Analysis of the Value of Component Commonality Through a Risk-Adjusted Assemble-to-Order System Optimization

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This study analyzes an assemble-to-order (ATO) system with multiple components and products. The stock replenishment is done according to base-stock policy, and the components are allocated to product demands according to first-come-first-served (FCFS) rule with inventory commitment. The lead times of all components are assumed to be constant, where the lead times of common components are significantly shorter and their procurement costs higher than those of other components. The problem is modeled through both a risk-neutral and a risk-adjusted two-stage stochastic programming problem with multiple periods at the second stage. Different from the literature, which usually assumes stationary and independent demands, this paper assumes non-stationary and correlated demands across multiple periods. Note that stationary demands assumption is reasonable for the maturity phase of a product life cycle, but it certainly does not hold for its decline phase. Because of the complexity, the problem is solved numerically through simulation-based optimization, namely Sample Average Approximation (SAA) method combined with a subgradient-based decomposition algorithm.

This study aims at investigating the following research questions:

1. Can commonality be valuable in terms of operational hedging even with perfect positive correlation when risk pooling is impossible?

2. How does the preference for commonality change with respect to the risk attitude and risk measures?

As a by-product, the component allocation rules provided by the second-stage solutions of the two-stage problem are compared with FCFS combined with product priority and fair-share allocation in the numerical examples.