Increasing Supply Chain Robustness through Process Flexibility and Strategic Inventory

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This paper combines process flexibility and strategic inventory to develop an effective disruption mitigation strategy. We consider a manufacturer with multiple plants producing multiple products where strategic inventory can be held for any product. We measure the level of supply chain robustness by proposing the concept of Time-to-Survive (TTS) defined as the maximum time that no customer demand is lost regardless of which plant is disrupted.

We first analyze K-chain flexibility designs in which each plant is capable of producing exactly K products. We show that a 2-chain design, which is known to be effective for matching supply with demand when there is no disruption, is not robust when there is both disruption and demand uncertainty. However, we find that a 3-chain design is significantly more robust and achieves the same robustness as full flexibility under high uncertainty level.

We then extend the model to an assembly system and find that investment in process flexibility designs changes the optimal inventory placements. In particular, when the degree of flexibility is high, more inventory is allocated to standard components, i.e. components used by multiple products, but when the degree of flexibility is low, more inventory is allocated to non-standard components.