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論　文　要　旨

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論　文　題　名	Supply Chain Management Models for Innovative Products

In the increasingly fierce competitive environment, innovation has become a core competency of an industrial organization. Innovative products are featured by higher profit margins, intrinsically unpredictable demand and short life cycles (Fisher, 1997). Many researchers study the newsvendor problems and supply chain management problems for innovative products, such as fashion goods (see the review by Cachon, 2003). However, the intrinsic one-shot characteristic of the decision related to innovative products has not been taken into account yet. The research in this dissertation is on characterizing the one-shot feature of innovative products in the supply chain management models based on the one-shot decision theory (Guo, 2011). Speaking in detail, it can be divided into four parts, that is, 1: General solutions in the one-shot decision theory; 2: Newsvendor models for innovative products; 3: Price-setting newsvendor models for innovative products; 4: Wholesale price contracts in the supply chain for innovative products. The detailed introduction is as follows.

1: General solutions in the one-shot decision theory

Guo (2011) initially proposed the one-shot decision theory (OSDT) for one-shot decision problems. Different from the probabilistic decision methods in which selecting an alternative equals selecting a probability distribution, in the OSDT, a person makes a one-shot decision based on some particular scenario (state) which is the most appropriate one for him/her while considering the satisfaction level incurred by this scenario and its likelihood level. The one-shot decision process is separated into two steps. The first step is to seek an appropriate scenario from all possible states for each alternative. This scenario is called as the focus point of the alternative. The second step is to evaluate the alternatives by the satisfaction levels incurred by the focus points for obtaining the optimal alternative. Different from the expected utility based models in which the different behaviors of the decision makers are assumed to be caused by the different utility functions of the decision makers, i.e., convex, concave and linear ones, the OSDT argues that the different behaviors of the decision makers result from the different personalities of them. The decision makers are divided into four types, i.e., active, passive, apprehensive and daring according to which type of focus point (scenario) they choose. Such idea is intuitively well-accepted.

By the OSDT, the one-shot decision problem is formulated as a bi-level optimization problem and there is no existing general optimization method for such problem. In this part, with an assumption that the likelihood level function and the satisfaction function are quasi-concave, the general solutions of the focus points and the optimal alternatives are obtained and the existence theorem is established in the one-shot decision theory.

2: Newsvendor models for innovative products

The newsvendor problem is a well-known inventory management problem. It has the following common characteristics. Prior to the season, the retailer must decide the quantity of the product to purchase. The procurement lead-time tends to be quite long relative to the selling season so that there is often not enough opportunity to replenish inventory once the season has begun. Excess stock can only be salvaged at a loss once the season is over. As the life cycle of innovative product is usually shorter than the procurement lead times, determining optimal order quantities of such products is a typical one-shot decision problem for the retailer. Therefore, newsvendor models for innovative products are proposed based on the OSDT.

In the proposed models, for each order quantity, the retailer chooses one appropriate demand (focus point) amongst all possible demands while considering the satisfaction level caused by the occurrence of the demand and the likelihood level of the demand. The optimal order quantity corresponds to the maximum satisfaction level of its focus point. The proposed newsvendor model (newsvendor-OSDT) is fundamentally different from the newsvendor model with the subjective expected utility theory (newsvendor-SEU), because the core hypothesis of SEU is that selecting an alternative equals selecting a probability distribution whereas the core hypothesis of OSDT is that selecting an alternative corresponds to selecting one appropriate state (scenario). Therefore, the newsvendor-SEU is lottery-based whereas the newsvendor-OSDT is scenario-based.

In this part, newsvendor models with four types of focus points are developed for four types of retailers; i.e., active, passive, apprehensive and daring retailers. The active retailer takes into account a demand with a higher satisfaction and a higher likelihood; the passive retailer focuses on a demand with a lower

satisfaction and a higher likelihood; the apprehensive retailer thinks over a demand with a lower satisfaction and a lower likelihood; the daring retailer considers a demand with a higher satisfaction and a lower likelihood. The optimal order quantities for these four types of retailers are obtained and there are following conclusions:

(1) The focus point of the active retailer's optimal order quantity is the optimal order quantity itself. It means that the active retailer has confidence that he/she can sell all the products that he/she has optimally ordered.

(2) The passive retailer chooses the optimal order quantity which makes its two focus points have the same normalized likelihoods and the same satisfaction levels.

(3) The apprehensive retailer takes into account two extreme demands (the highest and the lowest demand) and chooses the optimal order quantity which makes the satisfaction levels of the highest demand and the lowest demand equal.

(4) For the daring retailer, the highest demand is his/her optimal order quantity and he/she believes all ordered products can be sold.

(5) The optimal daring order quantity is always larger than any other type of optimal order quantity. If the normalized likelihood function is symmetric, the optimal active order quantity is larger than the optimal passive one; the optimal passive order quantity is larger than the optimal apprehensive one.

(6) Setting the satisfaction function as a linear function, the optimal active order quantity and its focus point are decreasing in the unit wholesale price, increasing in the unit revenue and the unit salvage price. The unit opportunity cost has no effect on them.

(7) The passive retailer offsets the loss caused by the increase of the unit opportunity cost by increasing the order quantity.

(8) The optimal apprehensive order quantity increases in the unit salvage price and the unit opportunity cost, decreases in the unit revenue. The unit wholesale price has no effect on it.

(9) The increase of the uncertainty of the demand can make an active retailer order more and make a passive retailer order less but does not have any effect on the apprehensive and daring retailers.

The above results provide managerial insights into the behaviors of different types of retailers.

3: Price-setting newsvendor models for innovative products

In the classical newsvendor model, the retail price is considered as an exogenous value. It is only for a perfect competitive market where the retailers are price-takers. This part deals with the retailer who sells an innovative product in a monopoly market. In this case, facing the uncertain demand, the retailer has only one chance to determine not only the order quantity but also the retail price to maximize his/her profit. There are many papers related to price-setting newsvendor models (see the review by Petruzzi and Dada, 1999). Until now, almost all price-setting newsvendor models are built to maximize the subjective expected utilities or the probability measures of achieving target profits. In this part, the price-setting newsvendor problem for the innovative product is considered.

As introduced in part 2, this dissertation highlights that for a retailer who sells an innovative product, how to determine the optimal order quantity can be regarded as a one-shot decision problem, which is typical for a situation where a decision is made only once under uncertainty. This part analyzes the

price-setting newsvendor models with the OSDT which fit the one-time feature of the retailer's joint price/quantity decision. Same as part 2, four types of retailers are taken into account. Suppose the four types of retailers have concave profit functions, there are following conclusions:

(1) For any retail price larger than unit wholesale price, the daring retailer will imagine the higher profit than the active retailer; the active retailer will imagine the higher one than the passive retailer; the passive retailer will imagine the higher one than the apprehensive retailer.

(2) The optimal daring retail price is higher than the optimal active one; the optimal active retail price is higher than the optimal passive one; the optimal passive retail price is higher than the optimal apprehensive one.

(3) With the increase of the price sensitivity of the market demand, every type of the retailer charges a lower retail price.

The above results provide managerial insights into the behaviors of different types of retailers in the monopoly market of the innovative product.

4: Wholesale price contracts in the supply chain for innovative products

As a fundamental research of the supply chain management, a single manufacturer selling (innovative) products to a retailer who faces a newsvendor problem has been extensively researched. Until now, most of the models have been developed within the expected utility framework which is not characterize the one-time feature of innovative products and most of the models are actually considered the make-to-order supply chain. In the past decades, the value of information sharing in the supply chain has attracted much

attention from both practitioners and researchers. But most of the works are focusing on the value of demand information sharing. Until now, the information sharing of participants' personalities in the supply chain is still on 'virgin territory'.

This part deals with the one-time feature of innovative products as follows: after observing the wholesale price, the retailer evaluating his/her order quantity only based on the selected demand (focus points). The optimal order quantity corresponds to the maximum satisfaction level of its focus point. In the proposed model, the retailer's personality information are considered. The optimal wholesale price contracts for the manufacturer when he/she is facing different personalities of retailers are obtained both in the make-to-order and make-to-stock supply chains. In the make-to-stock supply chains, the manufacturers' different production quantities result from the different strategies of the manufacturers. There are following conclusions for the make-to-order supply chain:

(1) The imagined profits of the supply chain when the manufacturer is facing the daring retailer is larger than facing the active retailer; facing the active retailer is larger than facing the passive retailer; facing the passive retailer is larger than facing the apprehensive retailer.

(2) When the manufacturer is facing the apprehensive or daring retailer, he/she always sets the wholesale price equal to retail price and obtains the whole profit in the supply chain.

(3) Suppose the market demand is a triangular distribution. When the manufacturer is facing the active retailer, his/her optimal wholesale price increases while the most possible demand increases.

The conclusions for the make-to-stock supply chain are as follows:

(1) When the manufacturer faces active retailer, the passive strategy can coordinate (production quantity

equals to order quantity) the supply chain.

(2) When the manufacturer is facing the passive retailer, no strategy can surely coordinate the supply chain.

(3) When the manufacturer is facing the apprehensive/daring retailer, the apprehensive/daring strategy can coordinate the supply chain.

The above results provide managerial insights into the behaviors of the participants in the make-to-order and make-to-stock supply chains of the innovative product.

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