Better to Bend than to Break: Sharing Supply Risk Using the Supply-Flexibility Contract

Mehdi Hosseinabadi Farahani∗ Milind Dawande∗ Haresh Gurnani† Ganesh Janakiraman∗

Supply disruption risk has become an important area of concern for procurement managers as supply chains have become complex and extended due to globalization of the supplier base. In decentralized supply chains facing disruption risk, the problem is magnified as the success of individual players depends on their ability to manage their individual pricing, ordering, or production decisions in order to match supply with demand. In this context, a number of risk management strategies have been extensively studied in the Operations Management literature. These include multi-sourcing, backup sourcing, emergency purchases, etc. In contrast, we study a new approach based on introducing supply flexibility in the contract – a practice that has been used by some firms but has not been addressed in the academic literature.

The transfer of risk to suppliers through the imposition of onerous contracts is common in traditional procurement practices. In particular, the price-only contract, which shifts risk primarily to the supplier, is the most common type of contract used even in the presence of disruption risk. The popularity of the price-only contract stems mainly from its simplicity and minimal administrative costs. However, such one-sided contracts seem to be less effective than what the buyers expect. Therefore, it is crucial for buyers to evaluate their decisions with regard to supply risk and how it can be shared amongst the parties in the supply chain. In particular, a buyer may be better off assuming a certain share of the supply risk if it can lead the supplier to reduce the wholesale price and commit to delivering at least a part of the buyer’s order on time. For instance, in construction procurement contracts, there is a desire to share risk between the two sides instead of adopting an adversarial stance. Ideally, supply risk should be shared between the parties through a contract that not only provides incentives to both the supplier and the buyer to engage into the contract but also maintains the simplicity of the price-only contract. Further, it would be assuring to see evidence of the use of such a contract in practice. These are the two goals that motivate our work in this paper.

In some situations, suppliers guarantee a certain amount of supply to buyers in order to cope with disruption risks. These contracts provide some level of flexibility for the supplier as opposed to price-only contracts, where the supplier is required to deliver the entire quantity ordered by the buyer. In the power-supply industry, contracts specify Fuel Supply Agreements (FSAs) that allow flexibility for the supplier to deliver a minimum fraction if conditions prove difficult to

∗Jindal School of Management, The University of Texas at Dallas; {mehdi, milind, ganesh}@utdallas.edu
†School of Business, Wake Forest University; gurnanih@wfu.edu
deliver the entire order. We also observe variants of such contracts across many industries such as commodities, PCB industry, in fresh foods as well as in spare parts supply services. While supply-flexible contracts have been used in practice, there is no academic research on the design of such contracts, and to our knowledge, the effect of supply-flexibility on the performance of supply-chain partners facing random demand has not been studied in the literature.

To address this gap, we analyze the effect of supply-flexibility on price-only contracts for fixed-price newsvendors and address the following questions:

- What is an optimal supply-flexibility contract for the supplier to share some of its production risk with the buyer?
- Would the buyer be willing to accept sharing risk in the contract?
- How does supply flexibility affect pricing and ordering decisions, individual player profits, and overall supply-chain efficiency?

To address these questions, we consider a supplier (she) who can produce a product using either regular production or an expedited supply source. The regular production is subject to disruption but the expedited source is perfectly reliable and available at a higher marginal cost. The buyer (he) faces a fixed-price newsvendor problem, where unmet demand is lost with no additional cost. We analyze a supply-flexibility contract in which the supplier offers a wholesale price and a minimum-delivery “flexibility” fraction to the buyer. If the buyer accepts the contract, he chooses the order quantity and the supplier guarantees delivery of a quantity that does not deviate below the order quantity by more than the flexibility fraction.

Our results indicate that supply-flexibility not only improves supply-chain efficiency, but also improves profits for both the supplier and the buyer. In other words, even if the buyer lets the supplier decide how supply risk is shared by the two players, his profit will be higher compared to that under a price-only contract. This is due to the fact that, in conjunction with supply-flexibility, the supplier sets a lower wholesale price (compared to that in the price-only contract) which, in turn, induces a higher order quantity from the buyer and helps the two parties to “expand the pie”, ultimately benefiting both of them. Further, supply-flexibility may be even more valuable for the buyer compared to the supplier. We also study the value of supply flexibility and show that it is most valuable when it is most needed, that is, when the expedited supply cost is high and/or the disruption risk is high.

The assumption that the supplier chooses the flexibility fraction naturally gives the supplier a leadership advantage in the contract design process. We adjust the balance of power in the supply chain and study an extension where the buyer chooses the flexibility fraction and show that, again, both the supplier and the buyer benefit from this contract. As expected, the buyer prefers to choose the flexibility fraction, whereas, the supplier is better off when she chooses it. In a second extension, we consider the case when the expedited supply option is available to both the players. We show that the supplier may reduce her wholesale price in face of added competition as expected, but in contrast to intuition, she may choose to require higher flexibility in the contract.
The supply-flexibility contract is a simple contract through which the supplier is able to share supply risk with the buyer by committing to a partial delivery quantity to the buyer. It possesses all the advantages of the price-only contract – it is easy to implement, there is no need to track unsold inventory or implement a returns policy, and there are no trust issues like those that arise in buy-back or revenue-sharing contracts. More importantly, the improvement in supply-chain efficiency offered by the supply-flexibility contract (over the price-only contract) can be substantial. Regardless of whether the supplier or the buyer decides on how supply-risk is shared, the flexibility contract benefits both the players. Moreover, in contrast to intuition, we show that the presence of a secondary supply source for the buyer can serve to promote higher risk sharing between the supplier and the buyer.