Decision Analysis of Dual-channel Supply Chain Based on Consumer Sensitivity And Blockchain

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Abstracts: In this paper, we constructed a dual-channel supply chain (DCSC) model for fresh meat products (FMP) including suppliers and retailers, introduced the parameters of consumer sensitivity coefficients of the time needed to test whether FMP is a green product and the probability that the test result is false, blockchain unit verification fee, and freshness-keeping effort, and analyzed them using the Stackelberg game model with and without blockchain technology. The pricing strategies of DCSC are compared.

Keywords: Dual channel; Consumer sensitivity; Blockchain; freshness effort

1 Introduction

With the continuous development of e-commerce and consumers' emphasis on healthy lifestyles, many suppliers have begun to open electronic direct sales channels on top of traditional retail channels, and many consumers are asking FMP processing and manufacturing enterprises to adopt the "four non-" processing technology based on green manufacturing. To meet consumers' personalized consumption preferences and concerns about product traceability, blockchain technology has the characteristics of decentralization, non-tampering and traceability, enterprises have introduced it to realize product production tracking [1].

Due to the rapid development of e-commerce, domestic and foreign scholars' research on DCSC has been more mature. LIU et al. considered the influence of suppliers' effort cost and consumers' heterogeneous preferences in system decision-making under different power structures [2]. SUN et al. analyzed two game models of supplier dominance and retailer dominance [3]. He et al. studied the vendors' pricing decisions of the product supply chain under different channel structures [4]. Meanwhile the freshness of fresh products on DCSC has been quite concerned, Yan et al. constructed a time-varying demand function based on freshness [5]. Cai et al. considered that the freshness effort will affect the quality and quantity of fresh products simultaneously, and put forward a cost model about the freshness effort [6].

The application of blockchain technology provides a new direction for traditional supply chain management, studies such as Casino et al. have advanced it from the technical level to the development of practical, consumer-ready technologies in the food supply chain [7]. Zhu et al. concerned about the impact of the introduction of blockchain technology on the market share of brand owners [8]. Liang et al. introduced parameters such as consumer sensitivity coefficients, blockchain unit verification fees, comparatively analyzed the impact of these parameters on DCSC decision-making before and after the adoption of blockchain [9]. Modak

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et al. studies the DCSC optimal pricing problem driven by blockchain technology [10].

In summary, this paper constructs a supply chain decision model under different contexts by further integrating freshness effort, consumer sensitivity coefficients, and blockchain -specific parameters on the basis of analyzing factors such as manufacturers' direct sales costs, and analyzes the optimal pricing strategies before and after adoption of blockchain technology.

2 Model Description and Assumptions

2.1 Model Description

In this paper, we consider a DCSC of FMP consisting of a supplier and a retailer, and the base model of the supply chain is shown in Fig. 1. In this supply chain, the supplier wholesales to the retailer at wholesale prices w, the retailer sells to the consumer at retail prices p_r, and the supplier sells to the consumer at direct prices p_d, while the supplier invests γ in freshness-keeping effort to preserve FMP during the sales process.

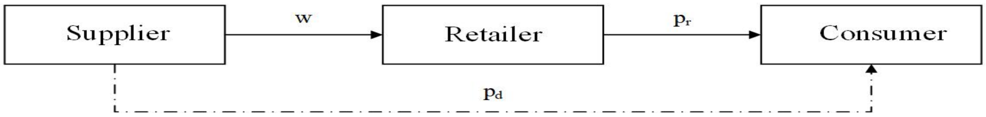

Fig. 1. DCSC sales base model for FMP

2.2 Basic Assumptions

(1)The freshness of fresh produce at the time of consumer receipt is portrayed using $k(\gamma) = v_0\gamma$, where v_0 denotes the initial freshness, and the supplier's investment in freshness effort γ brings about a corresponding cost, which in turn assumes a freshness cost function $c(\gamma) = \mu\gamma^2 / 2$,where is the cost coefficient of freshness effort μ .

(2) Under non-blockchain conditions, the probability that the FMP is a green product is p, and $0 < p < 1$, $1-p$ denotes the probability that the FMP test result is a non-green product; under blockchain conditions, it can be guaranteed that the FMP always a green product, that is $p = 1$.

(3) To guarantee the concavity of the profit function, the Hessian function is solved for each profit function in the paper. we solve the Hessian matrix, the following parameter ranges are obtained: $4\mu - \lambda^2 v_0^2 > 0$, $3\lambda^2 v_0^2 - 4\mu + 4b\mu + b\lambda^2 v_0^2 < 0$.

See Table 1 for specific symbols and symbol meanings.

Table 1. FMP DCSC model symbols and meanings

a	Total potential market demand
θ	Percentage of consumers who prefer online channels
c	Unit cost of supplier production
w	Fresh meat products at wholesale prices
b	Dual-channel price elasticity coefficient

γ	Freshness-keeping effort
v_0	Initial freshness of fresh meat products
λ	Elasticity of demand for freshness-keeping effort
p_r	Retailer offline retail prices for fresh meat products
p_d	Fresh meat products suppliers online direct prices
t	Time required to verify whether FMP are green under non-blockchain conditions
T	Time required to verify whether FMP are green under blockchain conditions
p	Probability of fresh meat products being green under non-blockchain conditions
β	Sensitivity coefficient of time required for consumers to test the quality level of FMP
δ	Sensitivity coefficient of consumers to the time required for verifying whether FMP are green
f	Unit cost of blockchain technology
F	Fixed costs of blockchain use borne by suppliers

3 FMPDCSC Decision Model Based on Consumer Sensitivity

3.1 FMP DCSC model construction under non-blockchain conditions

In the FMP DCSC model without utilizing blockchain (referred to as Model N), the retailer's demand function and the supplier's direct marketing demand function are as follows:

$$D_r^N = (1-\theta)a - p_r^N + bp_d^N - \beta t - \lambda(v_0 - v_0\gamma^N) - \delta(1-p) \tag{1}$$

$$D_d^N = \theta a - p_d^N + bp_r^N - \beta t - \lambda(v_0 - v_0\gamma^N) - \delta(1-p) \tag{2}$$

Solving the FMP DCSC model without using blockchain, $\prod_r^N$ denoting the retailer's profit and $\prod_d^N$ denoting the supplier's profit, the profit functions of the retailer and supplier are:

$$\prod_r^N = (p_r^N - w^N)D_r^N \tag{3}$$

$$\prod_d^N = (w^N - c)D_r^N + (p_d^N - c)D_d^N - c(\gamma^N) \tag{4}$$

Using backward induction, substituting Eqs. (1)(2) into (3) and taking a first-order derivation of p_r yields the retail price in the profit-optimizing case:

$$p_r^N = \left(w^N + b\mathrm{p}_d^N - \beta t + \delta(p-1) - a(\theta-1) - \lambda(v_0 - v_0\gamma^N)\right)/2 \tag{5}$$

Substituting Eq. (5) into Eq. (4) yields the supplier's profit function $\prod_d^N$ with respect to p_r^N, and solving for $\partial\prod_d^N/\partial p_d = 0, \partial\prod_d^N/\partial w = 0, \partial\prod_d^N/\partial\gamma = 0$ by association:

$$p_d^{N*} = \frac{\lambda^2 {v_0}^2(2c(b^2+4b+3) - a + 2a\theta) + 4\mu\left[(b+1)\left(\lambda v_0 + b\delta(1-p) + c(b-1) + \beta t\right) + a(b\theta - b - a)\right]}{2(b+1)\left(3\lambda^2{v_0}^2 - 4\mu + 4b\mu + b\lambda^2{v_0}^2\right)} \tag{6}$$

$$\gamma^{N*} = \frac{\lambda v_0\left(3c - a(\theta+1) + ab(\theta-1) - 2bc - b^2c + (b+3)\left((1-p)\delta + (\lambda v_0 + \beta t)\right)\right)}{3\lambda^2{v_0}^2 - 4\mu + 4b\mu + b\lambda^2{v_0}^2} \tag{7}$$

$$w^{N*} = \frac{\begin{array}{c} 4\mu\left((b+1)(\lambda v_0 + \beta t) + (1-p)(\delta - b\delta) + (a\theta - c - a + b^2 c - ab\theta)\right) \\ + \lambda^2 {v_0}^2 (2a + 6c + 2b^2 c + ab + 8bc - 4a\theta v_0 - 2ab\theta) \end{array}}{2(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} \tag{8}$$

By substituting the obtained p_d^{N*}, w^{N*}, γ^{N*} into Eq. (5), we can obtain this result:

$$p_r^{N*} = \frac{\begin{array}{c} \lambda^2 {v_0}^2 (3a + 6c + 2b^2 c + 2ab^2 + 8bc - 6a\theta - 4ab\theta) + 6a\mu(\theta - 1) + 6\delta\mu(1-p) \\ + 2\mu\left(ab^2(1-\theta) + bc(b^2 + b - 1) + b\delta(1-p)(2-b) + (2b + 3 - b^2)(\lambda v_0 + \beta t) - c - 2ab\theta\right) \end{array}}{2(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} \tag{9}$$

Substituting the obtained p_r^{N*}, p_d^{N*}, w^{N*}, γ^{N*} into Eq. (3)(4), we get

$$\Pi_r^{N*} = \frac{\left(a\lambda^2 {v_0}^2 (1-2\theta) + 2\mu(1-b)(\lambda v_0 + \delta - \delta p + a\theta + \beta t) + 2\mu(c - a + ab - 2bc + b^2 c)\right)^2}{4\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)^2} \tag{10}$$

$$\Pi_d^{N*} = \frac{\begin{array}{c} 2\mu\left(\delta(b+1)(b+3)\left(2(1-p)\beta t + (p^2+1)\delta\right) + a^2 b^2(\theta+1) + a^2 + b^4 c^2 + b^2\theta^2 t^2\right) + 6\mu\left(a^2\theta^2 + \beta^2 t^2 + c^2\right) - 28\mu\delta^2 p \\ + 8\mu\left(b\beta^2 t^2 - ab\beta t - b^2 c^2 + (1-\theta)a^2 b\theta\right) + (1-p)\left(4\mu(3\beta t - 2ab\delta - a\delta(\theta+1) + 2ab^2\delta(\theta-1) + (1-b^2)(3-b)c\delta\right) \\ + \lambda^2 v_0^2\left(4a^2\theta(1-\theta) + 9b\mu - a^2 + 2b^2\mu\right) + 4\mu\lambda v_0\left((b+1)(b+3)(\delta(1-p) - b + 1) + \beta t(4b + ab^2 + 3) - a(b+1)^2\right) \\ 4\mu\left((1-b^2)\left((b+3)\beta ct + (\theta-1)abc - bc^2\right) + (b^2+1)\left(ac(\theta+1) - a^2\theta\right) - (\theta+1)a\beta t + (\theta-1)ab^2\beta t - b\delta^2 p\right) \end{array}}{4(b+1)(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2)} \tag{11}$$

3.2 Analysis of calculation results

Corollary 1: A positive correlation exists between the direct selling price and freshness-keeping effort inputs and the supplier's share of the market, whereas a negative correlation exists between the wholesale price and retail price and the supplier's share of the market.

Proof: Solve $\frac{\partial p_{\mathrm{d}}^{N*}}{\partial \theta} = \frac{a\left(\lambda^2 {v_0}^2 - 2\mu + 2b\mu\right)}{(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} > 0$, $\frac{\partial \gamma^{N*}}{\partial \theta} = \frac{a\lambda v_0 (b-1)}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2} > 0$,

$\frac{\partial \mathrm{w}^{N*}}{\partial \theta} = -\frac{a\left(2\lambda^2 {v_0}^2 - 2\mu + 2b\mu + b\lambda^2 {v_0}^2\right)}{(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} < 0$, $\frac{\partial p_r^{N*}}{\partial \theta} = -\frac{a\left(\mu b^2 + 2b\lambda^2 {v_0}^2 + 2b\mu + 3\lambda^2 {v_0}^2 - 3\mu\right)}{(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} < 0$.

As the supplier's market share grows, the retailer will choose to lower its retail price to gain greater market share; otherwise, the supplier's growing market share will affect the retailer's margins.

Corollary 2: The sensitivity coefficients to the time required for the test of a non-green product are negatively correlated with the retail price, direct price, wholesale price, and freshness-keeping effort.

Proof: Solve $\frac{\partial p_r^{N*}}{\partial \beta} = -\frac{\mu t(b-3)}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2} < 0$, $\frac{\partial p_{\mathrm{d}}^{N*}}{\partial \beta} = \frac{2\mu t}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2} < 0$,

$\frac{\partial \mathrm{w}^{N*}}{\partial \beta} = \frac{2\mu t}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2} < 0$, $\frac{\partial \gamma^{N*}}{\partial \beta} = \frac{\lambda v_0 t(b+3)}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2} < 0$.

It can be concluded that, without the use of blockchain technology, when the sensitivity coefficient of consumers to the time required for inspection rises, to increase the influence of consumers' green preference coefficient in the supply chain and maximize profits, suppliers and retailers may reduce wholesale prices, freshness-keeping effort, direct selling prices, and retail prices to attract more consumers.

4 FMPDCSC decision-making model based on blockchain and consumer sensitivity

4.1 Construction of FMPDCSC model under blockchain conditions.

To solve the problem of consumers' inspection of whether FMP are green products, the supplier introduces blockchain technology into the DCSC to form the FMP DCSC based on blockchain and consumer sensitivity coefficients (referred to as Supply Chain Y), to ensure the accuracy of FMP inspection results as green products, we can establish the demand function of both the retailer and the supplier:

$$D_r^Y = (1-\theta)a - p_r^Y + bp_d^Y - \beta T - \lambda(v_0 - v_0\gamma^Y) \tag{12}$$

$$D_d^Y = \theta a - p_d^Y + bp_r^Y - \beta T - \lambda(v_0 - v_0\gamma^Y) \tag{13}$$

Solving the FMP DCSC model with the introduction of blockchain, where $\prod_r^Y$ denotes the retailer's profit and $\prod_d^Y$ denotes the supplier's profit, the profit functions of the retailer and the supplier are respectively:

$$\prod_r^Y = (p_{r2}^Y - c - f)D_r^Y \tag{14}$$

$$\prod_d^Y = (w^Y - c - f)D_r^Y + (p_{d2}^Y - c - f)D_d^Y - c(\gamma_2^Y) - F \tag{15}$$

Substituting Eqs. (12)(13) into Eq. (14) and taking the first order partial derivation of p_r^Y yields the retail price in the profit optimal case as:

$$p_r^Y = \left(w^Y + b\mathrm{p}_d^Y - \beta T - a(\theta-1) - \lambda(v_0 - \gamma^Y v_0)\right)/2 \tag{16}$$

Substituting Eq. (16) into Eq. (15) yields the supplier's profit function $\prod_d^Y$ with respect to p_r^Y, and solving for $\partial\prod_d^Y/\partial p_d = 0$, $\partial\prod_d^Y/\partial w = 0$, $\partial\prod_d^Y/\partial\gamma = 0$ in conjunction yields.

$$p_d^{Y*} = \frac{4\mu\left((c+f)(b^2-1) - a(b - b\theta + \theta)\right) + \lambda^2 {v_0}^2(2a\theta + (c+f)(6+2b^2+8b) - a) + 4\mu(b+1)\left(\lambda v_0 + \beta T\right)}{2(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} \tag{17}$$

$$\gamma^{Y*} = -\frac{\lambda v_0\left(a(\theta+1) - ab(\theta-1) - 3c - 3f + 2bc + 2bf + b^2c + b^2f - (b+3)(\lambda v_0 + \beta T)\right)}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2} \tag{18}$$

$$w^{Y*} = \frac{\lambda^2 {v_0}^2\left(a(2+b-4\theta-2b\theta) + (c+f)(6+2b^2+8b)\right) + 4\mu\left((b+1)(\lambda v_0 + \beta T) + (c+f)(b^2+1) + a(\theta - 1 - b\theta)\right)}{2(b+1)\left(3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2\right)} \tag{19}$$

This can be obtained by substituting the obtained $p_d^{N*}, w^{N*}, \gamma^{N*}$ into Eq. (16):

$$p_r^{Y*} = \frac{\begin{array}{c}\lambda^2 {v_0}^2\left((1-2\theta)(3a+2ab)+(c+f)(6+2b^2+8b)\right)+2\mu\lambda v_0(2b+3-b^2) \\ +2\mu\left((c+f)(b^3-1-b+b^2)-2ab\theta+b\beta T(2-b)+ab^2(1-\theta)\right)+6\mu(\beta T+a\theta-a)\end{array}}{2(b+1)\left(3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2\right)} \tag{20}$$

Substituting the resulting $p_r^{N*}, p_d^{N*}, w^{N*}, \gamma^{N*}$ into Eqs. (14) (15) gives $\prod_r^{Y*}$ and $\prod_{\mathrm{d}}^{Y*}$ as:

$$\prod_r^{Y*} = \frac{\left(a\lambda^2 {v_0}^2(1-2\theta)+2\mu(1-b)(\lambda v_0+a\theta+\beta T)+2\mu(ab-a+(c+f)(1-2b)+b^2c+b^2f)\right)^2}{4\left(3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2\right)^2} \tag{21}$$

$$\prod_{d2}^{N*} = \frac{\begin{array}{c}\lambda^2 v_0^2\left(4a^2\theta(1-\theta)+(3+4b+2b^2)(\mu+2F)-a^2\right)+8\mu\left(-b^2(c^2+f^2)+bcf(b^2-1)+(1-\theta)a^2b\theta+b\beta^2T^2-ab\beta T\right) \\ +16\mu(b^2F-F-b^2cf)+12\mu\left(cf+(c+f)(\beta T-b^2\beta T)\right)+6\mu\left(a^2\theta^2+c^2+f^2+\beta^2T^2\right)+2b\mu(c^2+f^2)(b^3+b^2-2) \\ +4\mu\lambda v_0\left((c+f)(3+b-b^3)-a(\theta+1)-2ab-3b^2c-b^2f+ab^2(\theta-1)+(b^2+4b+3)\beta T\right)+2\mu\left(a^2b^2(\theta+1)+a^2+b^2\beta T\right) \\ +4\mu\left[b^4cf-a^2\theta(b^2+1)+(f+1)(ab\theta+b\beta T)-a\beta T(\theta+1)+(\theta-1)ab^2\beta T-(c+f)\left(ab+b^3\beta+(\theta-1)ab^3+(\theta+1)(a-ab^2)\right)\right]\end{array}}{4(b+1)(3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2)} \tag{22}$$

4.2 Analysis of calculation results

Inference: in the FMP DCSC model with the introduction of blockchain technology, direct selling price, wholesale price and retail price are positively correlated with the blockchain unit cost, and after the introduction of blockchain technology, the suppliers will increase the direct selling price and wholesale price, and the retailers will increase the retail price; the suppliers' freshness-keeping effort inputs are negatively correlated with the blockchain unit cost, and after the introduction of blockchain technology, the suppliers will reduce the freshness-keeping effort inputs.

Proof: Subtracting the retail prices before and after the introduction of blockchain technology and deriving f yields: $\frac{\partial(p_r^{Y*}-p_{\mathrm{r}}^{N*})}{\partial f} = \frac{(b+3)\lambda^2 {v_0}^2-(1-b^2)\mu}{3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2} > 0$

Since $p_r^{Y*}-p_{\mathrm{r}}^{N*}$ is an increasing function with respect to f, there exists $p_r^{Y*} > p_{\mathrm{r}}^{N*}$, from which it follows that the retail price increases with the input cost of the blockchain and that the retail price after the introduction of the blockchain is higher than the retail price before the introduction of the blockchain.

The same reasoning can be obtained $\frac{\partial(p_d^{Y*}-p_d^{N*})}{\partial f} = \frac{(b+3)\lambda^2 {v_0}^2-2(1-b)\mu}{3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2} > 0$,

$\frac{\partial(w^{Y*}-w^{N*})}{\partial f} = \frac{(b+3)\lambda^2 {v_0}^2-2(1-b)\mu}{3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2} > 0$, $\frac{\partial(\gamma^{Y*}-\gamma^{N*})}{\partial f} = -\frac{\lambda v_0(b-1)(b+3)}{3\lambda^2 {v_0}^2-4\mu+4b\mu+b\lambda^2 {v_0}^2} < 0$.

It is evident that suppliers' direct selling prices and production costs rise in tandem with the increase in blockchain input costs. Consequently, the direct selling prices and production costs after the implementation of blockchain are higher compared to those prior to its introduction.

Since $p_r^{Y*} - p_r^{N*}$ is a decreasing function with respect to f, and $\gamma^{Y*} - \gamma^{N*} = -\dfrac{\lambda v_0 (b+3)\left(\delta(1-p) + \beta(t-T) - f\right)}{3\lambda^2 {v_0}^2 - 4\mu + 4b\mu + b\lambda^2 {v_0}^2}$,when $0 < f < \delta(1-p) + \beta(t-T)$, there exists $\gamma^{Y*} > \gamma^{N*}$, when $f > \delta(1-p) + \beta(t-T)$,there exists $\gamma^{Y*} < \gamma^{N*}$. It can be seen that the retailer freshness-keeping effort decreases with the increase of the blockchain input cost, when the blockchain unit cost is less than $\delta(1-p) + \beta(t-T)$, at this time, the blockchain unit input cost is low, and the supplier will choose to increase the freshness-keeping effort input to ensure their profit, while when the blockchain unit cost is higher than $\delta(1-p) + \beta(t-T)$, the wholesaler will instead choose to reduce the freshness-keeping effort input to secure their profit.

5 Numerical simulation simulation

To validate the accuracy of the aforementioned inferences, referring to[9], the parameters mentioned above are assigned the following values: $a = 220$, $c = 40$, $\theta = 0.65$, $v_0 = 10$, $t = 8$, $T = 2$, $b = 0.3$, $p = 0.4$, $\beta = 2$, $\lambda = 0.6$, $f = 1$, $F = 400$, $\mu = 85$;Prices and profits before and after the introduction of blockchain can be obtained as shown in Table 2.

Table 2. Prices and profits before and after the introduction of blockchain technology

	w	p_r	p_d	γ	D_r	D_d	Π_r	Π_d
Non-blockchain conditions	116.1	138.9	141.5	10.9	22.8	85.5	521.8	5348.1
Blockchain conditions	134.9	164.1	160.3	13.1	29.1	99.8	845.9	7067.4

When the other data remain unchanged, $\theta \in (0,1)$ or $\beta \in (0,5)$,the results can be obtained by substituting equations (6) (7) (8) (9) (17) (18) (19) (20) as shown in Fig. 2 and Fig. 3.

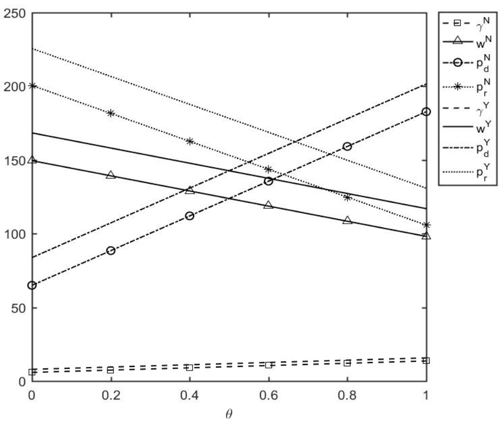

Fig.2. Chart of pricing changes with θ

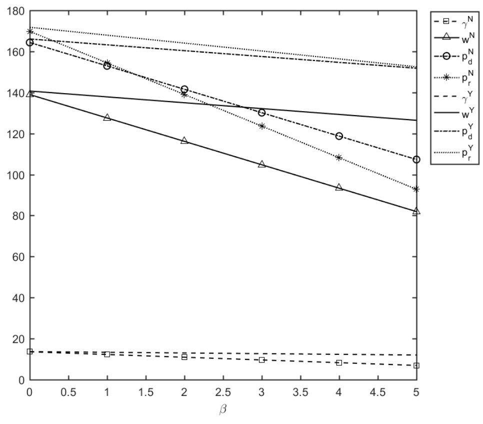

Fig. 3. Chart of pricing changes with β

As depicted in Fig. 2, the variation in the supplier's market share 0-1 reveals a consistent trend: the retail and wholesale prices decrease as the supplier's market share increases. The direct selling price and freshness-keeping effort show an upward trend with an increase in the retail share of the market, and the prices after the adoption of blockchain consistently surpass the prices without its utilization. Fig.3 shows when the consumer's time-sensitive coefficient exhibits a consistent pattern 0-5, the wholesale price, retail price, freshness-keeping effort, and direct price all demonstrate a decreasing trend, aligning with the earlier conclusions.

6 Conclusion

The research conducted in this paper discovered that as the proportion of suppliers' online direct sales grows, both direct sales prices and freshness-keeping effort rise, while retail and wholesale prices fall. when consumers' sensitivity coefficients to inspection time rise, wholesale, retail, and direct sales prices fall whether using blockchain or not. As the unit cost of blockchain rises, the direct selling price, wholesale price, and retail price also rise, resulting in a higher price after the blockchain application compared to the price before its introduction.

Through analysis and comparison, this paper concludes that the application of blockchain technology in the FMP DCSC can optimize pricing strategies and enhance the efficiency and reliability of the supply chain. Furthermore, parameters such as consumer sensitivity to result errors and inspection time, blockchain unit verification costs, and freshness effort also impact pricing strategies significantly. Future research should further explore the specific magnitude of these parameter impacts and how to optimize pricing strategies through their adjustment.

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