Bargaining Framework Comparison in Supply Chain Management

March 2, 2018

Bargaining is common in firms’ interactions within supply chains. Recently, many researchers apply bargaining frameworks to study various supply chain issues (e.g., Van Mieghem 1999, Feng and Lu 2013a,b, Chu et al. 2017). The most commonly used approach in the supply chain literature is the Nash bargaining (NB) solution (Nash 1950). The Nash bargaining framework derives the trading outcome based on a set of intuitive appealing axioms and yields an elegant solution that is easy to interpret. However, there has been significant criticism on this solution concept, the most significant one being on its axiom of independence of irrelevant alternatives (e.g., Roth 1977a,b). This axiom essentially states that despite of the fact that the one trading party may have improved prospective of his trade gain, the negotiation outcome stays unchanged. For example, consider a single supplier serves a single retailer as opposed to selling to two competing retailers. Naturally, one would expect that the supplier earns a higher profit in the second scenario. However, our analysis suggests that the NB solution may lead to the opposite negotiation outcomes simply because the improved perspective of the supplier by having a second retailer may not be captured in the NB solution.

To address this issue, Kalai and Smorodinsky (1975) propose an alternative axiom, called individual monotonicity. The key difference between two bargaining solutions lies in the fact that the NB solution only depends on the disagreement points (i.e., the players’ payoffs in case of negotiation breakdown), while the Kalai-Smorodinsky (KS) solution not only takes into account the disagreement points, but also the ideal profits (i.e, the maximum possible profits). The KS solution has been applied in social science (e.g., Alexander 1992) and engineering (e.g., Shrestha et al. 2008). However, it is much under studied in the supply chain contexts.

Our goal is to generate some understanding on the difference between the KS framework and the widely used NB framework in supply chain contract negotiations. We consider two-tier supply chains consisting of one or two suppliers selling products to one or two retailers. Two common market structures are analyzed: In a one-to-two channel, a common supplier sells a product to two competing retailers. In
a two-to-one channel, two suppliers sell substitutable products to a common retailer. The trade between a supplier and a retailer takes place through a bilateral negotiation over a wholesale-price contract. In the one-to-two or two-to-one channel, there are two bargaining units, each consisting of a supplier and a retailer. We allow for the possibility that two negotiations are parallel or sequential. We also distinguish the situations with contingency from those without. A trade party may impose contingency terms on a contract that the negotiated contract will be executed only if the other negotiation is successful. Once the contract terms are agreed upon, each retailer determines the quantity that he orders from each supplier whom he has signed a contract with.

Our study shows that when no contingency terms are imposed on the contract execution, the negotiation outcome under the KS solution captures the retailers’ ability to determine the order quantities. In particular, when negotiations are conducted simultaneously, the retailers’ effective bargaining power is 3/5 (as opposed to 1/2) regardless of the channel structure. In sequential negotiation, the KS solution also captures the common negotiator’s advantage in the first negotiation. Specifically, in the one-to-two channel, the supplier’s effective bargaining power in the first negotiation is above 2/5, while that in the second is 2/5. In the two-to-one channel, the retailer’s effective bargaining power in the first negotiation is above 3/5, while that in the second is 3/5. Moreover, the NB solution may violate the individual monotonicity condition in the sense that when a party’s potential prospect from a trade improves, a larger profit is indeed allocated to that party. Specifically, in the two-to-one channel, the NB solution may not allocate less trade surplus to the supplier in the first negotiation when the products are highly substitutable.

When contingency is imposed on contract execution, the KS solution enhances the power of the common trading party, the supplier in the one-to-two channel or the retailer in the two-to-one channel. For example, when contracts are negotiated in sequence, the supplier’s effective bargaining power in the first negotiation above 1/2, while that in the second is above 2/5. In the two-to-one channel, the retailer’s effective bargaining power is the first negotiation is above 0.7, while that in the second one is above 3/5.

In summary, we apply the KS framework in supply chain context. We seek to understand the potential issue in modeling with the NB solution and compare the solution derived under the KS solution in various
settings. We also consider the general nonlinear demand functions for robustness check. We find that the retailer’s advantage of making the order decision becomes more significant when the retailer’s revenue function is more concave. When imposing an alternative contract, we find that these two solutions have a one-to-one correspondence under a coordinating contract (e.g., two-part tariff). The KS solution corresponds to equal bargaining power under the NB solution.

References


