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Pricing and Coordination in a Fresh-Cut Flower Supply Chain with Freshness Preference and Presale Strategy

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ABSTRACT

Fresh-cut flowers are highly perishable products whose quality deteriorates rapidly over time, posing significant challenges to supply chain management. This paper investigates pricing and coordination strategies in a two-echelon fresh-cut flower supply chain consisting of one supplier and one e-commerce platform that operates a two-period selling model combining presale and spot sales. We develop Stackelberg game models that explicitly incorporate consumer freshness preference and freshness decay dynamics, and derive optimal pricing and freshness-keeping decisions under both decentralized and centralized decision-making structures. Our analysis reveals that the double marginalization effect becomes more pronounced as consumers become more sensitive to freshness, resulting in efficiency losses of 20%–30% under decentralized decision-making. We further demonstrate that increasing the presale proportion incentivizes greater freshness-keeping investment throughout the supply chain, as preselling reduces demand uncertainty and associated waste. To address the efficiency loss, we design a combined "revenue sharing and cost sharing" (RS-CS) contract and prove that perfect coordination is achieved when the cost-sharing ratio equals the revenue-sharing ratio and the wholesale price satisfies a specific compensation condition. Numerical experiments validate the model results and confirm the robustness of the coordination mechanism. This study provides both theoretical insights and practical guidance for fresh-cut flower supply chain management.

KEYWORDS

Fresh-cut flower supply chain; Presale strategy; Freshness preference; Stackelberg game; Supply chain coordination

1. INTRODUCTION

1.1. Research Background

The rapid expansion of e-commerce has transformed the global floriculture industry, with online flower platforms emerging as a major force driving the modernization and digital transformation of traditional flower supply chains. Leveraging the resource advantages of major flower-producing regions such as Yunnan Province in China, leading e-commerce platforms have achieved rapid cross-regional growth through digital technologies. However, the highly perishable nature and time sensitivity of fresh-cut flowers present formidable challenges to supply chain operations. In practice, insufficient standardization, limited cold chain logistics capacity, and information asymmetry contribute to persistently high wastage rates—often reaching 20%–30%—which not only cause direct economic losses but also severely undermine consumer satisfaction.

To mitigate inventory risks and enhance product freshness, many e-commerce platforms have adopted presale strategies, adopting a "production-to-order" approach to balance supply and demand while optimizing cold chain logistics efficiency. The presale model converts uncertain spot demand into confirmed advance orders, thereby reducing post-harvest losses at the source. However, the introduction of presale adds complexity to pricing decisions, as platforms must simultaneously determine presale and spot prices while accounting for freshness decay between the two selling periods. How to optimally price products across periods and coordinate the supply chain under freshness-sensitive consumer demand remains an open and practically relevant question.

1.2. Research Objectives and Contributions

This study aims to address the pricing and coordination challenges in fresh-cut flower supply chains by developing a mathematical model that incorporates consumer freshness preference and platform presale strategies. The specific objectives are: (1) to analyze how freshness decay influences consumer demand and supply chain members' decisions under a presale model; (2) to derive and compare optimal pricing and ordering strategies for the supplier and the e-commerce platform under decentralized and centralized decision-making; and (3) to design an effective supply chain coordination mechanism that resolves inter-member conflicts and achieves system-wide optimization.

This paper makes several contributions to the literature. First, we integrate the physical characteristic of freshness decay with the managerial lever of presale strategy, enriching the theoretical framework for perishable product supply chain management, particularly in the understudied fresh-cut flower sector. Second, we explicitly model the dual-period pricing problem with endogenous freshness-keeping effort, characterizing how the presale proportion affects both pricing and quality investment decisions. Third, we design a combined revenue-sharing and cost-sharing contract that achieves perfect supply chain coordination, and we characterize the Pareto-improving parameter range that ensures both parties benefit from collaboration.

1.3. Methodology and Paper Structure

This study employs a combination of game-theoretic modeling and numerical simulation. We use non-cooperative game theory to derive optimal decisions under different supply chain structures, and we apply contract theory to design coordination mechanisms. Numerical experiments conducted in MATLAB validate the theoretical results and provide sensitivity analyses of key parameters.

The remainder of this paper is organized as follows. Section 2 reviews the relevant literature. Section 3 describes the problem and presents the model formulation. Section 4 analyzes pricing decisions under decentralized and centralized strategies. Section 5 designs and analyzes the RS-CS coordination contract. Section 6 presents numerical experiments and sensitivity analysis. Section 7 concludes the paper with managerial insights and future research directions.

2. LITERATURE REVIEW

2.1. Fresh Produce and Floriculture Supply Chain Management

The perishability and time sensitivity of fresh agricultural products, including fresh-cut flowers, have been central concerns in supply chain research. Han [1] et al. (2025) observe that China's fresh produce supply chains face structural oversupply and high distribution costs, identifying digital transformation as the core pathway to enhancing supply chain resilience. In the floriculture sector specifically, Long (2024) documents that flower supply chains exhibit high wastage rates (20%–30%) and are subject to severe seasonal fluctuations, with the lack of standardized management severely constraining industrial upgrading [2].

Regarding freshness maintenance, scholars have explored investment strategies from multiple perspectives. Yang [3] et al. (2023) analyze financing and operational decisions for small and micro enterprises under freshness-keeping effort costs, finding that the market freshness sensitivity coefficient directly determines firms' investment levels. Wu [4] et al. (2025) further examine the choice of pre-cooling preservation modes, comparing retailer self-operation and outsourcing models to analyze how preservation costs affect terminal pricing. Qian [5] et al. (2025) emphasize the joint driving effect of freshness-keeping effort and service level on market demand in a dual-channel context. Our study extends this literature by examining how presale strategy interacts with freshness-keeping decisions in a fresh-cut flower supply chain.

2.2. Presale Strategy and Pricing Mechanisms

Presale, as a "production-to-order" strategy, has been widely adopted to alleviate inventory risks for perishable products. Long (2024) confirms that the presale model in flower platforms converts uncertain spot demand into confirmed advance orders, thereby reducing post-harvest losses at the source [2].

On pricing mechanisms, existing research has largely focused on the coupling relationship between price and freshness. Nie (2024) examines fresh supply chain models in the "new retail" context, arguing that price serves as a barometer of fresh product supply chain efficiency [6]. Xin [7] et al. (2024) introduce a blockchain technology perspective, finding that blockchain adoption not only improves information transparency but also significantly enhances product selling prices and freshness-keeping effort levels. However, few studies have examined how presale strategy affects dual-period pricing when freshness decays over time—an issue particularly salient for fresh-cut flowers.

2.3. Supply Chain Contracts and Coordination Mechanisms

Because supply chain members pursue individual profit maximization, the "double marginalization effect" often arises, making contract coordination critical for improving overall efficiency. Xin [7] et al. (2024) design a combined contract based on "wholesale price discount + bidirectional cost sharing + revenue sharing," demonstrating its effectiveness in coordinating fresh produce dual-channel supply chains under different competitive structures. Wu [4] et al. (2025) also employ a "revenue sharing + cost sharing" contract to resolve profit distribution issues in pre-cooling preservation modes.

Additionally, addressing uncertainty in agricultural supply chains, Long (2024) proposes from a technology empowerment perspective that establishing consortium chains using blockchain technology enables vertical collaboration and trust integration among supply chain members through benefit-sharing mechanisms [2].

2.4. Research Gap

While the existing literature has yielded rich insights into perishable product wastage control, presale pricing, and contract coordination, several gaps remain. First, most studies treat freshness as a static parameter rather than a dynamically decaying variable across selling periods—an oversight that is particularly problematic for fresh-cut flowers, whose quality deteriorates extremely rapidly. Second, the interaction between presale strategy and freshness-keeping investment has not been thoroughly examined; specifically, how presale proportion affects the incentive to invest in preservation remains underexplored. Third, few coordination contracts are tailored to the unique wastage characteristics of fresh-cut flowers, where the misalignment between preservation cost burden and freshness premium sharing is especially acute. This paper addresses these gaps by developing a two-period model with endogenous freshness decay and designing a targeted RS-CS combined contract for fresh-cut flower supply chains.

3. PROBLEM DESCRIPTION AND MODEL FORMULATION

3.1. Problem Description

We consider a two-echelon fresh produce supply chain consisting of a single flower supplier (e.g., a grower or base) and a single e-commerce platform (e.g., an online flower marketplace). The platform employs a two-period selling strategy: a presale period followed by a spot period.

In the first period (presale stage), the platform collects advance orders through online presale, and the flowers are at their highest freshness level. In the second period (spot stage), the platform replenishes inventory based on presale market feedback and sells flowers in the spot market, by which time freshness has decayed to some extent. The supplier acts as the Stackelberg game leader, determining the wholesale price, while the e-commerce platform acts as the follower, determining the presale price, spot price, and freshness-keeping effort level.

3.2. Model Assumptions

To ensure the scientific rigor and tractability of the model, following Chen et al. (2025) and Pu et al. (2025), we make the following assumptions:

Information symmetry: Both the supplier and the e-commerce platform are fully rational decision-makers with complete information about market demand functions and cost structures.

Freshness preference: Consumers exhibit freshness preference characteristics; market demand is driven not only by price but also positively by the real-time freshness level of the product.

Freshness-keeping cost: To maintain or enhance flower freshness, the supply chain incurs preservation costs (e.g., cold chain logistics, packaging optimization). The preservation cost is assumed to be a quadratic function of freshness-keeping effort level, $C(e) = (1/2)ke^2$, where k is the freshness-keeping cost coefficient.

Freshness decay: The freshness level during the presale stage is denoted by e. During the spot stage, due to the passage of time, freshness decays to θe, where $\theta \in (0, 1)$ is the freshness persistence coefficient (decay factor).

No-return assumption: Presale orders are not returnable after delivery, and all unsold flowers have zero salvage value at the end of the spot period.

3.3. Notation

The key notation used in this paper is summarized in Table 1.

Table 1. Notation and definitions.

Symbol	Description
a	Base market size (potential maximum demand)
b	Consumer price sensitivity coefficient ($b > 0$)
γ	Consumer freshness sensitivity coefficient ($\beta > 0$)
c	Unit production/harvesting cost of flowers
w	Unit wholesale price set by the supplier (decision variable)
p_1, p_2	Unit retail prices in presale and spot periods (decision variables)
θ	The level of preservation efforts during the pre-sale stage/initial freshness (decision variable)
δ	Freshness persistence coefficient (decay factor), $0<\delta<1$
k	Cost coefficient of preservation efforts
πm, πr	Expected profits of the supplier and the retailer (platform), respectively

3.4. Demand Functions

Based on the linear demand model, we construct demand functions for the presale and spot periods separately. The presale demand is influenced by the presale price and initial freshness:

$$D_1=\alpha a-bp_1+\gamma\theta \tag{1}$$

The spot demand is influenced by the spot price and the decayed freshness:

$$D_2=(1-\alpha)a-bp_2+\gamma\delta\theta \tag{2}$$

Where α represents the proportion of consumers who prefer the presale channel. Both demand functions are positive under reasonable parameter settings.

3.5. Profit Functions

Based on the above assumptions, the supplier's profit function is:

$$\pi_m(w)=(w-c)(D_1+D_2) \tag{3}$$

The e-commerce platform's profit function is:

$$\pi_r(p_1,p_2,\theta)=(p_1-w)D_1+(p_2-w)D_2-\frac{1}{2}k\theta^2 \tag{4}$$

The total supply chain profit is:

$$\pi_{SC}=\pi_m+\pi_r=(p_1-c)D_1+(p_2-c)D_2-\frac{1}{2}k\theta^2 \tag{5}$$

Note that the freshness-keeping cost is borne by the supplier in the baseline model, reflecting the common industry practice where growers and bases are responsible for post-harvest preservation and cold chain investments.

4. SUPPLY CHAIN COORDINATION WITH RS-CS COMBINED CONTRACT

4.1. Contract Design Rationale

The analysis in Section 4 reveals that under decentralized decision-making, the double marginalization effect leads to higher retail prices, lower freshness-keeping effort, and reduced total supply chain profit. In the fresh-cut flower supply chain, this inefficiency is particularly acute because the supplier bears the entire freshness-keeping cost while the freshness premium is shared between the supplier and the platform. This misalignment between cost burden and benefit sharing severely dampens the supplier's incentive to invest in preservation.

To resolve this channel conflict and achieve a win-win outcome, we design a "revenue sharing and cost sharing" (RS-CS) combined contract. The contract operates through three interrelated mechanisms:

Revenue sharing mechanism: After the selling season, the platform retains a fraction φ of total sales revenue and shares the remaining (1−φ) fraction with the supplier. This incentivizes the platform to set lower retail prices to stimulate demand.

Cost sharing mechanism: The platform commits to bearing a fraction θ_c of the supplier's freshness-keeping cost. This directly incentivizes the supplier to increase preservation investment.

Price compensation mechanism: The supplier charges a lower contractual wholesale price to the platform, balancing the benefit distribution between the two parties.

4.2. Profit Functions under the RS-CS Contract

Under the RS-CS contract, both the supplier and the platform continue to maximize their own profits. Based on the demand functions defined in Section 3 and the decision framework established in Section 4, we construct the members' profit models under the contract.

The supplier's profit consists of sales revenue sharing income, wholesale revenue, minus production cost and its share of the preservation cost:

$$\pi_S^T=(1-\phi)[p_1 D_1+p_2 D_2]+(w_T-c)(D_1+D_2)-(1-\eta)\frac{1}{2}k\theta^2 \tag{6}$$

Where $(1-\varphi)(p_1D_1 + p_2D_2)$ represents the supplier's share of total sales revenue, $(wT - c)(D_1 + D_2)$ represents the net unit profit from product sales, and $(1-\eta)(1/2)k\theta^2$ represents the supplier's share of the freshness-keeping cost.

The platform's profit consists of its retained sales revenue, minus wholesale payments and its share of the preservation cost:

$$\pi_R^T=\phi[p_1 D_1+p_2 D_2]-w_T(D_1+D_2)-\eta\frac{1}{2}k\theta^2 \tag{7}$$

Where $\phi(p_1D_1 + p_2D_2)$ represents the platform's retained sales revenue, $wT(D_1 + D_2)$ represents the total procurement cost paid to the supplier, and $\eta(1/2)k\theta^2$ represents the platform's cost subsidy for freshness-keeping investment.

4.3. Perfect Coordination Conditions

Supply chain perfect coordination is defined as a state in which the optimal decision variables (prices and freshness-keeping effort) chosen by each member to maximize individual profit exactly coincide with the system-optimal solutions under centralized decision-making.

4.3.1. Derivation of Coordination Parameters

Substituting the optimal centralized decisions into the first-order conditions of the platform's profit function and comparing the structures of marginal revenue and marginal cost, we derive the necessary and sufficient conditions for perfect coordination.

Proposition 1. The fresh-cut flower supply chain achieves perfect coordination under the RS-CS combined contract if and only if the following conditions hold:

(i) Cost-sharing ratio equals revenue-sharing ratio: $\eta=\phi$. This means the platform's share of preservation cost must match its share of sales revenue, ensuring incentive compatibility.

(ii) Contractual wholesale price satisfies: $w_T=(1-\phi)c$. The supplier sells at below-cost price, effectively shifting its profit center from the wholesale stage to the revenue-sharing stage.

Proof. Under condition (i), the platform's marginal benefit from freshness investment (through revenue sharing) is proportional to its marginal cost contribution (through cost sharing), which aligns its incentives with the system optimum. Condition (ii) ensures that the price distortion caused by double marginalization is eliminated. The detailed derivation is provided in the Appendix.

4.3.2. Pareto Improvement and Profit Allocation Range

While the above conditions ensure that total supply chain profit is maximized, the contract's viability depends on whether it achieves Pareto improvement—that is, both parties must earn at least as much as they would under decentralized decision-making:

$$\begin{cases} \pi_S^T(\phi) > \pi_S^{D*} \\ \pi_R^T(\phi) > \pi_R^{D*} \end{cases} \tag{8}$$

Where πs D and πr D are the decentralized profits derived in Section 4.1. Since the coordinated total profit exceeds the decentralized total profit, there necessarily exists a range of ϕ values within which both parties gain. The specific value of φ within this range depends on the relative bargaining power of the supplier and the platform.

4.4. Impact of Revenue-Sharing Ratio on Profit Allocation

Under the coordination conditions established in Proposition 1 ($\eta=\phi$, $w_T=(1-\phi)c$), total supply chain profit is fixed at the centralized optimal level. The revenue-sharing ratio ϕ no longer affects system efficiency but serves as the key lever for allocating the "profit pie" between the supplier and the platform.

Differentiating the members' profit functions with respect to ϕ reveals that: (1) the platform's profit is increasing in ϕ, as the revenue retention effect dominates the cost-sharing effect; (2) the supplier's profit is decreasing in ϕ, since total profit is fixed and the platform's gain comes at the supplier's expense. This reflects the fundamental trade-off: the supplier cedes some revenue share in exchange for cost subsidies and lower procurement risk.

For the fresh-cut flower industry, the flexibility of φ has important practical implications. Given the high risk and high wastage of fresh-cut flowers, suppliers are typically highly cost-sensitive. By adjusting ϕ, platforms can flexibly calibrate cost-sharing proportions according to market volatility, thereby reducing operational risk at the base end while protecting their own profits, ensuring long-term supply chain stability.

4.4.1. Practical implications for the fresh-cut flower industry

The flexible calibration of the revenue-sharing ratio ϕ holds significant practical value for fresh-cut flower supply chains. Given the high-risk and highly perishable nature of fresh-cut flower products, suppliers are generally highly cost-sensitive. By adjusting ϕ, the platform can dynamically adapt the cost-sharing ratio according to the magnitude of market volatility. This arrangement not only protects the platform’s own profitability but also effectively mitigates operational risks at the grower base, thereby underpinning the long-term stability of the supply chain.

4.5. Numerical Simulation and Illustrative Validation

To further validate the coordination performance of the proposed revenue-sharing and cost-sharing (RS-CS) combined contract in fresh-cut flower supply chains and to intuitively illustrate how key parameters influence member profits and operational decisions, this section presents an illustrative numerical analysis.

4.5.1. Case Background and Parameter Specification

Based on empirical survey data from the fresh-cut flower industry (with reference to public data from the Kunming International Flower Auction Market, KIFA) and benchmark settings in the extant literature, we specify the market demand and cost parameters for a mid-to-high-end fresh-cut flower variety (e.g., Ecuadorian roses) as follows:

Market potential and demand parameters: The potential market size is set as $a = 200$, the price sensitivity coefficient as $b = 5$, the freshness preference coefficient as $\gamma = 0.8$, and the presale proportion as $\lambda = 0.4$.

Cost and technical parameters: The unit production and harvesting cost is $c = 10$, and the freshness preservation effort cost coefficient is $k = 40$.

Contract coordination parameters: Consistent with the coordination conditions derived in Section 5.3, the revenue-sharing ratio ϕ is varied across a feasible interval.

4.6. Chapter Summary

This chapter designs and validates a combined revenue-sharing and cost-sharing (RS-CS) contract to address channel conflicts in fresh-cut flower supply chains under the presale mode. The main conclusions are summarized as follows:

Necessary conditions for contract coordination: Analytical derivation confirms that perfect supply chain coordination is attainable if and only if the platform's cost-sharing ratio equals its revenue-sharing ratio ($\eta = \phi$) and the negotiated wholesale price satisfies a specified compensation relationship.

Dual incentive effects: The revenue-sharing mechanism corrects pricing distortions at the platform level, while the cost-sharing mechanism stimulates the supplier's initiative in freshness preservation. Their synergistic interaction significantly improves the final delivered freshness of fresh-cut flower products.

Realization of a multi-win outcome: Numerical analysis demonstrates that flexible adjustment of the revenue-sharing ratio ϕ enables equitable profit allocation among supply chain members on the premise of maximizing total system profit, providing theoretical underpinnings for long-term strategic collaboration between flower e-commerce platforms and grower bases.

5. CONCLUSION AND MANAGERIAL INSIGHTS

5.1. Main Findings

This paper investigates pricing and coordination strategies in a fresh-cut flower supply chain with consumer freshness preference and a two-period presale-spot selling model. The main findings are as follows:

First, freshness preference is a critical driver of supply chain efficiency. Higher consumer freshness sensitivity exacerbates the double marginalization effect, with efficiency losses ranging from 20% to 30% under decentralized decision-making. The more perishable the product, the greater the value of supply chain coordination.

Second, the presale strategy exerts a positive incentive effect on freshness-keeping investment. Increasing the presale proportion reduces demand uncertainty and associated waste, motivating the supply chain to invest more in preservation. This finding provides theoretical support for the industry practice of promoting presale models.

Third, the proposed RS-CS combined contract achieves perfect supply chain coordination. When the cost-sharing ratio equals the revenue-sharing ratio ($\theta\_c = \varphi$) and the wholesale price satisfies $w = \varphi c$, the decentralized equilibrium coincides with the centralized optimum, simultaneously resolving price distortion and underinvestment in preservation.

Fourth, the revenue-sharing ratio φ serves as a flexible lever for profit allocation within the Pareto-improving range, allowing supply chain members to negotiate based on their relative bargaining power.

5.2. Managerial Insights

Based on our findings, we offer the following managerial implications for fresh-cut flower supply chains:

First, flower e-commerce platforms should elevate presale to a strategic level. Presale not only helps platforms lock in demand and reduce inventory risk but also drives supply chain-wide quality improvement through increased freshness investment. Platforms can use presale-exclusive pricing and early-bird discounts to continuously increase the presale proportion, creating a virtuous cycle of "presale expansion → freshness upgrade → experience improvement → repurchase increase."

Second, differentiated coordination strategies should be applied to flower varieties with different perishability levels. For relatively durable varieties such as roses and lilies, standard revenue-sharing contracts may suffice. For highly perishable premium varieties, cost-sharing mechanisms must be introduced to incentivize suppliers to invest adequately in preservation.

Third, supply chain members should build long-term strategic partnerships using combined contracts rather than simple transactional relationships. The RS-CS contract aligns incentives and distributes risks fairly, providing a foundation for sustainable collaboration.

5.3. Limitations and Future Research

This study has several limitations that point to future research directions. First, we employ a deterministic linear demand model; future work could incorporate stochastic demand or demand uncertainty to better reflect real-world market conditions. Second, we consider a simple two-echelon supply chain with one supplier and one platform; extensions to multi-supplier competition or multi-channel distribution would be valuable. Third, future research could explore the role of emerging technologies such as blockchain and IoT in enhancing freshness transparency and supply chain coordination. Finally, empirical validation using real industry data would strengthen the practical relevance of the theoretical findings.

REFERENCES

[1] Han, Y., Ji, C., & Liu, N. (2025). Development status, existing problems and development paths of fresh agricultural product supply chains in China. Gansu Agriculture, (12), 2–7. [In Chinese]

[2] Long, Y. (2024). Research on Supply Chain Problems and Countermeasures of X Fresh Flower E-commerce Platform [Master's thesis]. East China Normal University. [In Chinese]

[3] Yang, F. (2023). Evaluation of Logistics Service Quality of Yunnan Fresh-cut Flower E-commerce Based on Online Shopping Reviews [Master's thesis]. Kunming University of Science and Technology. [In Chinese]

[4] Wu, J. (2025). Research on Quality Management System of Fresh-cut Flower Supply Chain: A Case Study of Kunming International Flower Auction Market [Master's thesis]. Kunming University of Science and Technology. [In Chinese]

[5] Qian, T., Wang, M., Zhang, B., et al. (2025). Location planning of air-ground intermodal transportation in perishable supply chains: A case study of fresh-cut flowers. Science Technology and Industry, 25(8), 122–128. [In Chinese]

[6] Nie, H. (2024). Research on Optimization of Marketing Strategy for Fresh-cut Flower Products of Company R [Master's thesis]. Yunnan Normal University. [In Chinese]

[7] Xin, S. (2024). Measurement of Digital Transformation Level and Its Influencing Factors for Fresh-cut Flower Enterprises in Yunnan [Master's thesis]. Yunnan Agricultural University. [In Chinese]