Blockchain Technology Based Fresh Food Supply Chain Decision Making Research

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Abstract: In the fresh food supply chain, due to the limitations of traditional information technology, there are problems such as opaque information, lack of quality assurance and low efficiency in the circulation of fresh food products, which greatly affect consumers' willingness to buy and thus cause profit loss to enterprises. Blockchain has the characteristics of high transparency and decentralization, which can monitor the flow of fresh produce in real time, shorten the circulation time of goods and improve the efficiency of the supply chain. Therefore, based on the above characteristics of blockchain, this paper discusses the optimal decision of the supply chain under two scenarios, namely, the supplier does not use blockchain technology and the supplier uses blockchain technology, for the secondary supply chain considering the level of preservation effort. The study shows that the cost of preservation of goods and the cost of blockchain construction affect the wholesale price of goods, retail price, market demand and the level of preservation of suppliers; when the cost of blockchain construction is small, suppliers will choose to invest in blockchain and vice versa.

Keywords: Blockchain Technology; Secondary Fresh Produce Supply Chains; Freshness Effort Levels; Blockchain Construction Costs; Supply Chain Decision Making

1. Introduction

The concept of blockchain can be traced back to Satoshi Nakamoto's article "Bitcoin: A Peer-to-Peer Electronic Cash System" in 2008 which was initially used to implement the data storage and transmission process of the Bitcoin system, thus realising the peer-to-peer electronic cash technology[1]. In 2016, China's Ministry of Industry and Information Technology released the "White Paper on the Development of Blockchain Technology and Applications in China " which also mentions: Blockchain is an innovative technology that enables distributed data Blockchain is an innovative technology that enables distributed data storage, peer-to-peer transmission and cryptographic processing. In recent years, as the research and development of blockchain technology continues to advance, China has also introduced a series of corresponding policies to promote the continuous improvement of blockchain applications and the development of related industries. released the "German National Blockchain Strategy", which clearly points out the action measures for blockchain in five major areas such as finance, technological innovation and investment . The US Commodity Futures Trading Commission (CFTC) announced in 2017 the establishment of Blockchain Committee to strengthen the application of blockchain in the national financial sector. Blockchain has the characteristics of high transparency, high security and decentralization, therefore, when blockchain technology is applied to the supply chain commodities realize the traceability of specific information, transparency of circulation, and the trust system at all levels of the supply chain can be built under the application of blockchain, which guarantees the security of transactions and improves the efficiency of supply chain management.

In the traditional supply chain, the information flow rate is slow. Firstly, due to the centralised system of the traditional supply chain system, there is little communication between the various subjects of the supply chain, and the lack of trust between enterprises causes them to focus only on their own best interests, making it impossible for each enterprise in the supply chain to share information upstream and downstream of the supply chain to achieve the maximum benefit of the whole supply chain. Secondly, , a traditional supply chain contains many nodes, as the upstream of the supply chain cannot directly contact the leading customers, this will certainly affect the corresponding suppliers' decisions, increasing the bullwhip effect of the supply chain and causing a lot of unnecessary waste.

At the same time, the safety of fresh food is a major challenge in the fresh food supply chain and with the development of e-commerce channels, the transaction value of fresh products has increased significantly. In the process of commodity distribution, fresh products are often of substandard and varying quality, which not only poses a potential health risk to people, but also puts the reputation of retailers and companies in jeopardy. And because traditional supply chains, where supply chain companies often use traditional paper bills, make it impossible to reduce transport and storage times, the FAO report back in 2014 stated that approximately 1.3 billion tonnes of food are lost globally each year between harvest and consumption, and that inefficiencies in the fresh goods system only serve to significantly reduce the value of commodities, as well as having a negative impact on global carbon emissions.

At present, blockchain and supply chain fusion technology has gradually matured globally and plays an extremely important role in various aspects such as information flow and cost control. Founded in Singapore in 2015, Yojee optimises the selection of delivery paths for logistics companies by currently building an artificial intelligence and blockchain software platform, and uses machine learning to assign delivery paths to drivers, which not only reduces delivery costs, but also monitors the delivery and delivery of goods in real time through blockchain tracking, guaranteeing the safe delivery of goods. 2018 Chinese companies Cainiao Logistics and Tmall International have integrated blockchain technology in the processes of cross-border e-commerce overseas production and international logistics, which has greatly contributed to the improvement of international logistics efficiency. [2]Therefore, the construction of blockchain can effectively improve the efficiency of supply chain networks and help individual enterprises achieve higher returns. In this paper, we look at the problems faced by traditional fresh food supply chains, explore the changes in optimal decision making in fresh food supply chains before and after the application of blockchain technology, and then clarify the mechanism of the impact of blockchain technology on fresh food supply chains. In addition, by comparing the profit size of the supply chain before and after the application of blockchain, we will give the decision space for suppliers to build blockchain, which has some practical guidance.

2. Review of the literature

Blockchain technology has facilitated the operation of fresh food supply chains by helping all parties in the supply chain to view the information and flow of goods at all times. Many scholars at home and abroad have conducted research on supply chain management with the application of blockchain technology. Sun Linhui et al. (2022)[3] used control theory techniques to construct a secondary supply chain model consisting of distributors and retailers, and explored the inhibiting effect of blockchain technology on the bullwhip effect in the supply chain. Chen Zhifei (2022)[4] Combines blockchain technology with four aspects of fresh produce supply chain: commercial flow, logistics, capital flow and information flow, respectively, to solve the problems of privacy and security, data authenticity and processing efficiency in fresh produce supply chain. GUIDO PERBOLI et al. (2018)[5] Applying the advantages of blockchain to improve supply chain efficiency and transparency, a standard methodology for using blockchain is created to provide supply chain related companies to increase efficiency and improve quality.

In order to safeguard the quality issues of fresh produce, different scholars have conducted research on the construction of freshness levels for all parties in the supply chain. Zhang Qinyi et al. (2021)[6] propose that supply chain members can jointly safeguard the freshness of agricultural products by making centralised decisions to invest together, and at the same time achieve the overall supply chain optimum by designing reasonable contractual contracts for the distribution of benefits. Lee et al. (2012)[7] consider the impact of preservation technology on the optimal ordering and preservation inputs of firms and provide an application to Find the optimal level of investment in preservation technology. Cai et al. (2010)[8] show that the level of preservation effort of distributors for fresh produce affects the freshness of the product, and that their level of preservation effort is affected by multiple factors such as the wholesale price of the producer, the cost of preservation work and the demand for the product in the market, etc. By designing a contractual model to improve the level of preservation of distributors, the supply chain can be coordinated.

The significance of this research is to introduce the blockchain construction level into the model in the secondary fresh food supply chain considering the preservation effort level, to explore the optimal decision and optimal profit made by the supply chain under different blockchain construction levels, and to provide a theoretical reference for the supply chain enterprises to invest in the construction of blockchain.

3. Model building

3.1 Description of the problem

Consider a secondary fresh produce supply chain consisting of one supplier and one retailer, with separate subscripts r, s differentiate. The supplier will have a wholesale price$w$ and the cost of production$c$ The supplier is required to keep the food fresh as it is fresh food.γ The level of freshness effort is assumed to be . The retailer then sells the goods at a retail price of$p$ We assume that the supplier is able to accurately predict consumer demand in the market, i.e. that all the goods produced are sold out.

In the traditional scenario, consumers have certain doubts about the information about the goods because they do not have accurate access to information about the origin and transportation of the goods. For example, there is a need for fresh milk in the market to be passed off as being of Inner Mongolia origin, but consumers have no channel to identify it, so there is a certain trust problem for such goods. We assume that the trust level of consumers in the information advertised by the product isθ Since different consumers have different levels of trust in the same product, we assume that the level of trustθ follows a uniform distribution of (0-1), i.e.$\theta \sim U(0,1)$. Therefore, the consumer demand function is

$$q = a - \alpha p - \beta\theta + \delta\gamma$$

where$a$ denotes the total volume of the market, andα, β, δ denote the sensitivity coefficients for price sensitivity, consumer trust and level of supplier preservation effort, respectively, without loss of generality, we assume$\alpha = \beta = \delta = 1$

Blockchain technology is decentralised, traceable and non-tamperable. When blockchain technology is adopted in the supply chain, consumers will be able to check the origin of goods and even the transportation information of logistics through the blockchain system, which greatly enhances consumers' trust in goods.$\Delta\theta$ Therefore, after the adoption of blockchain technology, the demand function of the market is

$$q = a - \alpha p - \beta(\theta - \Delta\theta) + \delta\gamma$$

There is a cost associated with building a blockchain, and the cost is related to the level of traceability of the blockchain.$\bar{\theta}$ The higher the level of traceability of the blockchain, the more complex the technology and naturally the higher the cost of building it. Using a general approach, we assume that the cost of building a blockchain is a quadratic function of the level of traceability of the blockchain.$\bar{\theta}$ as a quadratic function of the level of blockchain traceability and the level of blockchain traceability as a linear function of the incremental consumer trust$\Delta\theta$ The cost of building a blockchain can therefore be expressed as a linear function of

$$C_b = \frac{1}{2}k(m\Delta\theta)^2$$

where k, m denote the blockchain construction cost factor and the blockchain traceability level linearity factor, respectively, without loss of generality, we assume$m = 1$.

3.2 Model building

Based on the above discussion, we can derive the profit functions for suppliers, retailers and the supply chain system under two different scenarios without and with blockchain technology.

Blockchain technology not used

$$\Pi_{rn} = (w - c)(a - p + \gamma) - \frac{\mu\gamma^2}{2}$$

$$\Pi_{sn} = (p - w)(a - p + \gamma)$$

Adopting blockchain technology

$$\Pi_{rb} = (w - c)(a - p - (\theta - \Delta\theta) + \gamma) - \frac{\mu\gamma^2}{2} - \frac{1}{2}k\Delta\theta^2$$

$$\Pi_{sb} = (p - w)(a - p - (\theta - \Delta\theta) + \gamma)$$

3.3 Model solving

3.3.1 Baseline model: blockchain not used

Proposition 1: When blockchain is not adopted, the optimal supply chain decision is$p^* = \frac{(3a+c)\mu-c}{4\mu-1}$, $w^* = \frac{2\mu a+2\mu c-c}{4\mu-1}$, $\gamma^* = \frac{a-c}{4\mu-1}$

Proof: For the solution of the Stackelberg master-slave game model, the inverse solution method is usually used to solve the optimal decision made by the retailer under the supplier's decision, and then solve the optimal decision of the supplier in the reverse direction. To solve for the retailer's optimal decision, first determine whether its profit functionΠ_{sn} whether there is an extreme value, solvingΠ_{sn} on$p$ the stationary point to obtain$p^* = \frac{a+w+\gamma}{2}$; next, solvep^* is then substituted intoΠ_{rn} in and solving for the stationing point that counts Π_{rn} with respect to p, γ_r of the Hessian matrix, we have $H(\Pi_{rn}) = \begin{bmatrix} -2 & 1 \\ 1 & -\mu \end{bmatrix}$, whose first order principal subformulae of order $-2 < 0$, and when $\mu > \frac{1}{2}$ When , its second order principal subformula $2\mu - 1 > 0$, the Hesse matrix is a negative definite matrix andw, γ is theΠ_{rn} the extreme value point of . From this, we let$\frac{\partial \Pi_{rn}}{\partial w} = 0, \frac{\partial \Pi_{rn}}{\partial \gamma} = 0$, and the system of parallel cubic equations, we have$w = \frac{2\mu a+2\mu c-c}{4\mu-1}$, $\gamma = \frac{a-c}{4\mu-1}$. Finally, by substitutingw, γ Substituting intop^* in to obtain$p^* = \frac{(3a+c)\mu-c}{4\mu-1}$

Proposition 2: (1) Optimal order quantity for supply chain system$q^* = \frac{\mu(a-c)}{4\mu-1}$; (2) Optimal profit for suppliers$\Pi_{sn} = \frac{\mu^2(a-c)^2}{(4\mu-1)^2}$, the retailer's optimal profit $\Pi_{rn} = \frac{\mu(a-c)^2}{8\mu-2}$, Optimal profit of the supply chain system$\Pi_n = \frac{\mu(a-c)^2(6\mu-1)}{2(4\mu-1)^2}$

3.3.2 Main model: adoption of blockchain

Proposition 3: When using blockchain, the optimal supply chain decision is$p^* = \frac{((3a+c-3\theta)k-c)\mu-ck}{(4k-1)\mu-k}$, $w^* = \frac{((2a+2c-2\theta)k-c)\mu-ck}{(4k-1)\mu-k}$, $\gamma^* = \frac{k(a-c-\theta)}{(4\mu-1)k-\mu}$, $\Delta\theta = \frac{\mu(a-c-\theta)}{(4k-1)\mu-k}$

First determine whether its profit functionΠ_{sn} whether there are extreme values and solve forΠ_{sn} with respect to$p$ the stationary points to obtain$p^* = \frac{a}{2} + \frac{\gamma}{2} - \frac{\theta}{2} + \frac{\Delta\theta}{2} + \frac{w}{2}$; next, substitutep^* Substitute intoΠ_{rn} in and solving for the stationing point that countsΠ_{rn} with respect to p, γ_r of the Hessian matrix, we have $H(\Pi_{rn}) = \begin{bmatrix} -1 & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & -\mu & 0 \\ \frac{1}{2} & 0 & -k \end{bmatrix}$, whose first order principal subformulae of order$-1 < 0$, and when$\mu > \frac{1}{2}$ when , and its second order principal subformula$2\mu - 1 > 0$, and when$\mu > \frac{-k}{1-4k}$ When , its third order principal subformula$-k\mu + \frac{1}{4}k + \frac{1}{4}\mu < 0$, the Hesse matrix is a negative definite matrix and$w, \gamma, \Delta\theta$ is theΠ_{rn} the extreme value point of . From this, we let$\frac{\partial \Pi_{rn}}{\partial w} = 0, \frac{\partial \Pi_{rn}}{\partial \gamma} = 0$, the$\frac{\partial \Pi_{rn}}{\partial \Delta\theta} = 0$ and the system of cubic equations, we have $w = \frac{((2a+2c-2\theta)k-c)\mu-ck}{(4k-1)\mu-k}$, $\gamma = \frac{k(a-c-\theta)}{(4\mu-1)k-\mu}$, $\Delta\theta = \frac{\mu(a-c-\theta)}{(4k-1)\mu-k}$. Finally, by substituting$w, \gamma, \Delta\theta$ Substituting intop^* in to obtain$p^* = \frac{((3a+c-3\theta)k-c)\mu-ck}{(4k-1)\mu-k}$

Proposition 4: (1) Optimal order quantity of the supply chain system $q^* = \frac{k\mu(a-c-\theta)}{(4k-1)\mu-k}$; (2) optimal profit for suppliers $\Pi_{rb} = \frac{k\mu(a-c-\theta)^2}{(8k-2)\mu-2k}$ (2) retailer's optimal profit $\Pi_{sb} = \frac{k^2\mu^2(a-c-\theta)^2}{(4k\mu-k-\mu)^2}$, Optimal profit of the supply chain system$\Pi_b = \frac{k\mu(a-c-\theta)^2(6k\mu-k-\mu)}{2(4k\mu-k-\mu)^2}$

3.4 Model discussion

Table 1 Results of the supply chain game before and after the application of blockchain

	Blockchain not applied	Applying Blockchain
w	$\frac{2\mu a+2\mu c-c}{4\mu-1}$	$\frac{((2a+2c-2\theta)k-c)\mu-ck}{(4k-1)\mu-k}$
p	$\frac{(3a+c)\mu-c}{4\mu-1}$	$\frac{((3a+c-3\theta)k-c)\mu-ck}{(4k-1)\mu-k}$
γ	$\frac{a-c}{4\mu-1}$	$\frac{k(a-c-\theta)}{(4\mu-1)k-\mu}$
Δθ	0	$\frac{\mu(a-c-\theta)}{(4k-1)\mu-k}$
Π_s	$\frac{\mu^2(a-c)^2}{(4\mu-1)^2}$	$\frac{k^2\mu^2(a-c-\theta)^2}{(4k\mu-k-\mu)^2}$
Π_r	$\frac{\mu(a-c)^2}{8\mu-2}$	$\frac{k\mu(a-c-\theta)^2}{(8k-2)\mu-2k}$
Q	$\frac{\mu(a-c)}{4\mu-1}$	$\frac{k\mu(a-c-\theta)}{(4k-1)\mu-k}$
Π	$\frac{\mu(a-c)^2(6\mu-1)}{2(4\mu-1)^2}$	$\frac{k\mu(a-c-\theta)^2(6k\mu-k-\mu)}{2(4k\mu-k-\mu)^2}$

Corollary 1: (1)$0>\frac{\partial_{Q_n}}{\partial\mu}>\frac{\partial_{w_n}}{\partial\mu}>\frac{\partial_{p_n}}{\partial\mu}>\frac{\partial_{\gamma_n}}{\partial\mu}$; $0>\frac{\partial_{Q_b}}{\partial\mu}>\frac{\partial_{w_b}}{\partial\mu}>\frac{\partial_{p_b}}{\partial\mu}$

When $0<k<\frac{1}{4}$, $\frac{\partial_{\gamma_b}}{\partial\mu}>0$, when $k>\frac{1}{4}$, $\frac{\partial_{\gamma_b}}{\partial\mu}<0$

When blockchain is not applied, consumers are skeptical about the information of the goods and the freshness cost factor of the supplier μThe higher the preservation cost factor, the more the supplier has to invest to get the same level of freshness, and for profit maximisation purposes, the manufacturer will reduce the level of preservation effort γ This leads to a reduction in market purchases. Suppliers and retailers do not want to see a decrease in market purchases, so they will increase market purchases by reducing wholesale and retail prices. Thus as the preservation cost factor μ increases, the γ, w, p, Q Both will fall. Among other things $|\frac{\partial_{w_n}}{\mu}|<|\frac{\partial_{p_n}}{\mu}|$ According to the bullwhip effect, when market purchases fall, retailers receive a greater change in market demand than suppliers, so as the freshness cost factorμ the retailer's retail price changes more than the supplier's wholesale price changes. Under this condition, when$0<\mu<\frac{1}{4}$ When the supply chain system optimal profit Π_n The customer demand for fresh goods increases as the freshness level increases; and when $\mu>\frac{1}{4}$ the optimal profit of the supply chain system increases with μ When the cost of investment is greater than the benefit, the supplier will choose to increase the price to make up for the loss, which makes the purchase of goods fall and the optimal profit of the supply chain cannot increase.

Under the conditions of using blockchain, when suppliers increase the level of freshness, both suppliers and retailers will increase the wholesale and retail prices accordingly in order to maintain their maximum interests. With the help of blockchain technology, customers can have timely information on the origin and shipping status of goods, resulting in increased purchases of goods. The level of freshness of suppliersγ would with their cost factor for building the blockchain$k$ change. When$0<k<\frac{1}{4}$ When the supplier's freshness cost factor μ increases, the supplier's freshness level γ also increases, i.e. the supplier's freshness level has a greater impact on demand with a better level of blockchain construction, so the benefits from increasing the freshness level outweigh the cost of freshness and the supplier will choose to increase the freshness level; when $k>\frac{1}{4}$, as the supplier freshness cost factor μ increases, the supplier's freshness level γ will decrease, under this condition, the supplier's block construction level is weak, the benefit brought by increasing the freshness level is not enough to cover the freshness cost paid, and the supplier will choose to reduce the freshness level.

(2)$0 > \frac{\partial Q_b}{\partial k} > \frac{\partial w_b}{\partial k} > \frac{\partial p_b}{\partial k}$； $\frac{\partial \gamma_b}{\partial k} < 0$；

With the application of blockchain technology, as the cost factor of supplier blockchain constructionk becomes smaller, suppliers will choose to increase the wholesale pricew to compensate for the cost of building blockchain, and retailers will increase their retail prices accordingly to ensure their interestsp To ensure their own interests, retailers will also increase their retail prices accordingly. As the blockchain construction cost factork for retailers is greater than that for suppliers, this suggests that retailers can also participate in the construction of suppliers' blockchain technology to improve the efficiency of the supply chain network. As the technology of building blockchain for suppliers becomes more sophisticated, the level of goods preservation for suppliers will increase, suggesting that suppliers should improve their ability to build blockchain technology to obtain higher quality goods at a lower cost.

Corollary 2: When$\begin{cases} \mu < \frac{-k\theta}{-4k\theta+a-c} & 4k\theta - a + c > 0 \\ \mu > -\frac{k\theta}{-4k\theta+a-c} & 4k\theta - a + c < 0 \end{cases}$ when$p_b > p_n$, the$w_b > w_n$,$\gamma_b > \gamma_n$, .$Q_b > Q_n$; and vice versa$p_b < p_n$, , and$w_b < w_n$, , and$\gamma_b < \gamma_n$, , and$Q_b < Q_n$

Proof: Let's subtractp_b from p_n to obtain $p_b - p_n = \frac{3((-4k\theta+a-c)\mu+k\theta)\mu}{(4k\mu-k-\mu)(4\mu-1)}$ and it is clear that when$(-4k\theta + a - c)\mu + k\theta > 0$, $p_b > p_n$, the proof is obtained. By the same token, it follows that$w_b - w_n = \frac{2((-4k\theta+a-c)\mu+k\theta)\mu}{(4k\mu-k-\mu)(4\mu-1)}$ that$\gamma_b - \gamma_n = \frac{(-4k\theta+a-c)\mu+k\theta}{(4k\mu-k-\mu)(4\mu-1)}$, and$Q_b - Q_n = \frac{((-4k\theta+a-c)\mu+k\theta)\mu}{(4k\mu-k-\mu)(4\mu-1)}$, all of the above is proved.

That is, when μ the smaller the cost of increasing the level of preservation effort by one unit, the more mature the firm's preservation technology. For the same cost, theμ smaller the firm will increase the level of preservation effort by more makingγ The level of freshness in the supply chain is therefore higher with blockchain than without blockchain. As a result of the additional capital investment required by the blockchain supplier, the wholesale price of the supplier will be higher compared to the non-blockchain supplier. Similarly, the $p_b > p_n$. With blockchain, the level of freshness of the goods is significantly improved and customer preference for the goods is increased, resulting in greater purchases than would have been the case without blockchain. This means that the more sophisticated a manufacturer's preservation technology is, the more competitive its products are in the marketplace. Howeverμ can be infinitely small, and since this paper ignores the R&D costs due to the change in preservation technology, whenμ infinitely small, the product's sales volume is infinitely large, which is clearly unrealistic. We will consider this factor in subsequent work.

Corollary 3: When $k < \frac{\mu(a-c)^2}{4\theta(4\mu-1)(2a-2c-\theta)}$, providers will choose to invest in building a blockchain and vice versa, they will not invest in building

Proof: Make Π_{rb} and Π_{rn} subtract from each other to obtain $\Pi_{rb} - \Pi_{rn} = \frac{((-8\theta(a-c-\frac{\theta}{2})k+(a-c)^2)\mu+2\theta(a-c-\frac{\theta}{2})k)\mu}{2(4k\mu-k-\mu)(4\mu-1)}$ and it is only necessary to determine the$(-8\theta(a-c-\frac{\theta}{2})k + (a-c)^2)\mu + 2\theta(a-c-\frac{\theta}{2})k$ so that the positive and negative signs of$(-8\theta(a-c-\frac{\theta}{2})k + (a-c)^2)\mu + 2\theta\left(a-c-\frac{\theta}{2}\right)k > 0$ and simplify to obtain$k < \frac{\mu(a-c)^2}{4\theta(4\mu-1)(2a-2c-\theta)}$. The converse is also true and will not be repeated.

When a supplier is relatively mature in building blockchain technology, its cost of building a blockchain will be less than that of a supplier with immature technology, so when k is small, suppliers are willing to increase their sales by investing in blockchain technology; when$k$ exceeds a specific value, the supplier will think that the cost of investing in building blockchain is greater than its own profit, and the supplier will give up building blockchain at this time. According to the data of the "Panorama Report on Blockchain Listed Companies in China A-share (2021)", among the 221 companies conducting blockchain business in China in 2021, large companies accounted for 79.15% of the total number of companies. As a new type of information technology, the initial stage of blockchain construction requires a large amount of human, material and financial resources, which poses a new challenge to the construction of enterprise blockchain. Large enterprises have great advantages in various aspects such as technology and capital, and are therefore more willing to further enhance their interests by investing in the construction of blockchain technology.

4. Conclusion

In summary, this paper provides a reference for supply chain enterprises to invest in the construction of blockchain technology by studying the secondary fresh supply chain considering the level of preservation effort in the application of blockchain technology and analysing the optimal decision of the supply chain by analysing the different levels of blockchain construction. The following conclusions were also drawn: (1) regardless of whether blockchain technology is applied, the wholesale price, retail price, market demand and the freshness level of suppliers in the supply chain will be affected by the suppliers' freshness cost; (2) with the application of blockchain technology, the wholesale price, retail price, market demand and the freshness level of suppliers in the supply chain will be affected by the suppliers' blockchain construction (3) when the supplier's preservation cost factor is small, the wholesale price, retail price, market demand and supplier's preservation level of commodities under the application of blockchain technology are greater than those without the application of blockchain technology; (4) when the supplier's blockchain construction cost factor is small, the supplier will choose to invest in the construction of blockchain to increase its revenue, and vice versa.

As this study only considers the single-channel scenario, while in fact dual channels, online and offline, are common in today's fresh food supply chain, there are limitations in this paper and the dual-channel scenario will continue to be explored in subsequent studies.

References

[1] Liu C. Research on optimal decision making of dual-channel fresh produce supply chain with application of blockchain [D]. Harbin University of Commerce, 2022.

[2] Chen J, Shang S. Research on the application of blockchain in logistics supply chain[J]. China Storage and Transportation,2022(10):161-162.

[3] Sun LH, Ge CC, Wu AB, Yuan XF. Research on dynamic responsiveness of supply chain systems under the influence of blockchain technology[J]. Operations Research and Management,2022,31(10):53-60.

[4] Chen Zhifei. Blockchain helps fresh e-commerce supply chain collaborative development [J]. Logistics Science and Technology,2022,45(01):147-150.

[5] Perboli G, Musso S, Rosano M, et al. Blockchain in logistics and supply chain: a lean approach for designing real-world use cases [J]. IEEE Access, 2018 , 6 (1): 62018-62028.

[6] Zhang QY, Cao AW. A study on price of agricultural products and preservation effort decision and coordination contract[J]. China Agricultural Resources and Zoning, 2021, 42(05): 159-168.

[7] Lee YP, Dye CY. An inventory model for deteriorating items under stock-dependent demand and controllable deterioration rate. Computers & Industrial Engineering, 2012, 63(2): 474-482.

[8] Cai XQ, et al. Optimization and Coordination of Fresh Product Supply Chains with Freshness-Keeping Effort[J]. Production and Operations Management, 2010, 19(3): 261-278.