Yokohama Publishers
ISSN 1349-8169 ONLINE JOURNAL

Pacific Journal of Optimization
Vol. 18, No. 4, pp. 755–764, 2022

BEHAVIORAL MODELS FOR CHANNEL COORDINATION IN THE SUPPLY CHAIN WITH ONE-SHOT DECISION THEORY*

Xiuyan Ma, Lili Xie, Ruyu Cheng, Yang Miao and Jiawei Gao†

Abstract: This paper deals with the channel coordination in the supply chain with one-shot decision theory (OSDT). The behavioral patterns of decision makers in the supply chain are discribed by OSDT (scenario-based) rather than the expected utility theory. With the one-shot decision theory, the newsvendor model can be formulated as a bilevel programming problem. The general analytical method is provided for this problem. Stackelberg equilibriums are obtained for the optimal contract policies of the manufacturer and the optimal order quantity of the retailer with the wholesale price and buyback contracts. The channel coordination is analyzed for these two types of contracts. The proposed models are scenario-based decision models which provide a fundamental alternative to analyze issues of channel coordination.

Key words: *channel coordination, Stackelberg equilibriums, newsvendor models, one-shot decision theory*

Mathematics Subject Classification: *90B06, 90B50, 91B06*

---

1 Introduction

The channel coordination in the supply chain is the fundament of supply chain contract models, which has been extensively researched in the supply chain management [2, 4]. The supply chain model usually with a single manufacturer selling a product to a retailer who faces a newsvendor problem. It is well known that the newsvendor problem has the following characteristics. Prior to the season, the retailer must decide the quantity of the goods to purchase and the demand for the product is uncertain. The procurement lead-time tends to be quite long relative to the selling season so that often there is 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 [6, 11].

Most of models for the channel coordination in supply chain management have been developed within the expected utility framework with the assumption that the decision makers in the supply chain valuate their decisions by the weighted average of all possible outcomes, see, e.g., [7, 12, 19]. However, a growing body of researches point out limitations of expected utility framework in the supply chain management [10, 18, 20, 21].

The newsvendor problem for the products with short life cycles is a typical one-shot decision problem, there is one and only one chance for only one state of demand (scenario)

*This work was supported in part by MOE (Ministry of Education in China) Youth Foundation Project of Humanities and Social Sciences (No. 22YJC630102) and Humanities and Social Sciences Project of Zhejiang University of Technology (No. SKY-ZX-20210195 and No. SKY-ZX-20210161).

†Corresponding author.

occurring. The OSDT is proposed for dealing with such one-shot decision problems [8]. The one-shot decision process is separated into two steps. The first step is to identify which state of nature (scenario) should be taken into account for each alternative with considering the relative likelihood degree of a state of nature (scenario) and satisfaction level of an outcome. The focused states of nature (scenario) are called focus points. Different kinds of focus points lead to different results which reflect a decision maker's attitude about relative likelihood degree and satisfaction level. The second step is to evaluate the alternatives to obtain the optimal alternative. Guo and Ma [9] and Ma [14] investigated the newsvendor problem within the OSDT framework. However, they made a relatively strong asumption for the relationships of parameters in the newsvendor model. In this paper, we firstly propose a more general newsvendor model with the OSDT and find more interesting results. Following a a series of mathematical generalization of OSDT [23, 24, 25], the newsvendor model with OSDT can be formulated as a bilevel programming problem.

Existing literature on channel coordination often defines the coordination as the consistency of the order (production) quantities [2, 22]. However, increasing evidence indicates that supply chain participants' behavioral patterns have a great impact on the supply chain coordination [1, 3, 5, 13]. Therefore, in this paper we propose the supply chain models with OSDT, and investagate the channel coordinations of wholesale price and buyback contracts.

Then we extend the standard newsvendor problem to a channel coordination problem in the decentralized supply chain system, which is a bilevel programming problem for Stackelberg game [16, 17]. We model a distribution channel where a manufacturer M sells a kind of products through a retailer R. First, we consider a system with wholesale price contact. With conjecturing the retailer's order quantity, the manufacturer charges a wholesale price of the product. After observing the wholesale price, the retailer who is facing uncertain demand needs to decide his/her order quantity. The Stackelberg equilibriums are proposed to analyze the optimal wholesale price of the manufacturer and the optimal order quantity of the retailer. After that, the channel coordinations for wholesale price and buyback contracts in this behavioral supply chain system are analyzed.

The rest of this paper is organized as follows. The next section introduces the benchmark model: the newsvendor model based on the OSDT. In Section 3, the channel coordinations of the wholesale price and buyback contracts are analyzed with the OSDT in the decentralized supply chain system. The summary of concluding remarks and research directions in the future are provided in Section 4.

2 Benchmark Model (Centralized Models)

2.1 The Newsvendor Model with the OSDT

We firstly set the centralized model for the channel as the benchmark. In the centralized channel, the manufacturer and the retailer are assumed to be an allied company (dominated by the manufacturer), in other words, the allied company produces and sells the product directly to the market. The market demand is characterized as a random variable X with the probability mass/density function $f(x)$. The allied company faces the newsvendor problem: he/she must choose a production quantity before the start of a single selling season that has uncertain market demand. The unit production cost is assumed to be c, the retail price is p, the production quantity is $q_o \in Q_o$, where Q_o is the set of possible production quantities. For each demand the market does not satisfy the allied company incurs a goodwill penalty cost g. The salvage value of the unsold product is zero. In the centralized model, the profit function of the allied company is

$$v(x, q_o) := \begin{cases} px - cq_o & \text{if } x < q_o, \\ (p-c)q_o - g(x - q_o) & \text{if } x \geq q_o. \end{cases} \tag{2.1}$$

We have the following definitions.

Definition 2.1 (Relative likelihood function)**.** Given the probability mass/density function $f(x)$,

$$\pi(x) = \frac{f(x)}{\max f(x)}, \tag{2.2}$$

is called the relative likelihood function.

$\pi(x)$ can be regarded as the normalized probability mass/density function, which is used to represent the relative position of the probability of x. For any x, $\pi(x)$ is called the relative likelihood degree of x. Clearly, the smaller the probability the smaller the relative likelihood degree.

Definition 2.2 (Satisfaction function)**.** Let V be the range of v, the function $u : V \to [0, 1]$ is called the satisfaction function if it satisfies that for all $v_1, v_2 \in V$, $u(v_1) > u(v_2) \Leftrightarrow v_1 > v_2$, and there exists v_c in the closed convex hull of V such that $u(v_c) = \sup_{v \in V} u(v) = 1$.

$u(x, q_o)$ is called the satisfaction level of q_o for x. It follows from Definition 2.2 that increasing the value of $v(x, q_o)$ will increase the satisfaction level.

Since one and only one state of nature (demand) will come up for a one-shot decision problem (newsvendor problem), the decision maker (allied company) needs to decide which state of nature (demand) ought to be considered for making a one-shot decision (production quantity). Each state of nature is equipped with a pair of relative likelihood degree and satisfaction level so that how to determine focus points (focused states of natures) depends on his/her attitudes about relative likelihood and satisfaction. Twelve types of focus points are proposed to help a decision maker in finding out his/her own appropriate one [8].

We consider one of the most representative types in this paper, which is shown as follows:

$$x^*(q_o) = \arg\max_{x} \min \left\{ \pi(x), u(x, q_o) \right\}. \tag{2.3}$$

For a production quantity q_o, there may be multiple positive foci, the set of $x^*(q_o)$ is denoted as $X^*(q_o)$. Since $\forall x_1, x_2$, if $\pi(x_1) \geq \pi(x_2)$ and $u(x_1, q_o) \geq u(x_2, q_o)$ then $\min\left\{\pi(x_1), u(x_1, q_o)\right\} \geq \min\left\{\pi(x_2), u(x_2, q_o)\right\}$, we know that equation (2.3) is used to seek the realization of the random variable of demand X which has a relatively high relative likelihood degree and a relatively high satisfaction level for any feasible decision $q_o \in Q_o$. The selected state of nature (demand) $x^*(q_o)$ is called an active focus point of an alternative (order quantity) q_o.

In the centralized model, the allied company regards the active focus point as his/her most appropriate demand and chooses one order quantity which can bring about the best consequences (highest satisfaction level) once the active focus point comes true. The optimal production quantity is

$$q_o^* = \arg \max_{q_o \in Q_o} \min_{x \in X^*(q_o)} u(x, q_o), \tag{2.4}$$

q_o^* is called the optimal active production quantity.

2.2 Analysis Results of the Newsvendor Models

In order to perform the analysis conveniently, we suppose the probability function $f(x)$ is continuous, and let us consider the solutions with the following assumptions of the demand probability distribution. From now on, the analysis in this paper is following these assumptions.

Basic Assumption. In the following parts, we suppose:
(1) The demand lies on the interval $S = [l, h]$, that is $\forall x \in [l, h]$, $f(x) > 0$;
(2) $f(x)$ is a strictly quasi-concave continuous function (see the definition in [15]), $\exists c_o \in (l, h)$, $f(c_o) = \max_{x\in[l,h]} f(x)$.

Clearly, $\pi(x)$ is strictly increasing in $[l, c_o]$ and strictly decreasing in $[c_o, h]$. Note that we generalize our assumptions as far as possible, several of the commonly applied demand distributions, including normal distribution, binomial distribution, gamma distribution and Poisson distribution, are all satisfied this basic assumption. We have the following lemmas for the properties of active focus points.

Lemma 2.3. *For any $q_o \in Q_o$, there is a unique solution of equation (2.3), it is as follows:*

(1) *if $u(q_o, q_o) \le \pi(q_o)$, then $x^*(q_o) = q_o$,*

(2) *if $u(c_o, q_o) \ge \pi(c_o)$, then $x^*(q_o) = c_o$,*

(3) *if $u(c_o, q_o) < \pi(c_o)$, $u(q_o, q_o) > \pi(q_o)$ and $q_o \le c_o$, then $x^*(q_o) = x_{ol}(q_o)$,*

(4) *if $u(c_o, q_o) < \pi(c_o)$, $u(q_o, q_o) > \pi(q_o)$ and $q_o > c_o$, then $x^*(q_o) = x_{ou}(q_o)$,*

where $x_{ol}(q_o)$ and $x_{ou}(q_o)$ are the solutions of the equation $u(x, q_o) = \pi(x)$ within $[q_o, c_o]$ and $[c_o, q_o]$, respectively.

Proof. According to the profit function (2.1), we know $u(q_o, q_o) > u(c_o, q_o)$, from the Basic Assumption (2), we know $0 < \pi(q_o) < \pi(c_o)$, therefore we have $\frac{u(q_o,q_o)}{\pi(q_o)} > \frac{u(c_o,q_o)}{\pi(c_o)}$.

(1) We have

$$\max_{x\in[l,h]} \min\{\pi(x), u(x, q_o)\} \le \max_{x\in[l,h]} u(x, q_o) = u(q_o, q_o). \tag{2.5}$$

$\min\{\pi(x), u(x, q_o)\}$ attains its maximum $u(q_o, q_o)$ if and only if $x = q_o$. It means $x^*(q_o) = q_o$.

(2) We have

$$\max_{x\in[l,h]} \min\{\pi(x), u(x, q_o)\} \le \max_{x\in[l,h]} \pi(x) = \pi(c_o). \tag{2.6}$$

$\min\{\pi(x), u(x, q_o)\}$ attains its maximum $\pi(c_o)$ if and only if $x = c_o$. It means $x^*(q_o) = c_o$.

(3) First, let us considering the cases satisfying $(q_o) \ne c_o$. Since $u(q_o, q_o) > \pi(q_o)$, $u(c_o, q_o) < \pi(c_o)$, $u(x, q_o)$ is strictly decreasing and $\pi(x)$ is strictly increasing within $[q_o, c_o]$, $u(x, q_o)$ and $\pi(x)$ have a unique intersection within $[q_o, c_o)$. The horizontal coordinate of this intersection is denoted as $x_{ol}(q_o)$. $\forall x \in [l, x_{ol}(q_o))$, $\pi(x)$ is strictly increasing so that

$$\min\{\pi(x), u(x, q_o)\} \le \pi(x) < \pi(x_{ol}(q_o)). \tag{2.7}$$

$\forall x \in (x_{ol}(q_o), h]$, $u(x, q_o)$ is a strictly decreasing function of x, so that

$$\min\{\pi(x), u(x, q_o)\} \le u(x, q_o) < u(x_{ol}(q_o), q_o). \tag{2.8}$$

Recalling $\pi(x_{ol}(q_o)) = u(x_{ol}(q_o), q_o)$, we have $x^*(q_o) = x_{ol}(q_o)$.

(4) Similarly, we have $x^*(q_o) = x_{ou}(q_o)$. $x_{ou}(q_o)$ is the horizontal coordinates of the unique intersections of $u(x, q_o)$ and $\pi(x)$ within $[c_o, q_o]$. □

Lemma 2.3 shows that for any production quantity q_o, the allied company always focus on one unique demand.

Lemma 2.4. *The following equation holds.*

$$\max_{q_o \in Q_o} \max_{x \in S} \ \min \big\{ \pi(x), u(x, q_o) \big\} = \max_{x \in S} \ \min \big\{ \pi(x), u(x, x) \big\}. \tag{2.9}$$

Proof. Set $h(x, q_o) = \min \big\{ \pi(x), u(x, q_o) \big\}$. Considering the following two equations

$$\max_{q_o \in Q_o} \max_{x \in S} h(x, q_o) = \max_{x \in S} \max_{q_o \in Q_o} h(x, q_o), \tag{2.10}$$

$$\max_{x \in S} \max_{q_o \in Q_o} \min \big\{ \pi(x), u(x, q_o) \big\} = \max_{x \in S} \min \big\{ \pi(x), \max_{q_o \in Q_o} u(x, q_o) \big\}, \tag{2.11}$$

we have the following equation

$$\max_{q_o \in Q_o} \max_{x \in S} \ \min \big\{ \pi(x), u(x, q_o) \big\} = \max_{x \in S} \min \big\{ \pi(x), \max_{q_o \in Q_o} u(x, q_o) \big\}. \tag{2.12}$$

With considering the profit function (2.1), we get equation (2.9). □

Based on Lemma 2.3 and Lemma 2.4, we provide the following theorems.

Theorem 2.5. *The optimal active production quantity q_o^* and its corresponding active focus $x^*(q_o^*)$ are as follows:*

(1) *if $u(c_o, q_o) \geq \pi(c_o)$, then $q_o^* = c_o$ and $x^*(q_o^*) = c_o$;*

(2) *if $u(q_o, q_o) \leq \pi(q_o)$, then $q_o^* = h$ and $x^*(q_o^*) = h$;*

(3) *if $u(c_o, c_o) < \pi(c_o)$ and $u(h, h) > \pi(h)$, then q_o^* is the solution of $u(x, x) = \pi(x)$, its corresponding active focus point $x^*(q_o^*) = q_o^*$.*

Proof. According to the profit function (2.1), we know $u(h, h) > u(c_o, c_o)$, from the Basic Assumption (2), we know $0 < \pi(h) < \pi(c_o)$, therefore we have $\frac{u(h,h)}{\pi(h)} > \frac{u(c_o,c_o)}{\pi(c_o)}$.

(1) Since $u(c_o, c_o) \geq \pi(c_o)$, according to equation (2.9), $u(x^*(q_o), q_o)$ attains its maximum $u(c_o, c_o)$ if and only if $q_o^* = c_o$.

(2) Since $u(h, h) \leq \pi(h)$, according to equation (2.9), $u(x^*(q_o), q_o)$ attains its maximum $u(h, h)$ if and only if $q_o^* = h$.

(3) Since $u(c_o, c_o) < \pi(c_o)$ and $u(h, h) > \pi(h)$ and $u(x, x)$ is strictly increasing continuous and $\pi(x)$ is strictly decreasing continuous within $[c_o, h]$, $u(x, x)$ and $\pi(x)$ have a unique intersection within (c_o, h). Denote the horizontal coordinate of the intersection as x_o. Since $u(x, x)$ is strictly increasing within $[l, h]$, $\forall x \in [l, x_o)$, we have

$$\min \big\{ \pi(x), u(x, x) \big\} \leq u(x, x) < u(x_o, x_o). \tag{2.13}$$

Meanwhile, $\forall x \in (x_o, h]$, we know

$$\min \big\{ \pi(x), u(x, x) \big\} \leq \pi(x) < \pi(x_o). \tag{2.14}$$

Therefore, according to equation (2.9), (2.13) and (2.14), the theorem is proved. □

Theorem 2.5 shows that in the centralized channel, there exists a unique optimal production quantity and a unique corresponding active focus point. The active focus point of optimal active production quantity q_o^* are alway equal to optimal active production quantity q_o^* itself. In other words, for the decison maker of active type, he/she chooses the production quantity because he/she believes that quantity of demand will occur.

Note that since the demand and profit functions in the decentralized case are sharing similar formula with centralized channel, Lemma 2.3, 2.4 and Theorem 2.5 also works on the decentralized channel. Different from Guo and Ma [9] in which the assumption $\pi(l) = \pi(h) = 0$ and $u(h,l) > u(l,h)$ is made, this paper relax this assumption.

3 The Wholesale-Price and Buyback Contracts in the Supply Chain System

3.1 Stackelberg Game with the Wholesale-Price Contract

In this section, let us consider the wholesale-price contract in the decentralized channel. The manufacturer acts as a Stackelberg leader, offering the unit wholesale price $W \in (c,p)$ to the retailer who faces the newsvendor's problem: he/she must choose an order quantity $q \in Q$, where Q is the set of possible order quantities before the start of a selling season. With conjecturing the retailer's order quantity, the manufacturer charges an optimal wholesale price, which maximize his/her own profit. After observing W, the retailer, who is the Stackelberg follower, places an optimal order quantity. Similar as (2.1), the retailer's profit function is

$$v_R(x,q) = \begin{cases} px - Wq & \text{if } x < q, \\ (p-W)q - g_R(x-q) & \text{if } x \geq q, \end{cases} \tag{3.1}$$

and the profit function of the manufacturer is

$$v_M(x,q) = \begin{cases} (W-c)q & \text{if } x < q, \\ (W-c)q - g_M(x-q) & \text{if } x \geq q, \end{cases} \tag{3.2}$$

where g_R and g_M are the goodwill penalty costs of the retailer and the manufacturer, respectively. In the decentralized model, the goodwill penalty cost is borne by the manufacturer and the retailer, therefore $g = g_R + g_M$.

Followed from (2.3) and (2.4), for the retailer, the active focus of the order quantity q is

$$x_R^*(q) = \arg\max_x \min \big\{\pi(x), u_R(x,q)\big\}, \tag{3.3}$$

and the optimal active order quantity of the retailer, q^* is

$$q^* = \arg\max_{q \in Q} \min_{x \in X_R^*(q)} u_R(x,q)\,, \tag{3.4}$$

where $u_R(x,q)$ is the satisfaction level of the retailer for his/her profit $v_R(x,q)$, $X_R^*(q)$ is the possible set of the active focus points $x_R^*(q)$.

Similarly, for the manufacturer we obtain the active focus of the retailer's optimal order quantity q^*

$$x_M^*(q^*) = \arg\max_x \min \big\{\pi(x), u_M(x,q^*)\big\}, \tag{3.5}$$

where $u_M(x,q^*)$ is the satisfaction level of the manufacturer for his/her profit $v_M(x,q^*)$.

3.2 Analysis Results of the Wholesale-Price Contract Model

Based on Lemma 2.3, 2.4 and Theorem 2.5, we provide the following theorem.

Theorem 3.1. *The channel coordination holds for the wholesale-price contract* $W = \frac{p+c}{2}$*.*

Proof. When $W = \frac{p+c}{2}$, according to Definition 2.2 and equation (3.1), (3.2), we have $u_R(x,x) = u_M(x,x) = \frac{(p-c)x}{2h}$, with considering Theorem 2.5, we know the coordination holds. □

From the above analysis of the behavioral model of wholesale-price contract, we find that in the supply chain models of OSDT, the wholesale price contract has the chance to coordinate the supply chain: when wholesale price equals to the average value of retail price and production cost, the supply chain is coordinated. The manufacturer and the retailer divide the profit of the whole supply chain system equally. This result is different with the traditional model in which the wholesale price contact can never coodinate the supply chain. However, our result is common in the business practice (e.g., see [2]). One possible reason is that the tradinational model didn't consider the focus/salience (attention-grabbing information) in the decision making process.

3.3 The Buyback Contract in the Behavioral Supply Chain Model

Buyback contracts are also called returns policies, with a buyback contract the manufacturer charges the retailer W per unit purchased, but pays the retailer b per unit remaining at the end of the season. A retailer should not profit from leftover inventory, so assume $b < W$. With a buyback contract, the retailer's profit is

$$v_R(x,q) = \begin{cases} (p-b)x - (W-b)q & \text{if } x < q, \\ (p-W)q - g_R(x-q) & \text{if } x \geq q, \end{cases} \tag{3.6}$$

and the manufacturer's profit is

$$v_M(x,q) = \begin{cases} (W-c-b)q + bx & \text{if } x < q, \\ (W-c)q - g_M(x-q) & \text{if } x \geq q. \end{cases} \tag{3.7}$$

Following the similar analysis process in Sction 3.2, we find the conclusion of buyback contract is similar with the wholesale-price contract. The channel coordination holds for the buyback contract only if the wholesale-price $W = \frac{p+c}{2}$.

3.4 Further Analysis Results for Two Types of Contracts

Through the analysis of wholesale-price contract and buyback contract models, easily we obtain the following propositions for the behavioral supply chain with active participants.

Proposition 3.2. *For the behavioral supply chain with wholesale-price contract, the optimal wholesale price* W^* *is only related with the retail price* p *and the production cost* c*.* W^* *is increasing with* p *and* c*.*

In other words, for the active participants in the supply chain, they believe that the quantity they will sell is exactly what they produced/ordered. Therefore they only care about the retail price and the production cost.

Proposition 3.3. *For the behavioral supply chain with buyback contract, neither the manufacturer nor the retailer cares about the returns policy b. The optimal wholesale price W^* is only related with the retail price p and the production cost c. W^* is increasing with p and c.*

The reason is that the manufacturer and the retailer are both of active types, they choose the production/order quantity because they believe that quantity of demand will occur and ignore the returns policy.

4 Conclusion

With the one-shot decision theory, this paper examines the channel coordination in a supply chain with a manufacturer and a retailer, both of them are of active type. A generalized newsvendor model is proposed and analyzed for centralized problem. For the decentralized problem, the models of wholesale price and buyback contracts are proposed and the channel coordinations are analyzed.

First, this research generalizes the OSDT based newsvendor model. Different from Guo and Ma [9] in which the probability density function and profit function follow a relatively strong asumption, in this paper, we firstly propose a more general newsvendor model with the OSDT and find similar analytical results with Guo and Ma [9].

Second, this research contributes to modelling wholesale price and buyback contracts with the OSDT, and discussing the channel coordinations in the supply chain. We find that the wholesale price contract with the OSDT has the chance to coordinate the supply chain: when wholesale price equals to the average value of retail price and production cost, the supply chain is coordinated. The manufacturer and the retailer divide the profit of the whole supply chain system equally. This result is different with the traditional model and one possible reason is that the tradinational model didn't consider the focus/salience (attention-grabbing information) in the decision making process. Another interesting finding for the buyback contract is that when the manufacturer and the retailer are both of active types, they choose the production/order quantity because they believe that quantity of demand will occur and ignore the returns policy.

This research enriches the literature of newsvendor models and channel coordination in the supply chain. There are several avenues for future research. First, we assume that the retailer and manufacturer are of active type, further research should consider other interesting types of focus points. Second, other forms of contract can be analyzed in the further. Third, our model shows different analysis results with the traditional model, some experimental results could be explained in the future research.

References

[1] M. Barratt, Understanding the meaning of collaboration in the supply chain, *Supply Chain Manag.* 9 (2004) 30–42.

[2] G.P. Cachon, Supply chain coordination with contracts, in *Handbooks in Operations Research and Management Science: Supply Chain Management, vol. 11*, S.C. Graves and A.G. de Kok, (eds), Elsevier, 2003, pp. 229–339.

[3] G.P. Cachon and M.A. Lariviere, Supply chain coordination with revenue-sharing contracts: Strengths and limitations, *Manage. Sci.* 51 (2005) 30–44.

[4] J. Chen, Returns with wholesale-price-discount contract in a newsvendor problem, *Int. J. Prod. Econ.* 130 (2011) 104–111.

[5] C. Fang, X. Ma, J. Zhang and X. Zhu, Personality information sharing in supply chain systems for innovative products in the circular economy era, *Int. J. Prod. Res.* 59 (2021) 5992–6001.

[6] M.L. Fisher, What is the right supply chain for your product, *Harvard Bus. Rev.* (1997) (Mar.–Apr.) 105–116.

[7] Y. Gerchak and Y. Wang, Revenue-sharing vs. wholesale-price contracts in assembly systems with random demand, *Prod. Oper. Manag.* 13 (2004) 23–33.

[8] P. Guo, One-shot decision theory, *IEEE Trans. Syst. Man Cybern. Paart A-Syst. Hum.* 41 (2011) 917–926.

[9] P. Guo and X. Ma, Newsvendor models for innovative products with one-shot decision theory, *Eur. J. Oper. Res.* 439 (2014) 523–536.

[10] J. Huber, S. Msller, M. Fleischmann and H. Stuckenschmidt, A data-driven newsvendor problem: From data to decision, *Eur. J. Oper. Res.* 278 (2019) 904–915.

[11] M. Khouja, The single-period (news-vendor) problem: Literature review and suggestion for future research, *Omega-Int. J. Manage. Sci.* 27 (1999) 537–553.

[12] M.A. Lariviere and E.L. Porteus, Selling to the newsvendor: An analysis of price-only contracts, *M&SOM-Manuf. Serv. Op.* 3 (2001) 293–305.

[13] C. H. Loch and Y. Wu, Social preferences and supply chain performance: An experimental study, *Manage. Sci.* 54(11) (2008) 1835–1849.

[14] X. Ma, Pricing to the scenario: price-setting newsvendor models for innovative products, *Mathematics* 7 (2019): 814.

[15] P. Madden, *Concavity and Optimization in Microeconomics*, Oxford, Blackwell, 1986.

[16] S.K. Maiti and S.K. Roy, Bi-level programming for Stackelberg game with intuitionistic fuzzy number: A ranking approach, *J. Oper. Res. Soc. China* 9 (2021) 131–149.

[17] B.A. Pasternack, Optimal pricing and return policies for perishable commodities, *Mark. Sci.* 4 (1985) 166–176.

[18] K. Ryu and E. Yscesan, A fuzzy newsvendor approach to supply chain coordination, *Eur. J. Oper. Res.* 200 (2010) 421–438.

[19] S.P. Sarmah, D. Acharya and S.K. Goyal, Buyer vendor coordination models in supply chain management, *Eur. J. Oper. Res.* 175 (2006) 1–15.

[20] M. E. Schweitzer and G. P. Cachon, Decision bias in the newsvendor problem with a known demand distribution: Experimental evidence, *Manage. Sci.* 46(3) (2000) 404–420.

[21] Y. Shen, X. Zhao and J. Xie, Revisiting prospect theory and the newsvendor problem, *Oper. Res. Lett.* 45 (2017) 647–651.

[22] O.Q. Wu and H. Chen, Chain-to-chain competition under demand uncertainty, *J. Oper. Res. Soc. China* 4 (2016) 49–75.

[23] X. Zhu and P. Guo, Approaches to four types of bilevel programming problems with nonconvex nonsmooth lower level programs and their applications to newsvendor problems, *Math. Method. Oper. Res.* 86 (2017) 255–275.

[24] X. Zhu and P. Guo, Bilevel programming approaches to production planning for multiple products with short life cycles, *4OR-Q. J. Oper. Res.* 18 (2020) 151–175.

[25] X. Zhu and P. Guo, Single-level reformulations of a specific non-smooth bilevel programming problem and their applications, *Optim. Lett.* 14 (2020) 1393–1406.

Manuscript received 29 September 2021
revised 10 February 2022
accepted for publication 31 March 2022

Xiuyan Ma
School of Management
Zhejiang University of Technology
Hangzhou 310023, China
E-mail address: max@zjut.edu.cn

Lili Xie
School of Management
Zhejiang University of Technology
Hangzhou 310023, China
E-mail address: xielili0417@163.com

Ruyu Cheng
School of Management
Zhejiang University of Technology
Hangzhou 310023, China
E-mail address: rg25788cheng@163.com

Yang Miao
School of Management and School of Public Administration
Zhejiang University of Technology
Hangzhou 310023, China
E-mail address: miao@zjut.edu.cn

Jiawei Gao
Business School
Hitotsubashi University, Tokyo 1860004, Japan
E-mail address: gaojiaweijp@hotmail.com