Manufacturing & Service Operations Management

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

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MANUFACTURING & SERVICE OPERATIONS MANAGEMENT
Vol. 19, No. 1, Winter 2017, pp. 72–83
http://pubsonline.informs.org/journal/msom/
ISSN 1523-4614 (print), ISSN 1526-5498 (online)

Leader-Based Collective Bargaining: Cooperation Mechanism and Incentive Analysis

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Received: February 13, 2015
Revised: September 18, 2015; March 7, 2016; May 13, 2016
Accepted: May 16, 2016
Published Online: November 7, 2016

https://doi.org/10.1287/msom.2016.0592

Abstract. We study leader-based collective bargaining (LCB), under which a leading buyer (leader) and a following buyer (follower) form an alliance to jointly purchase a common component from a supplier. Although the leader and the follower cooperate in their component purchase, they compete in selling their end products. We first analyze the most common and simple form of LCB, equal price LCB, under which the follower pays to the leader the same wholesale price that the leader obtains from his negotiation with the supplier. We compare each buyer's profit under the equal price LCB with the benchmark where each buyer purchases separately from the supplier. We find that although the alliance might obtain a lower wholesale price and although the leader is always better off under equal price LCB, the follower can be worse off if the competition intensity of the leader's and follower's products is within an intermediate region. We identify a competition effect resulting from equal price LCB that can place the follower at a disadvantage in the competition. This finding implies that the equal price LCB might not be sustainable in practice. In view of this limitation, we investigate an alternative form of LCB, fixed price LCB, under which the follower pays a fixed price to the leader regardless of the wholesale price the leader obtains from the supplier. We show that fixed price LCB benefits not only the leader but also the follower, compared with separate purchases, which implies that fixed price LCB always achieves a win–win outcome for the buyers. Our analysis further shows that even the supplier might benefit from this form of LCB.

Funding: The corresponding author, Baozhuang Niu, was supported by the National Natural Science Foundation of China [Grant 71571194].
Supplemental Material: The online appendix is available at https://doi.org/10.1287/msom.2016.0592.

Keywords: leader-based collective bargaining • separate purchase • commitment • equal price mechanism • fixed price mechanism

1. Introduction

Collective bargaining, by which two or more competing buyers form an alliance to jointly purchase goods or services from their suppliers, has become a frequently used cooperation strategy (King 2013). The Australian Competition and Consumer Commission (ACCC) acknowledges that public interest can be served and small businesses can be protected by collective bargaining (Nagarajan 2013). The use of collective bargaining by nonprofit organizations for their purchases has been well documented (European Commission 2008), and collective bargaining is now increasingly being used by firms in private sectors, such as construction, healthcare, automobiles, logistics, retailing, and telecommunications, to jointly purchase raw materials, components, professional services, and equipment (Komatsu Corporate Communications 2002, Kaufmann 2008, Deutsche Telekom 2011, Australian Competition and Consumer Commission 2011, Hu et al. 2012, Nagarajan 2013).

Among various forms of collective bargaining, two are the most popular in practice (Australian Competition and Consumer Commission 2011): the *representative-based collective bargaining* (*RCB*) alliance, which relies on a separate entity (e.g, an industry association) to manage and coordinate the joint purchases, and the *leader-based collective bargaining* (*LCB*) alliance, in which one of the alliance members (the leader) is given the authority to carry out the purchase activities on behalf of the other members (the followers). RCB has often been used by large buyers to form long-term cooperations (e.g., the joint procurement of automobile components between major car manufacturers). Meanwhile, LCB is less formal but more flexible, as it usually does not require establishing and operating a separate firm/association.[1] In recent years, LCB has received increasing attention from both public and private sectors because of its flexibility and low operating costs (Birch 2001, Schotanus and Telgen 2007, European Commission 2008). For example, the Mai Wiru

Corporation in Australia has bargained with suppliers on behalf of six local competitors since 2010. Mai Wiru is responsible for drafting and implementing the internal purchasing agreement, the Mai Wiru policy, which is signed by the other buyers.[2] Another example is R. J. Nuss Removals Pty Ltd. Australia, authorized by five competing companies as the leader to negotiate with the monopolistic rail line-haul freight services provider Pacific National. The companies need these professional services to finish their own removal services. Since 2008, Nuss has successfully coordinated the alliance and obtained the formal approval of the ACCC.[3]

Despite many documented practices of LCB, prior literature has rarely investigated this specific form of buyer cooperation. A critical question for the sustainability of LCB is how the collective bargaining profits should be shared among the buyers in the alliance (Schotanus et al. 2010). In practice, this distribution is often determined through an internal purchasing agreement between the leader and the followers, which is referred to as the collective arrangement (Schotanus et al. 2008, Australian Competition and Consumer Commission 2011, Nagarajan 2013). According to Schotanus (2007), many documented alliances use the equal price purchasing agreement, under which all the participants receive the same negotiated wholesale price charged by the suppliers. Although this mechanism is very convenient to use, its performance is not fully understood. Whether more effective mechanisms exist is also unclear.

In this paper, we aim to provide a thorough investigation of LCB. To that end, we consider two downstream buyers who purchase a common component from a single supplier to make their end products that compete in the downstream market. We first investigate the setting where the two buyers form an LCB alliance under the equal price mechanism and thus pay the same wholesale price that the leader obtains from his negotiation with the supplier. Interestingly, we find that although the leader is always better off, the follower can be worse off under this cooperation mechanism if the competition intensity between the leader's and follower's products is in an intermediate region. As a result, equal price LCB can be unsustainable. To explain this result, we identify two driving forces: the bargaining power effect and the competition effect. Intuitively, if the leader is a stronger bargainer than the follower (which is often the case in the LCB alliances in practice), then the wholesale price that the leader can obtain from the negotiation will be lower than what the follower can obtain when negotiating separately with the supplier. We call this positive effect the bargaining power effect. However, more subtly, equal price LCB can change the balance of the competition between the two buyers. Specifically, equal price LCB can put the follower in a disadvantageous position in the competition because his influence on the wholesale price can be weakened. As such, the leader will be able to sell more of his products while the follower will sell less under equal price LCB, compared to the case under separate procurement. Such a competition effect, which hurts the follower, is the strongest when the competition intensity of their products is in an intermediate region.

In view of this potential limitation of the equal price mechanism, we explore an alternative fixed price mechanism for LCB formation. In particular, under this scheme, the follower pays a fixed transfer price to the leader, regardless of the wholesale price that is determined in the negotiation with the supplier. We find that LCB is always sustainable under this mechanism. Fixed price LCB can benefit not only the leader but also the follower compared to separate procurement—a win–win outcome for the buyers. Therefore, this fixed price mechanism can likely facilitate LCB formation in practice.

The remainder of this paper is organized as follows. Section 2 reviews the related literature. Section 3 describes the model and analyzes the benchmark case in which each buyer purchases separately from the supplier. We analyze equal price LCB in Section 4 and fixed price LCB in Section 5. Section 6 discusses three extensions, and we conclude in Section 7.

2. Literature Review

Our work is related to the stream of literature that studies group buying. Anand and Aron (2003) provide an excellent survey of the online group buying research. This literature generally focuses on how a seller can design an appropriate pricing mechanism with volume discounts in anticipation of the potential responses from the buyers. More recently, Chen et al. (2007) studied the group buying auction and compared it with the fixed price mechanism in terms of the seller's profitability. Chen et al. (2010) investigate two common group buying mechanisms under quantity discounts: the uniform price mechanism, under which all buyers pay the same discounted price, and the proportional mechanism, under which the buyers that order large quantities enjoy lower prices. Interestingly, they find that group buying at times might not be sustainable under either mechanism. They then propose a revised Vickrey auction mechanism based on second-price auctions to facilitate group buying. Chen and Roma (2011) study a decentralized supply chain in which a supplier sells to two competing retailers. They consider both linear and nonlinear demand curves to investigate the benefits of group buying when the retailers are either symmetric or asymmetric with respect to their market base and/or efficiency. Although these studies also focus on joint purchases, LCB has a fundamental difference from group buying. For LCB, the buyers first form an alliance, and the leader then negotiates with the supplier for the purchase price. In contrast, for group buying, the seller first designs a price scheme and the buyers then decide on their participation in the group purchase. As such, our study can enrich the joint purchase literature by analyzing this special cooperative procurement mechanism applied in practice.

Another related stream of research investigates the value of joint procurement, inventory pooling, and exclusive purchase commitments. For instance, Chen (2009) studies a scenario where a group of retailers considers jointly procuring a product from a common supplier and pools their inventories to benefit both from the quantity discounts and from the hedging of demand uncertainty. He shows that an equilibrium profit allocation mechanism exists among the retailers to achieve joint procurement. In contrast, Hu et al. (2013) investigate a setting with asymmetric information between a powerful supplier and a group of buyers. They show that if the supplier can offer a take-it-or-leave-it menu of contracts, then a joint purchase from the supplier might hurt the buyers because it can help the supplier to extract information rents. Chen and Li (2013) investigate the effect of exclusive purchase commitments from buyers on sellers' quality improvement efforts. They find that an exclusive purchase commitment can benefit the buyers only if the intrinsic qualities of the products offered by the sellers are similar. Our study is different, considering how joint procurement through LCB might affect the buyers' bargaining power and their competitive advantages.

Our work also follows the recent research that uses the cooperative bargaining framework to study supply chain problems in the environment where the traditional take-it-or-leave-it contract approach is less appropriate (Lovejoy 2010). For instance, Nagarajan and Bassok (2008) study an assembling system in which a single manufacturer buys components from multiple suppliers. They identify the conditions under which the supply chain parties might form stable coalitions so as to enhance their bargaining powers. Leng and Parlar (2009) focus on a three-level supply chain in which a cooperative game is studied to find a fair allocation method for sharing the cost savings among the supply chain parties. Feng and Lu (2012, 2013a, b) use the generalized Nash bargaining (GNB) framework to investigate the outsourcing decisions and the effects of contract formats in competitive supply chains. We refer the readers to Bernstein and Nagarajan (2012) for an extensive review of the papers in this stream.

3. The Model and Benchmark

We first describe the model in Section 3.1 and then analyze a benchmark in Section 3.2.

3.1. Model Description

We consider a supply chain setting where two downstream buyers (indexed by $i = 1, 2$) source a critical component from a common upstream supplier (labeled s) to make their products. The buyers' end products are potentially substitutable. We assume the inverse demand function for buyer i's product as follows: $p_i = a - q_i - bq_j$, $i, j = 1, 2, i \neq j$, where p_i is the market price for product i, q_i and q_j are the selling quantities of the two products, a represents the market size, and $b \in [0, 1]$ measures the degree of competition intensity. When $b = 0$, the two products are independent, and when $b = 1$, the two products are perfect substitutes. Similar settings have been used in the supply chain literature (e.g., Cachon and Harker 2002, Feng and Lu 2012). To focus on the strategic driving forces, we assume away the factors that tend to benefit joint procurement, such as the economies of scale effect in contracting, production, and logistics. We assume that the supplier incurs a constant production cost c per unit for the component, while the buyers' production and selling costs are normalized to zero. This market setting and the supply chain parties' characteristics are common knowledge.

The buyers can choose to procure the component separately from the supplier or they can form a leader-based alliance to collectively bargain with the supplier (LCB). In either case, we use the GNB framework to model the contracting process among the supply chain parties. This bargaining framework has been increasingly used in the supply chain literature for a cooperative and more balanced allocation of the surplus (Bernstein and Nagarajan 2012). Let buyer i's bargaining power relative to the supplier be $\alpha_{is} \in (0, 1)$, and, accordingly, the supplier's bargaining power is $1 - \alpha_{is}$. We further use $\alpha_{ij} \in (0, 1)$ to denote the bargaining power of buyer i relative to buyer j. Finally, for simplicity, we normalize the profits that the supply chain parties can obtain from their outside options to zero. This assumption is relaxed in an extension study provided in the online appendix.

3.2. The Benchmark: Separate Procurement

In this subsection, we study a benchmark case in which the buyers separately decide their procurement quantity q_i and separately negotiate the wholesale price w_i with the supplier.[4] Clearly, if both negotiations succeed, buyer i's profit is

$$\pi_i(q_i, q_j, w_i) = (a - q_i - bq_j - w_i)q_i,$$

and the supplier's profit is

$$\pi_s(q_i, q_j, w_i, w_j) = (w_i - c)q_i + (w_j - c)q_j.$$

To solve this benchmark case, we adopt the so-called Nash–Nash solution concept commonly used in prior literature (see, e.g., Davidson 1988; Dukes et al. 2006; Horn and Wolinsky 1988; Feng and Lu 2012, 2013a, b), which assumes that the two bilateral negotiations are independent and take place simultaneously,[5] renegotiation is not permitted, and in each negotiation, the disagreement for the buyer is his reservation profit from the outside option, while the disagreement point for the supplier is his profit from the other negotiation, assuming it succeeds.[6] This framework requires that no information exchange between the two negotiation processes occurs even if they involve the same supplier. This situation is not uncommon in practice. Suppliers have confidentiality obligations to protect the transaction information of their clients. When the business involves competing clients, a supplier might even need to set up independent units to negotiate and execute the transactions. We make this assumption for our benchmark case. Specifically, in our context, the corresponding unit in one negotiation—whether that of the buyer or the supplier—needs to conjecture the order quantity and the wholesale price of the other negotiation. The goal of the supplier's two independent units is to maximize the supplier's total profit. Note that in a Nash–Nash equilibrium, the conjectures held by the supply chain parties are consistent with their actual decisions. We use "˜" to indicate the conjectured variables. Based on the GNB framework, the bargaining problem for the wholesale price can be formulated as follows:

$$\max_{w_i} \pi_i(q_i, \tilde{q}_j, w_i)^{\alpha_{is}} [\pi_s(q_i, \tilde{q}_j, w_i, \tilde{w}_j) - (\tilde{w}_j - c)\tilde{q}_j]^{1-\alpha_{is}}.$$

Lemma 1. *The wholesale prices under the Nash–Nash bargaining solution are* $w_i(q_i, \tilde{q}_j) = \alpha_{is} c + (1 - \alpha_{is}) \cdot (a - q_i - b\tilde{q}_j)$, *under which the profits of the buyers are* $\pi_i(q_i, \tilde{q}_j, w_i(q_i, \tilde{q}_j)) = \alpha_{is}(a - q_i - b\tilde{q}_j - c)q_i$, *for* $i, j = 1, 2$, $i \neq j$.

All proofs are provided in the online appendix. For each buyer, the wholesale price follows a weighted average of the supplier's production cost and the product's market price based on their bargaining power. Clearly, a lower market price directly implies a lower wholesale price. Therefore, when a buyer increases his quantity, not only the market price but also the wholesale price decreases. Because of competition, a product's market price and thus the wholesale price decrease in the other product's (conjectured) quantity, depending on the competition intensity b. Hence, in equilibrium, one buyer's quantity decision influences not only his own product's prices, but also those for the other buyer. Given the characterized wholesale price, we can see that buyer i's profit is a proportion, based on his bargaining power, of the total surplus that can be obtained from the sales of his product. Specifically, if buyer i's bargaining power goes to one, he can push the wholesale price down to the supplier's production cost and obtain the whole surplus. At the other extreme, if his bargaining power goes to zero, the wholesale price goes to the market price and buyer i obtains zero profit.

In the first stage, the two buyers decide their order quantities based on their conjectures of the other buyer's order quantity and the subsequent bargaining outcome; that is, they simultaneously solve $q_i^S = \arg\max_{q_i} \pi_i(q_i, \tilde{q}_j, w_i(q_i, \tilde{q}_j))$, $i, j = 1, 2$, $i \neq j$. A Nash equilibrium holds if the conjectures coincide with the actual optimal decisions; i.e., $q_i^S = \tilde{q}_i$, $i = 1, 2$. This case leads to the following equilibrium outcomes.

Proposition 1. *Under separate procurement, the equilibrium quantities, the wholesale prices, and the profits of the supply chain parties are* $q_i^S = (a - c)/(2 + b)$, $w_i^S = c + (1 - \alpha_{is})((a - c)/(2 + b))$, $\pi_i^S = \alpha_{is}((a - c)/(2 + b))^2$, $i = 1, 2$, *and* $\pi_s^S = (2 - \alpha_{1s} - \alpha_{2s})((a - c)/(2 + b))^2$, *respectively.*

Given the buyers' profit functions characterized in Lemma 1, their quantity decisions follow the classical Cournot game. Hence, we can notice from Proposition 1 that the total supply chain surplus does not achieve the first-best maximum under this separate procurement equilibrium. In particular, for an integrated supply chain, the optimal production quantities of the two products would be $q_i^I = (a - c)/(2(1 + b))$, based on which the total supply chain surplus would be $\pi_{sc}^I = (a - c)^2/(2(1 + b))$. Clearly, the buyers under separate procurement do not consider the effect of their quantity on the other buyer's market price and thus produce more than they would in the integrated solution. This intuition is helpful for the comparison between the outcomes of the benchmark case and equal price and fixed price LCB.

4. Equal Price LCB

Under equal price LCB, the buyers pay the same wholesale price to the supplier. For its simplicity and fairness,[7] most of the LCB practices adopt this agreement. This section aims to gain a better understanding of its performance. In our context, the two buyers first independently decide their procurement quantities q_i and q_j. Then, suppose buyer i is the designated leader who negotiates the wholesale price w with the supplier. If they reach an agreement, buyer i pays $w(q_i + q_j)$ to the supplier and gives q_j units to buyer j for a transfer payment wq_j. In contrast, if the negotiation breaks down, then no procurement will occur and all the supply chain parties will earn zero profit. An important element of the LCB alliances in practice is the members' commitment, which is often referred to as a collective boycott (Nagarajan 2013) or a group buying commitment (Chae and Heidhues 2004, Chen and Li 2013). As such, *"collective bargaining increases the bargaining power of small businesses because it makes possible a credible threat of a collective boycott"* (Nagarajan 2013, p. 111; italics in original). One way to enforce commitment is through an internal agreement to assign all negotiating and purchasing power to the leader. Hence, in our context, we assume that after an LCB alliance is formed, the leader is fully in charge of the negotiation, and the buyers agree not to buy the component from the supplier separately if the negotiation between the leader and the supplier fails. The case of weaker LCB alliances that always have the separate procurement option available is discussed in Section 6.1.

4.1. The Equal Price LCB Equilibrium

In the following, we derive the equilibrium for equal price LCB. Given q_i and q_j, the leader i's profit can be written as

$$\pi_i(q_i, q_j, w) = (a - q_i - bq_j - w)q_i,$$

and the supplier's profit as

$$\pi_s(q_i, q_j, w) = (w - c)(q_i + q_j).$$

By backward induction, the leader negotiates the wholesale price w with the supplier in the second stage. Their problem can be formulated as

$$\max_w [(a - q_i - bq_j - w)q_i]^{\alpha_{is}}[(w - c)(q_i + q_j)]^{1-\alpha_{is}}.$$

Because the Nash product is log-concave, the following results can be obtained.

Lemma 2. *Given q_i and q_j, the bargaining outcome of the wholesale price between the leader and the supplier is*

$$w(q_i, q_j) = \alpha_{is}c + (1 - \alpha_{is})(a - q_i - bq_j),$$

under which the leader's profit is $\pi_i(q_i, q_j, w(q_i, q_j)) = \alpha_{is}(a - q_i - bq_j - c)q_i$ and the follower's profit is $\pi_j(q_i, q_j, w(q_i, q_j)) = [a - q_j - bq_i - \alpha_{is}c - (1 - \alpha_{is})(a - q_i - bq_j)]q_j$.

From the above lemma, we can notice that both the wholesale price and the leader's profit function have the same form as those under separate procurement (see Lemma 1). In other words, under equal price LCB, whether the follower's order quantity is included does not affect the negotiation outcome between the leader and the supplier. This is mainly because the leader does not gain any extra profit from jointly procuring the follower's quantity, when the follower simply pays the leader for what the supplier charges. Hence, their negotiation focuses only on the allocation of the surplus from the leader's sales.

For the follower, however, given that he is now charged for the same wholesale price that the leader gets from the supplier, his profit function clearly differs from what it would be under separate procurement, and his bargaining power becomes irrelevant. Furthermore, even though the follower's order quantity can still influence the wholesale price, its influence is weaker than that of the leader's quantity. Notice that the leader's quantity has a direct effect on the market price of his product, while the follower's quantity influences it only through the indirect substitution effect, with a factor b. This observation is useful in understanding the equilibrium outcome.

In the first stage, the two buyers independently decide their order quantities in anticipation of the outcome of the subsequent negotiation between the leader and the supplier; that is, they solve $\max_{q_i} \pi_i(q_i, q_j, w(q_i, q_j))$, $i = 1, 2$, $i \neq j$, simultaneously.

Proposition 2. (a) *Under equal price LCB, the equilibrium order quantities of the leader and the follower are $q_i^L = (2(1-b) + b\alpha_{is})(a-c)/((4+b)(1-b) + 3b\alpha_{is})$ and $q_j^L = (1 - b + \alpha_{is})(a-c)/((4+b)(1-b) + 3b\alpha_{is})$, respectively, and the wholesale price is $w^L = c + (1 - \alpha_{is}) \cdot ((2(1-b) + b\alpha_{is})(a-c)/((4+b)(1-b) + 3b\alpha_{is}))$, under which the profits of the three supply chain parties are $\pi_i^L = \alpha_{is}((2(1-b) + b\alpha_{is})(a-c)/((4+b)(1-b) + 3b\alpha_{is}))^2$, $\pi_j^L = ((1 - b + \alpha_{is})[(1-b)^2 + \alpha_{is}(1 - b^2 + b\alpha_{is})](a-c)^2)/[(4+b)(1-b) + 3b\alpha_{is}]^2$, and $\pi_s^L = ((1 - \alpha_{is})(2(1-b) + b\alpha_{is})[(1 - b + \alpha_{is}) + 2(1-b) + b\alpha_{is}](a-c)^2)/[(4+b) \cdot (1-b) + 3b\alpha_{is}]^2$, respectively.*

(b) *$q_i^L \geq q_i^S$, $q_j^L \leq q_j^S$, and $q_i^L + q_j^L \leq q_j^S + q_j^S$.*

Proposition 2 characterizes the equal price LCB equilibrium. Interestingly, we can see that, compared to separate procurement, the leader now sells more units, while the follower sells fewer. The intuition of this outcome is tied to the effect of equal price LCB on the competition. Lemma 2 has shown that under equal price LCB, the two buyers receive the same wholesale price $w(q_i, q_j) = \alpha_{is}c + (1 - \alpha_{is})(a - q_i - bq_j)$. We can readily observe that an increase of the leader's quantity q_i reduces the wholesale price more than an increase of the follower's quantity q_j does. This change can shift the balance of the competition. In fact, the leader now has more incentives to increase the output, while the follower is compelled to reduce his output. Another consequence of this change is that the buyers' total output becomes lower than their total output under separate procurement. We call this effect the competition effect of equal price LCB.

4.2. Performance Comparison

The results of Proposition 2 enable us to assess the performance of equal price LCB compared to the performance of the separate procurement scenario. In the following, we present the comparisons from the perspectives of the leader, the follower, and the overall supply chain, respectively.

4.2.1. The Leader's Perspective. Comparing the leader's profit under equal price LCB with his profit under separate procurement, we obtain the following proposition.

Proposition 3. *The leader is always better off under equal price LCB; i.e., $\pi_i^L \geq \pi_i^S$.*

Although the result that the leader can benefit from LCB is likely to be anticipated, it does not directly stem from the larger order quantity that he negotiates with the supplier, a seemingly intuitive reason. In fact, as Lemma 2 has shown, simply adding the follower's order quantity to the negotiation does not change the negotiated wholesale price for the leader. To understand this result, recall our discussion about the competition effect following Proposition 2, namely, when the two buyers receive the same wholesale price that the leader negotiates with the supplier, the leader has an advantage in the quantity competition against the follower because a change in his order quantity can shift the wholesale price more than does a change in the follower's quantity. As a consequence, the follower's weakened position in the competition results in a larger quantity being sold by the leader, which increases the latter's profit compared to the case of separate procurement.

4.2.2. The Follower's Perspective. For the follower, the situation is much subtler. On the one hand, the previous discussion on the competition effect clearly indicates that equal price LCB puts the follower in a disadvantageous position in the competition against the leader. On the other hand, the leader can be a stronger bargainer relative to the supplier, which often is the reason a buyer joins LCB as a follower in practice; that is, joining LCB potentially renders the follower a lower wholesale price than he could negotiate with the supplier separately. We call this effect the bargaining power effect. How these two effects influence the follower's profit is not immediately clear. In the following, we present two results, focusing on the scenario in which $\alpha_{js} \le \alpha_{is}$.

Proposition 4. (a) *Given the other parameters, there exists a threshold* $\underline{\alpha}_{js}$ *such that the follower is better off under equal price LCB, i.e.,* $\pi_j^L \ge \pi_j^S$, *iff* $\alpha_{js} \le \underline{\alpha}_{js}$.

(b) *For any given* α_{is}, α_{js}, *the follower is either always better off* ($\pi_j^L \ge \pi_j^S$) *under equal price LCB for any* b *or worse off* ($\pi_j^L < \pi_j^S$) *iff* $b \in (\underline{b}, \bar{b})$ *whenever such an interval exists.*

Proposition 4(a) implies that the follower is better off under equal price LCB if and only if his bargaining power relative to the supplier is weak. In such a situation, the wholesale price that the leader can obtain from his negotiation with the supplier will be much more favorable than the price the follower could negotiate by himself. Hence, the benefit from the bargaining power effect dominates the loss from the competition effect.

Proposition 4(b) focuses on the competition intensity factor. It indicates that equal price LCB is more likely to benefit the follower when the competition intensity between them is either low or high. In particular, when b is small, one buyer's quantity has little affect on the other buyer's market price either under separate procurement or under equal price LCB. Hence, joining the equal price LCB does not place the follower in a severely disadvantaged position, while he can gain from teaming up with a stronger bargainer to access a lower wholesale price; that is, a small b implies the dominance of the bargaining power effect over the competition effect for the follower. The result is more intriguing when b is large, which seems to imply strong competition. However, from the wholesale price $w(q_i, q_j) = \alpha_{is}c + (1-\alpha_{is})(a - q_i - bq_j)$ characterized in Lemma 2 under the equal price LCB, we can see that when b is large, the influence of the two buyers' quantities on the wholesale price is similar; that is, the buyers can obtain similar gains by increasing their quantities, and thus the leader does not gain a significant advantage in the competition against the follower compared to the case of separate procurement. In other words, the competition effect resulting from the equal price purchasing agreement under LCB is in fact weak when b is large, which allows the follower to benefit from the equal price LCB. When b is in an intermediate region, the competition effect is the strongest, and thus joining the equal price LCB can make the follower worse off, even though the leader has greater bargaining power.

4.2.3. The Supply Chain's Perspective. Besides the results for the leader and the follower, it is also interesting to investigate the effect of the equal price LCB on the overall supply chain performance.

Proposition 5. *There exists* $\hat{b}$ *such that the whole supply chain is better off under equal price LCB, i.e.,* $(\pi_i^L + \pi_j^L + \pi_s^L) \ge (\pi_i^S + \pi_j^S + \pi_s^S)$, *iff* $b \ge \hat{b}$.

Proposition 5 shows that equal price LCB benefits the supply chain if and only if the competition intensity factor is above a certain threshold. To understand this result, it is useful to recall our discussion following Proposition 1. When the buyers make their quantity decisions under the separate procurement scenario, they do not take into account the external effect of their quantity on the other buyer's profit. As a result, they overproduce compared to the amount produced for the integrated supply chain, and this distortion increases in competition factor b. (When $b = 0$, there is no competition, and the total output under separate procurement coincides with the integrated solution.) Meanwhile, Proposition 2 reveals that the competition effect resulting from the equal price purchasing agreement leads to a smaller total supply chain output under LCB than under the separate procurement scenario. This downward "correction" might make the supply chain either more or less efficient. In particular, when b is large, this downward "correction" results in a total supply chain output closer to the integrated solution, and the supply chain thus becomes more efficient under equal price LCB. However, when b is small, it can instead lead to a downward distortion of the total supply chain output and thus make the supply chain less efficient.

This analysis has an intriguing implication: despite the popularity of the equal price LCB in practice, it might not be as beneficial as anticipated for the supply chain parties.[8] In fact, the imbalanced competition positions between the buyers surprisingly might lead to a smaller profit for the follower and can also undermine the overall supply chain performance. Clearly, if the follower is rational, he would deduce the harmful outcome of joining the LCB in such scenarios, and the LCB alliance would not be formed in the first place. The observation of this competition effect suggests the question of whether a more efficient transfer price agreement exists that can always make LCB a "win–win" strategy and thus facilitate its implementation. This question is explored in the following section.

5. Fixed Price LCB

From the previous analysis, we notice that the potential amplification of market competition is caused by the dependence of the transfer price on the subsequent negotiation between the leader and the supplier, which can lead to imbalanced incentives between the buyers. Furthermore, a "win–win" transfer price agreement, if it exists, needs to guarantee that both buyers obtain no less than what they would get under separate procurement. This goal motivates us to search for alternative transfer price agreements that can incorporate the buyers' reservation profits and can also disentangle the follower's procurement cost from the subsequent negotiation between the leader and the supplier. To answer the question of whether such purchasing agreements exist, we focus on fixed transfer prices and adopt the Nash bargaining framework to model the two buyers' transaction process in the first stage of LCB formation. Specifically, the two buyers first decide their procurement quantities q_i and q_j and then negotiate a fixed transfer price t per unit that the follower pays to the leader when the component is delivered. If the negotiation between the buyers fails to reach an agreement, they separately procure the component from the supplier. In contrast, if their negotiation reaches an agreement, then the designated leader is authorized with all negotiating and purchasing power, and the buyers are committed not to separately procure the component from the supplier, regardless of the subsequent negotiation outcome; that is, the leader, buyer i, negotiates the wholesale price w with the supplier to jointly procure $q_i + q_j$ units of the component. If this second stage negotiation breaks down, all the supply chain parties earn zero profit. (The case for the weaker LCB, which always includes the option of separate purchases, is discussed in Section 6.1.) Otherwise, the leader pays $w(q_i + q_j)$ to the supplier, the component is delivered, and the follower pays the leader tq_j for his portion, independent of w. To model the contracting processes in the two stages, we assume that buyer i's bargaining power relative to buyer j is $\alpha_{ij} \in (0, 1)$ and that his bargaining power relative to the supplier remains at α_{is}.

5.1. The Fixed Price LCB Equilibrium

In the following, we derive the fixed price LCB equilibrium. Under this fixed transfer price agreement, we can formulate the profit functions of the leader (buyer i) and the follower (buyer j) as

$$\pi_i(q_i, q_j, w, t) = (a - q_i - bq_j - w)q_i + (t - w)q_j \quad \text{and}$$
$$\pi_j(q_i, q_j, t) = (a - q_j - bq_i - t)q_j,$$

and the supplier's profit function as

$$\pi_s(q_i, q_j, w) = (w - c)(q_i + q_j).$$

By backward induction, we first analyze the negotiation between the leader and the supplier:

$$\max_w [\pi_i(q_i, q_j, w, t)]^{\alpha_{is}} [\pi_s(q_i, q_j, w)]^{1-\alpha_{is}}.$$

Maximizing the above Nash product results in the following lemma.

Lemma 3. *Given q_i and q_j, under fixed price LCB, the bargaining outcome of the wholesale price between the leader and the supplier is*

$$w(q_i, q_j, t) = \alpha_{is} c + (1 - \alpha_{is}) \frac{(a - q_i - bq_j)q_i + tq_j}{q_i + q_j},$$

under which the leader's profit is $\pi_i(q_i, q_j, w(q_i, q_j, t)) = \alpha_{is}[(a - q_i - bq_j - c)q_i + (t - c)q_j]$.

Notice that under this fixed transfer price agreement, once t is decided, the follower's profit is not affected by the subsequent negotiation between the leader and the supplier. Therefore, the negotiated wholesale price does not have any indirect competition effect. On the other hand, under this fixed transfer price agreement, the leader can make extra profit from the follower's transfer payment, which the supplier takes a share of through the wholesale price according to their bargaining power. As a result, we can observe from Lemma 3 that the leader's profit function contains an additional term, $\alpha_{is}(t - c)q_j$, compared to the previous cases. Clearly, with t appearing in both the leader's and the follower's profit functions, their quantity decisions can be influenced by this transfer price. In the following, we set up a generalized Nash product over the buyers' surplus, relative to separate procurement, to search for a "win–win" outcome:

$$\max_t [\pi_i(q_i, q_j, w(q_i, q_j, t), t) - \pi_i^S]^{\alpha_{ij}} [\pi_j(q_i, q_j, t) - \pi_j^S]^{1-\alpha_{ij}}.$$

Lemma 4. *Given q_i and q_j, the optimal transfer price is*

$$t(q_i,q_j) = \alpha_{ij}((a-q_j-bq_i)q_j - \pi_j^S)/q_j + (1-\alpha_{ij}) \cdot (\pi_i^S/\alpha_{is} - ((a-q_i-bq_j)q_i - c(q_i+q_j)))/q_j,$$

under which the leader's and follower's profits, denoted by $\pi_i(q_i,q_j)$ and $\pi_j(q_i,q_j)$, respectively, are

$$\pi_i(q_i,q_j) = \alpha_{is}\alpha_{ij}((a-q_i-bq_j-c)q_i + (a-q_j-bq_i-c) \cdot q_j - \pi_j^S) + (1-\alpha_{ij})\pi_i^S \quad \text{and}$$

$$\pi_j(q_i,q_j) = (1-\alpha_{ij})((a-q_i-bq_j-c)q_i + (a-q_j-bq_i-c)q_j) + \alpha_{ij}\pi_j^S - (1-\alpha_{ij})\pi_i^S/\alpha_{is}.$$

Lemma 4 solves for a unique transfer price that maximizes the Nash product of the two buyers' joint surplus. It follows a weighted average of the follower's marginal surplus and the leader's marginal deficit relative to their reservation profits. To build intuition about this closed-form expression, consider the extreme cases. In particular, when $\alpha_{ij} = 1$, this closed-form expression for $t(q_i,q_j)$ implies that the leader can demand a transfer price that captures all of the follower's surplus. In contrast, when $\alpha_{ij} = 0$, then the follower has full bargaining power relative to the leader, and this closed-form expression implies that the latter can only ask for a transfer price that warrants him the reservation profit.

In the first stage, the buyers decide their procurement quantities in anticipation of the outcomes of the subsequent negotiations; that is, they solve $\max_{q_i} \pi_i(q_i,q_j)$ and $\max_{q_j} \pi_j(q_i,q_j)$ simultaneously. This results in a Nash equilibrium as follows.

Proposition 6. *Under fixed price LCB, the equilibrium quantities are $q_i^L = q_j^L = (a-c)/(2(1+b))$, and the wholesale price is $w^L = \alpha_{is}c + (1-\alpha_{is})(a - q_i^L - bq_j^L + t(q_i^L, q_j^L))/2$, under which the profits of the supply chain parties follow: $\pi_i^L = (1-\alpha_{ij})\pi_i^S + \alpha_{ij}\alpha_{is}((a-c)^2/(2(1+b)) - \pi_j^S)$, $\pi_j^L = \alpha_{ij}\pi_j^S + (1-\alpha_{ij})((a-c)^2/(2(1+b)) - \pi_i^S/\alpha_{is})$, and $\pi_s^L = (a-c)^2/(2(1+b)) - \pi_i^L - \pi_j^L$, respectively.*

5.2. Performance Comparison

Based on the above results, we can readily assess the performance of this fixed price LCB.

Proposition 7. *$\pi_i^L \ge \pi_i^S$, $\pi_j^L \ge \pi_j^S$, and $(\pi_i^L + \pi_j^L + \pi_s^L) \ge (\pi_i^S + \pi_j^S + \pi_s^S)$; that is, the fixed price LCB benefits the leader, the follower, and the overall supply chain.*

Proposition 7 shows that both the leader and the follower can obtain higher profits under fixed price LCB, compared to the case of separate procurement. Therefore, the buyers' participation is assured. Clearly, LCB becomes more appealing to both buyers if the leader's bargaining power α_{is} increases relative to the supplier's. More interestingly, we can notice from Proposition 6 that under this fixed price LCB, the two buyers' procurement quantities coincide with the optimal solution for the integrated supply chain (i.e., q_i^I characterized in Section 3.2); that is, this transfer price incorporates the external effect that one buyer's quantity has over the other's profit and hence can lead them to refrain from overproduction. What becomes immediately clear is that under this fixed transfer price, LCB can improve the overall supply chain performance. For the supplier, however, the situation is more complex. On the one hand, such LCB can lead to more efficient order quantities, which might benefit the supplier; on the other hand, the leader is a stronger bargainer than the follower, which might reduce the share of the surplus that the supplier can obtain from the negotiation. The following proposition addresses this question.

Proposition 8. *There exists $\tilde{b}$ such that the supplier is better off under fixed price LCB, i.e., $\pi_s^L \ge \pi_s^S$, iff $b \ge \tilde{b}$ and $\alpha_{ij}(1-\alpha_{is}) \ge 4(1-\alpha_{js})(1-\alpha_{ij}(1-\alpha_{is}))$.*

Proposition 8 reveals the conditions under which the supplier can also benefit from fixed price LCB. To achieve such an outcome, b needs to exceed a threshold, and thus the market competition would be overly intense under separate procurement. Furthermore, α_{ij} and α_{js} need to be large, while α_{is} needs to be moderate. A large α_{js} implies that the supplier would obtain a small share of the profit from buyer j under separate procurement. In contrast, a large α_{ij} implies that the leader can demand a large transfer price from the follower under LCB, of which the supplier obtains a share, and a relatively small α_{is} implies that the supplier can have a large share of the profit from the negotiation with the leader for the joint procurement. We find from our numerical analysis that these conditions can be satisfied under various parameters. Therefore, fixed price LCB can lead to an "all-win" outcome for the supply chain parties.

In the above, we compared fixed price LCB with the separate procurement case. One might also compare fixed price LCB with equal price LCB. However, such an analysis is cumbersome. From our numerical study, where we vary $\alpha_{ij}, \alpha_{is}, \alpha_{js} \in \{0, 0.1, 0.2, \ldots, 1\}$ with $\alpha_{is} > \alpha_{js}$ and $b \in \{0, 0.02, 0.04, \ldots, 1\}$, we observe that the leader is always better off under fixed price LCB, while the follower is better off when the competition intensity b exceeds a certain threshold. This numerical result is consistent with our theoretical result that fixed price LCB completely eliminates the quantity distortions (from the first-best solution), whereas equal price LCB can only mitigate the distortions to a certain extent because the quantity distortions are more costly to the alliance as the competition intensity b increases. Another observation is that under fixed price LCB, the two buyers can be charged different wholesale prices, which can make the agreement appear less "fair" compared to equal price LCB. However, these issues might be mitigated, particularly in the scenarios where equal price LCB is not sustainable and by the fact that all the supply chain parties can benefit from fixed price LCB.

6. Discussions

6.1. LCB Without Commitment

We have assumed in our main model that the buyers agree not to negotiate separately with the supplier if the LCB negotiation fails, which is common in practice. As pointed out in the *Guide to Collective Bargaining Notifications* by the Australian Competition and Consumer Commission (2011), a commitment not to negotiate separately can put the supplier under increased pressure because of the buyers' threat of withdrawing orders. In essence, such a commitment can increase the LCB alliance's bargaining power. This subsection aims to provide a comparison with the case where the buyers are allowed to purchase separately from the supplier if the LCB negotiation fails. We again first consider equal price LCB and then discuss the fixed transfer price LCB.

6.1.1. Equal Price LCB. Without such a commitment, in the last stage of the game, the Nash product of the negotiation between the leader and the supplier changes to

$$\max_{w}[(a-q_i-bq_j-w)q_i-\pi_i^S]^{\alpha_{is}}[(w-c)(q_i+q_j)-\pi_s^S]^{1-\alpha_{is}}.$$

Solving this problem leads to the following lemma.

Lemma 5. *Given q_i and q_j, the bargaining outcome of the wholesale price between the leader and the supplier is*

$$w(q_i,q_j)=c+(1-\alpha_{is})(a-q_i-bq_j-c)+\frac{\alpha_{is}\pi_s^S}{q_i+q_j}-\frac{(1-\alpha_{is})\pi_i^S}{q_i},$$

under which the leader's profit is $\pi_i(q_i,q_j,w(q_i,q_j))=\alpha_{is}(a-q_i-bq_j-c)q_i-(\alpha_{is}q_i\pi_s^S)/(q_i+q_j)+(1-\alpha_{is})\pi_i^S$, and the follower's profit is $\pi_j(q_i,q_j,w(q_i,q_j))=(a-q_j-bq_i-c-(1-\alpha_{is})(a-q_i-bq_j-c)-\alpha_{is}\pi_s^S/(q_i+q_j)+(1-\alpha_{is})\pi_i^S/q_i)q_j$.

Compared to the case with commitment, deriving the equilibrium q_i and q_j without commitment becomes more challenging because the profit functions involve the buyers' reservation profits from separate purchases. Hence, to gain more insight, we conduct an extensive numerical study with the parameters chosen from Table 1. A total of 4,440 feasible instances is possible by keeping $\alpha_{is}\geq\alpha_{js}$ and $w(q_i,q_j)>c$. In each instance, we search for the equilibrium order quantities and then derive the corresponding profits.

Without the commitment, both buyers' profits under equal price LCB clearly must be greater than their profits under separate purchases because they can always choose the latter option. However, we find that the lack of a commitment always hurts the leader, even though it might benefit the follower when the competition intensity b is in the middle region (the competition effect is weakened with the separate purchase option). On average, the leader's profit increases by about 5% with the commitment, while the follower's profit increases about 3%. Another interesting observation from our numerical study is that, without commitment, equal price LCB might still benefit the supplier, compared to the separate procurement case. Figure 1 provides an example with a middle range of b, where the supplier's profit under equal price LCB can be significantly higher than his profit under the separate procurement case. This result is mainly because equal price LCB can increase the total supply chain surplus by softening downstream competition. This effect is the most significant when the competition intensity resides in the middle region.

Table 1. Summary of Parameters

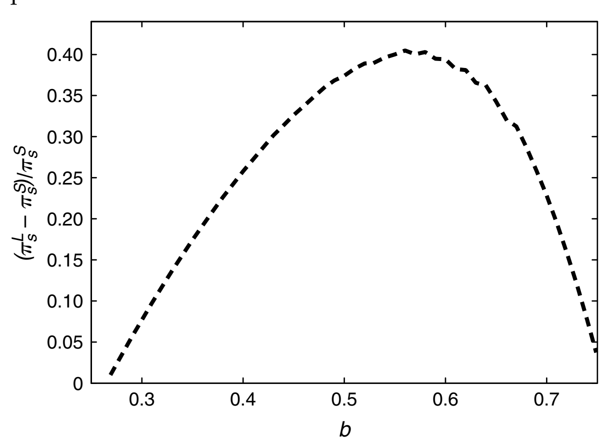
Market potential	$a=50,100,150,200$
Buyers' bargaining powers	$\alpha_{is}\in[0,1]$, step length $=0.1$
	$\alpha_{js}\in[0,1]$, step length $=0.1$
Competition intensity	$b\in[0,1]$, step length $=0.01$
Cost	$c=1,10,20$

6.1.2. Fixed Price LCB. We also investigate fixed price LCB by allowing the buyers to purchase separately from the supplier if the LCB negotiation fails. In the last stage, the Nash product of the negotiation between the leader and the supplier becomes

$$\max_{w}[(a-q_i-bq_j-w)q_i+(t-w)q_j-\pi_i^S]^{\alpha_{is}}\cdot[(w-c)(q_i+q_j)-\pi_s^S]^{1-\alpha_{is}}.$$

Maximizing this Nash product leads to the following lemma.

Figure 1. Comparison Between the Supplier's Profit Under Equal Price LCB Without Commitment and That Under Separate Procurement



Note. The parameters are $a=200$, $c=1$, $\alpha_{is}=0.4$, and $\alpha_{js}=0.3$.

Lemma 6. *Given q_i and q_j, under fixed price LCB, the bargaining outcome of the wholesale price between the leader and the supplier is*

$$w(q_i,q_j,t) = \alpha_{is}c + \frac{(1-\alpha_{is})[(a-q_i-bq_j)q_i + tq_j - \pi_i^S] + \alpha_{is}\pi_s^S}{q_i+q_j},$$

under which the leader's profit is $\pi_i(q_i,q_j,w(q_i,q_j,t),t) = \alpha_{is}[(a-q_i-bq_j-c)q_i + (t-c)q_j - \pi_s^S] + (1-\alpha_{is})\pi_i^S$.

With this outcome, the negotiation between the leader and the follower for the fixed transfer price t can be formulated as

$$\max_t [\pi_i(q_i,q_j,w(q_i,q_j,t),t) - \pi_i^S]^{\alpha_{ij}} [\pi_j(q_i,q_j,t) - \pi_j^S]^{1-\alpha_{ij}}.$$

Clearly, the Nash product is log-concave, and we can obtain a closed-form solution for the transfer price and for the buyers' profits.

Lemma 7. *Given q_i and q_j, the optimal transfer price is*

$$t(q_i,q_j) = (1-\alpha_{ij})c + \alpha_{ij}(a-q_j-bq_i) - \frac{\alpha_{ij}\pi_j^S + (1-\alpha_{ij})[(a-q_i-bq_j-c)q_i - \pi_s^S - \pi_i^S]}{q_j},$$

under which the leader's and follower's profits are

$$\pi_i(q_i,q_j) = \alpha_{is}\alpha_{ij}[(a-q_i-bq_j-c)q_i + (a-q_j-bq_i-c)q_j - \pi_i^S - \pi_j^S - \pi_s^S] + \pi_i^S \quad \text{and}$$
$$\pi_j(q_i,q_j) = (1-\alpha_{ij})[(a-q_i-bq_j-c)q_i + (a-q_j-bq_i-c)q_j - \pi_i^S - \pi_j^S - \pi_s^S] + \pi_j^S.$$

In the first stage, the buyers decide their procurement quantities simultaneously, which results in the following equilibrium.

Proposition 9. *Under fixed price LCB without commitment, the equilibrium quantities are $q_i^L = q_j^L = (a-c)/(2(1+b))$, under which the profits of the supply chain parties follow: $\pi_i^L = \pi_i^S + \alpha_{ij}\alpha_{is}((a-c)^2/(2(1+b)) - 2(a-c)^2/(2+b)^2)$, $\pi_j^L = \pi_j^S + (1-\alpha_{ij})((a-c)^2/(2(1+b)) - 2(a-c)^2/(2+b)^2)$, and $\pi_s^L = \pi_s^S + \alpha_{ij}(1-\alpha_{is})((a-c)^2/(2(1+b)) - 2(a-c)^2/(2+b)^2)$, respectively.*

Comparing Propositions 6 and 9, we can readily observe that under fixed price LCB, both buyers' profits decrease while the supplier's profit increases if the commitment is absent. Hence, the buyer commitment is beneficial for the buyers but harmful for the supplier.

6.2. LCB with Enhanced Bargaining Power

In our main model, we have assumed that the parameter α_{is}—which represents the leader's bargaining power relative to the supplier—does not change from the case of separate procurement to the case of LCB. In this subsection, we relax this assumption to incorporate the possibility that having a larger procurement quantity might increase the buyer's bargaining power. In particular, we assume that the leader's bargaining power is increased to $\alpha_{is} + \xi$ in the LCB negotiation, where $\xi \in [0, 1-\alpha_{is}]$; meanwhile, the supplier's bargaining power is reduced to $1-\alpha_{is}-\xi$. Let $\alpha'_{is} = \alpha_{is} + \xi$. Clearly, all our previous analysis remains intact. In the following, we discuss the effect of this modification on the negotiation outcomes.

6.2.1. Equal Price LCB. Similar to Proposition 2, we can derive the equilibrium order quantities under equal price LCB: $q_i^L = (2(1-b) + b\alpha'_{is})(a-c)/((4+b)(1-b) + 3b\alpha'_{is})$ and $q_j^L = (1-b+\alpha'_{is})(a-c)/((4+b)(1-b) + 3b\alpha'_{is})$, with the enhanced bargaining power α'_{is}. Taking the first derivatives with respect to ξ, we obtain

$$\frac{\partial q_i^L}{\partial \xi} = \frac{\partial q_i^L}{\partial \alpha'_{is}} \frac{\partial \alpha'_{is}}{\partial \xi} \le 0, \quad \frac{\partial q_j^L}{\partial \xi} = \frac{\partial q_j^L}{\partial \alpha'_{is}} \frac{\partial \alpha'_{is}}{\partial \xi} \ge 0,$$
$$\text{and} \quad \frac{\partial (q_i^L + q_j^L)}{\partial \xi} \ge 0.$$

Interestingly, the increase of the leader's bargaining power under equal price LCB can increase the follower's procurement quantity but decrease the leader's own quantity. We also find an increase of the total procurement quantity. This finding indicates that the competition effect is weakened, which can benefit the follower and possibly also the overall supply chain. Finally, greater bargaining power clearly can increase the buyer alliance's total profit.

6.2.2. Fixed Price LCB. From Proposition 6, we can notice that the equilibrium procurement quantities under fixed price LCB do not depend on α_{is}, and thus the change of the leader's bargaining power does not change the procurement quantities. Furthermore, from Proposition 6, we can readily observe that an increase of the leader's bargaining power reduces the supplier's profit but increases the buyer alliance's total profit as the leader becomes a stronger bargainer.

6.3. LCB Leader Choice

Thus far, we have assumed that the LCB leader is exogenously determined. In the following, we discuss the possible outcomes for an endogenous choice. We focus on the perspective of maximizing the two buyers' total profit, recognizing that they can always use a lump-sum transfer payment to share the gain.

6.3.1. Equal Price LCB. Recall from Proposition 2 that if buyer i is the leader, then the alliance obtains a total profit:

$$\pi_i^L + \pi_j^L = \big((1-b+\alpha_{is})[(1-b)^2 + (1-b^2+b\alpha_{is})\alpha_{is}] + \alpha_{is}[2(1-b)+b\alpha_{is}]^2\big) \cdot \big([(4+b)(1-b)+3b\alpha_{is}]^2\big)^{-1}(a-c)^2.$$

In contrast, if buyer i is the follower, then the alliance's total profit is as follows:

$$\pi_i^{L'} + \pi_j^{L'} = \big((1-b+\alpha_{js})[(1-b)^2 + (1-b^2+b\alpha_{js})\alpha_{js}] + \alpha_{js}[2(1-b)+b\alpha_{js}]^2\big) \cdot ([(4+b)(1-b)+3b\alpha_{js}]^2)^{-1}(a-c)^2.$$

Comparing these two profit functions, we can readily see that, from the buyer alliance's perspective, the buyer who has greater bargaining power relative to the supplier should be the leader. This outcome is intuitive because greater bargaining power relative to the supplier results in a larger share of the total supply chain surplus. This result also is in line with the anecdotal observations that the equal price LCB leaders are often the more powerful buyers in practice.

6.3.2. Fixed Price LCB. First, notice that under fixed price LCB, the first-best solution is always achieved regardless of which buyer is the leader. This outcome can be immediately seen from Proposition 6 because the result there does not depend on the leader choice. Second, in contrast to equal price LCB, now the two buyers' total profit depends on their relative bargaining power. This relationship can be seen from the comparison of the two buyers' total profits under different leader choices ($\pi_i^{L'} + \pi_j^{L'}$ denotes the two buyers' total profit if buyer j is the leader):

$$\begin{aligned}\pi_i^{L'} + \pi_j^{L'} - (\pi_i^L + \pi_j^L) &= [\alpha_{ij}(1-\alpha_{is}) - (1-\alpha_{ij})(1-\alpha_{js})] \cdot \left(\frac{(a-c)^2}{2(1+b)} - (1+\alpha_{is})\frac{(a-c)^2}{(2+b)^2}\right) \\ &\quad + (\alpha_{is}-\alpha_{js})(1+\alpha_{ij}(1-\alpha_{is}))\frac{(a-c)^2}{(2+b)^2}.\end{aligned}$$

The sign of this equation depends on the three bargaining power coefficients. In fact, we find that even if buyer i has greater bargaining power relative to the supplier than buyer j, buyer i does not necessarily have to be the leader; the choice also depends on the relative bargaining power between the two buyers. This is because, under the fixed price scheme, the profit that the supplier obtains from the negotiation with the leader depends on the profit that the leader obtains from the subsequent negotiation with the follower. As a result, if the leader is a stronger bargainer relative to the follower, he would obtain a large profit from the negotiation with the follower but would then share more profit with the supplier, which can reduce the two buyers' total profit. Clearly, the actual outcome depends on the specification of the three bargaining power coefficients. A more sophisticated investigation into this aspect is beyond the scope of this research.

7. Conclusion

This paper analyzes a few important issues related to the incentives and the cooperation schemes for the LCB formation. First, we investigate the equal price purchasing agreement, which has been commonly adopted for LCB alliances in practice. Interestingly, we find that such a joint procurement alliance always benefits the leader but might hurt the follower. Although teaming up with a stronger leader can provide the follower a lower wholesale price, equal price LCB can also change the balance of the competition, turn it in the leader's favor, and undermine the follower's profit. We identify conditions under which equal price LCB can lead to "win–win" and "win–lose" outcomes. Second, in view of the limitations of equal price LCB, we explore whether more efficient transfer price agreements exist that can facilitate LCB formation in practice. Specifically, we find that a fixed transfer price agreement, when properly designed, can resolve the competition effect and always result in a "win–win" outcome for the buyers. This scheme can improve the overall supply chain performance and also can benefit the supplier in various scenarios. These findings are potentially useful for LCB implementations in practice.

Acknowledgments

The authors are grateful to the editor-in-chief, the associate editor, and the anonymous referees for their constructive comments, which led to the present improved version of this paper.

Endnotes

[1] Although our study focuses on LCB, we also provide in the online appendix a quantitative comparison between RCB and LCB in our context.

[2] ACCC public registers: Mai Wiru Regional Stores Council Aboriginal Corporation-Collective Bargaining Notifications-CB00150-CB00155. Accessed December 5, 2014, http://registers.accc.gov.au/content/index.phtml/itemId/1006664/fromItemId/773840/display/acccCorrespondence.

[3] ACCC public registers: R J Nuss Removals Pty Ltd and Ors–Collective Bargaining Notification–CB00007-CB00283. Accessed December 1, 2014, http://registers.accc.gov.au/content/index.phtml/itemId/1127175/fromItemId/815577.

[4] The procurement quantity can be decided either before or during the price negotiation, which leads to the same outcome because of the cooperative feature of the Nash bargaining framework. Detailed discussions on this point can be found in the bargaining literature (see, e.g., Nash 1951, Roth 1979, Nagarajan and Sošić 2008).

[5] An extension where the two buyers negotiate with the supplier sequentially is discussed in the online appendix.

[6] Under the Nash bargaining framework, the two negotiations always succeed in equilibrium. Therefore, the purpose of the latter two assumptions is simply to justify the setting for the disagreement point.

[7] Schotanus (2007) shows that equal price LCB satisfies most properties of fairness defined by prior literature.

[8] We have assumed away other factors in our analysis that tend to benefit joint procurement (e.g., the economies of scale effect). To incorporate such factors likely would make equal price LCB more beneficial.

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