Is Simplicity the Ultimate Sophistication?

The Superiority of Linear Pricing

The emerging literature in behavioral economics has acknowledged that people have limited cognitive abilities in optimizing their utilities (Simon, 1955). In behavioral operations management, numerous experiments have been conducted to verify and explain human newsvendors deviation from the optimal order quantity predicted by the normative theory (Su, 2008; Wu and Chen, 2014; Schweitzer and Cachon, 2000); the non-optimizing behavior which we refer to as bounded rationality. On the other hand, the supply chain coordination literature has shown that a simple wholesale price contract fails to align the incentives of a rational retailer with those of the supply chain. To alleviate this misalignment, some non-linear contracts developed by researchers, e.g. buy-back, rebate, and revenue sharing contracts. In contrast to the praise of these non-linear contracts in theory, simple wholesale price contracts are still commonplace in many businesses. Our paper aims to address this puzzle by incorporating the retailer’s boundedly rational behavior in the study of supply chain contracting.

In a dyadic two echelon supply chain and examine if the retailer’s behavioral biases would affect the manufacturer’s choice of contract. In particular, we introduce a general newsvendor behavioral order quantity framework which can be parameterized to include well-known behavioral order quantity models as its special cases. Examples of such behavioral models are demand chasing (Schweitzer and Cachon, 2000; Bostian et al., 2008), mean anchoring (Schweitzer and Cachon, 2000; Bostian et al., 2008), and Logit choice (Su, 2008). We also consider a general supply chain contract framework which encapsulates many well-known supply chain contracts as its special case. Examples of contracts that can be captured by our general framework are wholesale price, buy-back, revenue sharing, rebate, and penalty contracts.

When the retailer is fully rational, under a wholesale price contract, the retailer tends to order
less than the supply chain optimal order quantity. However, the supply chain optimal can be achieved under non-linear contracts such as buy-back and revenue sharing contracts. Take buy-back contracts as an example, there exist pairs of buy back contracts \((w, b)\) under which the supply chain is coordinated. In addition, arbitrary supply chain profits allocation between the retailer and the manufacturer can be achieved by changing the buy-back price \(b\). The manufacturer’s profit increases with the buy-back price \(b\). Given that the retailer has certain bargaining power in a supply chain (e.g. the retailer has a reservation value or outside option), the manufacturer will extracts all surplus from the retailer except for the reservation value by choosing the buy back contract at maximum buy-back price \(b\) among all coordinated pairs of \((w, b)\).

However, the results may not continue to hold when the retailer is boundedly rational and her order quantity includes systematic behavioral biases or random errors. In this study, we address research questions in supply chain contracting with boundedly rational retailers. How does a manufacturer’s choice of contract changes when he is dealing with a boundedly rational newsvendor. Are non-linear contracts still preferred over wholesale price contracts? How the manufacturer’s choice of contract changes with factors such as business profit margin, demand variance, retailer’s bounded rationality, and reservation value?

We find that the manufacturer may not necessarily be better off by adopting a non-linear contracts. We identify the potential advantage of wholesale price contracts as compared to the other non-linear contracts such as buy-back and revenue sharing contract. First, a boundedly rational retailer may place orders that are already lead to small stockout probability compared to the rational best response under the wholesale price contract. Hence, non-linear contracts wouldn’t help in moving the retailer’s order quantity toward the supply chain optimal. This finding is in sharp contrast with the classic newsvendor coordination where, for example of buy-back contract, the manufacturer’s profit is increasing in the buy-back price and he always prefers larger buy-back price. In addition, under a linear contract, the manufacturer can avoid to paying for the errors made by a boundedly rational retailer and thus it can be potentially more profitable.

We provide conditions that ensure a linear contract, e.g. wholesale price, performs better than non-linear contracts. We find that the manufacturer is more likely to implement a wholesale price contract when the profit margin is relatively low, which seems to be in line with real world supply chain practices in which complicated contracts are mostly adopted in the high profit margin
industries like DVD rentals, semiconductor, and software industries. On the other hand, low margin industries such as grocery stores are more likely to adopt simple wholesale price contracts. The advantage of linear contracts also depends on the demand variance, the retailer’s bounded rationality and reservation value (or bargaining power). In particular, wholesale price contracts are more likely to be adopted when the retailers’ demand variance is high, the retailer is less rational, and the reservation value (or bargaining power) is high.

References


