Fresh Food E-commerce Supply Chain Coordination Mechanism Under the Background of New Retail

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Abstract. In recent years, the rapid development of new retail has promoted the growth of the fresh food e-commerce industry. More and more fresh food e-commerce enterprises are selling their products through platforms similar to JD Daojia, and there are also platform-based, new retail-based operation modes. In this context, it is particularly important to compare the operation modes of fresh food e-commerce and study the coordination mechanisms of fresh food e-commerce supply chains to improve the overall benefits of the supply chain. This paper constructs a dual-channel supply chain consisting of fresh food e-commerce enterprises and fresh food e-commerce platforms. Based on the consideration of the input of fresh preservation efforts, it compares and analyzes the operation modes of platform-based and new retail-based fresh food e-commerce, and studies the coordination problems of platform-based e-commerce supply chains.

Keywords: Fresh Food E-commerce · Fresh-keeping Effort · Coordinating Covenants

1 Introduction

1.1 Background

The concept of "new retail" was first introduced at the "Cloud Conference" in 2016 [1]. It is Alibaba's strategy to transform traditional retail elements such as people, goods, and venues into an information-based and data-driven mode through mobile internet technology. As consumer demand for high-quality products has increased, the traditional fresh food e-commerce mode has become inadequate to meet these needs [2]. From 2016 to 2019, the industry experienced a downturn, resulting in layoffs, bankruptcies, and capital chain ruptures. However, the outbreak of COVID-19 at the end of 2019 led to a surge in online sales of fresh products, which are essential for daily life [3]. This sudden increase in consumer demand has brought about a "rebirth" of the nearly bankrupt fresh food e-commerce industry [4]. Under the new retail mode, fresh food e-commerce enterprises utilize their own channels, technology, and big data advantages to effectively address the coverage radius and variety issues of traditional fresh products, and further meet the needs of consumers for quality differentiation [5]. Consumers can purchase

Y. P. Tu and M. Chi (Eds.): WHICEB 2024, LNBIP 515, pp. 62–73, 2024.
https://doi.org/10.1007/978-3-031-60264-1_6

fresh products in two ways under this new operational mode: the first is to place an order and complete payment on a specialized APP in the new retail environment, after which merchants assign special logistics personnel to distribute the fresh products through self built logistics or third-party logistics companies. The second way is for consumers to visit offline stores to buy products according to their preferences, and then hand them over to professionals in the store for processing and cooking, thereby enhancing the overall shopping experience.

1.2 Research Purpose and Significance

With the continuous growth of new retail formats, the fresh food e-commerce industry is flourishing, and many scholars at home and abroad are conducting academic research in this direction. The vast majority of scholars are studying how to better optimize the fresh food e-commerce supply chain, in order to draw some conclusions that are worth learning from. Among them, the transformation of fresh food e-commerce supply chain channels, coordination among members, and the establishment of contractual relationships to promote supply chain coordination have greatly helped the rapid development of the fresh food e-commerce industry [6]. However, considering the different perceptions and operational modes of different enterprises towards the development of fresh food e-commerce under the new retail environment, and referring to various research methods of fresh food e-commerce supply chains, this article plans to take the new retail environment as the research background, compare and explore the operational modes of the two most popular fresh food e-commerce supply chains in China under certain factors, and design coordination contracts for the less efficient operational modes, In order to further optimize the total revenue of its supply chain.

This article is a study on the coordination mechanism of fresh food e-commerce supply chain considering preservation efforts in the context of new retail. It is based on the deduction of mathematical modes, and then simulates the real operation situation through numerical analysis, ultimately verifying the effectiveness of the contract mode. By considering the optimal pricing, preservation level, and profit of the supply chain under preservation efforts for two common fresh food e-commerce operation modes, we can identify the operation mode with lower efficiency, and design corresponding coordination mechanisms to optimize the overall efficiency of the supply chain.

1.3 Literature Review

In the context of new retail, China's fresh e-commerce industry has undergone a new transformation, gradually forming a pattern of multiple models coexisting. Maruyama et al. [7] explored the factors that Chinese consumers purchase fresh food from traditional and modern retail forms, and further explored the regional differences in consumer shopping behavior, providing substantive suggestions for China's retail transformation and upgrading. Xiyue Xiao [8] discussed the supply chain model of fresh e-commerce under the background of "new retail". He believes that the arrival of the "new retail" era requires fresh e-commerce enterprises to improve their supply chain model, build a complete product supply chain, ensure product quality, improve distribution efficiency, and introduce advanced technology to transform traditional management concepts into

consumer demand-based management concepts. Strengthen the concept of fresh supply chain to better promote the improvement of the fresh supply chain.

At present, there are still a lot of relevant studies on the preservation efforts of fresh agricultural products. Considering consumers' requirements for the freshness of fresh agricultural products and their personalized needs for the service of fresh food e-commerce platform, scholars at home and abroad take the preservation efforts of fresh agricultural products provided by supply chain members as the main influencing factor to discuss the coordination of the supply chain of fresh agricultural products. To ensure a balance of interests among decision-makers, Zhang et al. [9] models the time-dependent demand for fresh products and proposes an incentive mechanism to coordinate the new retail fresh products' supply chain; further, it demonstrates that the prices can be significantly decreased with the designed contract, and all the supply chain members can benefit from Pareto improvement. In order to explore the impact of preservation efforts on the inventory and profit of fresh agricultural products, Shuyun Wang et al. [10] established a two-level inventory mode of fresh agricultural products supply chain composed of a supplier and a retailer, so as to maximize the profit of the whole fresh agricultural supply chain and achieve win-win cooperation between the two sides. Jie Ding et al. [11] studied the coordination problem of the dual-channel supply chain dominated by fresh food e-commerce, designed a hybrid contract of cost sharing and fixed compensation to optimize the coordination of the supply chain, and finally conducted a numerical analysis to explore the influence of crossprice and other parameters. Xue Wang [12] established a fresh supply chain system composed of fresh merchants and fresh merchant platforms. An improved combination contract of "commission discount+fresh effort cost sharing" was designed for coordination.

From many academic studies, we find that there is a certain basis for the current research on fresh food e-commerce's fresh preservation effort, and there are also a lot of studies on the coordination mode design of fresh food e-commerce supply chain. However, it is only for the decision of a single fresh food e-commerce supply chain, and it is still rare to design the coordination contract based on the optimal decision of multiple fresh food e-commerce operation modes.

2 Construction of Fresh Food E-commerce Supply Chain Mode

2.1 Mode Hypothesis

Platform-Based Operation Mode. The platform-based operation mode of fresh food e-commerce [13] refers to fresh food sellers utilizing the powerful resource integration capabilities of comprehensive e-commerce platforms such as JD Daojia to provide a trading platform for fresh food sellers and consumers. Build a platform style fresh food e-commerce supply chain consisting of fresh food sellers and consumers as shown in the left figure of Fig. 1, assuming that the fresh food seller is the sole supplier of the entire fresh food supply chain. One sales channel is for the fresh food seller to publish product information through a third-party fresh food e-commerce platform, and the seller provides a proportional commission to the e-commerce platform for selling fresh agricultural products on the platform. Third party e-commerce platforms invest in preservation efforts. Another sales channel is for fresh food sellers to directly use their

own offline sales channels to sell products, where consumers pay fees offline. At the same time, suppliers prepare goods and directly ship them to consumers. During the delivery process, fresh food suppliers invest their own preservation efforts.

New Retail-Based Operation Mode. The new retail-based fresh food e-commerce operation mode [14] refers to consumers having the option to browse products online or experience them firsthand in physical stores. Construct a secondary supply chain consisting of fresh food e-commerce enterprises and consumers as shown in the right figure of Fig. 1, assuming that the fresh food e-commerce enterprise is the sole supplier of the entire fresh supply chain. In the context of new retail, fresh food e-commerce enterprises promote their products through self built platforms and offline stores simultaneously. One channel is to use online platforms for promotion and sales of fresh products, with fresh food e-commerce companies investing in preservation efforts. Another sales channel is for fresh food e-commerce enterprises to directly use their offline stores to sell products, while the enterprise directly ships to consumers. During the delivery process, fresh food suppliers invest their own efforts in preserving fresh agricultural products.

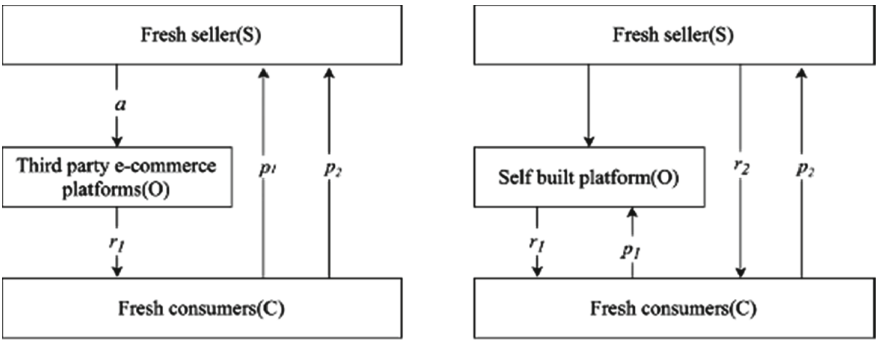

Fig. 1. Platform/New retail fresh food e-commerce supply chain structure

At the same time, combined with the research of existing scholars, this paper makes the following hypotheses:

Hypothesis 1: Considering the investment in preservation efforts, the freshness of fresh products after the investment in preservation technology is:

$$\delta(r_i) = \delta_0 + k_1 r_i \tag{1}$$

Hypothesis 2: Since fresh food e-commerce enterprises and third-party e-commerce platforms need certain cost support when investing in fresh preservation efforts, we further assume that the cost functions of fresh preservation efforts are respectively:

$$c_{\mathrm{i}} = k_r r_i^2/2 \tag{2}$$

Hypothesis 3: Consumer demand is mainly determined by product price and freshness. Where the total demand is inversely proportional to the selling price, directly proportional

to the relative selling price, and directly proportional to the freshness of the product. There is no difference between basic demand and freshness, and the demand functions of online and offline sales channels in the two modes are constructed as follows:

Online channel demand function:

$$d_1 = m - p_1 + \beta p_2 + \theta\delta(r_1) \tag{3}$$

Offline channel demand function:

$$d_2 = m - p_2 + \beta p_1 + \theta\delta(r_2) \tag{4}$$

Hypothesis 4: The online and offline channels of the two modes of operation are in a perfect information environment, and both the fresh food e-commerce enterprises (fresh food sellers) and the third-party fresh food e-commerce platforms are absolutely rational, with the ultimate goal of maximizing profits.

In order to construct the relevant supply chain structure mode, this paper also sets the main variables and their meanings as shown in Table 1.

Table 1. Main variables and their meanings.

Parameters	Meaning
m	Basic market demand
α	The proportion of commission given by sellers to e-commerce platforms for unit products
p_1	Sales prices through online channels
p_2	Sales prices for offline channels
r_1	Fresh preservation efforts in online channels
r_2	Fresh preservation efforts in offline channels
δ_0	Freshness of fresh agricultural products when they reach consumers without preservation efforts
c_1	The cost of preservation efforts in online channels
c_2	The cost of preservation efforts in offline channels
θ	The freshness demand elasticity of fresh agricultural products
β	Cross price elasticity coefficient between online and offline channels
k_1	The level of impact of preservation efforts on freshness
k_r	The coefficient of impact of preservation efforts on preservation costs
d_1	The demand for online channels
d_2	The demand for offline channels
π_s	Profit of fresh food e-commerce enterprises (fresh food sellers)

(*continued*)

Table 1. (*continued*)

Parameters	Meaning
π_p	Profit of third-party e-commerce platforms
Superscript e	The optimal decision of platform mode
Superscript f	The optimal decision for the new retail mode
Superscript g	The optimal decision under the coordination mode

2.2 Optimal Decisions Under Different Modes of Operation

Platform-Based Operation Mode. Considering that the operation mode of platform based fresh food e-commerce has a decentralized decision-making mode, a decentralized decision-making mode is adopted for the supply chain of platform based fresh food e-commerce [15]. That is, fresh food sellers first determine their online and offline sales prices and the preservation efforts provided by offline sales based on market demand, and then third-party fresh food e-commerce platforms decide the preservation efforts provided by their online sales channels, Finally, the optimal decision for fresh food sellers and third-party e-commerce platforms in a decentralized decision-making order is obtained, as well as the online and offline market demand and profits of fresh food sellers and third-party e-commerce platforms:

$$p_1^e = \frac{k_r(\theta\delta_0 + m)\left\{[(\beta+2)\alpha - 2\beta - 2]k_r - k_1^2\theta^2(-1+\alpha)\right\}}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{5}$$

$$p_2^e = \frac{k_r(1-\alpha)(\theta\delta_0 + m)\left[(\alpha\beta - 2\beta - 2)k_r + 2k_1^2\alpha\theta^2\right]}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{6}$$

$$r_2^e = \frac{k_r(1-\alpha)(\theta\delta_0 + m)\left[(\alpha\beta - 2\beta - 2)k_r + 2k_1^2\alpha\theta^2\right]\theta}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{7}$$

$$r_1^e = \frac{\alpha\theta k_1(\theta\delta_0 + m)\left\{[(\beta+2)\alpha - 2\beta - 2]k_r - k_1^2\theta^2(-1+\alpha)\right\}}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{8}$$

$$d_1^e = -\frac{(\theta\delta_0 + m)\left\{(\beta+1)[(\beta-2)\alpha - 2\beta + 2]k_r^2 + \theta^2k_1^2\left[(\beta+2)\alpha^2 - \alpha - 1\right]k_r - k_1^4\alpha\theta^4(\alpha-1)\right\}}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{9}$$

$$d_2^e = \frac{k_r(\alpha-1)(\theta\delta_0 + m)\left\{(\beta+1)[\alpha\beta - 2\beta + 2]k_r - \theta^2k_1^2[(\beta+2)\alpha - \beta]\right\}}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{10}$$

$$\pi_p^e = -\frac{(\theta\delta_0 + m)^2\left(E_1k_r - \theta^2(\alpha-1)k_1^2\right)\alpha\left(E_2k_r^2 + E_3k_1^2k_r - \frac{3k_1^4\alpha\theta^4(\alpha-1)}{2}\right)k_r}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha + 1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{11}$$

$$\pi_s^e = -\frac{\left[(\alpha-2)(\beta+1)k_r + k_1^2\theta^2(\alpha+1)/2\right](\theta\delta_0+m)^2 k_r(\alpha-1)}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha+1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)} \tag{12}$$

The total profit is:

$$\begin{aligned}\pi^e &= \pi_p^e + \pi_s^e \\ &= -\frac{(\theta\delta_0+m)^2 k_r\left[(\beta+1)E_4k_r^3 + 2k_1^2\theta E_5k_r^2 - k_1^4E_6(\alpha-1)\theta^4k_r + \theta^6k_1^6\alpha(\alpha-1)^2(5\alpha/2+1)\right]}{\left(a^2\beta^2 - 4\alpha\beta^2 + 4\beta^2 + 4\alpha - 4\right)k_r^2 - 4(-1+\alpha)k_1^2\theta^2(\alpha+1/2)k_r + 2k_1^4\alpha\theta^4(-1+\alpha)}\end{aligned} \tag{13}$$

New Retail-Type Operation Mode. Considering that the new retail style fresh food e-commerce operation mode is a dual channel mode for fresh food e-commerce enterprises to meet market demand, consisting of online channel sales achieved by fresh food e-commerce enterprises through self built e-commerce platforms and offline store channel sales. Therefore, a centralized decision-making mode is adopted for the supply chain of new retail style fresh food e-commerce [15], which means that fresh food e-commerce enterprises and their self built e-commerce platforms belong to the same role for decision-making, Make joint decisions on the sales prices and preservation efforts of the fresh food e-commerce supply chain in a dual channel mode. The optimal decision for fresh food e-commerce enterprises under this decision-making mode is:

$$p_1^f = p_2^f = -\frac{k_r(\theta\delta_0+m)}{k_1^2\theta^2 + 2\beta k_r - 2k_r} \tag{14}$$

$$r_1^f = r_2^f = -\frac{\theta k_1(\theta\delta_0+m)}{k_1^2\theta^2 + 2\beta k_r - 2k_r} \tag{15}$$

Online and offline market demand are as follows:

$$d_1^f = d_2^f = \frac{k_r(\beta-1)(\theta\delta_0+m)}{(2\beta-2)k_r + k_1^2\theta^2} \tag{16}$$

The optimal profit is:

$$\pi^f = -\frac{k_r(\theta\delta_0+m)^2}{(2\beta-2)k_r + k_1^2\theta^2} \tag{17}$$

From this, we can see that under the operation mode of new retail-based fresh food e-commerce, the optimal price is the same as that of online and offline channels, and the effort level of fresh preservation is the same.

2.3 Optimal Decisions Under Different Modes of Operation

The first two sections respectively solve the optimal decision of the platform-based fresh food e-commerce operation mode and the new retail-based fresh food e-commerce operation mode, and obtain the optimal fresh-keeping effort, optimal pricing, optimal demand and optimal profit of the two modes. This section makes a comparative analysis of the optimal decision of the two modes of operation, so as to draw some conclusions. (1) Compared with the new retail fresh food e-commerce supply chain, the platform fresh food e-commerce supply chain has a loss of offline sales price and a loss of online consumer demand. (2) Compared with the new retail mode, the online and offline fresh preservation efforts of the platform mode are lost. (3) Compared with the new retail mode, the overall profit of the platform mode decreases, which indicates that there is a double marginal effect in the platform fresh food e-commerce supply chain, that is because both the fresh seller and the third-party e-commerce platform take the maximization of their own interests as the premise. Therefore, it is necessary to coordinate and optimize the operation mode of platform fresh food e-commerce.

2.4 Construction of Coordination Mode

Due to the fact that the new retail-based fresh food e-commerce operation mode is a relatively ideal state, while the platform-based fresh food e-commerce operation mode with fresh food sellers as the main body can only rely on the online sales channels of third-party e-commerce platforms, there will be dual marginal effects, which will damage the overall revenue of the supply chain. If we set the total revenue of the platform based fresh food e-commerce supply chain under the new coordination contract to be equal to the total revenue under the new retail mode, and the revenue of fresh food sellers and third-party e-commerce platforms increases simultaneously, that is, achieving Pareto improvement, then as rational supply chain members, they will voluntarily fulfill this contract. Therefore, we assume that fresh food sellers will actively bear a certain proportion of the cost of preservation efforts on third-party e-commerce platforms. At the same time, fresh food sellers will provide a fixed fee to third-party e-commerce platforms to ensure that they can provide a better online sales channel for preservation efforts. The cooperation between fresh food sellers and third-party e-commerce platforms can not only stimulate their enthusiasm, but also adjust their profit levels, continuously optimizing the entire supply chain. At this point, the dual channel decision-making mode corresponding to the platform-based fresh food e-commerce operation mode is:

Profit of the third-party platform under the coordination mode:

$$\pi_p^g = \alpha p_1 d_1 - (1-\varepsilon)c_1 + F \tag{18}$$

Profit of fresh food sellers under the coordination mode:

$$\pi_s^g = (1-\alpha)p_1 d_1 + p_2 d_2 - \varepsilon c_1 - c_2 - F \tag{19}$$

And the constraint condition is required:

$$S.t. \begin{cases} \pi_p^g \geq \pi_p^e \\ \pi_s^g \geq \pi_s^e \end{cases} \tag{20}$$

According to the backward solution method, the optimal decision solution of the platform fresh food e-commerce supply chain under the coordination mode can be obtained as follows:

$$\varepsilon = 1 - \alpha \tag{21}$$

There is a fixed cost that enables the coordination of the platform based fresh food e-commerce supply chain, and the value of the fixed cost will be determined by the bargaining power of both coordinating parties. Fresh food sellers and third-party e-commerce platforms can negotiate and adjust the relative proportion of fixed costs, which can encourage both parties to freely allocate and coordinate the increased profits of this supply chain before and after.

$$\begin{aligned} &-\frac{(\theta\delta_0+m)^2\left(E_1k_r-\theta^2(\alpha-1)k_1^2\right)\alpha\left(E_2k_r^2+E_3k_1^2k_r-\frac{3k_1^4\alpha\theta^4(\alpha-1)}{2}\right)k_r}{\left(a^2\beta^2-4\alpha\beta^2+4\beta^2+4\alpha-4\right)k_r^2-4(-1+\alpha)k_1^2\theta^2(\alpha+1/2)k_r+2k_1^4\alpha\theta^4(-1+\alpha)} \\ &+\frac{\alpha k_r(\theta\delta_0+m)^2}{(4\beta-4)k_r+2k_1^2\theta^2}\le F\le\frac{(\alpha-2)k_r(\theta\delta_0+m)^2}{(4\beta-4)k_r+2k_1^2\theta^2} \\ &+\frac{\left[(\alpha-2)(\beta+1)k_r+k_1^2\theta^2(\alpha+1)/2\right](\theta\delta_0+m)^2k_r(\alpha-1)}{\left(a^2\beta^2-4\alpha\beta^2+4\beta^2+4\alpha-4\right)k_r^2-4(-1+\alpha)k_1^2\theta^2(\alpha+1/2)k_r+2k_1^4\alpha\theta^4(-1+\alpha)} \end{aligned} \tag{22}$$

By coordinating with fresh food sellers to take the initiative to bear the cost of fresh preservation efforts on third-party e-commerce platforms, while ensuring that the platforms provide optimal online sales channels for fresh preservation efforts, fresh food sellers offer a fixed fee to support the quality of fresh preservation efforts. This supply chain coordination mechanism of cost sharing and fixed compensation promotes effective collaboration between fresh food sellers and third-party e-commerce platforms. As a result, it effectively enhances the profits of both parties and elevates the overall profit level of the supply chain to that of the new retail fresh food e-commerce operation mode.

3 Verification of Coordination Mechanism

According to the parameter assignment provided by scholars Ding Jie et al. [11] in their article, assign certain numerical values to the variables involved in the article. The specific parameter values are shown in Table 2, and based on this, a detailed case analysis is conducted on the optimal decision.

Table 2. Parameter values

Variable	m	α	δ_0	θ	β	k_1	k_r
Assignment	100	0.3	1	10	0.3	0.5	100

3.1 Optimal Decision Analysis

In this section, we use Maple software to calculate and obtain the optimal pricing, optimal fresh-keeping level, optimal demand and optimal profit of the two operation modes, as shown in Table 3.

Table 3. Comparison of optimal decision making

Optimal decision	Optimal pricing	Optimal freshness level	Optimal demand	Optimal demand
Platform-based operation mode	$p_1^e = 95.132$	$r_1^e = 1.427$	$d_1^e = 49.177$	$\pi^e = 9946.262$
	$p_2^e = 90.581$	$r_2^e = 4.529$	$d_2^e = 70.604$	
New retail-type operation mode	$p_1^f = 95.652$	$r_1^f = 4.783$	$d_1^f = 66.957$	$\pi^f = 10521.739$
	$p_2^f = 95.652$	$r_2^f = 4.783$	$d_2^f = 66.957$	

From the table, it is apparent that in the platform's fresh operation mode, both the fresh food sellers and the third-party e-commerce platform prioritize their own interests and are reluctant to invest significantly to guarantee the quality of fresh agricultural products. Consequently, even if prices are lowered, they fail to meet consumers' expectations for high-quality fresh agricultural products. This ultimately results in a decline in the overall profit of the supply chain.

3.2 Verification of Coordination Mechanism

When other parameters are determined, we discuss the influence of the coefficient of preservation effort on preservation costs on the upper and lower limits of fixed compensation costs. At the same time, considering the limitations of certain conditions that the equilibrium solution needs to meet in the previous text, in order to ensure the rationality of the final result, the range of the coefficient of preservation effort on preservation costs is set to $50 < k_r < 200$.

From Fig. 2, it is evident that there is an optimal interval for the fixed compensation costs obtained by third-party e-commerce platforms. Additionally, as the impact coefficient continues to increase, the upper limit of fixed compensation costs decreases. This implies that as the impact of preservation efforts on costs increases, fresh food sellers can provide lower fixed compensation costs. As fresh food sellers are important stakeholders, they consider their own interests and respond to market changes when determining compensation costs in order to balance their own losses. Lastly, it was discovered that the lower limit of the fixed compensation fee falls in the negative range within a certain impact coefficient range. This suggests that when fresh food sellers share the cost of freshness preservation efforts on third-party e-commerce platforms, if the sharing ratio sufficiently meets the optimal profit increase of the third-party e-commerce platform, they may not need to provide compensation fees. Consequently, the existence and amount of compensation fees are determined by the bargaining power of both parties.

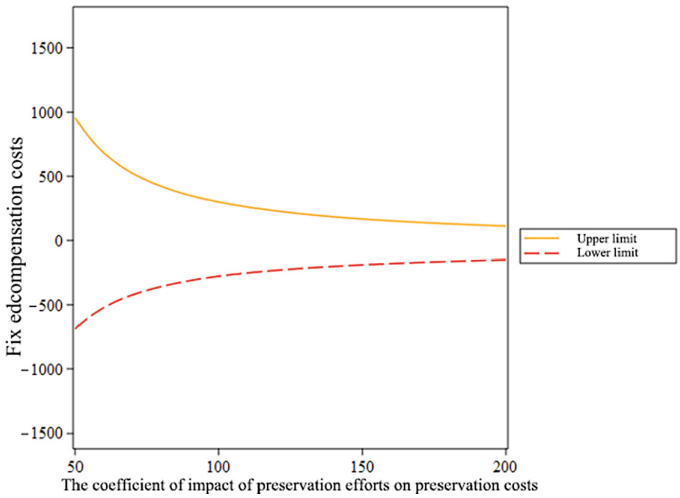

Fig. 2. The impact of changes in k_r on the upper and lower limits of fixed compensation costs

4 Conclusions

Based on the previous scholars' research on the operation mode of the current fresh ecommerce industry, this paper focuses on the optimal decision-making relationship among pricing, demand and profit of the two most popular operation modes of fresh food e-commerce supply chain, and constructs the contract coordination mode for the one with low overall benefit of the supply chain. In order to meet the development needs of fresh food e-commerce industry under the current new retail background, so as to improve the overall profit of the supply chain.

First of all, in the process of studying the new retail mode, it is found that the online and offline sales prices are the same, and the effort level of fresh preservation is the same [16]. This shows that in the context of new retail, fresh food e-commerce enterprises pay equal attention to online and offline sales channels, and do not prefer a single channel. Secondly, in the comparative analysis of the platform mode and the new retail mode of fresh food e-commerce, it is found that under the new retail mode of fresh food e-commerce, fresh food e-commerce enterprises are more sensitive to the perception of consumers' demand for fresh agricultural products, and can respond quickly to ensure consumers' demand for freshness of agricultural products. This shows that fresh food e-commerce enterprises should focus on consumers' demand for freshness of fresh agricultural products and pay attention to the concept of green health, which can bring more benefits. Finally, in the process of optimizing and coordinating the platform mode, it is found that if the fresh food e-commerce enterprises and the third-party e-commerce platform can deeply cooperate and encourage each other, they can effectively coordinate the benefits of both sides, and then improve the overall benefits of the supply chain.

However, this article only designed two typical operation modes of fresh e-commerce supply chain modes that consider preservation efforts in the context of new retail, and

constructed a coordination contract mode for the operation mode with lower overall efficiency of the supply chain, ultimately enabling continuous coordination and optimization of the supply chain. Moreover, author has simplified and idealized the construction of the supply chain mode, and have not included important supply chain members such as third-party logistics platforms and suppliers in the mode construction, which makes the mode research in this article lack comprehensive exploration. In future research, suppliers, third-party logistics enterprises, and other members can be introduced into the supply chain to explore more comprehensive and practical supply chain modes. At the same time, platform service level, logistics distribution level, and consumer timeliness of agricultural products can be added to further explore the operation mode of the fresh e-commerce industry.

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