

## **Bounded Rationality in Supply Chain Interactions**

Basak Kalkanç, Georgia Institute of Technology  
Georgia Perakis, Massachusetts Institute of Technology

Experiments show that the standard theory does not capture the newsvendor behavior. Two complementary approaches emerge to describe the observations: human newsvendors make ordering errors and do not optimize; they are *boundedly rational*. Human newsvendors exhibit *reference-dependent preferences* and incur psychological costs from leftovers and stockouts. Motivated by these observations, the goal of this paper is to investigate the impact of retailer's behavior in a supply chain. We consider a two-tier supply chain in which a supplier offers a wholesale price and sells to a newsvendor retailer. The retailer is not an optimizer: she can choose any quantity with some probability and quantities leading a higher expected utility are chosen more often. The retailer also incurs additional psychological costs from leftover inventory and stockouts. We consider the following questions: (1) Does the supplier prefer to work with a behavioral retailer (instead of a rational one)? (2) Does the overall supply chain benefit from the retailer's behavior? (3) Are alternative decision criteria (such as minimizing regret) effective for the supplier, if he cannot fully anticipate the retailer's decisions?

Our results reveal a nontrivial relationship between the retailer's bounded rationality and the supplier's profits, driven by the customer demand. If the demand cumulative density function (CDF) is concave (e.g., Exponential distribution, Gamma or Weibull distributions where  $k < 1$ ), the supplier prefers to work with a boundedly rational retailer. Service levels are significantly lower for quantities less than the expected-utility maximizing one, and hence, a boundedly rational retailer orders more than the optimal on average. On the other hand, if the demand CDF is convex or if the customer demand has a unimodal density (e.g., Normal, Triangular, Gamma or Weibull with  $k > 1$ ) and the optimal quantity is in the convex portion of the CDF, the supplier may prefer to work with an optimizer retailer. Here, overordering is more costly than underordering, and a boundedly rational retailer may underorder on average. Surprisingly, the retailer can strategically benefit from being boundedly rational. Regardless of bounded

rationality, a supplier's profit increases with the aversion to stockouts and decreases with the aversion to leftovers.

Behavioral deviations can also be desirable for the supply chain. While these deviations reduce the retailer's profits, they can also reduce double marginalization (to the extent that they increase the retailer's order quantity). Particularly, under fixed and sufficiently high wholesale prices, bounded rationality increases the supply chain profits. Finally, we observe that the minimax regret approach leads to surprisingly simple yet effective pricing decisions for a supplier facing uncertainty about the retailer's behavior.