Research on Revenue-Sharing Contracts in Aquatic Product Supply Chain

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Abstract: The demand and requirements for aquatic products have grown during the past few years. The supply chain of aquatic products is more complex and significant than regular supply chains because aquatic products bear characteristics that make them difficult to preserve and vulnerable to corruption. Therefore, it is particularly important to coordinate the supply chain of fresh aquatic products. This paper employs theoretical and literary research methods to thoroughly examine the impact of freshness on the quality of aquatic products in the supply chain made up of retailers and suppliers. It also introduces the cost of preservation and constructs the relevant function, examines the decentralized decision, and obtains the profit sharing between suppliers and retailers as well as the revenue-sharing contract based on the allocation.

Keywords: supply chain; supply chain coordination; revenue-sharing contract

1. Introduction

The production of aquatic products in China has ranked first globally over the last 30 years, essentially demonstrating an upward tendency. Aquatic products have a sizable sales volume and are exported to Japan, the United States, South Korea, Brazil, the European Union and other countries. However, China's aquatic product operators are mostly individual businesses or individual business organizations with low-intensive levels of supply chain organization, and backward information construction. Worse still, aquatic products have substantial logistics costs associated with their market circulation, storage, and transportation, as well as numerous waste and deterioration issues. In summary, our country has not yet formed a reasonable supply chain management mode due to the complexity of the aquatic product supply chain. According to the research data, the current refrigerated transportation rate of aquatic products in China is 69%, while the logistics refrigerated rate of perishable food in developed countries is as high as 90% with a relatively low loss rate of aquatic products. Many of 80% of fish in China are circulated and primarily processed at room temperature. The total annual loss of aquatic products hits 4.2655 million tons, with an average annual loss rate of 8.09%. The loss rate of Marine aquaculture, freshwater aquaculture, and Marine fishing aquatic products are 12.37%, 6.59% and 5.82% respectively. As for the grade interval of aquatic products, storage, retail, and other links, the annual loss is up to 10 billion yuan. The happiness of people is tied to the quality and safety of aquatic products, necessitating a change from the conventional aquatic product supply chain to the modern aquatic product supply chain.

The aquatic product supply chain is composed of different economies. This supply chain must

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be reliable and well-coordinated for the profit allocation in each economy to be appropriate. Each subject of interest will achieve win-win cooperation if the distribution of interests is reasonable, and the supply chain will grow successfully and steadily. Thus, it is important to research how to more fairly transfer the profits across supply chain participants.

2. Literature review

People have never ceased researching supply chains since Peter Drucker first put forward its concept in the 1980s. Later, Michael Porter extended it to the value chain in his book *Competitive Advantage*; Cachon [1] (2001) proposed to transform the supply chain into a revenue chain; Mortimer [2] (2000) not only explained the significance of the revenue-sharing contract in economics but also calculated the approximate profit range for enhancing the efficiency of the supply chain; Gerchak and Wang [3] (2004) investigated the situation of uncertain demand examined two methods adopted by the assembler/retailer and its suppliers: revenue-sharing vendor-managed inventory and wholesale price-driven contract, as well as exploring a revenue-plus subsidy incentive plan; Pasternaek [4] (2009) studied the issue of single-cycle channel coordination, in which manufacturers will sell goods to suppliers through two contract strategies: direct and revenue sharing (consignment), and investigated the impact of this strategy on supplier procurement decisions based on revenue sharing, and demonstrate how to use this revenue sharing strategy to achieve channel coordination (Pareto improvement). Giri, Majhi, and Chaudhuri [5] (2021) analyzed the coordination mechanism of the supply chain under the uncertainty of demand and supply risk, and observed that the revenue-sharing contract can lead to win-win outcomes for all participants in the supply chain. Shen [6] (2021) mainly used price discounts and revenue-sharing contracts with stochastic demand dependent on time and price to coordinate the supply chain.

At present, the main research direction in China is the supply chain and coordination of fresh agricultural products. After introducing the current situation of the agricultural product supply chain in detail, Zhang [7] (2004) further proposed that it is a no-brainer to apply supply chain theory knowledge to the agricultural product supply chain, and gave suggestions to cultivate core enterprises as soon as possible. Supply chain coordination is realized by selecting various supply chain contracts and constructing relevant supply chain profit functions accordingly. For example, Jiang [8] (2012) established a model based on the revenue-sharing contract to calculate the optimal expected profit of the supply chain, and gave the range of contract parameters between retailers, suppliers, and other members of the supply chain; Jiang and Wu [9] (2016) conducted an in-depth analysis of the issues present in the aquatic product supply chain, and actively put forward coordination countermeasures for the aquatic product supply chain from the perspective of freshness affecting demand, and they highlighted the beneficial effects of the "contract docking" model on coordinating the aquatic product supply chain as well. Wu [10] (2019) studied the supply chain coordination of online and offline channels of agricultural cooperatives and offline retail supermarkets, and built a supply chain decision-making model on the basis of fresh-keeping investment; Liu, Dan, and Ma [11] (2020) designed a "revenue-sharing two-way cost-sharing" contract for the supply chain composed of a fresh e-commerce and a fresh supplier, and achieved perfect coordination and Pareto improvement of the fresh e-commerce supply chain through reasonable design of contract parameters; Cao, Wang, Xue, and Liu [12] (2021) designed two pricing contracts, wholesale price coordination contracts and hybrid coordination contracts made up of cost-sharing and compensation strategies from the perspective of channel cooperation and profit maximization; Hu [13] (2021) underlined a range of issues, including obvious shortage of funds supply, substantial exclusion from digital finance, difficulty in effectively protecting the legitimate rights and interests of participants, imperfect credit reporting system, and dislocation of digital financial supervision in the process of combining agricultural supply chain finance with digital technology; Sun and Yan [14] (2021) analyzed the collaborative decision-making method of income distribution in aquatic product supply chain; Sun, Cheng, et al. [15] (2021) studied the loss of aquatic products in different industrial chains in the supply chain and proposed countermeasures.

3. Problem description and hypothesis

3.1. Problem description

S Company is a company focusing on the sales of fish, shrimp, shellfish, seafood, and other river fish. The company's business covers Beijing, Shanghai, Ningbo, Jiaxing in Zhejiang province, Wuxi in Jiangsu province, Shenzhen in Guangdong province and other provinces and cities. It mainly cooperates with some restaurants to sell fresh aquatic products to the hotel R company, which forms a supply chain of aquatic products.

This article attempts to address the revenue issue between S Company and Hotel R Company, requiring the following explanation:

Note 1: S Company sells fish, shrimp, shellfish, seafood, and other river fish, which are not easy to preserve. The logistics and transportation cost and the loss risk shall be borne by S Company itself.

Note 2: The products sold by S company have a freshness period, beyond the period. Demand D (p, φ) is affected by the freshness of φ. At the same price, the higher the freshness of the product, the greater the demand for the product.

Note 3: Market demand $D(p, \varphi)$ is affected by the price and freshness, which can be expressed as follows:

$$D(p, \varphi) = a - bp + k\varphi \tag{1}$$

Among them, α represents the total market demand, p represents the retail price of this product, the market demand status is positively correlated with the total demand a, freshness φ, and negatively correlated with the retail price p; b represents the price elasticity coefficient of demand a, and b is greater than 0; k represents the sensitivity coefficient of market demand on product freshness, and k is greater than 0.

Company R's profits are affected by retail prices, demand, wholesale prices and preservation costs.

The preservation cost is affected by the freshness and demand of the product, which can be expressed as follows:

$$C_{freshness}=C^*\varphi D(p,\varphi) \tag{2}$$

Then, the profit function of Company R is:

$$\pi_R = pD(p,\varphi) - \omega D(p,\varphi) - C^*\varphi D(p,\varphi) \quad (3)$$

The first is the income of water sales of R Company, the second is the wholesale cost of R Company, and the third is the preservation cost. Among them, ω represents the wholesale price given to Company R, and C represents the unit insurance cost guaranteeing the freshness of aquatic products.

The profit of S Company is affected by the wholesale price, the demand of R Company, the production and transportation cost and the preservation cost, so the profit function of S Company is:

$$\pi_S = \omega D(p,\varphi) - C_a D(p,\varphi) - C * \varphi D(p,\varphi) \quad (4)$$

The first item is the income of S Company, the second one is the logistics and transportation cost of S Company, and the third one is the preservation cost. Among them, C_a represents the unit logistics and transportation cost of S company, and C represents the insurance cost to ensure the freshness of aquatic products per unit, mainly including storage cost, logistics cost, labor cost, etc.

The market demand $D(p,\varphi)$ is replaced into the profit function of Company S and Company R respectively:

$$\pi_R = (p - \omega - C^*\varphi)(a - bp + k\varphi) \quad (5)$$

$$\pi_S = (\omega - C_2 - C * \varphi)(a - bp + k\varphi) \quad (6)$$

And $\frac{\partial^2 \pi_R}{\partial p^2}$=-2b<0,(b>0),

Therefore, it follows that π_R is a strictly concave function of p.

Let $p = \omega + e$, e represents the price increase of R company, which can be obtained, the profit function of S company is:$\pi_S = (\omega - C_2 - C * \varphi)\{a - b(\omega + e) + k\varphi\}$,

And $\frac{\partial^2 \pi_R}{\partial \omega^2}$=-2b<0,(b>0),$\frac{\partial^2 \pi_R}{\partial \varphi^2}$=-2kC<0,(k>0)

Therefore, it is concluded that π_R is a strictly concave function of ω and φ, that is, both S company and R company have the maximum profit.

3.2. Game process between Company S and Company R

Both S Company and R Company prioritize maximizing their own profits in the established aquatic product supply chain. Their decision-making process is dynamic and may be loosely divided into two stages. In the first stage, Company S determines the wholesale price ω and freshness to Company R, while Company R determines the retail price p.

Here, we resolve it by applying the reverse analysis method.

Formula (5) finds the first-order partial derivative of p,

$$\frac{\partial \pi_R}{\partial p} = a - 2bp + k\varphi + b\omega + b\varphi^*C = 0$$

Get: $$p=\frac{a+k\varphi+b\omega+b\varphi*C}{2b} \tag{7}$$

After substituting Formula (7) with Formula (6), we can obtain

$$\pi_S=(\omega-C_2-C*\varphi)*\frac{a+k\varphi-b\omega-b\varphi C}{2}$$

We take the first order of ω and make it equal to 0:

$$\frac{\partial\pi_S}{\partial\omega}=\frac{a+k\varphi-2b\omega+bC_2}{2}=0$$

Approach: $$\omega=\frac{a+k\varphi+bC_2}{2b} \tag{8}$$

We seek the first-order partial derivative for φ and make it equal to 0, thus:

$$\frac{\partial\pi_S}{\partial\varphi}=\frac{-aC-2kC\varphi+2bC\omega+2bC^2\varphi+k\omega-kC_2+bCC_2}{2}=0$$

Approach: $$\varphi=\frac{aC+kC_2+bCC_2-2bC\omega-k\omega}{2bC^2-2kC} \tag{9}$$

In parallel with Formula (8) and Formula (9), the optimal wholesale price and product freshness of S Company at this time are:

$$\omega=\frac{4ab^2C^2+2bk^2C^2+2b^2C^2C_2+\frac{k^2C_2}{2}-bk^2C_2-4abkC-2bkCC_2}{4b^2C^2-4bkC+k^2} \tag{10}$$

$$\varphi=\frac{2bkC^2-ak-bkC_2}{4b^2C^2-4bkC+k^2} \tag{11}$$

With the optimal wholesale price and product freshness substitution (7), the optimal retail price of R company p is:

$$p=\frac{12ab^2C^2+6bk^2C^2+4b^2C^2C_2+4b^2kC^3-2bk^2C_2-14abkC-6b^2kCC_2}{(4b)(4b^2C^2-4bkC+k^2)} \tag{12}$$

The optimal wholesale price ω, product freshness φ, and the optimal retail price p are added into Formula (5) and Formula (6) respectively. At this time, the maximum profit of Company R and Company S is:

$$\pi_R=\left(\frac{12ab^2C^2+6bk^2C^2+4b^2C^2C_2+4b^2kC^3-2bk^2C_2-14abkC-6b^2kCC_2}{(4b)(4b^2C^2-4bkC+k^2)}-\frac{4ab^2C^2+2bk^2C^2+2b^2C^2C_2+\frac{k^2C_2}{2}-bk^2C_2-4abkC-2bkCC_2}{4b^2C^2-4bkC+k^2}-C*\frac{2bkC^2-ak-bkC_2}{4b^2C^2-4bkC+k^2}\right)*\left(a-\frac{12ab^2C^2+6bk^2C^2+4b^2C^2C_2+4b^2kC^3-2bk^2C_2-14abkC-6b^2kCC_2}{4(4b^2C^2-4bkC+k^2)}+k*\frac{2bkC^2-ak-bkC_2}{4b^2C^2-4bkC+k^2}\right)$$

$$\pi_S=\frac{4ab^2C^2+2bk^2C^2+2b^2C^2C_2+\frac{k^2C_2}{2}-bk^2C_2-4abkC-2bkCC_2}{4b^2C^2-4bkC+k^2}-C_2-C*\frac{2bkC^2-ak-bkC_2}{4b^2C^2-4bkC+k^2})*(a-\frac{12ab^2C^2+6bk^2C^2+4b^2C^2C_2+4b^2kC^3-2bk^2C_2-14abkC-6b^2kCC_2}{4(4b^2C^2-4bkC+k^2)}+k*\frac{2bkC^2-ak-bkC_2}{4b^2C^2-4bkC+k^2})$$

In the second stage, when Company R is the leader and Company S is the follower, Company R first decides the retail price p, and the wholesale price and freshness are decided by Company S in accordance with the retail price p and cost.

Hence, e represents the markup of the R company, which is attainable, and the profit function of the S company is:

$$\pi_S=(\omega-C_2-C*\varphi)\{a-b(\omega+e)+k\varphi\} \tag{13}$$

Similarly, using the reverse analysis method:

Formula (13) finds the first-order partial derivative of ω, and obtains:

$$\omega=\frac{a+k\varphi+bC_2+b\varphi C-bp}{b} \tag{14}$$

Formula (6) for the first order of φ:

$$\omega=\frac{bpC+k\omega-aC-kC_2}{2kC} \tag{15}$$

Joint formula (14) and formula (15) can obtain:

$$\omega=\frac{b^2pC^2+akC+bkCC_2-bkpC-abC^2-k^2C_2}{bkC-k^2} \tag{16}$$

$$\varphi=\frac{b^2pC+ak-abC-bkp}{bkC-k^2} \tag{17}$$

Putting Formulas (16) and formula (17) into formula (5), we obtain the first

order partial derivative of p:

$$(a-2b)*p=k\varphi+b\omega+b\varphi*C,$$

Approach:

$$p=\frac{ak^2+abkC+bkCC_2-bk^2C_2}{a+bk^2+b^2C-2b} \tag{18}$$

Putting the optimal wholesale price ω, product freshness φ, and the optimal retail price p into (5) and (6) respectively, the maximum profit of retailer R company and supplier S company is:

$$\pi_R=(\frac{ak^2+abkC+bkCC_2-bk^2C_2}{a+bk^2+b^2C-2b}-\frac{b^2pC^2+akC+bkCC_2-bkpC-abC^2-k^2C_2}{bkC-k^2}-C*\frac{b^2pC+ak-abC-bkp}{bkC-k^2})(a-b*\frac{ak^2+abkC+bkCC_2-bk^2C_2}{a+bk^2+b^2C-2b}+k*\frac{b^2pC+ak-abC-bkp}{bkC-k^2}$$

$\pi_S =$
$$\left(\frac{b^2pC + ak - abC - bkp}{bkC - k^2} - C_2 - C * \frac{b^2pC + ak - abC - bkp}{bkC - k^2}\right) * \left(a - b * \frac{ak^2 + abkC + bkCC_2 - bk^2C_2}{a + bk^2 + b^2C - 2b} + k * \frac{ak^2 + abkC + bkCC_2 - bk^2C_2}{a + bk^2 + b^2C - 2b}\right)$$

4. Nash equilibrium and centralized decision-making

In such a supply chain for aquatic products, S company and R company participate in the game, namely, R company decides on the retail price p, and S company decides on the wholesale price ω and freshness φ. As a result, S company and R company are not in a position of leadership. Instead, they are in a cooperative game with one another. In order to achieve their expected profits, S and R company are not willing to change their strategy unilaterally, because the first party may bear the adverse consequences.

In other words, in order to maximize their profits, S Company and R Company seek to obtain the optimal wholesale price ω, product freshness φ, and the optimal retail price p using the reverse analysis method.

Vertically combining Formulas (7), (14) and (15), the optimal wholesale price ω, product freshness φ, and optimal retail price p are respectively:

$$\omega = \frac{akC + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{3b^2C^2 - 3bkC} \tag{19}$$

$$\varphi = \frac{\frac{akC + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{b^2C^2 - bkC} - a - 2bC_2}{k + bC} \tag{20}$$

$$p = \frac{2akC + 2abC^2 + 4bC^2C_2 + 2k^2C_2 - 6bkCC_2 - 2b^2C^2C_2}{3b^2C^2 - 3bkC} + C_2 \tag{21}$$

Substituting the above formula into Formulas (5) and (6), the maximum expected profit of Company R and Company S is as follows:

$\pi_R^* =$
$$\left\{\left(\frac{2akC + 2abC^2 + 4bC^2C_2 + 2k^2C_2 - 6bkCC_2 - 2b^2C^2C_2}{3b^2C^2 - 3bkC} + C_2\right) - \frac{akC + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{3b^2C^2 - 3bkC} - C * \frac{\frac{akC + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{b^2C^2 - bkC} - a - 2bC_2}{k + bC}\right\} * \left\{a - b * \left(\frac{2akC + 2abC^2 + 4bC^2C_2 + 2k^2C_2 - 6bkCC_2 - 2b^2C^2C_2}{3b^2C^2 - 3bkC} + C_2\right) + k * \frac{\frac{akC + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{b^2C^2 - bkC} - a - 2bC_2}{k + bC}\right\}$$

$$\pi_S^*=(\frac{akC + abC^2+2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{3b^2C^2 - 3bkC} - C_2 - C * \frac{\frac{akc + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{b^2C^2 - bkC} - a - 2bC_2}{k + bC}) * \{(a - b * \frac{2akC + 2abC^2 + 4bC^2C_2 + 2k^2C_2 - 6bkCC_2 - 2b^2C^2C_2}{3b^2C^2 - 3bkC} + C_2) + k * \frac{\frac{akC + abC^2 + 2bC^2C_2 + k^2C_2 - 3bkCC_2 - b^2C^2C_2}{b^2C^2 - bkC} - a - 2bC_2}{k + bC}\}$$

In the case of centralized decision-making, Company S company and Company R are inclined to adopt a win-win collaboration to optimize the total benefits in the supply chain for aquatic products rather than maximizing their own profits.

At this point, the overall profit function of the supply chain is:

$$\pi = (p - C_2 - 2C * \varphi) * (a - bp + k\varphi) \tag{22}$$

Formula (22) takes the first-order partial derivative of p, and we obtain:

$$a - 2bp + (k + 2bC) * \varphi + b * C_2 = 0$$

The first-order partial derivative of equation (22) is obtained:

$$(k + 2bC)p - 4kC * \varphi - kC_2 - 2aC = 0$$

The top two types are combined to solve the optimal retail price and freshness:

$$p = \frac{(KC_2+2aC)(k+2bC)-4akC-4bkC_2}{(k+2bC)^2-8bkC} \tag{23}$$

$$\varphi = \frac{2bkC_2+4abC-(a+bC_2)(k+2bC)}{(k+2bC)^2-8bkC} \tag{24}$$

By substituting (22), the maximum overall profit of the supply chain is as follows:

$$\pi = (\frac{(KC_2 + 2aC)(k + 2bC) - 4akC - 4bkC_2}{(k + 2bc)^2 - 8bkC} - C_2 - 2C * \frac{2bkC_2 + 4abC-(a+bC_2)(k + 2bc)}{(k + 2bc)^2 - 8bkC}) * (a - b * \frac{(kC_2 + 2aC)(k + 2bC) - 4akC - 4bkC_2}{(k + 2bc)^2 - 8bkC} + k * \frac{2bkC_2 + 4abC-(a+bC_2)(k + 2bc)}{(k + 2bc)^2 - 8bkC}$$

5. Model and example analysis under revenue sharing contract

5.1.Revenue-sharing contract

We use the revenue-sharing contract to coordinate on the basis of the above game between Company S and Company R in order to encourage continued collaboration between the two sides of the game and maximize the overall interests and respective interests of the secondary aquatic product supply chain. Company S receives a set amount of income from Company R in exchange for selling to Company R at a reduced price. The revenue proportion of R company is μ, and the proportion of the additional income of S company is 1- μ. The profits of

R Company can be obtained as follows:

$$\pi_R(\mu) = \mu p(a - bp + k\varphi) - (\omega + C * \varphi)(a - bp + k\varphi)$$

$$\pi_S(\mu) = (1 - \mu)p(a - bp + k\varphi) + \omega(a - bp + k\varphi) - (C_2 + C * \varphi)(a - b\acute{p} + k\varphi),$$

According to the above formula:

$$\pi_R(\mu) = (\mu p - \omega - C * \varphi)(a - bp + k\varphi) \quad (25)$$

$$\pi_S(\mu)=\{(1-\mu)p+\omega-C_2-C^*\varphi)(a-bp+k\varphi) \quad (26)$$

The first-order partial derivative of Formula (25) can be obtained:

$$p(\mu) = \frac{\mu a+\mu k\varphi+b\omega+b\varphi c}{2b\mu} \quad (27)$$

Formula (23) equals Formula (27) in the supply chain contract state because both parties' decisions cause the supply chain as a whole to become centralized.

The solution is as follows:

$$\omega(\mu) = \mu C + (C_2 + C)(\mu - 1) \quad (28)$$

At this time, the supplier's profit is:

$$\pi_S(\mu) = \pi - \pi_R(\mu) = (1 - \mu)\pi \quad (29)$$

According to the revenue-sharing agreement, it is crucial to make sure that both firms' profits do not fall below their profits before coordination in order to achieve good collaboration between Company S and Company R, i.e. $\pi_S(\mu) \geq \pi_R(\mu) *$ and $\pi_S(\mu) \geq \pi_S$*.

5.2. Example analysis

Assume the market demand$D$(p,φ)=a-bp+kφ, the market size a=100, the demand price elasticity coefficient b=2, the sensitivity coefficient of market demand to product freshness k=1, the logistics and transportation cost of S company C_2=3, and the unit insurance cost of ensuring the freshness of aquatic products C=2, which is obtained by $\pi_S(\mu) \geq \pi_R(\mu) *$, and $\pi_S(\mu) \geq \pi_S$*,0.48≤ μ ≤0.63.

In the decentralized state, the wholesale price is equal to 51, the freshness of products is equal to 14.3, the profit of S company is 1230.3, and the profit of R company is 1689.7. In the centralized mode, the overall profit of the supply chain is 3658.1, and the freshness of products is 22.7.

Taking 0.04 as a stage, we take μ= 0.48, 0.52, 0.56, 0.60, 0.64. The impact of contract parameter selection on other parameters is observed, and the results are shown in **Table 1.**

Table 1. Influence of contract parameter selection on other parameters

μ	φ	$\pi_S(\mu)$	$\pi_R(\mu)$	π
0.48	17.3	2135.6	1754.7	3890.3
0.52	15.8	1945.3	1797.8	3743.1
0.56	13.4	1790.8	1911.1	3701.9
0.60	11.9	1581.5	2056.7	3638.2

0.64	8.1	1324.5	2233.3	3557.8

The effects of the revenue-sharing coefficient on the freshness of products and the profits of R and S companies are plotted through the calculation results, as shown in **Figure 1. Figure 2.** and **Figure 3.**

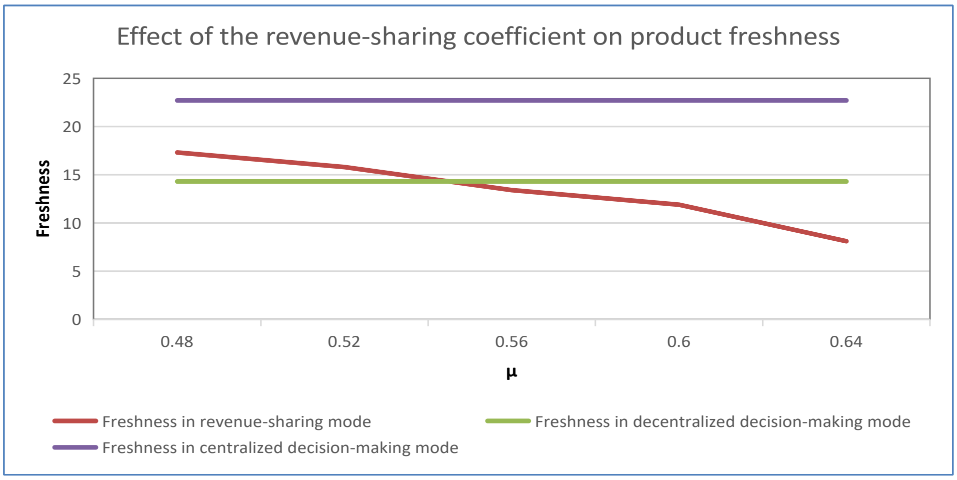

Figure 1. Effect of the revenue-sharing coefficient on product freshness

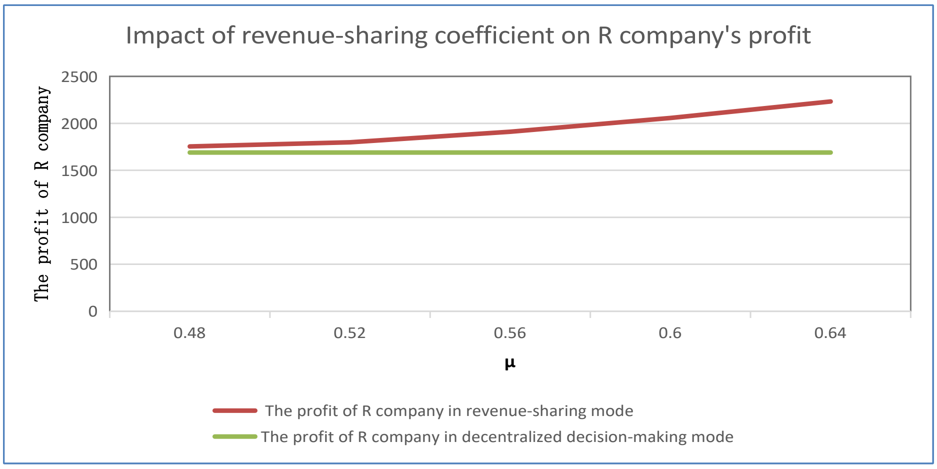

Figure 2. Impact of revenue-sharing coefficient on R company's profit

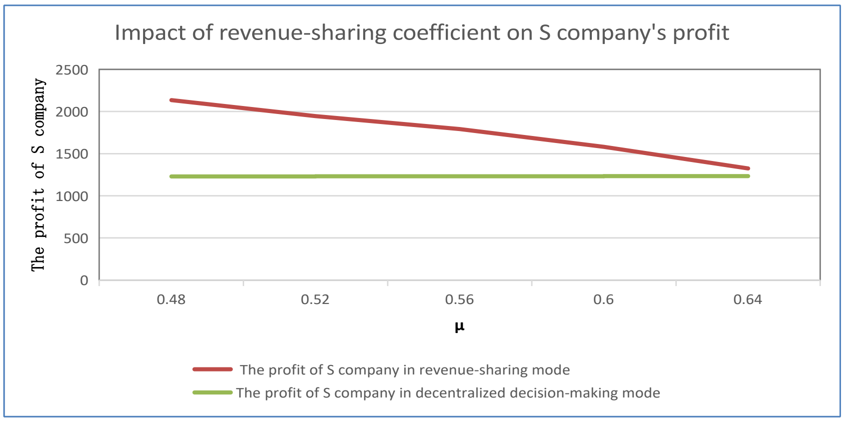

Figure 3. Impact of revenue-sharing coefficient on S company's profit

It can be seen in **Figure 1.**:

(1) The freshness of products in the centralized state is greater than that in the decentralized state, indicating that the centralized decision-making mode is superior to the decentralized decision-making mode.

(2) With the revenue-sharing coefficient μ in the case of revenue-sharing, the freshness of the product is decreasing with the increase of μ, which explains the change in sharing coefficient μ. The profit of the R company increases as it grows, while the profit of the S company is gradually decreasing. S Company will take specific actions to cut costs, such as reducing the transportation cost and fresh-keeping input, resulting in the reduction of product freshness. When $\mu \leq 0.48$ or $\mu \geq 0.63$, it is not possible to ensure that each economic entity in the supply chain will earn more money under the revenue-sharing contract than they would without one. At this time, both parties may consider their own interests and are unwilling to cooperate, so they will not adopt the revenue-sharing contract. When μ=0.54, the product freshness in the decentralized state is equal to the product freshness in the revenue-sharing state. When μ continues to increase, and the freshness of products in the decentralized state is greater than that in the revenue-sharing state, the best value of μ is 0.43~0.54 so as to ensure freshness.

It can be seen in **Figure 2.** and **Figure 3.**:

As the revenue sharing coefficient μ increases with the rise of R, the profit of R company is increasing, while the profit of S company is decreasing. Yet, the profit of both companies under the condition of revenue sharing is generally greater than that under the condition of dispersion, indicating that the revenue sharing coefficient has a regulatory effect on the supply chain.

6. Conclusions

The freshness and preservation inputs are used in this paper to construct the profit function of the secondary supply chain of aquatic product suppliers and retailers, analyze the game process between the two, and determine the parameter range of the sharing coefficient. The revenue-sharing contract serves as a coordinating mechanism in the supply chain. Since the issue at hand in this paper is complicated, there are actually more factors to take into account when formulating assumptions and constructing a brief. For example, when conducting supplier cost research, suppliers' opportunity costs were ignored, and the relationship between freshness and time was not explored. As a result, there are still problems of this kind to be studied.

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