Optimal Outsourcing Strategy Determination and Pricing Model in Dual-Channel Supply Chain under Uncertainty

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Abstract: In the past, traditional channel or retailer was used for selling products but with the development of e-commerce, a large company in the world considers another sale channel like websites. Considering the existence of two channels for sale, choosing the right strategy for pricing has become important. In pricing and production planning, risk is a very important factor. In this paper, outsourcing policies have been used to deal with risks and a new mathematical model is presented for simultaneous decision-making on pricing and outsourcing in a three-level and two-channel supply chain despite uncertainty. In this paper, a nonlinear model is presented for supply chain profit function. According to the complexity of profit function, a meta-heuristic algorithm based on simulated annealing and scenario-based stochastic model are used to solve the proposed model. The initial parameters of this algorithm are set by Taguchi method. The computational results and sensitivity analysis indicate the effectiveness of the proposed solving method for problem solving.

Keywords: Dual-channel Supply Chain, Risk, Disruption Management, Pricing

Introduction: The rapidly expanding Internet provides an opportunity for organizations to distribute their products via a direct channel, while continuing to sell their products through the traditional retail channel. Although a hybrid channel strategy provides firms with many benefits and enables them to capture a larger share of the market, combining the retail distribution channel with direct channel may pose some challenges (Chiang et al., 2003). A comprehensive review of multi-channel models can be found in Cattani et al. (2004) and Tsay and Agrawal (2004). On the other hand, the disruption in supply networks is an important supply chain risk. Natural or man-made disasters such as equipment breakdowns, labors trikes, traffic interruptions, earthquakes, floods, and hurricanes may cause supply disruptions (Chen & Xiao, 2015). In this paper, we focus on supply disruption which happened by production downtime. One of the most common policies for risk mitigation is flexible multiple-sourcing. We use both the regular production run and the outsourcing mode due to the production disruption risk and uncertainty of capacity allocation. One of the applied studies conducted on pricing and disruption management is by Huang et al. (2013) in which production costs are disrupted. Yu et al. (2009) focus on evaluating the impacts of supply disruption risks on the choice between the famous single and dual sourcing methods in a two-stage supply chain with a non-stationary and price-sensitive demand. Chen and Xiao, et al (2015) developed supply chain game models with multiple uncertainties, and outsourcing mode due to his production disruption risk and uncertainty of capacity allocation. In the literature examined, the effect of outsourcing on pricing and production planning in dual channel supply chain which is under disruption risks is not taken into account.

Materials and Methods: We consider a dual channel supply chain in which a manufacturer sells to retailers as well as directly to end customers. The manufacturer sells the products to the retailer at wholesale price w. The retailer sells the products to end customers at retail price P_r. The manufacturer sells the products to end customers directly at direct sale price P_o. We assume that the channel demand functions in the two channels are

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random and linear in self-price and cross-price effects. Regular production capacity of the manufacturer is denoted by *Y*. We assume production is subject to a random disruption risk, and with disruption, the regular production will reach zero. The probability of disruption of production will be indicated by *P*. When the supply disruption occurs, the manufacturer cannot fulfill the order from the retailer. Therefore, we assume that in addition to a regular production run, the manufacturer has access to an outsourcing option with the higher procurement cost and the outsourcing production is perfectly reliable. The expected total profit for integrated dual channel supply chain is obtained as follows which comprises total revenue, production, holding, and shortage costs in both manufacturer and retailer under both disruption and non-disruption situations.

$$E(\pi_m)+E(\pi_r)=E(P[P_o min\{d_o, I-X\}-h_m max\{I-X-d_o,0\}-g_m max\{d_o+X-I,0\}-c_o min\{I-X,d_o\}]+(1-P)\times$$
$$[P_o min\{d_o, I+Y-X\}-h_m max\{I+Y-X-d_o,0\}-g_m max\{d_o+X-Y-I,0\}-c_o min\{I+Y-X,d_o\}-Yc_1]-Ic_2+wX)+$$
$$E([P_r \min\{d_r, X\}-h_r \max\{X-d_r,0\}-g_r \max\{d_r-X,0\}-c_r \min\{X-d_r\}-wX]$$

Then, to simplifying the model, the problem is remodeled based on scenarios

Results and Discussion: In this study, in order to achieve an optimal pricing and outsourcing, simulated annealing algorithm (SA) is developed. To get better output from SA, the initial solution is obtained from the scenario-based model which is solved by GAMS. This solution is used in SA algorithm. This method shows that the combination of SA and scenario based model in this specific way can adapt advantages of both methods. The sensitivity analysis show that with the increased sensitivity of direct channel demand or indirect channel demand to the price, the price of both channels decreases. With increasing the potential market demand, prices will rise. With increasing cost of outsourcing, prices on both channels are reduced.

Conclusion: In this paper, a non-linear stochastic model for pricing and determining the amount of outsourcing in the dual channel supply chain with disruption was presented. Regarding the non-linearity and complexity of model, the simulated annealing algorithm was used to solve the model. To improve the algorithm and approaching the answer to the optimal answer, the initial response value in the algorithm was obtained using a scenario-based model used in the algorithm.

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