

Stochastic Inventory Decisions under Ambiguity: An Experimental Study

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The growing body of literature in behavioral operations on biases in the newsvendor model assumes decision-making under *risk*, where the decision-maker has the exact knowledge of the probabilities associated with the outcomes. Firms launching new products and managing a wide variety of short life cycle products are often not able to gather complete and exact information about the demand distribution resulting in decision-making under ambiguity. Decision theory recognizes the difference between exact probabilities and more realistic ambiguous probabilities that characterize most decision-making situations. The studies on ambiguous decision-making situations suggest that decision-makers deviate from rationality and violate the axioms of subjective expected utility.

In this study, we examine the newsvendor ordering preferences under *ambiguity* (unknown demand distribution), and compare the ordering decisions with the normative benchmarks under ambiguity and under risk. Our experimental settings capture ordering behavior under a) two levels of demand, b) two levels of cost structure.

The subjects take repetitive newsvendor decisions for risky as well as ambiguous demand patterns in the first experiment. In the second experiment, the subjects take single-shot decisions for both risky and ambiguous demand patterns. In the third experiment, the subjects are partitioned into two sets and each set is assigned to determine single-shot ordering decisions under either risk or ambiguity.

The experimental results show that the subjects deviate from rationality. They exhibit strong pull-to-center bias under risk and ambiguity. The subjects overorder high-cost products and underorder low-cost products. We report strong ambiguity-aversion in situations comprising both risk and ambiguity. The subjects order less under ambiguity as compared to the order quantity under risk. Interestingly, we observe ambiguity-neutral preferences for situations that involve either risk or ambiguity. These observations question the ability of newsvendor decisions to utilize the additional information for better decisions. The knowledge of exact demand distribution does not necessarily reduce the ordering biases. The normative models suggest the influence of cost and demand structure on the optimal order quantity. However, we observe the influence of procedure followed in an experiment on the ordering decisions. This indicates that subjects violate the principle-of-procedural-invariance. In addition to the ordering biases, we also study willingness-to-pay to attenuate ambiguity, willingness-to-accept for a fixed pay-off, and effect of the external evaluation on the ordering decisions. Our results easily extend to decision-making in structurally equivalent but procedurally different operations management problems.

Our research contributes to behavioral operations by analyzing the decision biases in one of the most significant problems of operations management. In addition to the managerial implications of the results, the study forms the basis of development of new normative benchmarks in decision-making under uncertainty.