining power. According to this case, Adidas, as a result of merging with Reebok in 2006, “used greater bargaining power with suppliers to slash its procurement costs”.

The assumption with the bargaining power of the subcontractor as an increasing function of the proportion of production supplied by this subcontractor can be seen as a formalization of Porter’s (1980) influential view, according to which size is a crucial source of bargaining power for a supplier. Some empirical studies have subsequently explored the determinants of bargaining power, for example, the study by Draganska et al. (2010) focusing on the distribution of bargaining power between retailers and manufacturers. These authors found that the distribution of bargaining power differs among different manufacturers-retailer pairs and that firm size significantly affects bargaining power.

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 of view. Earlier studies have modeled endogenous bargaining power through the reservation values (see Muthoo (1999)). Our assumption that the bargaining power parameter of the subcontractor is an increasing function of the proportion of production outsourced can be justified by reference to an argument focusing on the reservation value of the subcontractor. Namely, assume that the outside option of the subcontractor depends on the amount outsourced \( \phi_0(x) \). For example, for a capacity-constrained subcontractor larger contracts might force this subcontractor to drop increasingly profitable alternative supply contracts, meaning that a larger subcontractor has less to lose if the negotiations under consideration fail. Such a mechanism would lead to an increase in the negotiated price of external supply in a way similar to an increase in the subcontractor’s bargaining power.

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 imposed timing structure means that the production mode is inflexible at the stage when the firm negotiates with the trade union and the subcontractor. Such a timing structure seems plausible when the implementation of a production mode with outsourcing requires irreversible and firm-specific long-term investments for the establishment of a network of external suppliers. In principle, the relative timing between the negotiations and the production mode decision could also be reversed. Such a configuration would capture that the negotiated wage serves as a long-term commitment relative to the production mode decision. Such a reversed timing structure could be relevant for outsourcing of standard inputs for which there already exists plants and established capacity in low-wage countries. Skaksen’s (2004) analysis of international outsourcing has analyzed such a timing structure by assuming that the firms could flexibly adjust their production mode and decide whether to initiate foreign outsourcing after the determination of domestic wages. Relatedly, Braun and Scheffel (2007) have developed a simple two-stage game between a monopoly union and a firm by assuming that the union sets wages before the firm flexibly decides on the degree of outsourcing and the level of production. Finally, the amount of outsourcing could also be subject to negotiations in a way analogous to labor economics models of efficient bargaining with the feature that firms and trade unions negotiate with respect to both wages and employment rather than with respect to wages alone as in the right-to-manage approach. Overall, from the related extensive literature focusing on the scope of bargaining in labor economics we know that the consequences for negotiated wages and employment are sensitive to the timing of decision and to the scope of bargaining.

As for implications, 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

We now 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

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5 See, for example, chapter 7 in Cahuc and Zylberberg (2004).

6 The recent endogenous game approach developed by Conley and Neilson (2009) could be viewed to present an alternative theoretical justification for why firms might constrain the dimensions along which they negotiate with suppliers.
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 decreasing 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 find the simultaneous Nash bargaining solution:\footnote{We can easily show that the second-order conditions for optimality are satisfied.}

\[ \phi^N = \phi_0 + \beta(x)(P - \phi_0), \]
\[ w^N = w_0 + \beta_c(P - w_0). \]

The negotiated price for the external supplier incorporates a markup over its reservation price. This markup is proportional to the gains from trade \( P - \phi_0 \) 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 \( P - w_0 \) with the union’s bargaining power \( \beta_c \) 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

\[ \pi(x, w^N, \phi^N) = \pi_0(x) - (1 - x)\beta_c(P - w_0) - x\beta(x)(P - \phi_0), \]

where \( \pi_0(x) = P - (1 - x)w_0 - x\phi_0 \) 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:\footnote{The second-order condition for an internal production mode solution with multiple sourcing is satisfied if \( 2\beta(x) + x\beta'(x) > 0 \).}

\[ w_0 - \phi_0 - (x^N \beta'(x^N) + \beta(x^N))(P - \phi_0) + \beta_c(P - w_0) = 0. \] \hspace{1cm} (3)

The first-order condition (3) captures three effects associated with a marginal increase in outsourcing. The first component, \( w_0 - \phi_0 \), captures the savings in marginal costs imposed by outsourcing. The second component, \( (x^N \beta'(x^N) + \beta(x^N))(P - \phi_0) \), denotes the marginal cost increase associated with the subcontractor’s increased bargaining power. The third component, \( \beta_c(P - w_0) \), 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.

By totally differentiating (3) we find that \( (\partial \phi^N / \partial x) > 0 \), meaning that a stronger bargaining for the trade union implies a production mode with a higher proportion of outsourcing. This property is consistent with the empirical evidence presented by Bas and Carluccio (2009).

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) complete in-house production \((x = 0)\) when \( \beta_c \geq (w_0 - \phi_0)/(P - \phi_0) + \beta_c(P - w_0)/(P - \phi_0) \)

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

**Result 1** captures the idea that it is not sufficient to simply compare the bargaining powers \( \beta_c \) and \( \beta_c \) when determining the optimal production mode with single sourcing, but that the difference in the outside options, \( w_0 - \phi_0 \), also has to be taken into account. If there is no cost advantage to outsourcing \((w_0 = \phi_0)\), conditions for single sourcing in Result 1 would reduce to direct comparisons between the bargaining power parameters \( \beta_c \) and \( \beta_c \). In Result 1, we assume that the firm maintains in-house production when the bargaining powers satisfy the linear relationship in 1 (a) with a strict equality.

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 \( 0 \leq x^N \leq 1 \). We will now shift to the more 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 \( \beta(1) = \beta < 1 \). 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:

\[
\beta_0 < \frac{w_0 - \phi_0}{P - \phi_0} + \beta_c \frac{P - w_0}{P - \phi_0} \quad \text{and} \quad \beta'(1) + \beta = \frac{w_0 - \phi_0}{P - \phi_0} + \beta_c \frac{P - w_0}{P - \phi_0}.
\]  

(4)

The condition on \(\beta_0\) in (4) guarantees that initially some outsourcing would occur. The second condition in (4) on \(\beta'(1) + \beta\) makes it too expensive to outsource all production.

In this model, partial integration is an organizational mechanism to balance cost advantages associated with outsourcing against the subcontractor’s increased bargaining power. This mechanism for multiple sourcing complements those presented in the existing literature. The first-order condition (3) implies 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 \(w_0\) and \(\beta_c\) and a decreasing function of \(P\) and \(\phi_0\).

The comparative statics properties with respect to \(w_0\), \(\beta_c\), and \(\phi_0\) are intuitive. 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 with foreclosing power**

Thus far we analyzed a configuration where the firm negotiates with the trade union and the subcontractor simultaneously. In Sections 4 and 5, 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. It turns out that the implications of sequential bargaining depend to a large extent on whether the supplier with whom the firm negotiates first has power to block the firm from subsequently negotiating with the alternative supplier. In the next two subsections we analyze two configurations of sequential negotiations: (1) the firm negotiates first with the trade union, and (2) the firm negotiates first with the external supplier.

4.1. **Sequential bargaining with the negotiated wage as a commitment**

In this subsection, 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. In addition, we here assume that the trade union has the power to block the firm from subsequently negotiating with the subcontractor if the first-round negotiations fail. One mechanism for this would be a trade union on strike obstructs any attempts of the firm to negotiate with a subcontractor.

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

\[
\max_{\phi} \Omega_{\phi}(x, w, \phi) = \left(\phi - \phi_0\right)x(1-x)^{\frac{\beta_0}{\beta_c}} \left(xP_0 - \phi\right)^{(1-\beta_0)(x)} ,
\]

which yields the Nash bargaining solution:

\[
\phi^F = \phi_0 + \beta(x)(P - \phi_0).
\]

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

\[
\max_{\phi} \Omega_{\phi}(x, w, \phi^F) = \left(1-x\right)(w - w_0)^{\frac{\beta_0}{\beta_c}} \left(xP_0 - \phi_0\right)^{(1-\beta_0)(x)}.
\]

The optimization problem (5) captures that the value to the firm of reaching a wage agreement is \((P - w)(1-x) + (P - \phi^F)\). 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 \(\phi^F\). Substituting \(\phi^F\) into the above and solving for \(w\), we find that the negotiated wage is:

\[
w^I = w_0 + \frac{\beta_c}{1-x} \left[\pi_0(x) - x\phi(x)\right]_0 .
\]

where, as earlier, \(\pi_0(x) = P - (1-x)w_0 - x\phi_0\). By substituting \(w^I\) and \(\phi^F\) back into the profit function, we find that sequential bargaining implies the following profit to the firm:

\[
\pi^I(x) = (1-\beta_c)\left[\pi_0(x) - x\phi(x)\right]_0 .
\]
From (6) we can characterize the optimal production mode with sequential negotiations \( x^L \) by:

\[
w_0 - \phi_0 - (x^L \beta(x^L) + \beta(x^L))(P - \phi_0) = 0.
\] (7)

The optimality condition (7) exhibits two effects associated with a marginal increase in outsourcing. As in (3), the first component, \( w_0 - \phi_0 \), captures the savings in marginal costs imposed by outsourcing. The second component, \((x^L \beta(x^L) + \beta(x^L))(P - \phi_0)\), denotes the marginal cost increase associated with the subcontractor’s increased bargaining power. Unlike the case with simultaneous bargaining, the optimal production mode with this type of sequential negotiations is independent of the bargaining power of the trade union.

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. Based on such a comparison we find:

**Result 4.** Consider sequential negotiations such that the firm first reaches a wage agreement with the trade union and assume that the trade union has foreclosure power. The optimal proportion of outsourced production is then 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, because \( w^L(1 - x^L) > w^N(1 - x^N) \). 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, since \( \phi^N x^N < \phi^L x^L \). 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. Whenever the in-house supplier negotiates first, its ability to foreclose future negotiations allows the in-house supplier to capture some of the surplus associated with the firm-subcontractor negotiation. This explains why the firm finds it optimal to reduce the proportion of outsourcing under this configuration compared with a regime of simultaneous bargaining.

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 unwielded 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 when the external and internal inputs are complements.

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 characterize the optimal production mode with simultaneous bargaining according to

\[
x^N = \frac{w_0 - \phi_0 + \beta_c(P - w_0)}{2a(P - \phi_0)}.
\]

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

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

---

9 As in the previous section, we assume the sufficient second-order condition to hold true.
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 serve 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. In addition, we here assume that the external supplier has the power to foreclose the firm from subsequently conducting in-house production if the first-round negotiations fail. Such a configuration could be plausible under conditions where, for example, the external supplier is in possession of exclusive knowledge necessary to conduct production or in possession of associated intellectual property rights.

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

\[
\max_w \Omega(x, w, \phi) = [(w - w_0)(1 - x)]^{\beta(x)}[(1 - x)(P - w)]^{1 - \beta(x)},
\]

which yields the Nash bargaining solution

\[
w^F = w_0 + \beta(x)(P - w_0).
\]

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

\[
\max_{w_F} \Omega(x, w^F, \phi) = [x(\phi - \phi_0)]^{\beta(x)}[(P - (1 - x)w^F - x\phi)]^{1 - \beta(x)}.
\]

The expression \( P - (1 - x)w^F - x\phi = x(P - \phi) + (1 - x)(P - w^F) \) denotes the value to the firm of reaching an agreement with respect to \( \phi \) with this sequence of bargaining, this 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 that the external supplier can foreclose subsequent in-house production by the firm.

Based on the appropriate substitution of \( w^F \), we find that the negotiated price for external supply is given according to

\[
\phi^F = \phi_0 + \frac{\beta(x)}{x}[(\pi_0(x) - (1 - x)\beta(x)(P - w_0))].
\]

By substituting \( \phi^F \) 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:

\[
\pi(x, \phi^F, w^F) = (1 - \beta(x))[(\pi_0(x) - (1 - x)\beta(x)(P - w_0))]
\]

Differentiating this profit function with respect to \( x \), we find the following necessary condition for the firm’s optimal production mode, \( x = x^F \), with this sequential pattern of bargaining:

\[
-\beta'(x^F)[\pi_0(x^F) - (1 - x^F)\beta(x^F)(P - w_0)] + (1 - \beta(x^F))[w_0 - \phi_0] + \beta(x^F)(P - w_0) = 0.
\]

We can compare the optimal production mode of bargaining \( x^F \) with that of the alternative order of negotiations \( x_0 \) 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 the fact that an increase in \( x \) not only allows the subcontractor to appropriate less from the second-round negotiation between the firm and the trade union, but at the same time it also increases the subcontractor’s bargaining power in the first-round negotiation with the firm. The total effect of an increase in \( x \) is, in general, ambiguous and depends on the functional form of \( \beta(x) \).

For reasons of tractability, we again rely on a linear bargaining power function \( \beta(x) = ax \), \( 0 < a < 1 \), as in Section 4.1, in order to compare \( x^F \) and \( x^N \). For the purpose of facilitating more transparent comparisons, in this subsection we further 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: \( x^N = (\beta_x P + (1 - \beta_x)w_0)/2aP \), \( x^I = w_0/2aP \), and \( x^C = ((\beta_e(1 + a) - 1)P - \beta_e(1 + a)w_0)/2a[\beta_e P + (1 - \beta_e)w_0] \), 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 reaches an agreement with the external supplier and assume that this supplier has foreclosure power. The optimal proportion of outsourced production is then 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 \( x^I \), we can formulate the following result when the external and internal inputs are complements:

**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 \( P < ((2 + a)/a)w_0 \). 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, \( x^C < x^I \).

(b) Assume that \( P > ((2 + a)/a)w_0 \) and define \( \beta_e \) as the solution to the equation \( P[\beta_e(1 + a) - 1]P - \beta_e(1 + a)w_0] = w_0[\beta_e P + (1 - \beta_e)w_0] \). The optimal production modes satisfy that \( x^C > x^I \) if and only if \( \beta_e > \beta_e \).

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 when the firm first negotiates with the external subcontractor than when 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 (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 \( P < ((2 + a)/a)w_0 \). 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 \( P > ((2 + a)/a)w_0 \), which would be more likely to hold when there are multiple production factors.

### 5. Sequential bargaining without foreclosure power

In Section 4 we analyzed sequential bargaining with the particular assumption that the firm is unable to produce the part negotiated with the second party if the negotiations with the first party fail. Such foreclosing power appears reasonable in many industries. Alternatively, for example, in the trucking industry the services of external drivers can very well benefit the firm independently of the firm's negotiations with its internal drivers. In the trucking industry example the trade unions might not be able to foreclose the firm from signing contracts with external suppliers. In this section we will analyze sequential bargaining in situations where the first input supplier to negotiate with the firm does not have foreclosing power relative to alternative input suppliers.

Let us focus on a sequential pattern of bargaining with the feature that the negotiated wage serves as an irreversibility commitment relative to the firm's negotiations with the external subcontractor. Then, if the wage negotiations fall at stage I, the firm can nevertheless negotiate with the subcontractor at stage II so that the subcontractor would produce the proportion \( x \) of outsourced units. Under such circumstances the terms of the external contract are, like before, determined as the solution to

\[
\max_{\phi, \beta} \Omega_c(x, w, \phi) = [(\phi - \phi_0)x]^{\hat{\beta}(x)}[(P - \phi)x]^{1 - \hat{\beta}(x)}
\]

which leads to the negotiated price \( \phi^F = \phi_0 + \beta(x)(P - \phi_0) \) for external supply.

The profit to the firm associated with outsourcing the proportion \( x \) is then

\[
G^0 = x(P - \phi^F) = x(1 - \beta(x))(P - \phi_0).
\]

Under these circumstances the bargaining problem associated with wage determination can be formulated according to

\[
\max_{\phi_0} \left[(1 - x)(w - w_0)\right]^{\hat{\beta}(x)}[P - (1 - x)w - x\phi^F - G^0]^{1 - \hat{\beta}(x)}
\]

(9)
where $G^0$ is given by (9). Substituting $G^0$ into this Nash maximand, we directly see that the bargaining problem is identical to that associated with a configuration where the firm negotiates with the trade union and the subcontractor simultaneously as determined by (2). Thus, we can draw the following conclusion.

**Result 9.** Assume that the input supplier with which the firm negotiates first cannot foreclose. Then the outcome of sequential bargaining is equivalent to that with simultaneous bargaining.

When the input supplier with which the firm negotiates at stage I is unable to block subsequent negotiations with alternative suppliers sequential bargaining is equivalent to that associated with simultaneous bargaining. Essentially, without foreclosing power the bargaining problems are independent, and the outside option to the firm is invariant to whether the negotiations are conducted sequentially or simultaneously. As the alternative to the negotiated settlement is invariant to the timing, the negotiated input prices with sequential bargaining are identical to those associated with simultaneous bargaining (as computed in Section 3). For this reason the optimal production mode, i.e. the optimal proportion of outsourcing, is also identical across these regimes. Thus, the comparisons regarding the optimal production mode between simultaneous and sequential bargaining without foreclosing power can directly be extended to apply for comparisons of the optimal production mode with sequential bargaining with such foreclosing power. That is, without foreclosing power the proportion outsourced under sequential bargaining will be greater and the total welfare will be higher than with foreclosing power. Also when the input supplier engaged in first-round negotiations is unable to block subsequent negotiations with alternative suppliers, the firm will be indifferent between simultaneous or sequential negotiations.

6. Concluding comments

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. A unique feature of our model is that the bargaining power of the subcontractor is a function of the proportion of production subcontracted. 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 when bargaining power is endogenous. In this respect, we find that the optimal proportion of outsourcing is lower with sequential negotiations than with simultaneous negotiations, if the external and internal labor suppliers have the power to foreclose subsequent negotiations. Under such circumstances we also characterize the relationship between the optimal production modes and the order in which the firm conducts sequential negotiations. Furthermore, the outcome of sequential bargaining is equivalent to that with simultaneous bargaining, if the factor suppliers do not have the power to block subsequent 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 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. For example, according to Carson (2007) the iPhone 4 touchscreen is provided by one of four possible suppliers. An extension to multiple sources or multiple factors would add significantly to our knowledge of optimal sourcing patterns.

Our model could be modified to explore to analyze the optimal organization of sales and how this depends on bargaining power between the manufacturer and independent retailers. Chemla (2003) has analyzed some important aspects of this problem within the framework of a model where the upstream firm can choose the number of downstream firms it supplies to and thereby the degree of competition prevailing in the final goods market. Chemla (2003) recognizes that bargaining power is an important feature for the organization of sales, but he models the bargaining game in a significantly different way.

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 A. Proofs of results

A.1. Proof of Result 2

Differentiating the profit associated with the simultaneous Nash bargaining solution with respect to \( x \), we find that \( \pi'(x) = w_0 - \phi_0 - (x\beta'(x) + x\beta(x)(P - \phi_0) + \beta(P - w_0)). \) In particular, it holds true that \( \lim_{x \to 0^+} \pi'(x) > 0 \) if \( \beta_0 < (w_0 - \phi_0)/(P - \phi_0) + \beta_0(P - w_0)/(P - \phi_0) \), and that \( \lim_{x \to 1^-} \pi'(x) < 0 \) if \( \beta_1 > (w_0 - \phi_0)/(P - \phi_0) + \beta_0(P - w_0)/(P - \phi_0). \)

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 \( \pi'(x^N) = 0. \)

A.2. Proof of Result 3

Rearranging \( \pi'(x) \), we have:

\[
x^N \beta'(x^N) + \beta(x^N) = \frac{w_0 - \phi_0 + \beta_0(P - w_0)}{P - \phi_0} = K.
\]

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 \( \partial K/\partial w_0 > 0 \) as \( \beta_e < 1 \), \( \partial K/\partial \beta_e > 0 \), \( \partial K/\partial \phi_0 = -(1 - \beta_e)(P - w_0)/(P - \phi_0)^2 < 0 \), and \( \partial K/\partial P = -(1 - \beta_e)(w_0 - \phi_0)/(P - \phi_0)^2 < 0 \).

A.3. Proof of Result 4

According to \( \pi'(x) \), the optimal proportion of outsourcing with simultaneous negotiations satisfies:

\[
x^N \beta'(x^N) + \beta(x^N) = \frac{w_0 - \phi_0 + \beta_0(P - w_0)}{P - \phi_0} + \beta_0(P - w_0)/(P - \phi_0).
\]

According to \( \pi'(x^N) \), the optimal proportion of outsourcing with sequential negotiations is:

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

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 \( x^S < x^N \).

A.4. Proof of Result 7

By direct substitution, we find that the inequality \( x^C < x^N \) is equivalent to:

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

We define \( g(\beta_e) = P((\beta_e + 1)P - \beta_e(1 + a)w_0) \) and \( h(\beta_e) = [\beta_eP + (1 - \beta_e)w_0]^2 \). Clearly, both of these functions are strictly increasing with \( g'(\beta_e) = \beta_eP + (1 - \beta_e)w_0 > 0 \) and \( h'(\beta_e) = 2[\beta_eP + (1 - \beta_e)w_0](P - w_0) > 0 \). 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 \( x^C < x^N \).

A.5. Proof of Result 8

By direct substitution, we find that the inequality \( x^C < x^L \) is equivalent to:

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

We define \( g(\beta_e) = P((\beta_e + 1)P - \beta_e(1 + a)w_0) \) and \( k(\beta_e) = w_0[\beta_eP + (1 - \beta_e)w_0] \). Both of these functions are strictly increasing with \( g'(\beta_e) = \beta_eP + (1 - \beta_e)w_0 > 0 \) 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 \( g(1) = P[aP - (1 + a)w_0] < w_0P = k(1) \) if only if \( P < ((2 + a)/a)w_0 \).

From these properties, we can directly conclude that \( g(\beta_e) < k(\beta_e) \forall \beta_e \in [0, 1] \) if \( P < ((2 + a)/a)w_0 \). This completes the proof of Result 8 (a).

If, on the other hand, \( P \geq ((2 + a)/a)w_0 \), 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 \( P((\beta_e + 1)P - \beta_e(1 + a)w_0) = w_0[\hat{\beta}_eP + (1 - \hat{\beta}_e)w_0] \). This completes the proof of Result 8 (b).
References


Supplier Relationship News, 2007. Adidas uses supplier bargaining to bring down procurement costs, posted August 15.
