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Original Paper

Research on Optimization of Compensation Strategy for Online Retailers of Fresh Agricultural Products Considering Spoilage Rate

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Abstract

In the context of the rural revitalization strategy, online retail of fresh agricultural products has developed rapidly. However, the loss caused by the perishability of products and consumer dissatisfaction have become key pain points restricting the industry's development. To balance consumer satisfaction and retailer profits, this paper aims to explore the differences in optimal pricing and profit decisions between online retailers adopting and not adopting compensation strategies in the face of product spoilage. The article constructs a mathematical model based on the spoilage rate, deriving the retailer's expected profit functions under the "no compensation strategy" and "with compensation strategy" scenarios, respectively. It analyzes the impact of spoilage rate on pricing, compensation amount, and market demand through numerical simulation. The research findings are as follows: First, compensation strategies are not applicable in all scenarios, exhibiting a significant threshold effect of spoilage rate; Second, when the spoilage rate is below the threshold (approximately 0.69), compensation strategies can effectively increase sales and profits, but they will push up the selling price; Third, when the spoilage rate exceeds the threshold, compensation strategies instead lead to a decline in profits and shrinking sales.

Keywords

fresh agricultural products, spoilage rate, online retailers, compensation strategies

1. Introduction

1.1 Research Background

Since the "Rural Revitalization Strategy" was officially proposed at the 19th National Congress of the

Communist Party of China in 2017, China's work related to "agriculture, rural areas, and farmers" (referred to as "three rural issues") has entered a new era. With the continuous efforts of the Chinese people, the current rural revitalization strategy has entered a phase of comprehensive implementation and promotion, with consolidating the achievements of poverty alleviation and vigorously promoting agricultural and rural modernization becoming core tasks. Against this backdrop, more and more rural and township enterprises are venturing into e-commerce platforms, leveraging their unique regional resources to vigorously develop rural e-commerce. Public data shows that China's rural online retail sales have experienced explosive growth, jumping from 353 billion yuan in 2015 to 2.56 trillion yuan in 2024. At the same time, the promulgation of the "Law of the People's Republic of China on Promoting Rural Revitalization" and a series of policy supports such as the implementation opinions jointly issued by the Ministry of Commerce and other eight departments have provided a solid institutional guarantee for the upward movement of agricultural products.

Fresh food retailing, a fundamental industry for people's livelihood, is undergoing a transformation from "scale expansion" to "high-quality growth". In 2024, the market size of fresh food retailing in China reached 6.57 trillion yuan, and it is expected to reach approximately 7.2 trillion yuan in 2026, representing a year-on-year growth of 4.7%. However, unlike other categories, fresh food products exhibit notable characteristics such as perishability, strong timeliness, and high dependence on cold chain logistics. During the lengthy logistics journey, due to uncontrollable factors such as transportation duration and temperature fluctuations, it is difficult to completely avoid product spoilage and loss. According to data from the Ministry of Agriculture and Rural Affairs, the loss rate of fresh agricultural products in circulation in China is as high as 20% to 30%. This characteristic often leads to discrepancies between what consumers receive and their expectations (such as decreased quality and damaged appearance), which in turn can trigger dissatisfaction, negative reviews, and even customer loss.

Facing the dual pressures of high losses and customer complaints, online retailers urgently need to explore effective coping mechanisms. Currently, some e-commerce platforms (such as JD.com's fresh food self-operated area) have clearly stated the rule that "fresh food products do not support 7-day unconditional returns, and compensation is only provided for damaged fruits." They have also widely adopted compensation strategies: when consumers are dissatisfied with the product but do not meet the return criteria, merchants offer a certain percentage of discount, partial refund, or coupon compensation. This strategy is essentially a variant of "discounted sales" aimed at balancing merchant costs and consumer satisfaction. However, most existing research has considered the actual return situation, lacking systematic mathematical analysis of the specific situation of "no refund, only compensation." Especially in the context of rural revitalization, how to quantify the impact of compensation strategies on online retailers' profits, pricing decisions, and market demand has become an urgent practical issue to address.

1.2 Research Question and Purpose

Based on the aforementioned background, this paper takes online retailers of perishable fresh agricultural products as the research subject, constructing a mathematical model to delve into the merits and demerits of compensation strategies. The purpose of this study is to address the following core questions:

(1) Compared to not adopting compensation strategies, can implementing compensation strategies significantly enhance the expected profits of online retailers?

(2) How does compensation strategy affect the optimal pricing decision of online retailers?

(3) How does the effectiveness of compensation strategies (profit, demand) change as the product spoilage rate varies?

(4) At what range of spoilage rates should online retailers choose to adopt compensation strategies?

By addressing the aforementioned questions, this paper aims to unveil the intrinsic relationship among spoilage rate, compensation intensity, and operational performance, thereby providing theoretical support for the operation and decision-making of fresh food e-commerce platforms.

1.3 Significance of the Study

In terms of theoretical significance, this study enriches the theoretical research on pricing and compensation optimization for online retailers of fresh agricultural products. While existing literature has primarily focused on return policies, this paper specifically focuses on the niche scenario of "no return, only compensation," thereby expanding the application research of compensation strategies in the perishable goods sector. In terms of practical significance, firstly, this study provides scientific decision-making references for fresh food e-commerce enterprises. The research conclusions can assist merchants in determining whether to activate the compensation mechanism under specific levels of loss, and how to set the optimal compensation amount to maximize profits. Secondly, it contributes to rural revitalization and the upward circulation of agricultural products. By optimizing after-sales mechanisms, consumer concerns can be alleviated, and purchasing willingness can be enhanced, thereby facilitating the smooth sales of high-quality agricultural products in remote areas. Thirdly, it improves the consumer experience and industry ecology. Reasonable compensation strategies can effectively mitigate consumer disputes while controlling merchant costs, enhance consumer satisfaction, and promote the healthy and sustainable development of the fresh food e-commerce industry.

1.4 Research Methods and Thesis Structure

This paper adopts a research methodology combining mathematical modeling and numerical simulation. Firstly, it constructs market demand functions, expected profit functions, and consumer dissatisfaction functions under both scenarios: with and without compensation strategies. Secondly, it derives the optimal pricing decisions and equilibrium results for each scenario, and through numerical examples, compares and analyzes the differences in the impact of changes in spoilage rates on profits, prices, and dissatisfaction levels under the two strategies. Finally, it draws inferences and provides pricing and management insights for online retailers.

The structure of the rest of this paper is as follows: Section 2 introduces relevant literature; Section 3 explains model assumptions and parameters, constructs the model for solving, and presents the optimal decision variables and equilibrium results under two scenarios; Section 4 visually demonstrates the impact of decay rate on key indicators through simulation experiments; and Section 5 summarizes the research content of the entire paper.

2. Literature Review

2.1 Research on Spoilage and Pricing Strategies of Fresh Agricultural Products

Fresh agricultural products have their uniqueness in supply chain management due to their perishability. Existing research generally suggests that consumers' demand for fresh products is not only influenced by price, but also strongly depends on their perceived freshness, which is directly determined by the decay rate of the product or the time it spends in transit.

At the fundamental demand modeling level, numerous studies have confirmed that consumers' demand for fresh produce is not solely determined by price, but is also strongly influenced by their perceived freshness, which is directly dictated by the spoilage rate (or product age). Kaya and Bayer (Kaya & Bayer, 2017) constructed a bivariate age-price stochastic demand function, explicitly stating that as time progresses, the decline in product freshness leads to a significant reduction in demand at the same price. In response to this challenge, decreasing pricing has become mainstream. Research by Xu (2023) focused on the cooperation model between e-commerce platforms (such as JD.com and Amazon) and fresh produce suppliers, finding that the time-based price reduction policies implemented by the platforms can effectively address the issue of product quality declining over time. Specifically, a premium price is set when the product is at its freshest, followed by a tiered price reduction based on the remaining shelf life and inventory level, in order to accelerate the turnover of products nearing expiration. However, the effectiveness of such strategies heavily relies on accurate predictions of the spoilage process.

In addition, how to control the decay process itself is also a research hotspot. Iqbal (2024) proposed treating the decay rate as a controllable variable, arguing that by optimizing cold chain storage conditions or using preservation techniques, the effective lifespan of products can be actively extended, thereby creating a time window for maintaining high prices. In summary, existing literature has fully demonstrated the negative impact of decay rate on pricing and demand, but it mostly focuses on addressing it through "price promotions" or "preservation technologies", with few studies exploring the use of "after-sales compensation" as a service strategy to offset the negative effects of decay.

2.2 Research on Compensation Strategies and Return Policies

Research by Rokonuzzaman and Lyer (2020) indicates that a no-questions-asked return policy can significantly reduce consumers' perceived risk, enhance their trust in online retailers, and subsequently improve purchase conversion rates and customer satisfaction. This effect is particularly pronounced in high-uncertainty product categories, such as clothing and cosmetics, where consumers cannot directly

experience product quality before making a purchase. However, research by Khoujia (2023) also points out that the return rate for e-commerce is generally as high as 20-30%, significantly higher than that of physical stores. This includes a large number of non-quality-related returns due to impulse purchases or opportunistic behavior, which incurs substantial hidden costs for merchants.

To balance consumer experience and operational costs, the academic community has proposed various compensation strategy models. Among them, Return Shipping Insurance (RSI) is one of the most widely adopted mechanisms. Yiming Li and Gang Li's research (2021) distinguished between two models: free RSI (where the retailer bears the insurance premium) and paid RSI (where the consumer pays the insurance premium), and analyzed their impacts on return rates and pricing strategies. Based on this, Boshi Tian (2025) found that on Chinese e-commerce platforms (such as Taobao and JD.com), while free RSI increases operational costs, it effectively screens out consumers with genuine return needs, reducing the behavior of "forcing retention" due to concerns about shipping fees, thereby enhancing the overall customer experience.

Although return shipping insurance can provide consumers with a better shopping experience, such a strategy does not reduce the return rate. Merchants still have to deal with returned goods, which undoubtedly incurs greater hidden costs for them. Therefore, some e-commerce platform merchants adopt a strategic compensation approach, such as issuing consumer vouchers or providing partial cash compensation. Through such compensation, consumers are encouraged to voluntarily give up returning goods when they are dissatisfied with the product. Li Jianbin et al. (2026) constructed a mathematical model and concluded that a monopoly manufacturer's strategy of increasing return compensation on the basis of promising no-reason returns can reduce the product return rate and increase the manufacturer's profits. However, existing research on "compensation strategies" is mostly based on the assumptions of "actual returns occurring" or "non-perishable products," and there is still insufficient discussion on the specific scenario of "no returns, only compensation (discount)" in fresh food e-commerce.

2.3 Literature Review and Direction Orientation

By reviewing existing literature, it can be found that: firstly, in the field of fresh food pricing, research has mostly focused on how to address spoilage losses through price adjustments or preservation techniques, neglecting the use of after-sales services (compensation) to recover customer losses caused by spoilage; Secondly, in the field of compensation strategies, research has mostly been based on traditional e-commerce's full refund policy or manufacturing's recycling model, lacking analysis specific to the specific situation of fresh agricultural products where "spoilage leads to dissatisfaction but no refund".

With the advancement of the rural revitalization strategy, the scale of online retail sales of fresh agricultural products continues to expand. Against this backdrop, consumers' demands for service quality are increasing, while the high spoilage rate of fresh produce is unavoidable. Therefore, how to quantify the application effect of the "no return, only compensation" strategy in perishable fresh food

e-commerce, especially analyzing the joint impact of spoilage rate and compensation intensity on retailer pricing and profit, remains an unexplored research gap in existing literature.

Based on this gap, this article constructs a mathematical model to compare and analyze the decision-making differences between online retailers adopting and not adopting compensation strategies, aiming to provide a theoretical basis for the refined operation of fresh food e-commerce.

3. Model Construction and Notations Explanation

3.1 Symbol Description and Assumptions

The research object of this article is some online retailers of rural revitalization products (fresh produce and agricultural products). Compared to other online retailers, due to the perishability of the goods, these online retailers experience a certain percentage of loss in the forward logistics after consumers' purchase. If consumers return the goods, there is also loss during the reverse logistics process, resulting in a low residual value being recovered, making it difficult for the online retailers to dispose of or resell them. Therefore, most online retailers of fresh produce and agricultural products do not adopt a return policy. Instead, when consumers are dissatisfied with the goods or the goods have already suffered some damage by the time they reach the consumers, the online retailers offer certain compensation, which is equivalent to "selling at a discount". Through such compensation strategies, consumer complaints and reputation loss for the online retailers are reduced.

Based on the above background and references from Shan et al. (2016), the following assumptions are made to simplify the model:

(1) In the model, there is only one online retailer and a group of heterogeneous consumers, and the online retailer only sells one product;

(2) Consumers have fully understood the perishability of the product and the compensation strategy of the merchant before making a purchasing decision;

(3) In the context of compensation strategy, consumers will apply for compensation for the spoiled part. Since there is no return policy, consumers will accept any compensation offered by the online retailer. Even if the product is not spoiled, there will still be opportunistic consumers who will demand compensation from the online retailer.

(4) The shipping costs for products purchased by consumers are borne by the online retailer. Apart from compensation values, all other expenses incurred by the online retailer are consolidated as costs.

The notations and their explanations are shown in Table 1.

Table 1. Notations Explanation

Variable	Meaning
p	The price of the goods
r	When consumers are dissatisfied with the product (due to spoilage, low quality,

	etc.), the compensation offered by the online retailer
c	Various costs of online retailers
θ	Commodity spoilage rate
i	Two types of strategic scenarios,$i \in \{1,2\}$

3.2 Demand Function

Based on the research model proposed by Xiong et al. (2024), this paper assumes that market demand is uncertain. Without considering the impact of return compensation on demand, a basic demand function is constructed using a linear model as follows:

$$q = a - b\,p + \varepsilon \tag{1}$$

Based on this, it is assumed that the better the compensation policy provided by an online retailer, the greater the market demand it attracts, expressed as:

$$q_0 = \omega r \tag{2}$$

Where is ω the sensitivity coefficient of market demand to compensation policy. This paper assumes ω>0.

In equation (1), qrepresents the demand function of online retailers, which is the basic market demand and is not affected by price and compensation; bis the sensitivity coefficient of commodity demand to commodity price, and is a random disturbance term that follows an upper-symmetric uniform distribution, representing other factors that may affect demand, such as policies and public opinion. This paper assumes that b>0.

3.3 Dissatisfaction Quantity Function

Referring to the return function in the study by Li et al. (2013), this paper constructs a similar linear function to represent the total unit quantity of consumer applications for dissatisfaction compensation:

$$R = d + \mathrm{h}\,r \tag{3}$$

In equation (3), represents the portion of the product that consumers are dissatisfied with and require compensation for after receiving it, such as partially spoiled fruits, for which online retailers will provide compensation. d is represents the basic or inherent dissatisfaction level, which not dependent on the quality or compensation value but solely related to the characteristics of the product, such as poor taste or flavor, or discrepancies between the shape and packaging display. h represents the sensitivity of dissatisfaction level to compensation policy: the higher the compensation value, the higher the dissatisfaction level. This paper assumes d>0 that all and and h>0 are true simultaneously.

3.4 Model

To compare the revenue of online retailers before and after the introduction of compensation strategies, it is necessary to consider the scenario where online retailers do not adopt strategic compensation. Therefore, this paper distinguishes between two scenarios: one where online retailers do not adopt strategic compensation and another where they do.

1. Online retailers do not adopt compensation strategies

When online retailers do not adopt compensation strategies, consumers cannot obtain corresponding compensation when they are dissatisfied with the products, and online retailers will not incur compensation expenses during the sales process. At this time, the sales volume of online retailers is:

$$q_1=a-bp_1+\varepsilon \tag{4}$$

The profit function of an online retailer is:

$$\pi_1=(p_1-c)q_1 \tag{5}$$

namely $\pi_1=(p_1-c)(a-bp_1+\varepsilon)$

At this point, the second derivative of the profit function of the online retailer with respect to price p_1 is $\frac{\partial^2\pi_1}{\partial p_1^2}=-2b<0$, indicating that the profit of the online retailer has a maximum value. According to the principle of profit maximization, let $\frac{\partial\pi_1}{\partial p_1}=bc-2bp_1+a+\varepsilon=0$ to obtain the optimal selling price of the online retailer's product:

$$P_1^*=\frac{cb+a+\varepsilon}{2b} \tag{6}$$

By substituting expression (6) into expressions (5) and (4), we obtain the expected market demand and the expected profit of the online retailer at this time, respectively:

$$E\left[q_1^*\right]=-\frac{cb}{2}+\frac{a}{2} \tag{7}$$

$$E\left[\pi_1^*\right]=\frac{3b^2c^2-6abc+A^2+3a^2}{12b} \tag{8}$$

In this scenario, the number of potentially dissatisfied consumers equals the amount of spoiled products plus the inherent dissatisfaction, expressed as:

$$R_1=\left(-\frac{cb}{2}+\frac{a}{2}\right)\theta+d \tag{9}$$

We can then calculate the dissatisfaction rate of consumers in scenario one:

$$\Gamma_1^*=\frac{\left(\frac{cb}{2}+\frac{a}{2}\right)\theta+d}{\frac{cb}{2}+\frac{a}{2}} \tag{10}$$

2. Online retailers adopt compensation strategies

When online retailers adopt compensation strategies, consumers can apply to the online retailers for compensation for unsatisfactory units, resulting in compensation expenses beyond costs incurred during the sales process. At this point, the sales volume of the online retailer consists of the basic sales volume plus the incremental sales volume brought about by the adoption of compensation strategies:

$$q_2=a-bp_2+\varepsilon+\omega r \tag{11}$$

The unit amount of compensation for consumer dissatisfaction is the inherent dissatisfaction plus the increase in dissatisfaction units brought by the compensation value, as well as the spoiled portion of the product:

$$R_2=d+\mathrm{h}r+(-bp_2+\omega r+a+\varepsilon)\theta \tag{12}$$

The profit function of an online retailer is:

$$\pi_2=(p_2-c)q_2-rR_2 \tag{13}$$

Namely $\pi_2=(p_2-c)(-bp_2+\omega r+a+\varepsilon)-r(\mathrm{h}r+(-bp_2+\omega r+a+\varepsilon)\theta+d)$

Proposition 1: In scenario two, when $\sqrt{b^2\theta^2+\omega^2\theta^2+2\mathrm{h}\omega\theta+b^2-2b\mathrm{h}+\mathrm{h}^2+\omega^2}<\omega\theta+b+\mathrm{h}$, the profit of the online retailer is a strictly concave function of the product priceπ_2 and the compensation value.

Proof: Based on the profit function of online retailers, we can obtain$\frac{\partial^2\pi_2}{\partial p_2^2}=-2b<0$, $\frac{\partial^2 r}{\partial R^2}=-2\omega\theta-2\mathrm{h}<0$, and further derive the Hessian matrix of the profit function of online retailers with respect to the sales pricep_2 and compensation valuer:

$$\begin{bmatrix} -2b & b\theta+\omega \\ b\theta+\omega & -2\omega\theta-2\mathrm{h} \end{bmatrix} \tag{14}$$

According to the properties of matrices, when the second-order Hessian matrix is negative definitely, it is a strictly concave function with respect to π_2 and r, and there exists an optimal solution. Secondly, calculate the first partial derivative of with respect to p_2 and r, we obtain:

$$\frac{\partial\pi_2}{\partial p_2}=rb\theta+cb-2bp_2+\omega r+a+\varepsilon \tag{15}$$

$$\frac{\partial\pi_2}{\partial r}=bp_2\theta-2\omega r\theta-a\theta-c\omega-2\mathrm{h}r+\omega p_2-\theta\varepsilon-d \tag{16}$$

Finally, by solving the simultaneous equations $\frac{\partial\pi_2}{\partial p_2}=0$, $\frac{\partial\pi_2}{\partial r}=0$, we obtain the optimal pricing and compensation value for the scenario where the online retailer adopts a compensation strategy:

$$p_2^*=\frac{ab\,\theta^2-bc\omega\theta+b\,\theta^2\varepsilon-a\omega\theta-2bc\mathrm{h}+bd\theta+c\,\omega^2-\omega\theta\varepsilon-2a\mathrm{h}+d\omega-2\mathrm{h}\varepsilon}{b^2\theta^2-2b\omega\theta-4b\mathrm{h}+\omega^2} \tag{17}$$

$$r^*=\frac{-b^2c\theta+ab\theta+bc\omega+b\theta\varepsilon-a\omega+2bd-\omega\varepsilon}{b^2\theta^2-2b\omega\theta-4b\mathrm{h}+\omega^2} \tag{18}$$

Substituting equations (17) and (18) back into equations (11) and (13), we obtain the expected market demand and the profit of the online retailer in scenario two:

$$E\left[q_2^*\right]=-\frac{b(-2bc\mathrm{h}+bd\theta+2a\mathrm{h}-d\omega)}{b^2\theta^2-2b\omega\theta-4b\mathrm{h}+\omega^2} \tag{19}$$

$$E\left[\pi_2^*\right]=\frac{(-c^2\mathrm{h}+cd\theta)b^2+\left(-d^2+(-\theta a-\omega c)d+2ac\mathrm{h}\right)b+ad\omega-\mathrm{h}\left(a^2+\frac{A^2}{3}\right)}{b^2\theta^2+(-2\omega\theta-4\mathrm{h})b+\omega^2} \tag{20}$$

The expected compensation unit amount at this time is:

$$E[R_2]=\frac{b^2c\mathrm{h}\theta+\left((-\theta a+\omega c-2d)\mathrm{h}-d\omega\theta\right)b-\omega(a\mathrm{h}-d\omega)}{b^2\theta^2+(-2\omega\theta-4\mathrm{h})b+\omega^2} \tag{21}$$

Finally, it is concluded that under the situation where online retailers adopt compensation strategies, the consumer dissatisfaction rate is the ratio of the unit amount of compensation applied by consumers to the expected sales volume of the merchant:

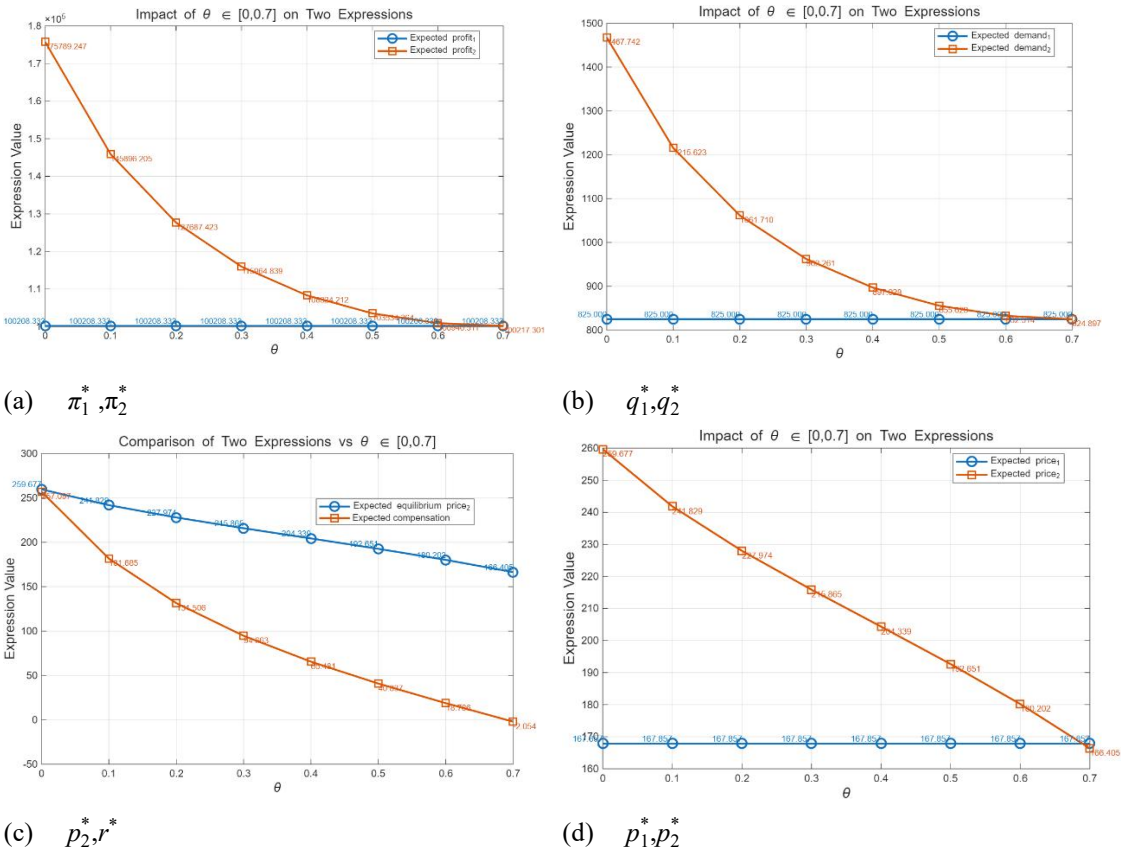
$$\Gamma_2=\frac{-c\mathrm{h}\theta\,b^2+ab\mathrm{h}\theta-bc\mathrm{h}\omega+bd\omega\theta+a\mathrm{h}\omega+2bd\mathrm{h}-d\,\omega^2}{b(-2bc\mathrm{h}+bd\theta+2a\mathrm{h}-d\omega)} \tag{22}$$

4. Model comparison and analysis

Due to the complexity of the expressions, it is difficult to directly obtain the comparative results of the profits, sales volumes, and optimal pricing of online retailers under the two scenarios. In this paper, we employ numerical examples for comparative analysis and utilize MATLAB R2025a for data analysis. Based on the research conducted by Xiong et al. (2024), a set of data was selected as exogenous market parameters as shown in Table 2 to investigate the impact of decay rate:

Table 2. Exogenous Market Parameters

Parameter	a	b	c	ω	A	d	h
Numerical value	2000	7	50	5	500	20	2



(a) π_1^*, π_2^* (b) q_1^*, q_2^*

(c) p_2^*, r^* (d) p_1^*, p_2^*

Figure 1. Comparison of Profits, Selling Prices, Sales Volumes, and Compensation Values of Online Retailers under Two Strategies

The data comparison and analysis are shown in Figure 1.

All the exogenous market parameters mentioned above satisfy the conditions outlined in Section 3. To ensure that the compensation value for online retailers is meaningful, i.e., non-negative, it is stipulated

that 0 ≤θ≤0.7... From the figure, several observations can be drawn.

It is evident from the figure $\pi_2^*>\pi_1^*$ that we can draw the following conclusion: Observation 1: Compensation strategies can increase the profits of online retailers. As the decay rate increases, the profits of online retailers adopting compensation strategies gradually decrease. An increase in the decay rate will increase the compensation costs borne by online retailers, thereby reducing their profit levels. When θ exceeds a certain critical value (approximately 0.7), compensation strategies are no longer economically feasible.

Observation 2: When the decay rate is low (θ<0.6895), online retailers adopting compensation strategies will set higher selling prices than those not adopting such strategies. At this time, online retailers will add their own compensation costs to the selling price and ultimately pass them on to consumers. When the decay rate exceeds a threshold (θ>0.6895), online retailers adopting compensation strategies will set lower selling prices than those not adopting such strategies. At this time, a high decay rate will bring a large number of compensation applications to online retailers. To reduce compensation costs, online retailers can only lower their selling prices to suppress demand in order to control compensation expenses.

Observation 3: As the decay rate increases, the difference between the selling price and the compensation value of online retailers adopting compensation strategies will continue to grow, reflecting that retailers are forced to compress their profit margins to maintain the effectiveness of the strategy. When the decay rate is low, consumers who apply for unsatisfactory compensation are often opportunistic consumers, accounting for a very small proportion of the total consumer base. At this time, the higher unit compensation cost expenditure has no significant impact on the profits of online retailers. However, the price pressure brought about by the increase in decay rate will significantly reduce the profits of online retailers. Online retailers can only maintain their profits by reducing compensation costs more significantly than if they do not adopt compensation strategies, making the compensation strategy meaningful.

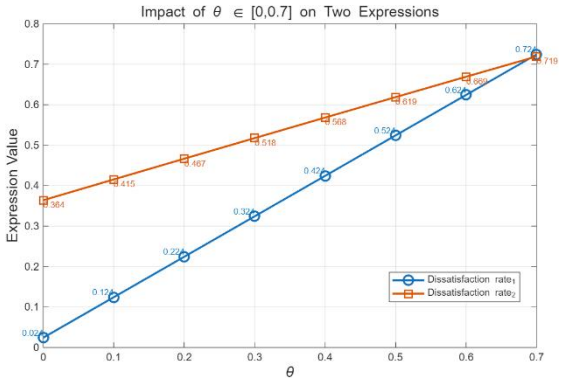


Figure 2. (Potential) Dissatisfaction Rate of Consumers under Two Strategies

Observation 4: The promotional effect of compensation strategies on sales has a clear decay rate

threshold. When the threshold is exceeded, it turns into a negative impact. At θ<0.69865this time,$q_1^*<q_2^*$ compensation strategies can stimulate consumers' purchasing desire and increase product sales. When $\theta>0.69865$, the compensation value of online retailers is too low, the actual compensation value is lower than consumers' expectations, and the product selling price is also lower than that without compensation strategies, ultimately leading to a decline in product sales.

The comparison and analysis of dissatisfaction rates are shown in Figure 2.

Observation 5: At that time, it was always evident that offering compensation strategies when online retailers did not accept returns could not effectively reduce consumer dissatisfaction rates. Instead, it would stimulate consumers' opportunistic claims, exacerbating the burden on merchants. At that time, it was always the case$\Gamma_2<\Gamma_1$. By then, the rate of product spoilage had exceeded consumer expectations, making compensation a necessary means of appeasement. This strategy was more suitable for consumers.

5. Conclusion and Suggestions

This paper studies the after-sales compensation strategies of online retailers of perishable fresh agricultural products in the context of rural revitalization. By constructing a pricing and compensation decision-making model for online retailers that considers spoilage rates, and conducting a numerical analysis, the research reveals that: (1) Compensation strategies have a significant "double-edged sword" effect and applicable boundaries: compensation strategies do not necessarily improve retailer performance at all spoilage rates, but rather there is a critical spoilage rate threshold (approximately 0.69). When the spoilage rate is below this threshold, compensation strategies can effectively reduce consumers' perceived risk and stimulate demand growth, thereby increasing retailer profits; however, when the spoilage rate exceeds this threshold, high compensation costs will erode profit margins, and low compensation amounts fail to meet consumer expectations, leading to a decrease in both sales and profits. (2) Compensation strategies change the price formation mechanism: in the low spoilage rate range, retailers tend to pass the expected compensation costs onto consumers, resulting in product prices significantly higher than those without compensation; in the high spoilage rate range, retailers are forced to adopt low-price strategies to control demand scale in order to curb excessive compensation expenses; (3) Compensation strategies cannot directly reduce dissatisfaction rates and require prevention of speculative behavior: simulation results show that although compensation strategies can adjust sales volume through price leverage, they cannot substantially reduce the physical spoilage rate of products. In the low spoilage rate stage, compensation mechanisms may instead induce speculative claims by consumers (i.e., "fleece"), increasing the review and operational costs for merchants.

Based on the above conclusions, the following suggestions are proposed for the operational practices of online retailers of fresh agricultural products:

(1) Retailers should not blindly implement a uniform compensation policy for all products. It is

recommended to categorize products based on their real-time freshness status. For high-quality fresh produce with a long shelf life and a low spoilage rate, compensation strategies should be actively implemented to enhance consumer trust. For products nearing their expiration date or with a high spoilage rate, compensation strategies should be adopted with caution.

(2) Establish a dynamic pricing and compensation algorithm that automatically adjusts pricing and compensation based on real-time spoilage rates, ensuring that compensation costs are covered while maintaining a reasonable profit margin, and avoiding losses caused by delayed human-based pricing.

(3) Set a monthly compensation limit threshold. When compensation expenditure reaches or exceeds the threshold, online retailers should respond promptly, identify the sources of consumer dissatisfaction, promptly improve compensation policies, strengthen compensation review efforts, and reduce consumer speculative behavior.

Although a series of inferences have been drawn through mathematical models, there are still many deficiencies. This paper does not quantify the loss of business reputation caused by consumer dissatisfaction. However, in real life, a business's reputation directly affects future sales and indirectly impacts future profits. This is a direction worthy of exploration in future research. In addition, this paper only considers the single oligopoly scenario of a two-tier supply chain. In real life, there are often multiple e-commerce enterprises competing, and there are also scenarios involving a three-tier supply chain. In such cases, what would be the compensation strategy of the business? This is also a direction for future research.

References

Chang, X., Tijun, F., Qi, Z. et al. (2023). Contract selection for fresh produce suppliers cooperating with a platform under a markdown-pricing policy. *International Journal of Production Research*, *61*(11), 3756-3780.

Iqbal, W. M., Malik, I. A., Ramzan, B. M. et al. (2024). Consumer response to adjustable price and shelf-life of fresh food products under effective preservation policy. *Computers \& Industrial Engineering.*

Kaya, O., & Bayer, H. (2017). Pricing and lot-sizing decisions for perishable products when demand changes by freshness. *Journal of Industrial \& Management Optimization*, *13*(5), 0-0.

Li, J. B., & Li, Y. (2026). Optimal online pricing and compensation strategy in MBG returns policy. *Systems Engineering—Theory \& Practice*, *36*(11), 2811-2819.

Li, Y., Xu, L., & Li, D. (2023). Examining relationships between the return policy, product quality, and pricing strategy in online direct selling. *International Journal of Production Economics*, *144*(2), 451-460.

Md R., Pramod, I., & Ahasan, H. (2020). Return policy, No joke: An investigation into the impact of a retailers return policy on consumers decision making. *Journal of Retailing and Consumer Services*.

Moutaz, K., & Ramzi, H. (2023). Optimizing price, order quantity, and return policy in the presence of consumer opportunistic behavior for online retailers. *European Journal of Operational Research*, *309*(2), 683-703.

Shan, M. Y., Jiang, H. S., & Liu, X. H. (2016). Research on Profitability and Return Policy of Online Retailers. *East China Economic Management*, *30*(11), 123-128.

Tian, B., & Wang, H. (2025). E-coupon or return-freight insurance? Selection of the online retailer's return-freight compensation policy. *Electronic Commerce Research*, 1-23.

Xiong, S., & Zheng, D. (2024). Optimal Refund and Ordering Decisions for Fresh Produce E-Commerce Platform: A Comparative Analysis of Refund Policies. *Systems*, *12*(10), 393-393.

Xiong, S., & Zheng, D. (2024). Optimal Refund and Ordering Decisions for Fresh Produce E-Commerce Platform: A Comparative Analysis of Refund Policies. *Systems*, *12*(10), 393-393.

Yiming, L., Gang, L., Kumar, G. T. et al. (2021). Return shipping insurance: Free versus for-a-fee?. *International Journal of Production Economics*, *235*.