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Quality Control Decision Research of Two-Level Supply Chain Based on the "ERC" Fairness Preference

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Abstract. The parameters of quality control and quality inspection are considered as important factors affecting market demand, and the "ERC" fairness preference model is introduced to construct a supply chain quality control decision model when the retailer and the manufacturer have fair preferences respectively. Through numerical calculation examples, we further observe the internal relationship between quality control variables and other parameters such as product price and market demand in case of the retailer and the manufacturer with fairness preferences respectively, and suggest to improve product quality by establish cooperative mechanism through supply chain parties. This is an important guide to the overall optimization of the supply chain.

Keywords. "ERC" fairness preference, supply chain, the retailer, the manufacturer, quality control

1. Introduction

Due to the change of marketing model and consumer perception, requiring companies to focus on the overall profit and quality level from the perspective of the supply chain. As a result, more and more theoretical research on supply chain will be an essential measure of the quality factors for further analysis.

With the in-depth research and practice of supply chain management theory, the phenomenon of fairness has begun to be widely concerned. The so-called fairness preference is in decision-making process, decision-makers are not only worried about whether their own benefits are treated fairly but also concerned about the benefits to others associated with them. Therefore, based on the theory of fairness preference, the research on the relationship between upstream and downstream firms in the supply chain has become an important research area.

In this paper, quality control and quality inspection parameters are considered important factors affecting market demand[2]. At the same time, the "ERC" fairness preference model is introduced to construct a supply chain decision model in that the retailer and the manufacturer have fairness preferences respectively [3]. Through numerical calculation examples, we further observe the trend of each decision variable influenced by the degree of fairness preference.

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2. Model Description

2.1. Problem Description

This paper constructs a two-level supply chain consisting of a single manufacturer (m) and a single retailer (r) based on a linear market demand function model with appropriate modifications to the market demand function and conducts model decision research[4]. The basic model is as follows: Suppose a supply chain is a two-level system consisting of a single manufacturer and a single retailer. Among them, the manufacturer controls the quality of the product, and it is possible to determine the level of quality control of the product (η) and incur product quality control costs ($c(\eta)$). The retailer orders from the manufacturer based on market demand (D), and the manufacturer sells the product to the retailer at wholesale price (w). The retailer inspects the product at the quality inspection level (θ) and incurs quality inspection cost ($c(\theta)$). Next, the retailer sells the product to the end customer at retail price (p) and earns a profit. The manufacturer produces the product with quality control effort (η) to ensure product quality and then sells the product to the retailer at wholesale price (w). Second, The retailer inspects the product provided by the manufacturer with a quality inspection effort (θ), and then sells the qualified products to the end customer at retail price (p) for a profit [5]. The supply chain member decision time sequence is shown in Figure 1.

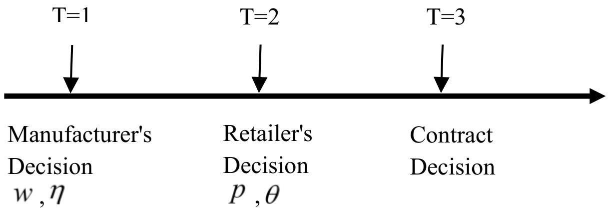

Figure 1. Timing of supply chain member decisions.

2.2. Parameter and Assumption

Assumption: The manufacturer (m) and the retailer (r) make decisions with complete rationality and information symmetry. Retailers' sales volume is equal to market demand (D), which is influenced by decision variables such as retail price (p), control effort (η), and inspection effort (θ), and all are linearly correlated. The symbols are described as follows.

D : The market demand

p : The retailer's product retail price

w : The manufacturer's product wholesale price

α : The market size, assuming that the market size is constant

η : The manufacturer's quality control effort, reflecting the manufacturer's quality control level

θ : The retailer's quality inspection effort, reflecting the retailer's quality inspection level

ε : The retailer's marketability coefficient for product quality inspection. The larger ε indicates that a more minor quality inspection effort improvement by the retailer can lead to a larger increase in market demand.

β : The retailer's marketability coefficient for retail product price.

γ : The manufacturer's marketability coefficient for product quality control.

$c(\eta)$: The manufacturer's product quality control cost, assuming the cost function is an exponential function $c(\eta)=1/2l\eta^2$. Among them l is the manufacturer's product quality control cost capability coefficient.

$c(\theta)$: The retailer's product quality inspection cost, assuming the cost function is an exponential function $c(\theta)=1/2k\theta^2$. Among them, k is the retailer's product quality inspection cost capacity coefficient.

3. Model Construction

When both the retailer and the manufacturer are fair and neutral.The anticipated revenue of the whole supply chain is the sum of the anticipated revenue of the retailer and the manufacturer[6]. The predicted revenue functions for the manufacturer (m), the retailer (r), and the entire supply chain are shown below.

The manufacturer's expected revenue function:

$$\pi_m=(\alpha-\beta p+\gamma\eta+\varepsilon\theta)(w-c)-1/2l\eta^2 \tag{1}$$

The retailer's expected revenue function:

$$\pi_r=(\alpha-\beta p+\gamma\eta+\varepsilon\theta)(p-w)-1/2k\theta^2 \tag{2}$$

The entire supply chain's expected revenue function:

$$\pi_c=(\alpha-\beta p+\gamma\eta+\varepsilon\theta)(p-c)-1/2k\theta^2-1/2l\eta^2 \tag{3}$$

3.1. Model Construction and Decision Research When the Retailer Has Fairness Preference

When the retailer has a fairness preference and the manufacturer is fair-neutral, the retailer's utility function is to consider its own benefit while focusing on the degree of satisfaction obtained from fairness. The manufacturer's utility function considers only its own expected return. Thus, the utility functions of the retailer, the manufacturer, and the entire supply chain are expressed as follows.

The retailer's utility function:

$$\begin{aligned}u_r&=a\pi_r-b(\pi_r-\frac{\pi_c}{2})\\&=(a-b)\left[(\alpha-\beta p+\gamma\eta+\varepsilon\theta)(p-w)-\frac{1}{2}k\theta^2\right]+\frac{b}{2}\left[(\alpha-\beta p+\gamma\eta+\varepsilon\theta)(p-c)-\frac{1}{2}k\theta^2-\frac{1}{2}l\eta^2\right]\end{aligned} \tag{4}$$

Among them, a denotes the retailer's concern for its own revenue, b denotes the retailer's concern for fairness, and a/b denotes the retailer's degree of fairness preference. When $a/b<1$ indicates that the retailer is more concerned with revenue fairness; when $a/b>1$ demonstrates that the retailer is more concerned with its own revenue.

Since the manufacturer doesn't have a fairness preference, the manufacturer's utility function is as follows:

$$u_m=\pi_m=(\alpha-\beta p+\gamma\eta+\varepsilon\theta)(w-c)-\frac{1}{2}l\eta^2 \tag{5}$$

The entire supply chain's utility function:

$$u_c=u_r+u_m \tag{6}$$

Proposition 1: When the retailer has a fairness preference, the manufacturer's utility function is a convex function concerning the wholesale price (w) and quality control effort (η) of the product, and there exists a unique optimal wholesale price (w^*) and optimal quality control effort (η^*) that maximizes the manufacturer's utility function. The retailer's utility function is a convex function of the retail price (p) and quality inspection effort (θ) of the product, and there exists a unique optimal retail price (p^*) and optimal quality inspection effort (θ^*) that maximizes the retailer's utility function. At this point, the optimal wholesale price (w^*), the optimal quality control effort (η^*), the optimal retail price (p^*), and the optimal quality inspection effort (θ^*) are shown below.

$$w^*=\frac{(\frac{a}{b}-1)(4lk\beta^2c+4lk\beta\alpha-2l\varepsilon^2\beta c-2l\alpha\varepsilon^2-2\beta ck\gamma^2)-2lk\beta^2c+2lk\beta\alpha+l\varepsilon^2\beta c-l\varepsilon^2\alpha-\beta ck\gamma^2}{\beta\left[(\frac{a}{b}-1)(-2k\gamma^2+8lk\beta-4l\varepsilon^2)-k\gamma^2\right]}$$

$$\eta^*=\frac{-k\gamma\left[(\frac{a}{b}-1)(2\beta c-2\alpha)+\beta c-\alpha\right]}{(\frac{a}{b}-1)(-2k\gamma^2+8lk\beta-4l\varepsilon^2)-k\gamma^2}$$

$$p^*=\frac{(a-b)(2k\beta w+2k\alpha+2k\gamma\eta-2\varepsilon^2w)-b\varepsilon^2c+kb\beta c+kb\alpha+kb\gamma\eta}{4ka\beta-2kb\beta-2a\varepsilon^2+b\varepsilon^2}$$

$$\theta^*=\frac{\varepsilon\left[(a-b)(2\gamma\eta-2\beta w+2\alpha)+b\gamma\eta-b\beta c+b\alpha\right]}{(-b+2a)(2k\beta-\varepsilon^2)}$$

Proof: First, we consider the retailer in the game's second stage and find the first-order and second-order partial derivatives of p and θ , respectively for the retailer's utility function (u_r).

$$\frac{\partial u_r}{\partial p}=(a-b)\left[-\beta(p-w)+\alpha-\beta p+\gamma\eta+\varepsilon\theta\right]+\frac{1}{2}b\left[-\beta(p-c)+\alpha-\beta p+\gamma\eta+\varepsilon\theta\right]$$

$$\frac{\partial u_r}{\partial \theta} = (a-b)\left[\varepsilon(p-w) - k\theta\right] + \frac{1}{2}b\left[\varepsilon(p-c) - k\theta\right]$$

$$\frac{\partial^2 u_r}{\partial p^2} = -2(a-b)\beta - b\beta < 0\,,\ \frac{\partial^2 u_r}{\partial \theta^2} = -(a-b)k - \frac{1}{2}bk < 0$$

The Hessian matrix of u_r is

$$H(p,\theta) = \begin{bmatrix} \frac{\partial^2 u_r}{\partial p^2} & \frac{\partial^2 u_r}{\partial p \partial \theta} \\ \frac{\partial^2 u_r}{\partial \theta \partial p} & \frac{\partial^2 u_r}{\partial \theta^2} \end{bmatrix} = \begin{bmatrix} -2(a-b)\beta - b\beta & (a-b)\varepsilon + \frac{1}{2}b\varepsilon \\ (a-b)\varepsilon + \frac{1}{2}b\varepsilon & -(a-b)k - \frac{1}{2}bk \end{bmatrix}.$$

Letting the first-order derivative be 0, the result can be obtained as follows.

$$p = \frac{(a-b)(2k\beta w + 2k\alpha + 2k\gamma\eta - 2\varepsilon^2 w) - b\varepsilon^2 c + kb\beta c + kb\alpha + kb\gamma\eta}{4ka\beta - 2kb\beta - 2a\varepsilon^2 + b\varepsilon^2}$$

$$\theta = \frac{\varepsilon\left[(a-b)(2\gamma\eta - 2\beta w + 2\alpha) + b\gamma\eta - b\beta c + b\alpha\right]}{(-b+2a)(2k\beta - \varepsilon^2)}$$

Second, the retailer's retail price (p) and the product quality inspection (θ) obtained above on the manufacturer's utility function (u_m) are found as the first and second order partial derivatives of w and η respectively.

$$\frac{\partial^2 u_m}{\partial w^2} = \frac{-4k\beta^2(a-b)}{4ka\beta - 2\beta bk + b\varepsilon^2 - 2a\varepsilon^2} < 0\,,\ \frac{\partial^2 u_m}{\partial \eta^2} = -l < 0$$

Letting the first-order derivative be 0, the manufacturer's optimal wholesale price (w^*) and optimal quantity control effort (η^*) can be found.

$$w^* = \frac{(a-b)(4lk\beta^2 c + 4lk\beta\alpha - 2l\varepsilon^2\beta c - 2l\alpha\varepsilon^2 - 2\beta ck\gamma^2) - 2lk\beta^2 bc + 2lk\beta b\alpha + l\varepsilon^2 b\beta c - l\varepsilon^2 b\alpha - \beta ck\gamma^2 b}{\beta\left[(a-b)(-2k\gamma^2 + 8lk\beta - 4l\varepsilon^2) - k\gamma^2 b\right]}$$

$$\eta^* = \frac{-k\gamma\left[(a-b)(2\beta c - 2\alpha) + b\beta c - b\alpha\right]}{(a-b)(-2k\gamma^2 + 8lk\beta - 4l\varepsilon^2) - k\gamma^2 b}$$

Finally, the manufacturer's optimal wholesale price (w^*) and optimal quality control effort (η^*) obtained above are brought into p and θ , and in turn, the retailer's optimal retail price (p^*) and product quality inspection effort (θ^*) are obtained

Conclusion 1: When the retailer has a fairness preference, the manufacturer's utility function tends to increase and then decrease as the wholesale price of the product and quality control effort continue to increase. At the same time, the retailer's utility function tends to increase and then decrease as the retail price and quality inspection effort increase.

3.2. Model Construction and Decision Research When the Manufacturer Has Fairness Preference

When the manufacturer has a fairness preference, and the retailer is fair-neutral, the manufacturer's utility function is to consider its own benefit while focusing on the degree of satisfaction obtained from fairness, and the retailer's utility function is to consider only its own expected benefits. Thus, the utility functions of the retailer, the manufacturer, and the entire supply chain are expressed as follows [7].

The retailer's utility function:

$$u_r = \pi_r = (\alpha - \beta p + \gamma\eta + \varepsilon\theta)(p - w) - \frac{1}{2}k\theta^2 \tag{7}$$

The manufacturer's utility function:

$$u_m = (a-b)\left[(\alpha - \beta p + \gamma\eta + \varepsilon\theta)(w-c) - \frac{1}{2}l\eta^2\right] + \frac{b}{2}\left[(\alpha - \beta p + \gamma\eta + \varepsilon\theta)(p-c) - \frac{1}{2}l\eta^2 - \frac{1}{2}k\theta^2\right] \tag{8}$$

Among them, a denotes the manufacturer's concern for its own revenue, b denotes the manufacturer's concern for fairness, and a/b denotes the manufacturer's degree of fairness preference. When $a/b < 1$ indicates that the manufacturer is more concerned with revenue fairness; when $a/b > 1$ suggests that the manufacturer is more concerned with its own revenue.

The entire supply chain's utility function:

$$u_c = u_r + u_m \tag{9}$$

Proposition 2: When the manufacturer has a fairness preference, the manufacturer's utility function is a convex function with respect to the wholesale price (w) and quality control effort (η) of the product, and there exists a unique optimal wholesale price (w^*) and optimal quality control effort (η^*) that maximizes the manufacturer's utility function. The retailer's utility function is a convex function of the retail price (p) and quality inspection effort (θ) of the product, and there exists a unique optimal retail price (p^*) and optimal quality inspection effort (θ^*) that maximizes the retailer's utility function. At this point, the optimal wholesale price (w^*), the optimal quality control effort (η^*), the optimal retail price (p^*), and the optimal quality inspection effort (θ^*) are shown below.

$$w^* = \frac{(\frac{a}{b}-1)(4lk\beta^2 c + 4lk\beta\alpha - 2l\varepsilon^2\beta c - 2l\alpha\varepsilon^2 - 2\beta ck\gamma^2) + 2lk\beta^2 c - l\varepsilon^2\beta c - \beta ck\gamma^2}{\beta\left[(\frac{a}{b}-1)(-2k\gamma^2 + 8lk\beta - 4l\varepsilon^2) + 2lk\beta - l\varepsilon^2 - k\gamma^2\right]}$$

$$\eta^* = \frac{-k\gamma\left[(\frac{a}{b}-1)(2\beta c - 2\alpha) + \beta c - \alpha\right]}{(\frac{a}{b}-1)(-2k\gamma^2 + 8lk\beta - 4l\varepsilon^2) + 2lk\beta - l\varepsilon^2 - k\gamma^2}$$

$$p^{*}=\frac{k\beta w+k\alpha+k\gamma\eta-\varepsilon^{2}w}{2k\beta-\varepsilon^{2}},\quad \theta^{*}=\frac{\varepsilon(-\beta w+\alpha+\gamma\eta)}{2k\beta-\varepsilon^{2}}$$

Proof: First, we consider the retailer in the second stage of the game and find the first-order and second-order partial derivatives of p and θ respectively for the retailer's utility function (u_r).

$$\frac{\partial u_r}{\partial p}=-\beta(p-w)+\alpha-\beta p+\gamma\eta+\varepsilon\theta,\quad \frac{\partial u_r}{\partial \theta}=\varepsilon(p-w)-k\theta$$

$$\frac{\partial^2 u_r}{\partial p^2}=-2\beta<0,\quad \frac{\partial^2 u_r}{\partial \theta^2}=-k<0$$

The Hessian matrix of u_r is $H(p,\theta)=\begin{bmatrix}\frac{\partial^2 u_r}{\partial p^2} & \frac{\partial^2 u_r}{\partial p\partial\theta}\\ \frac{\partial^2 u_r}{\partial\theta\partial p} & \frac{\partial^2 u_r}{\partial\theta^2}\end{bmatrix}=\begin{bmatrix}-2\beta & \varepsilon\\ \varepsilon & -k\end{bmatrix}$.

If $2k\beta-\varepsilon^2>0$, then it can be decided that the above Hessian matrix is negative definite. Letting the first order derivative be 0, the following result can be obtained.

$$p=\frac{k\beta w+k\alpha+k\gamma\eta-\varepsilon^{2}w}{2k\beta-\varepsilon^{2}},\quad \theta=\frac{\varepsilon(-\beta w+\alpha+\gamma\eta)}{2k\beta-\varepsilon^{2}}$$

Next, the retailer's retail price (p) and the product quality inspection (θ) obtained above on the manufacturer's utility function (u_m) are found as the first and second order partial derivatives of w and η respectively.

Letting the first-order derivative be 0, the manufacturer's optimal wholesale price (w^*) and optimal quantity control effort (η^*) can be found.

$$w^{*}=\frac{(a-b)(4lk\beta^{2}c+4lk\beta\alpha-2l\varepsilon^{2}\beta c-2l\alpha\varepsilon^{2}-2\beta ck\gamma^{2})+2lk\beta^{2}bc-l\varepsilon^{2}b\beta c-\beta ck\gamma^{2}b}{\beta\left[(a-b)(-2k\gamma^{2}+8lk\beta-4l\varepsilon^{2})+2blk\beta-bl\varepsilon^{2}-k\gamma^{2}b\right]}$$

$$\eta^{*}=\frac{-k\gamma\left[(a-b)(2\beta c-2\alpha)+b\beta c-b\alpha\right]}{(a-b)(-2k\gamma^{2}+8lk\beta-4l\varepsilon^{2})+2blk\beta-bl\varepsilon^{2}-k\gamma^{2}b}$$

Finally, the manufacturer's optimal wholesale price (w^*) and optimal quality control effort (η^*) obtained above are brought into p and θ, and in turn, the retailer's optimal retail price (p^*) and product quality inspection effort (θ^*) are accepted

Conclusion 2: When the manufacturer has a fairness preference, the manufacturer's utility function tends to increase and then decrease with the increasing wholesale price and quality control effort. At the same time, the retailer's utility function tends to increase and then decrease as the retail price and quality inspection effort increase.

4. Numerical Calculation Example

To further observe the trend of each decision variable influenced by the degree of fairness preference (a/b) in the case of the retailer and the manufacturer with fairness preference respectively and to obtain intuitive findings. This paper uses the following numerical calculation example to demonstrate further.

Assume the following values are assigned to the parameters therein: $\alpha=20$, $\beta=10$, $\gamma=1$, $\varepsilon=1$, $k=0.1$, $l=0.1$, $c=1.6$. By bringing each of the above parameters into the model for calculation, the trend of each decision variable under the retailer with fairness preference (Table 1) and the trend of each decision variable under the manufacturer with fairness preference (Table 2) are obtained.

4.1. Numerical Algorithm Analysis When the Retailer Has Fairness Preference

According to Table 1, it can be seen that in the case of the retailer with fairness preference, when fairness preference (a/b) varies on the interval [0, 2], there are two interruptions in the other decision variables due to the effect of the non-zero denominator of the equation in the model. These two interruptions split the interval into three parts. The separate observations for different interval sections can be obtained as follows. Both the manufacturer's product quality control effort (η) and the wholesale price (w) of the product decrease as the retailer's fairness preference decreases. Similarly, the retailer's retail price (p) and product quality inspection effort (θ) decrease as its own degree of fairness preference decreases. In the case of the supply chain system, the overall supply chain revenue (u) tends to decrease and then increase as the retailer's fairness preference decreases.

Table 1.Table of trends in each decision variable under the retailer with fairness preference

a/b	η	ω	p	θ	u_r	u_m	u
0.0	38.33	4.73	4.13	19.67	20.78	8.27	29.05
0.1	38.14	4.71	4.11	19.57	20.83	8.23	29.06
0.2	37.92	4.69	4.09	19.46	20.89	8.19	29.08
0.3	37.67	4.67	4.07	19.33	20.93	8.13	29.06
0.4	37.34	4.64	4.04	19.18	20.97	8.07	29.04
0.5	—	—	—	—	—	—	—
0.6	36.56	4.56	3.96	18.78	21.01	7.91	28.92
0.7	36.00	4.50	3.90	18.50	21.00	7.80	28.80
0.8	35.29	4.42	3.83	18.14	20.95	7.66	28.61
0.9	34.34	4.33	3.73	17.67	20.83	7.47	28.30
1.0	33.00	4.20	3.60	17.00	20.60	7.20	27.80
1.1	31.00	4.00	3.40	16.00	20.13	6.80	26.93
1.2	27.67	3.67	3.07	14.33	19.07	6.13	25.20
1.3	21.00	3.00	2.40	11.00	16.04	4.80	20.84
1.4	1.00	1.00	0.40	1.00	0.12	0.80	0.92
1.5	—	—	—	—	—	—	—
1.6	81.00	9.00	8.40	41.00	4.28	16.80	21.08
1.7	61.00	7.00	6.40	31.00	18.36	12.80	31.16
1.8	54.33	6.33	5.73	27.67	20.88	11.47	32.35
1.9	51.00	6.00	5.40	26.00	21.77	10.80	32.57
2.0	49.00	5.80	5.20	25.00	22.20	10.40	32.60

4.2. Numerical Algorithm Analysis When the Manufacturer Has Fairness Preference

According to Table 2, it can be seen that in the case of the manufacturer with fairness preference, when fairness preference (a/b) varies on the interval [0, 2], there is an interruption in the other decision variables due to the effect of the non-zero denominator of the equation in the model. This one interruption splits the interval into two parts. The separate observations for different interval sections can be obtained as follows. The manufacturer's product quality control effort (η) decreases as its own fairness preference decreases, while the wholesale price of the product remains constant. Similarly, the retailer's retail price (p) and product quality inspection effort (θ) decrease as the manufacturer's degree of fairness preference decreases. In the case of the supply chain system, the overall supply chain revenue (u) basically tends to increase and then decrease as the retailer's fairness preference decreases.

Table 2. Table of trends in each decision variable under the manufacturer with fairness preference

a/b	η	ω	p	θ	u_r	u_m	u
0.0	19.00	2.00	2.20	19.00	0.20	1.30	1.50
0.1	18.78	2.00	2.18	18.78	0.16	1.36	1.52
0.2	18.50	2.00	2.15	18.50	0.11	1.41	1.52
0.3	18.14	2.00	2.11	18.14	0.07	1.45	1.52
0.4	17.67	2.00	2.07	17.67	0.02	1.49	1.51
0.5	17.00	2.00	2.00	17.00	0.00	1.50	1.50
0.6	16.00	2.00	1.90	16.00	0.05	1.48	1.53
0.7	15.67	2.00	1.73	15.67	0.36	1.39	1.75
0.8	11.00	2.00	1.40	11.00	1.80	1.14	2.94
0.9	1.00	2.00	0.40	1.00	12.80	0.22	13.02
1.0	—	—	—	—	—	—	—
1.1	41.00	2.00	4.40	41.00	28.80	4.38	33.18
1.2	31.00	2.00	3.40	31.00	9.80	3.46	13.26
1.3	27.67	2.00	3.07	27.67	5.69	3.21	8.90
1.4	26.00	2.00	2.90	26.00	4.05	3.11	7.16
1.5	25.00	2.00	2.80	25.00	3.20	3.10	6.30
1.6	24.33	2.00	2.73	24.33	2.69	3.11	5.80
1.7	23.86	2.00	2.69	23.86	2.35	3.15	5.50
1.8	23.50	2.00	2.65	23.50	2.11	3.19	5.30
1.9	23.22	2.00	2.62	23.22	1.94	3.24	5.18
2.0	23.00	2.00	2.60	23.00	1.80	3.30	5.10

5. Conclusion and Outlook

In this paper, based on a two-level supply chain consisting of a single manufacturer (m) and a single retailer (r), a supply chain model that considers the impact of quality when the retailer has fairness preference or the manufacturer has fairness preference is developed and researched separately for decision-making. First, we establish the supply chain model considering the impact of quality when the retailer and the manufacturer have fairness preferences respectively. The comparative model analysis reveals that the manufacturer's utility function tends to increase and then decrease as the wholesale price and quality control effort increase, while the retailer's utility function tends to increase and then decrease as the retail price and quality inspection effort increase. Second, numerical examples are used to observe the trend of each decision variable influenced by the degree of fairness preference when the retailer and the manufacturer have fairness preferences respectively.

This paper is based on a two-level supply chain consisting of a single manufacturer and a single retailer and only considers the impact of quality factors on supply chain decisions when the retailer has a fairness preference or the manufacturer has a fairness preference. Future research can consider supply chain decision-making research where both parties have a fairness preference to compensate for the rationality and completeness of the research.

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