An Examination of the Impact of Flexibility and Agility on Mitigating Supply Chain Disruptions

1. Problem Definition

This paper examines the effect of flexibility and agility on supply chain responsiveness. We examine a supply chain with multiple sites, multiple transportation channels, and multiple product planning, over multiple time periods, under supply risk and demand risk. We determine the relationship between three objective functions related to responsiveness, risk, and cost, then discuss the impact of flexibility and agility on mitigating supply chain disruptions. A numerical example is presented to illustrate the efficiency of our model and provide insights for managers. To show a trade-off among objective functions in our numerical example, we solve the multi-objective mixed-integer programming model using two multi-objective optimization methods: the weighted goal programming method and the augmented ε-constraint method. While previous studies have shown flexibility and agility have a positive effect on improving supply chain responsiveness, our results indicate that the effect of agility is greater than the effect of flexibility on improving responsiveness to supply chain disruptions. In addition, we show different transportation channels play a pivotal role in mitigating supply chain disruptions. Our findings help decision makers with these two tasks: anticipate how much improvement in flexibility and agility will lead to an improvement in responsiveness; and create an investment plan to minimize the negative impact of supply chain disruptions by an examination of the trade-offs among responsiveness, risk, and cost.

2. Methodology and Assumption

Based on our findings from the literature, we develop a conceptual model for supply chain responsiveness where supply chain agility and flexibility affect supply chain responsiveness.
Figure 1. The Relationship among Antecedents of Supply Chain Responsiveness

Using our conceptual model, a mathematical model is developed incorporating supply chain responsiveness and supply chain risk as well as supply chain cost to examine their relationships in a supply chain exposed to demand and supply disruption risks. Our mathematical model consists of three objective functions: maximization of responsiveness, minimization of risk, and minimization of cost. Using the augmented $\varepsilon$-constraint method for solving the model, a trade-off among objective functions is proposed. The GAMS software has been used for coding and solving the model.

3. Results and Implications

First, while previous studies have shown flexibility and agility have a positive effect on improving supply chain responsiveness, our results indicates that agility’s effect is greater than flexibility’s effect in improving responsiveness to disruptions in supply and demand. Thus, for managers who are looking to improve responsiveness regardless of the other objective functions, investing in supply chain agility provides the most improvement on supply chain responsiveness for the firm. Interestingly, For managers looking to decrease the total cost by investing in responsiveness, our study shows that the best strategy is investing 60% in flexibility and 40% in agility.
Second, we found that improvement in responsiveness decreases supply and demand disruption risks considerably. These results help us understand how investment in responsiveness in situations involving disruption risk could mitigate supply and demand disruptions.

Third, we showed the important role of different transportation channels as a routing flexibility strategy on mitigating disruption risks. Our results showed that when a disruption occurs in the supply chain, the more responsive and reliable transportation channel helps to mitigate the supply chain disruption risks.

Finally, our findings help decision makers to anticipate how much investment in flexibility and agility leads to improvement in responsiveness to mitigate demand and supply disruption risks. In addition, our model assists managers in creating a cost plan for situations involving risk.