Pre-Sale Strategy for Fresh Agricultural Products Under the Consideration of Logistics Services

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This work was supported in part by the National Natural Science Foundation of China under Grant 72001059, in part by the 2017 In-Station Postdoctoral Research Support Program under Grant BSH022, and in part by @A-[2019] No. 24 Intellectual Property Project of Supplementary Service Industry in Zhejiang Province under Grant ZSCQ202009.

\section*{ABSTRACT}
\textbf{Purpose} – There is particularly high loss rate for fresh agricultural products (FAP) in the operation of actual supply chain and the development of FAP e-commerce is hindered to some extent. The purpose of this paper is to solve the customer to business (C2B) pre-sale problems of FAP supply chain, in which a third-party logistics service provider (TPLSP) participates in decision-making, to increase the income of each member and to ensure that consumers can obtain the freshest FAP.

\textbf{Design/methodology/approach} – This paper considers the C2B pre-sale strategies as a three-echelon fresh FAP supply chain, where the supplier pre-sell products through the online retailers. The market demand in the online channel depends on the retailer’s service level, the pre-sale discount rate and the logistics service efforts of TPLSP.

\textbf{Findings} – Stackelberg game method is adopted to study the equilibrium strategies of a supplier-led FAP supply chain under centralized and decentralized decision-making with the existence of a TPLSP, and the optimal pre-sale discount rate, the optimal online service level and the optimal logistics service price provided by TPLSP in the two decision modes are obtained, as well as the optimal profits of the supply chain and each member.

\textbf{Practical implications} – The paper provides a practical guideline to managers in fresh products industry in terms of how to cooperate with other supply chain members so as to maximize total profit and to achieve Pareto improvement, and at the meantime, to supply the freshest and safest products to the target market under e-commerce environment.

\textbf{Originality/value} – For the e-commerce supply chains with TPLSP participates in decision-making, there are few studies which considers the FAP pre-sale, especially consider the case that the market demand for FAP is affected by freshness and online selling price per unit simultaneously. This paper takes these cases into account, establishes the corresponding mathematical model, and designs a coordination mechanisms.

\section*{INDEX TERMS}
TPLSP, Nash bargaining strategy, C2B pre-sale, freshness, online service level.

\section*{I. INTRODUCTION}
Owing to the seasonality, corrosion and perishability of fresh agricultural products (FAP), it is quite difficult to improve their economic benefits through traditional marketing vehicles. Fortunately, the development of Internet and e-commerce has provided opportunities for the online trade of FAP and promoted the sale significantly. In 2019, the gross sales of FAP on e-commerce platform in China exceeded 49.846 billion U.S, up 65.38% on a year-on-year basis [1]. In order to obtain the market demand information ahead of time in e-commerce, Chinese agricultural enterprises have come up with many new selling patterns, such as community group purchase, agricultural public financing and C2B pre-sale. In a C2B pre-sale pattern, the online retailers will publish the pre-sale information on the electronic business platform before the fresh products are fully grown, allowing the customers to place orders online. And then the suppliers will pick or catch FAP according to the orders and make on-time delivery. In recent years, many large e-commerce platforms have set up special channels for the sale of FAP, such as Jingdong fresh, Taobao MIAO fresh food, etc. According to the trade data...
of Tmall, 4 million oranges, 3 million 500 thousand steaks and 1 million 500 thousand sea cucumbers were pre-sold online in the first hour in the eleventh of November in 2019 double eleven day. C2B pre-sale help agricultural product suppliers acknowledge the consumer demand in advance, enabling them to match the output level exactly matching the sale amount.

Unlike ordinary products, high quality logistic conditions are required during the transportation of FAP, including cold chain system and specified fresh-keeping technologies, which are quite costly for most of companies. Therefore, the FAP logistics services are usually outsourced to a third-party logistics service provider (TPLSP) who owns the specialized equipment and technologies. As the service level of TPLSP influences the quality of FAP and consequently the profits of the supply chain members, the supplier and online retailers have to consider the behaviors of the TPLSP when deciding their operational strategies. This paper discusses the C2B pre-sale decisions of FAP supply chains with the participation of TPLSP, and provide some suggestions on how to reduce supply chain stages and achieve zero inventory. We aim to work out the optimal strategies of supply chain members, which may not only increase their own profits but also ensure the consumers to get the freshest products from their original area, and to a certain extent, decrease the unsalable FAP caused by asymmetric information.

The rest of the paper is organized as follows. Section 2 reviews the relevant literature. Section 3 introduces the research settings and presents the model description as well as the basic assumptions. In Section 4 and Section 5, we study the equilibrium C2B presale strategies considering the TPLSP’s behaviors in the supplier-led centralized and decentralized supply chains, respectively. Based on the optimal discount rate, network service level, price of TPL service providers and the corresponding profit of the supply chain members, a Nash bargaining strategy is proposed to coordinate the supply chain. Numerical examples are given in Section 6 to verify the reliability of the conclusions.

II. LITERATURE REVIEW

Studies on FAP supply chain with TPLSP mainly focused on the services the TPLSP provides. While early studies emphasize the transportation services of TPLSP only [2], [3], recent researches pay more attention to their value-added services. Wang [4] and Cai et al. [4] propose that TPLSP can enhance the value of FAP through making an effort to keep the product fresh. Using sequential non-cooperative game model, Feng [6] studies the value-add issue under the TPLSP-led supply chain and the supplier-led supply chain, respectively, and introduces a logistics cost sharing and a revenue sharing contract to distribute the extra value between the participants. Zhang et al. [7] argue that the freshness of FAP is related to both output time and transportation time, and establish a quadratic function to depict the freshness. Under the precondition that TPLSP can increase supply chain profit by controlling transportation time, they study the decision-making and coordination of the FAP supply chain consisting of a supplier, a TPLSP and a retailer. Song [8] considers a three-tier FAP supply chain, which is composed of a fresh product producer, a TPLSP and an online convenience store. A new game model is developed to work out the optimal decision of each member within the centralized and decentralized channels, and different contract coordination mechanisms are designed to improve supply chain performance.

Early researches on retailer’s pre-sale mainly focused on the impact of pre-sale strategies on the market demand with the first theoretic analysis conducted by Shugan and Xie [9]–[11]. Prasad et al. [12], Li and Zhang [13] and Yu et al. [14] study the advantages of pre-sale when the seller uses the pre-order information as a signal for current demand. Based on the stochastic demand assumption, Zhao et al. [15] prove that the enterprise would get more profit by updating demand prediction according to the pre-sale information, and obtain the optimal pre-sale discount rate. The following studies intend to show the effect of consumer behavior on the pre-sale. Considering the consumer’s risk averseness, Zhao [16] and Weng [17] derive the optimal pre-sale pricing and inventory strategies when the retailer does not offer pre-sale, offers moderate discount and offers generous discounts, respectively. Li et al. [18] provide the retailer’s optimal strategies when selling in advance and at spot with the existence of customers who overestimate the value of products in the pre-sale period. Tian [19] supposes the number of consumers in spot market depends on the number of consumers in pre-sale market and proves the existence of the only rational equilibrium solution. Zeng et al. [20] divide customers into two types basing on whether they are experienced or not, and conclude that retailer’s choice between pre-sale with discount, pre-sale with premium and pre-sale with normal price is related to customer type. Observing entrepreneurs always exaggerate the quality of the product in pre-sale crowdfunding, Cao [21] makes a deep analysis on this behavior and suggests the corresponding preventive measures. Lei Xiao et al. [22] study the seller’s equilibrium pricing strategy under two classical pre-sale pricing schemes. Based on the characteristics of strategic consumers, Li Hui et al. [23] compare the retailer’s profit under pre-sale with the case without pre-sale when the market size is uncertain. Ma et al. [24] pay attention to the case where the manufacturer is powerful enough to affect the price of raw material market and conclude that the manufacturer can perform different pre-sale strategies according to his market power and consumer’s risk averseness to increase market demand. Taking the retailer’s option on pre-sale into consideration, Zhao et al. [25] point out that pre-sale is not always beneficial to the retailers and the whole supply chain, and provide the retailer’s different strategic choices as the marginal production cost varies. Lim et al. [26] notice that pre-sale will generate speculation and discuss the implementation of the retailer’s pre-sale strategy based on the competition between the speculator and the retailer.

Different from the above-mentioned works which focus on pre-sale only, some scholars study the issue of pre-sale from
the perspective of its relationship with other commonly-used contracts, such as option and repurchase. Nasiry and Popescu [27] investigate how the seller chooses the appropriate pre-sale strategies considering the consumer’s regret behavior and analyze the return policy of the non-defective product under limited capacity. Mu et al. [28] combine pre-sale with optional purchase and prove the existence of a unique optimal pre-sale discount when the length of selling season is subject to the normal distribution. In addition, there are studies addressing the combination of pre-sale strategy with other strategies. Li et al. [29] study the pre-sale problem under the return policy and find the retailer should support return of goods with partial refund in the equilibrium solutions. Mao et al. [30] compare the single pre-sale strategy with the joint decision on pre-sale and repurchase, and find that pre-sale combined with repurchase strategy is a strategy to get better returns when the unit production cost is relatively high or the repurchase price is relatively low. Loginova [31] studies whether a retailer should implement pre-sale and whether she should provide price protection during presale. The research of Cheng et al. [32] shows that greater benefits will be achieved through the combination of pre-sale strategy and other marketing strategies. Wu et al. [33] for the first time, explore whether an entrepreneur should use advertisement to induce his customers’ early ordering behavior and come up to the conclusion that the pre-sale and advertisement strategies of the entrepreneur depends on the pre-sale discount. If the discount is lower than a certain threshold, the company should adopt pre-sale and use advertisement when the proportion of strategic consumers is large enough. If the pre-sale discount exceeds a certain threshold, then the company should not advertise and adopt pre-sale when the proportion of strategic consumers is small enough.

In recent years, C2B pre-sale of FAP has absorbed many attentions in academia. Shao et al. argue that C2B crowdfunding enables FAP to be transported from farms to the consumers directly, which is helpful to link the production and marketing, reduce logistics cost and ensure the quality and safety of FAP [34]. Dan et al. [35] put forward the “Internet +” pre-sale mode of FAP supply chain based on the consumption crowdfunding, and explain this mode from the following four aspects: value proposition, core resources, operation process and profit pattern. Under the new situation that consumers participate in consumption experience and pursue product quality and safety protection, Shao et al. [36] propose a joint-decision model and the corresponding mechanism of the vertical integrated FAP supply chain where crowdfunding pre-sale and crowdsourcing production are carried out through the electronic commerce platform. Chen Jun et al. [37] construct decision models of the manufacturer’s pre-sale and the retailer’s pre-purchase under complete pre-sale contract and partial pre-sale contract, with concerning the quality uncertainty of FAP during the production, and obtain the equilibrium results by solving the leader-and-follower game between the participants.

Based on the above literature, we find that there are few studies considering TPLSP service providers’ participation in decision-making in the pre-sale fresh agricultural supply chain literature. this paper studies the C2B pre-sale strategies of an online FAP retailer under the centralized and decentralized decision making process, analyzing the optimal behaviors of supply chain members when the market demand can be influenced by the effort of the TPLSP. The innovative points of this paper are as follows: 1. A TPLSP was introduced into the FAP supply chain by considering the impact of its logistics service level on the market demand. 2. The C2B pre-sale strategies of the centralized and decentralized supply chain with the supplier as the leader and the online retailer as the follower were obtained. 3. The optimal pre-sale discount rate, network service level and logistics service level under the two scenarios were compared, and a Nash bargaining strategy was designed to coordinate the supply chain to eliminate the “dual margin” effect of the decentralized supply chain.

III. MODEL DESCRIPTION AND BASIC ASSUMPTIONS

Considering a three-tier FAP supply chain consisting an FAP supplier (he), an online retailer (she) and a TPLSP who participates in the decision making, the model structure is shown in Figure 1.

The basic assumptions are as follows:

Assumption 1 The supplier and retailer are risk-neutral, and the information is symmetric between the supply chain members. The C2B pre-sale enables the supplier to prepare FAP with a relatively long time and determine the production quantity according to the online pre-sale. Consequently, the supply amount of the supplier is consistent with the demand of consumers.

Assumption 2 The freshness of FAP is denoted by $\theta$, which reflects the comprehensive quality characteristics of FAP, such as the surface glossiness, decay degree and water content. $\theta$ is one of the most important factors that affect consumer demand and is mainly determined by the service level of TPLSP. In logistics service literature, $\theta$ is always expressed as a linear or exponential function of the service level, for example, [38] assumes $\theta = \theta_0 e^{\theta_0 u}$ and [39] supposes $\theta = \theta_0 e^{\lambda u} \in [0, 1]$, where $u$ represents the logistics service level for the TPLSP service provider, $\theta_0 (0 < \theta_0 \leq 1)$ is the lowest level of freshness required by customers and $\lambda > 0$ measures the sensitivity of the freshness of FAP to logistics service level.

Assumption 3 The relationship between the cost of logistics service and the logistics service level can be described by the following equation [6]:

$$C(u) = \frac{1}{2} u \mu^2 \quad \mu > 0$$

The cost of logistics service here refers to the extra expenditures of the TPLSP in the cold chain technology to maintain the freshness of the FAP and in other measures to improve the timeliness and reliability of logistics services.
TABLE 1. Notations and their meanings.

| Symbol | Description |
|--------|-------------|
| \(c_m\) | The production cost of FAP supplier; |
| \(c_l\) | The cost of the basic logistics service for TPLSP. |
| \(p\) | The selling price of FAP per unit; |
| \(p_i\) | The price of logistics service. |
| \(\omega\) | The wholesale price of FAP. |

Assumption 4 The retail price of the FAP is denoted by \(p\) and is exogenous in our context. In order to encourage customers to buy in advance to reduce the risk caused by the uncertainty of demand, the online retailer will offer a discount to the customers. Consequently, the price of the pre-sale products is \((1 - \alpha)p\), where \(\alpha\) is the discount rate.

Assumption 5 Suppose the number of potential consumers during the pre-sale stage online is \(n\) and the service level of online retailers is \(s\), then, according to the research of Weng and Parlar [8], the basic demand of the C2B online pre-sale can be expressed as \(d(n, s) = na + bs\). Since FAP is a necessity for daily life, the market demand for it is relatively stable in general, which is mainly influenced by freshness and basic demand. It can be described by combining the two elements. Referring to [38] and [39], the demand function of FAP can be defined in additive form as \(D(n, s, \theta) = na + bs + \lambda \theta n\) or multiplicative form as \(D(n, s, \theta) = (na + bs)\theta e^{\lambda n}\), where \(\beta > 0\), and \(\lambda > 0\) represent the sensitivity of consumers demand to the level of network services and logistics service.

Assumption 6 The cost of online retailer’s network service, referring to the platform construction and maintenance cost expended to enable consumers to get accurate information in time for the sale of FAP, is defined as:

\[
C(s) = \frac{1}{2} \eta s^2 \quad \eta > 0
\]

Thus, the cost of network services increases with the network service level, and the marginal cost of network services increases.

For convenience of discussion, the following symbols are defined:

In addition, we use \(\Pi_i^T\) to indicate the overall profit of the supply chain under centralized decision making, use \(\Pi_i^M\), \(\Pi_i^R\) and \(\Pi_i^l\) to indicate the profits of the supplier, online retailer and TPLSP under decentralized decision-making

\[i = A, M\] represents additive and multiplicative requirement, respectively.

IV. ESTABLISHMENT OF THE MODEL

A. CENTRALIZED DECISION MAKING MODEL

1) ADDITIVE DEMAND-CENTRALIZED DECISION MAKING (AC MODEL)

Centralized decision making refers to the case that the FAP supplier establishes his own portals for online pre-sale and distributes products through his own logistics system. In this situation, the supplier has to decide the discount rate, the service level of network service and the level of logistics service to maximize his profit.

\[
\scriptsize \Pi^A_c = [(1 - \alpha)p - c_l - c_m]D(\alpha, s, \theta) - C(u) - C(s) - \frac{1}{2} \mu u^2 - \frac{1}{2} \eta s^2 - \lambda \theta u
\]

In equation (1), the first item represents the total revenue of the supply chain, while the second and the third item are the logistics service cost and network service cost, respectively.

**Proposition 1:** When \(\mu(n - p\beta^2) > p\lambda^2\theta_0^2\eta\) is true, under centralized decision-making, the optimal solutions of the decision variables satisfy

\[
\begin{align*}
\alpha^{A*} & = 1 - \left[\frac{m\mu(p - c_l - c_m)}{\mu(2n\eta - p\beta^2) - p^2\eta\lambda^2\theta_0^2} + \frac{c_l + c_m}{p}\right] \\
\lambda^{A*} & = \frac{\mu(2n\eta - p\beta^2) - p^2\eta\lambda^2\theta_0^2}{m\lambda\theta_0(p - c_l - c_m)} \\
\theta^{A*} & = \frac{\mu(2n\eta - p\beta^2) - p^2\eta\lambda^2\theta_0^2}{\mu(2n\eta - p\beta^2) - p^2\eta\lambda^2\theta_0^2}
\end{align*}
\]

The optimal profit of the supplier, or equivalently the whole supply chain, is

\[
\scriptsize \Pi^{A*}_c = \frac{n^2\mu\eta(p - c_l - c_m)^2}{2p[\mu(2n\eta - p\beta^2) - p\eta\lambda^2\theta_0^2]}
\]
It is noticeable that whether the precondition \(2\eta > p\beta^2\) is true or not, is mainly determined by the number of consumers \(n\). FAP supplier has the opportunity to open up online channels for pre-sale only if the number of consumers in the pre-sale stage is large enough. With the development of IOT (internet of things) technology, logistics technology as well as storage and transportation technology of FAP, people can learn the quality of the products in advance. Consequently, the number of potential consumers in the online channel will increase, which promotes the development of online sale of FAP.

2) MULTIPlicative DEMAND CENTRALIZED DECISION MAKING (MC MODEL)

SIMilar to the case with additive demand, the centralized decision making problem under multiplicative demand is to maximize the following profit function.

\[
\Pi_M^* = [(1 - \alpha)p - c_l - c_m]D(\alpha, s, \theta) - C(u) - C(s)
\]

\[
= [(1 - \alpha)p - c_l - c_m](n\alpha + bs)\theta_0e^{\lambda u}
- \frac{1}{2}\mu u^2 - \frac{1}{2}\eta^2 u^2
\]

The optimal strategies and profit for the FAP supplier are summarized in Proposition 2.

\[
\alpha_{M^*} = \frac{\mu}{2}\left(\frac{c_l - c_m}{n\alpha + bs}\right)\theta_0e^{\lambda u} + \frac{c_l + c_m}{p}
\]

\[
\lambda_{M^*} = \frac{n\beta\theta_0e^{\lambda u}}{p(2n\eta - p\beta^2)}\frac{c_l - c_m}{n\alpha + bs}
\]

\[
\mu_{M^*} = \frac{n^2\eta^2\lambda\theta_0e^{\lambda u}}{p2n\eta - p\beta^2}\frac{c_l - c_m}{n\alpha + bs}^2
\]

The optimal profit of the supply chain is

\[
\Pi_M^* = \frac{n^2\eta^2\lambda\theta_0e^{\lambda u}}{p2n\eta - p\beta^2}\frac{c_l - c_m}{n\alpha + bs}^2 - \frac{1}{2}\mu(u_{M^*})^2
\]

B. DECENTRALIZED DECISION MAKING MODEL

1) DECENTRALIZED DECISION MAKING FOR ADDITIVE DEMAND (AD MODEL)

Under decentralized decision-making, the supplier of FAP is the core of the Stackelberg game, while the online retailer is the follower. In addition, there exists static game between the supplier and the TPLSP. All the three parties pursue the maximization of their own profit respectively. The sequence is as follows: The TPLSP gives the price of the logistics service and the level of logistics service, at the meantime, the supplier determines the wholesale price. Observing the wholesale price, the price of the unit logistics service and the level of logistics service, the retailer decides the discount rate and the level of network service.

The supplier’s profit is determined by the marginal profit of product per unit and the market demand, and can be expressed as equation (7).

\[
\Pi_m = [\omega - c_m]D(\alpha, s, \theta)
\]

The retailer’s profit below contains two parts, the first one represents the sales profit of the online retailer, while the second one represents the network service cost.

\[
\Pi_r = [(1 - \alpha)p - \omega - p_1]D(\alpha, s, \theta) - \frac{1}{2}\eta^2 u^2
\]

The TPLSP’s profit equals its net incomes, which is paid for fulfilling the basic logistics task, minus the logistics service cost.

\[
\Pi_l = [p_1 - c_l]D(\alpha, s, \theta) - \frac{1}{2}\mu u^2
\]

Proposition 3: If \(2\eta > p\beta^2\) is true, the equilibrium strategies of the three supply chain members will satisfy the following equations.

\[
\alpha_{A^*} = \frac{n^2\mu^2\eta(2n\eta - p\beta^2)(p - c_l - c_m)^2}{p[3\mu(2n\eta - p\beta^2) - p\eta\lambda^2\theta_0^2]}
\]

\[
\lambda_{A^*} = \frac{2p[3\mu(2n\eta - p\beta^2) - p\eta\lambda^2\theta_0^2]}{p[3\mu(2n\eta - p\beta^2) - p\eta\lambda^2\theta_0^2]}
\]

\[
\mu_{A^*} = \frac{n^2\mu^2\eta(2n\eta - p\beta^2)(p - c_l - c_m)^2}{p[3\mu(2n\eta - p\beta^2) - p\eta\lambda^2\theta_0^2]}
\]

\[
\Pi_{A^*} = \Pi_m + \Pi_r + \Pi_l
\]

\[
= \frac{n^2\mu^2\eta(p - c_l - c_m)^2}{2p[3\mu(2n\eta - p\beta^2) - p\eta\lambda^2\theta_0^2]}
\]

2) DECENTRALIZED DECISION MAKING FOR MULTIPLICATIVE DEMAND (MD MODEL)

Referring to the case with additive demand, the profit functions of the supplier, the online retailer and the TPLSP are presented as equation (14), (15) and (16).

\[
\Pi_m = [\omega - c_m](n\alpha + bs)\theta_0e^{\lambda u}
\]

\[
\Pi_r = [(1 - \alpha)p - \omega - p_1]D(\alpha, s, \theta) - \frac{1}{2}\eta^2 u^2
\]

\[
\Pi_l = [p_1 - c_l]D(\alpha, s, \theta) - \frac{1}{2}\mu u^2
\]
\[ \Pi^M = [p_l - c_l]D(\alpha, s, \theta) - \frac{1}{2} \mu u^2 \]  

(16)

**Proposition 4:** If \( \eta > p\beta^2 \) is true, the equilibrium strategies of the three supply chain members satisfy the following equations.

\[
\begin{align*}
\alpha^{M*} &= \frac{(p - c_l - c_m)(\eta - p\beta^2\theta_0e^{\lambda u^{M*}})}{3p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})} \\
\eta^{M*} &= \frac{n\beta \theta_0 e^{\lambda u^{M*}}(p - c_l - c_m)}{3(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})} \\
\mu^{M*} &= \frac{2n^2\eta^2\lambda \theta_0 e^{\lambda u^{M*}}(p - c_l - c_m)^2}{9p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})} \\
\rho_l^{M*} &= \frac{9\mu p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})}{(p - c_l - c_m) + c_l} \\
\sigma^M &= \frac{(p - c_l - c_m)}{3} + c_m
\end{align*}
\]  

(17)

The equilibrium profits of each member and the whole supply chain satisfy

\[
\begin{align*}
\Pi_{m}^{M*} &= \frac{n^2\eta^2\lambda \theta_0 e^{\lambda u^{M*}}(p - c_l - c_m)^2}{9p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})} \\
\Pi_{r}^{M*} &= \frac{18p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})}{n^2\eta^2\lambda \theta_0 e^{\lambda u^{M*}}(p - c_l - c_m)^2} \\
\Pi_{l}^{M*} &= \frac{18p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})}{n^2\eta^2\lambda \theta_0 e^{\lambda u^{M*}}(p - c_l - c_m)^2} \\
\Pi_c^{M*} &= \frac{5n^2\eta^2\lambda \theta_0 e^{\lambda u^{M*}}(p - c_l - c_m)^2}{18p(2\eta - p\beta^2\theta_0e^{\lambda u^{M*}})} - \frac{1}{2} \mu (\mu^{M*})^2 \\
\end{align*}
\]  

(19)

**Proof:** The conclusion can be deduced from proposition 3 directly.

**Property 2:** No matter under centralized or decentralized decision making, with the increase of product sales price, the optimal pre-sale discount increases first and then decreases, and the optimal network service level and logistics service level increase.

**Property 3:** Under decentralized decision making, the net income of the supplier \( \alpha^{A*} - c_m \) equals the net income of the TPLSP from the sale of one unit product \( \rho_l^{A*} - c_l \), both are \( \frac{\mu^2(2\eta - p\beta^2)(p - c_l - c_m)}{3\mu^2(2\eta - p\beta^2)(p - c_l - c_m)} \).

**Proof:** The conclusion can be deduced from proposition 3 directly.

In addition to the above properties, the following conclusions are obtainable when \( \mu(\eta - p\beta^2) > p\lambda^2\theta_0^2\eta \) is true.

**Conclusion 1:** The optimal pre-sale discount rate, optimal network service level and optimal logistics service level under centralized decision-making are all higher than those under decentralized decision-making.

**Proof:** Based on equation (2) and (11), calculate \( \alpha^{A*} - \alpha^{A**}, \sigma^A - \sigma^{A**}, \mu^{A*} - \mu^{A**} \), then the conclusion can be easily achieved.

In conclusion 1, \( \alpha^{A*} > \alpha^{A**} \) means the price of FAP under centralized decision making is lower than that under decentralized decision making. Thus, the cooperation between enterprises is beneficial to consumers and can promote consumers to purchase online. \( \sigma^A > \sigma^{A**} \) shows that the online retailer is more willing to increase investment in network service level to promote the demand in the pre-sale stage, and further to reduce the impact of consumer demand uncertainty, in the centralized decision occasion. The result that \( \mu^{A*} > \mu^{A**} \) when the centralized decision is made can be attributed to the multiple roles of the FAP supplier. Because the supplier is also a network retailer and a TPLSP in this case, the logistics information of the whole supply chain is transparent. Consequently, the TPLSP is fully aware of the demand of the consumers’ logistics services, which enables it to execute a time-saving, labor-saving and money-saving logistics service plan and ensure that the FAP are delivered to the consumers with the most satisfactory logistics service.

**Conclusion 2** Under decentralized decision making, the supplier earns the highest profit, followed by the TPLSP.
profit of the retailer is the lowest and is half of the supplier’s profit.

Conclusion 3: The total profit of supply chain under centralized decision making is higher than the sum of profit of the supplier, online retailer and the TPLSP.

V. NASH BARGAINING COORDINATION STRATEGY

FROM the above analysis, we can see that the overall profit of the centralized supply chain decision is higher than the case that the supplier, the retailer and the TPLSP make decisions separately. According to the Nash bargaining theory, the members of the supply chain can choose to make centralized decisions and negotiate on how to distribute the total profit distribution, and the agreement can be reached when the profit is higher than the decentralized case for each member.

Based on practical experiences, the supplier, online retailer and TPLSP will sign agreements according to their bargaining power. Suppose the bargaining powers of the supplier, online retailer and the TPLSP are denoted by \( \tau_1, \tau_2, \tau_3 \), respectively, and the three members can earn profits with the coordination strategy of Nash bargaining, then the optimization problem is as follows:

\[
\begin{align*}
\max & \quad (\Pi_{Nm} - \Pi_m^*)^T \left( \frac{\partial \Pi_{Nm}}{\partial \Pi_m} - \frac{\partial \Pi_{m}}{\partial \Pi_m} \right)^T \\
\text{s.t.} & \quad \Pi_{Nm} + \Pi_{Nr} + \Pi_{Nl} = \Pi^*,
\end{align*}
\]

The KKT method is used to solve (21). Firstly, construct the following Lagrange function.

\[
L(\Pi_{Nm}, \Pi_{Nr}, \Pi_{Nl}; k) = \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3 - k \left( \Pi_{Nm} + \Pi_{Nr} + \Pi_{Nl} - \Pi^* \right)
\]

Then, take first order partial derivative of \( L \) with respect to \( \Pi_{Nm}, \Pi_{Nr}, \Pi_{Nl} \).

\[
\frac{\partial L}{\partial \Pi_{Nm}} = \tau_1 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3 - k
\]

\[
\frac{\partial L}{\partial \Pi_{Nr}} = \tau_2 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3 - k
\]

\[
\frac{\partial L}{\partial \Pi_{Nl}} = \tau_3 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3 - k
\]

The problem will be solved by combining the first order conditions with \( k \left( \Pi_{Nm} + \Pi_{Nr} + \Pi_{Nl} - \Pi^* \right) = 0 \). When \( k > 0 \), \( \Pi_{Nm} + \Pi_{Nr} + \Pi_{Nl} - \Pi^* = 0 \) must be true, thus,

\[
\begin{align*}
\Pi_{Nm} = & \frac{\tau_1 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} \\
\Pi_{Nr} = & \frac{\tau_2 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} \\
\Pi_{Nl} = & \frac{\tau_3 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3}
\end{align*}
\]

And when \( k = 0 \), \( \Pi_{Nm} + \Pi_{Nr} + \Pi_{Nl} - \Pi^* > 0 \) must be true, then it will be deduced that

\[
\begin{align*}
\Pi_{Nm} = & \Pi_m^* \\
\Pi_{Nr} = & \Pi_r^* \\
\Pi_{Nl} = & \Pi_l^*
\end{align*}
\]

Since we have got \( \Pi_{Nm} + \Pi_{Nr} + \Pi_{Nl} < \Pi^* \) in conclusion 3, the optimal solution should be the one obtained in the case that \( k > 0 \).

Conclusion 4: Under the Nash bargaining coordination strategy, the profits of the supplier, the retailer and the TPLSP are as below.

\[
\begin{align*}
\Pi_{Nm}^{**} = & \frac{\tau_1 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} \\
\Pi_{Nr}^{**} = & \frac{\tau_2 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} \\
\Pi_{Nl}^{**} = & \frac{\tau_3 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3}
\end{align*}
\]

Conclusion 5: The optimal profit gained by each member in the coordinated supply chain monotonously increases with its bargaining power and monotonously decreases with the bargaining power of other members.

Conclusion 6: Under the Nash bargaining coordination strategy, the remaining profits of the supplier, the online retailer and the TPLSP have the following properties.

\[
\begin{align*}
\Delta \Pi_m^{**} = & \Pi_{Nm}^{**} - \Pi_m = \frac{\tau_1 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} > 0 \\
\Delta \Pi_r^{**} = & \Pi_{Nr}^{**} - \Pi_r = \frac{\tau_2 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} > 0 \\
\Delta \Pi_l^{**} = & \Pi_{Nl}^{**} - \Pi_l = \frac{\tau_3 \left( \Pi_{Nm} - \Pi_m^* \right) \tau_1 \left( \Pi_{Nr} - \Pi_r^* \right) \tau_2 \left( \Pi_{Nl} - \Pi_l^* \right) \tau_3}{\tau_1 + \tau_2 + \tau_3} > 0
\end{align*}
\]

From the conclusion 6, all the three members gain higher profit than in the case of decentralized decision making Model, which means Nash bargaining strategy can achieve supply chain coordination in practice. Furthermore, conclusion 6 also shows that the coordination strategy is closely related to the relative bargaining power of the participants: the more bargaining power a member occupies, the more extra profit he will get.

VI. NUMERICAL EXAMPLE

From the above analysis, we can obtain that when logistics service has an influence on market demand, both the supplier and the online retailer should make their decisions based on the logistics service level of the TPLSP. Consequently, the equilibrium solutions and the corresponding profits will change with logistics service cost.

A. ADDITIVE DEMAND

Suppose that the relevant parameters of a FAP supply chain are as follows: \( n = 10, p = 4, \beta = \eta = \lambda = \theta_0 = 1, c_m = 2, \mu = 1 \), which satisfy the constraints of proposition 1 and proposition 3.

1) IMPACT OF SERVICE COST ON PRE-SALE DISCOUNT AND NETWORK SERVICE LEVEL

Let the unit logistics service cost \( c_l \) increase from 0 to 2, Figure 2 and 3 depict how the optimal discount rate and the level of network service change accordingly.
FIGURE 2. The influence of logistics service cost on the optimal pre-sale discount rate.

FIGURE 3. The impact of logistics service cost on the optimal network service level.

In Figure 2 and Figure 3, with the increase of unit logistics service cost, both the optimal pre-sale discount rate and optimal network service level decrease considerably. That means the retailer prefers to cooperate with TPLSP having cost advantage, which will ensure the network service level of the online retailer and solve the “cheap sale” problem faced by the FAP supplier. In addition, the difference between the optimal network service levels, as well as the optimal discount rates, under the two decision making modes gets smaller as the logistics service cost increases. This result suggests that the supplier is more willing to establish his own online pre-sale platform when the unit logistics service cost is low, and at the same time, invest in the network service to attract consumers to buy in advance. The vertical integration of the supplier is helpful to solve the “expensive purchase” problem faced by the consumers.

2) EFFECT OF LOGISTICS SERVICE COST ON THE PROFITS OF SUPPLY CHAIN MEMBERS

FIGURES 4 and 5 describe the changes in pre-sale volume and optimal profit of each member with the increase of logistics service cost.

Figure 4 and Figure 5 show that the pre-sale quantity and the profits of the supply chain members also decrease with the increase of the logistics service cost. Combining with Figure 2 and Figure 3, the reduction of pre-sale quantity is not only because it is costly to guarantee the freshness of the FAP, but is also related to the higher pre-sale price and lower network service level. The above factors then decide the lower profits of the supply chain members jointly.

B. MULTIPLICATIVE DEMAND

Suppose that the relevant parameters of a FAP supply chain are as follows: \( n = 10, p = 4, \beta = \eta = \lambda = 1, \theta_0 = \frac{1}{2}, c_m = 1, \mu = 1 \), which satisfy the constraints of proposition 2 and proposition 4.

1) IMPACT OF LOGISTICS SERVICE COST ON PRE-SALE DISCOUNT AND NETWORK SERVICE LEVEL

Let the unit logistics service cost increase from 0 to 3, Tables 2, Figure 6 and Figure 7 describe the impact of logistics service costs on the optimal pre-sale discount rate and network service level.

Compared to the case with additive demand, the optimal strategies of the supply chain members show two different properties. On the one hand, with the increase of unit logistics cost the optimal discount rate increases slightly first and then decrease. That means the larger expenditure on logistics service does not necessarily leads to the negative strategies which will restrain the market demand for pre-sale products, the online retailer may attract consumers by offering more discount when the logistic service cost is not very high. On the other hand, the optimal discount rate is more sensitive to the unit logistics service when it is below a certain threshold under decentralized supply chain, and similar property can be observed for the optimal online service level. Consequently, it is more effective for supply chains with relatively low cost to
TABLE 2. Impact of logistics service costs on pre-sale discount rates.

| Logistics costs | Pre-sale discount rate |
|-----------------|------------------------|
| 1.98617         | 0.09673                |
| 1.96855         | 0.09869                |
| 1.97338         | 0.10098                |
| 1.98406         | 0.10093                |
| 2.0026          | 0.10016                |
| 2.03179         | 0.09967                |
| 2.0763          | 0.09667                |
| 2.14571         | 0.09104                |
| 2.2485          | 0.08113                |
| 2.42604         | 0.06289                |

FIGURE 6. Impact of logistics service cost on optimal pre-sale discount rate.

2) IMPACT OF LOGISTICS SERVICE COST ON THE PROFITS OF MEMBERS IN THE SUPPLY CHAIN

Figures 8 and 9 describe the changes in pre-sale volume and optimal profit of each member with the increase of logistics service cost.

In Figure 8, with the increase of unit logistics service level, the total profit under centralized supply chain does not fall seriously at the very beginning, which is in accordance with the property of the pre-sale discount rate. And the property of pre-sale quantity under decentralized supply chain shown in Figure 9 is in line with the changes of optimal discount rate and online service level with respect to unit logistics service cost.

VII. CONCLUSION

Considering the participation of TPLSP in decision-making, this paper studies the C2B online pre-sale of FAP supply chain under centralized decision-making and decentralized decision-making. The results show that, compared to the decentralized supply chain, the optimal pre-sale discount rate, optimal online service level of FAP and the total profit of the supply chain are all much higher under centralized decision-making than that under decentralized decision-making. When the logistics service level of the TPLSP is fixed, the optimal pre-sale discount rate decreases, while the optimal network service level increases, with the increase of freshness.
sensitivity coefficient. In most cases, the optimal discount rate, optimal online service level and the profit of the supply chain all get smaller when the unit logistics service cost gets larger, hence the TPLSP has incentive to reduce such cost to improve the competitiveness of the FAP supply chain. Nash bargaining strategy is able to coordinate the supply chain, and the member with more bargaining power will gain more profit in the coordination contract.

Under the background of C2B online pre-sale, this paper only investigates the impact of the TPLSP’s behavior on the pre-sale strategies in a supplier-led FAP supply chain. Besides that, there are many other factors worth further study, such as customer utility, purchasing options and government subsidies. We will examine how these factors influence the pricing and coordination of FAP supply chain in the future.

APPENDIX

Proof of Proposition 1: Take the first order derivative of \( \Pi_c^A \) with respect to \( \alpha, s, u \), we can have

\[
\frac{\partial \Pi_c^A}{\partial \alpha} = -p(2\alpha + \beta s + \lambda \theta_0 u - n) - n(c_1 + c_m) \\
\frac{\partial \Pi_c^A}{\partial s} = \beta[(1 - \alpha)p - c_1 - c_m] - \eta s \\
\frac{\partial \Pi_c^A}{\partial u} = \lambda \theta_0 [(1 - \alpha)p - c_1 - c_m] - \mu u
\]

Then, the following Hessian matrix can be obtained.

\[
H = \begin{bmatrix}
-2np & -p\beta & -p\lambda \theta_0 \\
-p\beta & -\eta & 0 \\
-p\lambda \theta_0 & 0 & -\mu
\end{bmatrix}
\]

When \( \mu(n\eta - p\beta^2) > p\lambda^2 \theta_0^2 \eta \), the Hessian matrix is negative definite and consequently the objective function is a concave function of \( \alpha, s, u \). Let \( \frac{\partial^2 \Pi_c^A}{\partial \alpha^2} = \frac{\partial^2 \Pi_c^A}{\partial s^2} = \frac{\partial^2 \Pi_c^A}{\partial u^2} = 0 \) and it is easy to prove formula (2) by solving the equations. By inserting formula (2) into (1), we can get formula (3) directly.

Proof of Proposition 2: Under multiplicative demand, the first order derivatives of \( \Pi_c^M \) are as follows

\[
\frac{\partial \Pi_c^M}{\partial \alpha} = -p(2\alpha + \beta s - n) - n(c_1 + c_m) \theta_0 e^{\lambda u} \\
\frac{\partial \Pi_c^M}{\partial s} = \beta[(1 - \alpha)p - c_1 - c_m] \theta_0 e^{\lambda u} - \eta s \\
\frac{\partial \Pi_c^M}{\partial u} = \lambda \theta_0 [(1 - \alpha)p - c_1 - c_m] \theta_0 e^{\lambda u} - \mu u
\]

Then, the corresponding Hessian matrix has a more complicated form compared to the additive demand case.

\[
H = \begin{bmatrix}
-2np & -p\beta & 0 \\
-p\beta & -\eta \theta_0 e^{\lambda u M^*} & \beta[(1 - \alpha)p - c_1 - c_m] \\
0 & \beta[(1 - \alpha)p - c_1 - c_m] & n^3 \eta^2 \lambda (p - c_1 - c_m)^2 (2p\eta - p\beta^2 \theta_0 e^{\lambda u M^*})^2 - \mu u \theta_0 e^{\lambda u M^*}
\end{bmatrix}
\]

Since the Hessian matrix \( H \) is negative when \( \mu > \frac{p(2\eta - \beta^2 \theta_0^2)}{2p^2 \eta - p\beta^2} \), \( (\alpha^{M*}, s^{M*}, u^{M*}) \) is the local optimal solution of the objective function

Proof of Proposition 3. Proof: The equilibrium strategies of the three members can be deduced by using the backward induction method.

First, take the first order derivative of \( \Pi_r^A \) with respect to \( \alpha, s, \) and we have

\[
\begin{align*}
\frac{\partial \Pi_r^A}{\partial \alpha} &= -p(2\alpha + \beta s + \lambda \theta_0 u - n) - \omega - p_l \\
\frac{\partial \Pi_r^A}{\partial s} &= -\beta[(1 - \alpha)p - \omega - p_l] - \eta s
\end{align*}
\]

Then, the Hessian matrix of \( \Pi_r^A \) with respect to \( \alpha, s \) is

\[
H = \begin{bmatrix}
-2np & -p\beta & -p\lambda \theta_0 \\
-p\beta & -\eta & 0 \\
-p\lambda \theta_0 & 0 & -\mu
\end{bmatrix}
\]

\( H \) is negative when \( 2n\eta > p\beta^2 \). Thus, the equilibrium strategies of the online retailer satisfy \( \frac{\partial \Pi_r^A}{\partial \alpha} = \frac{\partial \Pi_r^A}{\partial s} = 0 \), i.e.

\[
\begin{align*}
\alpha &= \frac{(n\eta - p\beta^2)(p - \omega - p_l) + \eta \lambda \theta_0}{p(2n\eta - p\beta^2)} \\
\beta &= \frac{\lambda \theta_0 p(n\eta - p\beta^2 - p\beta^2)}{2n\eta - p\beta^2} \\
\eta &= \frac{2np - p\beta^2}{2n\eta - p\beta^2}
\end{align*}
\]

Next, insert formula (A4) into the profit functions of the supplier and TPLSP and take the first order partial derivative of (7) with respect to \( \omega \) and (9) with respect to \( p_l \) and \( u \). By letting these partial derivatives be zero and solving the corresponding equation set, we can prove that equation (11) will always be true. Finally, we can insert (11) into (A4) to obtain equation (10) and insert (10) and (11) into (7), (8) and (9) to get (12).

Proof of Property 2: Let \( A = n\eta \mu, B = \mu \beta^2 + \eta \lambda^2 \theta_0^2 \), \( C = c_1 + c_m \) then \( \alpha^* = \frac{C + 2\frac{B}{A} \beta^2}{2A \beta^2 - 2\frac{B}{A} \beta^2} \), \( C < p < \frac{A}{B} \). Take the first partial derivative of \( \alpha^* \) with respect to \( p \), i.e.

\[
\frac{\partial \alpha^*}{\partial p} = \frac{B(BC - A)p^2 - 2ABCp + 2A^2 C}{(2Ap - Bp^2)^2}
\]

Define \( g(p) = B(BC - A)p^2 - 2ABCp + 2A^2 C \). Since \( BC - A < 0, g(C) > 0, g(\frac{A}{B}) < 0 \), the conclusion is proved. The similar proof can be done with the optimal network service level and logistics service level.

ACKNOWLEDGMENT

The authors would like to thank Dr. Shizhen Bai for his many efforts and comments to improve the quality of this article during the revision process of this article.

REFERENCES

[1] [Online]. Available: https://www.wahuigu.net/zonghe/2023166958211.HTML

[2] X. X. Chen, Y. Wang, and H. L. Yu, “Three-level supply chain model for deteriorating items with time-varying demand based on the third party logistics provider,” Chin. J. Manage. Sci., vol. 22, no. 1, pp. 65–73, 2014.

[3] Y. Liang, X. Zuo, and H. Lei, “Research on supply chain coordination of TPL supplier participation,” J. Service Sci. Manage., vol. 4, no. 1, pp. 1–7, 2011.
W. S. Lim and C. S. Tang, “Advance selling in the presence of speculators,” J. Ind. Eng. Eng. Manage., vol. 29, no. 1, pp. 200–206, Jan. 2015.

X. Q. Cai, J. Chen, Y. Xiao, and X. Xu, “Optimization and coordination of fresh product supply chains with freshness-keeping effort,” Prod. Oper. Manage. Soc., vol. 19, no. 3, pp. 261–278, 2009.

Y. Feng and J. Gu, “Coordination in a fresh agri-products supply chain considering TPL service provider’s leading priority,” Syst. Eng., vol. 34, no. 31, pp. 112–118, 2016.

Y. Z. Zhang, T. X. Wang, and Y. Feng, “Decision and coordination of fresh agri-products production, transportation and marketing supply chain with controllable output time,” Syst. Eng., vol. 12, no. 36, pp. 58–66, 2018.

Z. L. Song and S. W. He, “Contract coordination of new fresh produce three-layer supply chain,” Ind. Manage. Data Syst., vol. 119, no. 1, pp. 148–169, 2019.

S. M. Gan and J. Xie, “Advance pricing of services and other implications of separating purchase and consumption,” J. Service Res., vol. 2, pp. 227–239, Feb. 2000.

J. Xie and S. M. Gan, “Electronic tickets, smartcards, and online pre-payment: When and how to advance sell,” Marketing Sci., vol. 20, pp. 219–243, Aug. 2001.

S. M. Shugan and J. Xie, “Advance selling for services,” California Manage. Rev., vol. 46, no. 3, pp. 37–54, Apr. 2004.

A. Prasad, K. E. Stecke, and X. Zhao, “Advance selling by a newsvendor retailer,” Prod. Oper. Manage., vol. 20, no. 1, pp. 129–142, Jan. 2011.

C. Li and F. Zhang, “Advance demand information, price discrimination, and preorder strategies,” Manuf. Service Oper. Manage., vol. 15, no. 1, pp. 57–71, Feb. 2013.

M. Yu, H.-S. Ahn, and R. Kapuscinski, “Rationing capacity in advance selling to signal quality,” Manage. Sci., vol. 61, no. 3, pp. 560–577, Mar. 2015.

C. S. Tang, K. Rajaram, A. Alptekinoğlu, and J. Ou, “The benefits of advance booking discount programs: Model and analysis,” Manage. Sci., vol. 50, no. 4, pp. 465–478, Apr. 2004.

X. Zhao and K. E. Stecke, “Pre-orders for new to-be-released products considering consumer loss aversion,” SSRN Electron. J., vol. 19, no. 2, pp. 98–213, 2010.

Z. K. Weng and M. Parlar, “Integrating early sales with production decisions: Analysis and insights,” IIE Trans., vol. 31, no. 11, pp. 1051–1060, Nov. 1999.

Y. Li, M. Shan, and M. Z. F. Li, “Advance selling decisions with overconfident consumers,” J. Ind. Manage. Optim., vol. 12, no. 3, pp. 891–905, Sep. 2015.

Z. G. Tian and Y. F. Wang, “Advance selling with preorder dependent customer valuation,” Oper. Res. Lett., vol. 44, no. 4, pp. 557–562, 2016.

C. Zeng, “Optimal advance selling strategy under price commitment,” Pacific Econ. Rev., vol. 18, no. 1, pp. 233–258, 2013.

Y. Zeng, G. S. Qiu, and S. J. Huang, “The exaggeration of product quality and its precautions in the pre-order crowdfunding,” J. Manage. Sci. China, vol. 22 no. 7, pp. 89–106, 2019.

L. Xiao, M. Xu, Z. Chen, and X. Guan, “Optimal pricing for advance selling with uncertain product quality and consumer fitness,” J. Oper. Res. Soc., vol. 70, no. 9, pp. 1–18, 2019.

H. Li and E. Qi, “Advance selling in the presence of uncertainty market size,” Chin. J. Manage. Sci., vol. 25, no. 2, pp. 50–56, 2017.

S. Ma, G. Li, S. P. Sethi, and X. Zhao, “Advance selling in the presence of market power and risk-averse consumers,” Decis. Sci., vol. 50, no. 1, pp. 142–169, Feb. 2019, doi: 10.1111/dsci.12318.

X. Y. Zhao, Z. Pang, and E. S. Kathryn, “When Does a Retailer’s Advance Selling Capability Benefit Manufacturer, Retailer, or Both?” Prod. Oper. Manage. Soc., vol. 25, no. 6, pp. 1073–1083, 2016.

W. S. Lim and C. S. Tang, “Advance selling in the presence of speculators and forward-looking consumers,” Prod. Oper. Manage. Soc., vol. 22, no. 3, pp. 571–587, 2013.

J. Nasiry and I. Popescu, “Advance selling when consumers regret,” Manage. Sci., vol. 58, no. 6, pp. 1160–1177, Jun. 2012.

Y. P. Mu, Y. Feng, and X. W. Tang, “Integrating option procurement with advance selling under demand uncertainty,” J. Manage. Sci. China, vol. 14, no. 6, pp. 47–56, 2011.

Y. J. Li, L. X. Yu, and X. L. Yang, “Advance selling, return policy and failure false return for a newsvendor retailer,” Nankai Business Rev., vol. 15, no. 5, pp. 105–113, 2012.

Z. F. Mao, W. W. Liu, and H. Li, “Joint strategy of advance-selling and buy-back for seasonal perishable products,” J. Manage. Sci. Chem., vol. 19, no. 2, pp. 74–84, 2016.

O. Loginova, “Pricing strategies in advance selling: Should a retailer offer a pre-order price guarantee?” Rev. Ind. Org., vol. 49, no. 3, pp. 1–25, 2016.

Y. Cheng, H. Li, and A. Thorstenson, “Advance selling with double marketing efforts in a newsvendor framework,” Comput. Ind. Eng., vol. 118, pp. 352–365, Apr. 2018.

M. Xu, S. X. Zho, and R. H. Teunter, “Advance selling and advertising: A newsvendor framework,” Decis. Sci., vol. 52, no. 1, pp. 182–215, Feb. 2021, doi: 10.1111/dsci.12423.

T. W. Shao and X. M. Lv, “Price fresh agricultural products by C2B based on F2F,” J. Manage. Sci. China, vol. 11, no. 24, pp. 146–152, 2016.

B. W. J. Dank and Z. Shao, “Research on ‘internet +’ fresh agricultural products supply chain pre-sale model based on consumer crowd-funding,” Rural Economy, vol. 2, pp. 83–88, 2017.

T. W. Shao and X. M. Lv, “Joint decision between crowdfunding in pre-selling and crowd sourcing in production on flesh agricultural products,” Syst. Eng. Theory Pract. vol. 38, no. 6, pp. 1502–1511, 2018.

J. Chen and H. J. Fu, “Advance selling strategies for agri-food producer with uncertain quality,” Ind. Eng. Manage., vol. 25, no. 2, pp. 101–108, 2020.

Y. Feng, Y.-L. Yu, Y.-Z. Zhang, and Q. Wu, “Coordination in a three-echelon supply chain of fresh agri-products with TPLSP’s participation in decision-making,” J. Ind. Eng. Eng. Manage., vol. 29, no. 4, pp. 213–221, Oct. 2015.

P. H. Hsu, H. M. Wee, and H. M. Teng, “Preservation technology investment for deteriorating inventory,” Int. J. Prod. Econ., vol. 12, no. 2, pp. 388–394, 2010.

F. Yi, Q. Wu, and Y. Z. Zhang., “Supply chain coordination of fresh agri-product based on cost allocation of residual products under VMCI,” J. Syst. Manage., vol. 28, no. 3, pp. 579–586, 2019.

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