Study on pricing strategy of fresh agricultural products supply chain under C2B mode

Yanyan An

School of Economics and Management, Chongqing University of Posts and Telecommunications, Chongqing 400065, China

Abstract

In order to study the pricing strategy of fresh agricultural products supply chain under the C2B mode, in this paper, we establishes a centralized control model and a decentralized decision-making model based on a two-echelon supply chain composed of a manufacturer and a retailer. The effects of fresh degree of fresh agricultural products on customization effort, price and profit in supply chain are all discussed. The results show that fresh degree is positively correlated with most decision variables. The fresher the fresh produce the retailer provides, the more likely it is to attract customers and thus increase demand. Finally, according to the conclusion of the model, the paper gives the decision-making recommendations for different enterprises.

Keywords

C2B e-business model, fresh produce, supply chain, Pricing Strategy.

1. Introduction

With the increasing living standard of consumers in recent years, people are no longer satisfied with the ordinary fresh, the demand for high-quality green fresh agricultural products is also increasing. Green fresh agricultural products have always been perishable, easy to consume and so on, for logistics and storage has brought great problems, resulting in high costs. Driven by the "Internet plus" innovation, the traditional supply-oriented business model of fresh agricultural products supply chain is gradually changing to the demand-oriented C2B business model in order to meet the increasingly individualized and diversified needs of consumers. However, the innovation of C2B business model will lead to the reconstruction of enterprise value chain, the division of Labor and cooperation process among the member enterprises of fresh agricultural products supply chain will also be changed. It brings a lot of complexity and uncertainty to the realization of business model innovation. At the same time, the disappearance and change of many key elements in the mode of traditional fresh agricultural products supply chain also make the realization path of the former business model lack of reference in the innovation of the C2B business model. which makes the fresh agricultural product supply chain C2B business model It has become more difficult in implementation.

In recent years, scholars have also done some research on C2B e-commerce model. Xiao pointed out in her research that the C2B e-commerce model is a powerful way to sell fresh agricultural products. She quoted the “O2O+C2B” model as a case, and also proposed that the sales of fresh agricultural products must comply with the wishes of consumers, demand-oriented, and increase the degree of personalization. These ideas can effectively make a profit for the company. Wang (2017) proposed the e-commerce operation method and strategy of fresh agricultural products in C2B mode from two aspects: the e-commerce logistics system of agricultural products and the cultivation of agricultural products. Chen (2017)[2] conducted an in-depth analysis of the influencing factors of consumer purchasing behavior under the C2B e-commerce model, and stated that community activities can stimulate consumers' individualized needs and draw conclusions on the impact of consumers purchasing agricultural products. The factors are diversified, and fresh produce does not have a mature market. This is a market that many companies have encountered but have few successes.

Supply chain pricing is one of the most important parts, and the content of this part is related to the interests of various members in the supply chain. The main literature on the pricing of fresh agricultural products is as follows: Chen et al. (2008) studied the optimal ordering strategy for efforts to control the flow loss based on the consideration of the impact of the effort level on the loss rate and freshness. Xiong et al.(2017)[4] conducted an in-depth study on the pricing of fresh agricultural product supply chain from the perspective of fairness preference. It was found that the manufacturer's fair preference behavior can be the retailer's pricing level and its own quality input level. When a retailer has a fair concern, the manufacturer's fair preference has an inhibitory effect on it. Zhang et al. (2016) [5]studied the pricing strategy of fresh agricultural product supply chain under different fair concerns, and divided the sub-sectors into the supply chain members to discuss the profit and the price of each supply chain. The extent of impact to analyze the pros and cons of different situations. Yang et al. (2017) established the Stackelberg game model, studied the supply chain pricing strategy of fresh agricultural products under the demand dependence level, and introduced the revenue sharing contract in order to maximize the supply chain profit and prove feasible. Numerical analysis shows that retailers, suppliers, and supply chain profits increase as demand-dependent efforts increase. It was found that an increase in initial freshness and a reduction in the discount price sensitivity factor can increase the retailer's profit. Caietal[7] concluded that in order to determine his order quantity, freshness, effort and sales price, the dealer must consider the manufacturer's wholesale price, preservation efforts, and the degree of deterioration that may occur during transportation and the market demand for the product. Chen and Lian (2014) [9]established a multi-cycle planning perspective, an optimal dynamic decision model for a decentralized supply chain with a single producer and a single channel, integrating product and market planning.

Although the existing literature is rich in research on supply chain pricing, there is a lack of pricing for graduate fresh agricultural product supply chain under the C2B e-commerce model. In particular, to study the decision-making problems of supply chain members in the C2B mode, and not to consider the degree of personalization efforts. Therefore, it is very necessary to study the pricing decision of fresh agricultural product supply chain under C2B mode. This paper constructs an e-commerce supply chain pricing model driven by consumers' individualized demand, and considers the impact of individualized efforts on supply chain pricing, which provides a theoretical basis for optimizing pricing decisions.

2. Problem description and hypothesis conditions

This paper considers a two-echelon supply chain consisting of a manufacturer and a retailer, in which the retailer bears the customization cost. The model assumes the following:

The market demand of products is affected by their own price, the freshness of agricultural products reaching the supermarket and the level of customization efforts. Consumers tend to buy products with high freshness, low sales price and high degree of customization. The market demand function is:

$$d = a - \frac{b}{\theta} p + \gamma e \tag{1}$$

Where a is the potential market size of the product, p is the selling price of the product, b is the sensitivity coefficient of the consumer to the price, c is the freshness of the unit product reaching the consumer, r is the consumer's sensitivity to personalization coefficient, e is the degree of customization of the retailer. Equation (1) shows that the higher the degree of personalization, the greater the market demand.

The manufacturer's unit production cost is c, the retailer's wholesale price is w, and the retailer's retail price is p. The retailer needs to bear a certain personalized customization cost I. We assume that the personalized customization cost has a quadratic relationship with the degree of personalization, that is, $I = \frac{k}{2} e^2$, where k is a customized input cost coefficient, which is a larger normal amount.

We convert the supplier's shipping costs, transportation losses, and retailer's inventory costs into wholesale and retail prices, not separately.

π_m is the profit of the manufacturer; π_r is the profit of the retailer; π_{sc} is the overall profit of the supply chain.

3. Pricing decision model under centralized decision-making

In a centralized decision making environment, the decision maker takes the whole supply chain profit maximization as the goal, and the optimization function is:

$$\pi_{sc} = (p-c)(a-\frac{b}{\theta}p+\gamma e)-\frac{k}{2}e^2 \tag{2}$$

The calculated Hessian Matrix is:

$$H=\begin{pmatrix} -\frac{2b}{\theta} & \gamma \\ \gamma & -k \end{pmatrix} \tag{3}$$

The values of the first-order subformula and determinant is respectively $|H_1| = -\frac{2\theta}{b} < 0$, $|H| = \frac{2kb-\theta\gamma^2}{\theta}$. It is known from hypothesis (2) that the Hessian matrix is negative, and there is a unique optimal solution for the overall profit function of the supply chain. Ask A for the first-order partial derivative of p and e, so that it is zero, and the retailer's optimal selling price and personalization degree are:

$$p^* = \frac{c\gamma^2\theta - ak\theta - bck}{\gamma^2\theta - 2bk} \tag{4}$$

$$e^* = -\frac{\gamma(a\theta - bc)}{\gamma^2\theta - 2bk} \tag{5}$$

From (4), (5) the total optimal profit of the supply chain is:

$$\pi_{sc}^* = -\frac{k(a\theta-bc)^2}{\theta(\gamma^2\theta-2bk)} \tag{6}$$

Proposition 1 When $\frac{dp^{r*}}{d\theta} = \frac{\gamma^2\theta(a\gamma^2-4abk)-b^2k(\gamma^2c-6ak)}{2b(2bk-\gamma^2\theta)^2} > 0$ is established, the optimal solution of supply chain profit exists.

Proof $\pi_{sc}^* = -\frac{k(a\theta-bc)^2}{\theta(\gamma^2\theta-2bk)}$, There is a condition for the optimal solution of the supply chain profit $\pi_{sc}^* > 0$, $\frac{-2k}{\theta(\gamma^2\theta-2bk)} > 0$ is established. The certificate is completed.

From equation (6) , we can see that under the centralized decision, the total profit of supply chain and the size of the market (a) , product freshness (θ) , customized input cost (k) and other factors.

4. Pricing decision model under decentralized decision making

In the decentralized decision-making, the manufacturer and the retailer are completely rational, and both of them take their own profit maximization as their decision-making goal. The optimization functions are:

$$Max\pi_m{}^r = (w-c)(a-\frac{b}{\theta}p+\gamma e) \tag{7}$$

$$Max\pi_r{}^r = (p-w)(a-\frac{b}{\theta}p+\gamma e)-\frac{k}{2}e^2 \tag{8}$$

The game order of the model is as follows: firstly, the retailer determines the selling price and the degree of customization; secondly, the manufacturer determines the production price after observing the retailer's decision; finally, the retailer sells the product to the customer to satisfy the market demand. According to the above game order, the first derivative of p and e is obtained and made to be zero. The retailer's retail price and customization system considering both product customization and profit are as follows:

$$p^r{}_1 = \frac{\gamma^2\theta w - a\theta k - bwk}{\gamma^2\theta - 2bk} \tag{9}$$

$$e^r{}_1 = -\frac{\gamma(a\theta - bw)}{\gamma^2\theta - 2bk} \tag{10}$$

Calculate the Hessian matrix of π^r as:

$$H_1 = \begin{pmatrix} -\frac{\theta}{2b} & \gamma \\ \gamma & -k \end{pmatrix} \tag{11}$$

The values of the first-order sub-form and the determinant are $H_1 = -\frac{2b}{\theta} < 0$ and $|H_1| = \frac{2bk}{\theta} - \gamma^2 > 0$, respectively. According to the hypothesis (2), the Hessian matrix is negative, and the optimal solution exists in the equation (8), then (9) and (10) are the optimal solutions.

Substituting (9) and (10) into π^m, the manufacturer's profit is:

$$\pi^r{}_1 = \frac{(c-w)bk(a\theta - bw)}{\theta(\gamma^2\theta - 2bk)} \tag{12}$$

If I ask $\pi^r{}_1$ for the first derivative of w and make it zero, the retailer's wholesale price w is:

$$w^{r*} = \frac{(a\theta + bc)}{2b} \tag{13}$$

Relative to the manufacturer, $\frac{\partial^2\pi^r}{\partial w^2} = \frac{2b^2k}{\theta(\gamma^2\theta - 2bk)}$, from the assumption 2, $\frac{2b^2k}{\theta(\gamma^2\theta - 2bk)} < 0$, so equation (7) has the optimal solution.

Plug (13) into (9),(10), to get the optimal retail price p and personalized system e as follows:

$$p^{r*} = \frac{\gamma^2(a\theta^2 + bc\theta) - bk(3a\theta + bc)}{2b(\gamma^2\theta - 2bk)} \tag{14}$$

$$e^{r*} = -\frac{\gamma(a\theta - bc)}{2(\gamma^2\theta - 2bk)} \tag{15}$$

Substituting (13), (14) and (15) into (7) , (8) yields the best profits for manufacturers and retailers as well as for the supply chain as a whole:

$$\pi_m^* = -\frac{k(a\theta - bc)^2}{4\theta(\gamma^2\theta - 2bk)} \tag{16}$$

$$\pi_r^* = -\frac{k(a\theta - bc)^2}{8\theta(\gamma^2\theta - 2bk)} \tag{17}$$

$$\pi_{sc}^* = -\frac{3k(a\theta - bc)^2}{8\theta(\gamma^2\theta - 2bk)} \tag{18}$$

5. Comparative Analysis

Proposition 2 When $0 < \theta < \frac{2bk}{\gamma^2}$, it is clear that there is an optimal solution for retailer profit under decentralized decision making.

Theorem 1 $\frac{de^{r*}}{d\theta} > 0$.

Proof According to formula (15) ,we can obtain: $\frac{de^{r*}}{d\theta} = \frac{b\gamma(2ak - c\gamma^2)}{2(\gamma^2\theta - 2bk)^2} > 0$.

Theorem 1 shows that the degree of personalized customization will increase with the increase of the freshness of agricultural products when the retailer considers the goal of personalized customization and the game is dominant. When the retailer takes the freshness of agricultural products into the decision-making goal, the degree of customization will be enhanced to meet the customization needs of consumers.

Theorem 2 $\frac{d\pi_m^{r*}}{d\theta} > 0$, $\frac{\partial\pi_r^{r*}}{\partial\theta} > 0$, $\frac{d\pi_{sc}^{r*}}{d\theta} > 0$, $\frac{dp^{r*}}{d\theta} > 0$

Proof According to formulas (16), (17) and (18):

$$\frac{d\pi_m^{r*}}{d\theta} = -\frac{k(a\theta - bc)b(c\gamma^2\theta - ak\theta - bck)}{2\theta^2(\gamma^2\theta - 2bk)^2} > 0;$$

$$\frac{\partial\pi_r^{r*}}{\partial\theta} = -\frac{k(a\theta - bc)b(c\gamma^2\theta - ak\theta - bck)}{4\theta^2(\gamma^2\theta - 2bk)^2} > 0;$$

$$\frac{d\pi_{sc}^{r*}}{d\theta} = -\frac{3k(a\theta - bc)b(c\gamma^2\theta - ak\theta - bck)}{4\theta^2(\gamma^2\theta - 2bk)^2} > 0;$$

$$\frac{dp^{r*}}{d\theta} = \frac{\gamma^2\theta(a\gamma^2 - 4abk) - b^2k(\gamma^2c - 6ak)}{2b(2bk - \gamma^2\theta)^2} > 0.$$

Theorem 2 shows that retailers and manufacturers and overall profits in sales prices and supply chains increase as product freshness increases as retailers consider individualized goals and dominate the game. The higher the freshness of the fresh produce provided by the retailer, the more attractive it is to attract customers and the increased demand. Although the increase in freshness has also led to an increase in sales prices, with the improvement of modern people's living standards and per capita income, the increase in price brought by the increase in freshness does not affect consumers' high desire to purchase.

This study finds that under the decentralized decision, the overall profit of the supply chain is lower than the overall profit under the centralized decision. This phenomenon may be due to the fact that retailers are dominant, in order to increase their own profits, reduce their product costs by reducing

the degree of customization. But this decision has reduced consumers' desire for consumption, resulting in a decline in demand and a loss of interest in the entire supply chain.

6. Conclusion

This paper focuses on the pricing of fresh agricultural product supply chain under C2B mode, considering the influence of the freshness of fresh produce on the degree of individualized efforts, price, profit and other factors in the supply chain, and established two game models and carried out comparative analysis. Finally, the research shows that from the results of the situational solution in the decision-making model, the decision-makers look at the issue of interest claims from the perspective of the entire supply chain. In this scenario, the retail price and the degree of customization are directly solved. Proof is already the only optimal solution. From the final decision profit function, variable freshness is one of the important factors that directly affect the profit level.

In this paper, we consider the game models under centralized decision and decentralized decision. We do not consider the case of adding profit-sharing contract. The next step is to add coordination contract to realize perfect coordination based on the two models .Thus goes to draw the conclusion which is suitable for the more enterprise, makes the theory support for the enterprise.

References

[1] Xiao Li ping. Research on O2O+ Reverse C2B Model of Fresh Agricultural Products in Henan Province[J]. Contemporary Economy, 2017(16): 80-81.
[2] Wang Chun ping. Methodology of E-commerce Operation of Agricultural Products under C2B Mode[J]. Modern Economic Information, 2017(16): 314.
[3] Chen Wei. Analysis of factors affecting consumer purchasing behavior under C2B mode of agricultural products [D]. Wuhan University of Engineering, 2017.
[4] Dan Bin, Chen Jun. Coordination of Supply Chain of Fresh Agricultural Products Based on Value Loss[J]. China Management Science, 2008(05): 4249.
[5] Xiong Feng, Yuan Jun, Wang Meng, Chen Fang yu. Research on Quality Input and Pricing of Fresh Agricultural Products under Fair Preference[J].Soft Science, 2017, 31(04): 122-127.
[6] Zhang Qing, Zhang Xu. Pricing Strategy of Fresh Agricultural Product Supply Chain under Different Fair Concern Behaviors[J]. Systems Engineering, 2016, 34(09): 89-96.
[7] Yang Lei, Xiao Xiao cui, Zhang Zhi yong. Optimal pricing strategy for fresh agricultural product supply chain with demand-dependent effort level[J].Journal of Systems Management, 2017, 26(01):142-153.
[8] Cai X, Chen J, Xiao Y, et al. Optimization and coordination of fresh product supply chains with freshness keeping effort[J].Production and Operations Management, 2010, 19(3): 261-278.
[9] Chen L T. Optimal dynamic policies for integrated production and marketing planning in business-to-business marketplaces[J]. Intemational Journal of Production Economics, 2014, 153: 46-53.
[10] Wang Lei. Ordering, Pricing and Supply Chain Coordination of Fresh Agricultural Products Affecting Consumer Utility [D]. Chongqing University, 2013.