Supply Chain Disruption Simulation

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Introduction

- More than 97% of companies believe that they will or have experienced impact due to COVID-19 disruptions according to a survey by the Institute of Supply Chain Management
- Industries such as Health Care and Social Assistance and Computer & Electronic Products have reported increasing demands since the pandemic, while most other (81%) organizations surveyed reported decreasing demands
- With such varying and unpredictable demands, it would be crucial to study how disruptions could affect inventory planning for different businesses

Simulation Model

- Two-state Markov chain systems were used to simulate disruptions, with base stock policies applied at each node in the system (Fig. 1)

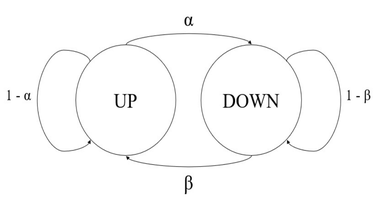

Figure 1. a Markov chain system model

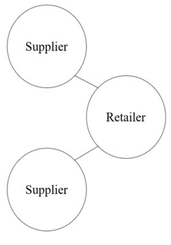

Figure 2. the three-node assembly system

- A Python-based simulation model with nodes and links that could form any supply chain structure desired was developed; this project focused on studying a three-node assembly model (Fig. 2)
- One unit from each supplier is needed to produce one finished product at the retailer in this system

Disruption Comparison

- Short & frequent disruptions and long & infrequent disruptions were simulated: the optimal base stock levels under each disruption level were identified, and the corresponding optimal costs for the entire simulation system were compared (Fig. 3)

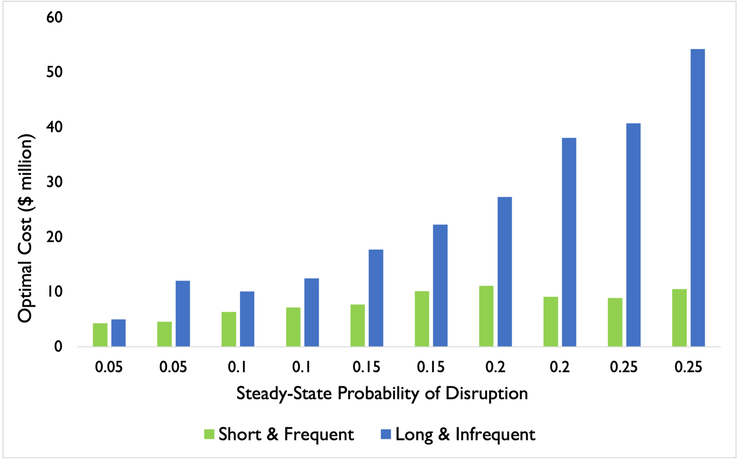

Figure 3. Comparison of Optimal Costs for 10 Pairs of Short & Frequent vs. Long & Infrequent Disruptions

Retailer & Supplier Comparison

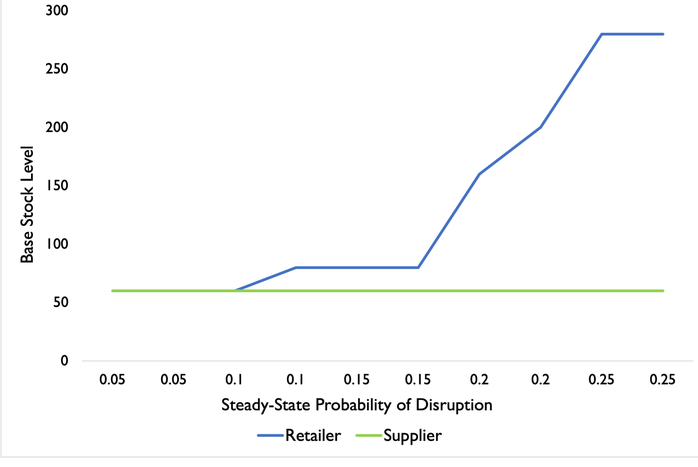

Figure 4. Comparison of Optimal Base Stock Levels for Retailers and Suppliers in the Same System; Disruption Simulated at Supplier Nodes

Analysis

- Long & infrequent disruptions could be up to 5 times more expensive than short & frequent disruptions (Fig. 3); the cost differences increase as the steady-state probability of disruption increases
- This difference (Fig. 3) could be explained by the higher variability in long & infrequent disruptions
- Retailers experiencing supply disruptions may wish to raise base stock levels more than suppliers in the same supply chain system to optimize base stock levels & associated costs (Fig. 4)

Conclusions & Future Work

- This work presents comparisons of different disruption types on optimal costs and base stock levels in different supply chain systems
- A flexible supply chain simulation system that could model any supply chain structure was developed
- Future work will focus on modeling and studying supply chain systems for specific industries

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