

Game Analysis of Dual-channel Supply Chain Based on Different Rights Structure

Dingnan Ye^{1,*}, Jingwen Li²

¹ School of Economics and management, Southwest Petroleum University, Chengdu Sichuan, 610500, China

² School of Economics and management, Southwest Petroleum University, Chengdu Sichuan, 610500, China

* Corresponding author: Ye Ding Nan (Email:yedingnan2022@163.com)

Abstract: Based on members' different bargaining power in a dual channels system, this paper discusses the impact of three games on channel pricing, demand and members' profits by building Manufacturer Stackelberg, Retailer Stackelberg and Vertical Nash game model. The study finds that: (1) When the coefficient of cross-price elasticity of demand is 0, the effects of the three game strategies on the competitive equilibrium solution of the two-channel supply chain are undifferentiated. (2) When the coefficient of cross-price elasticity of demand is not 0, under the Stackelberg game dominated by the retailer (manufacturer), the traditional channel (direct channel) has the highest pricing, and the demand of the traditional channel (direct channel) is the smallest, while the demand of the traditional channel (demand of the direct channel) is the largest in the Stackelberg game dominated by the manufacturer (retailer); both manufacturers and retailers are willing to choose to give up their power and do the Stackelberg game. Both manufacturers and retailers are willing to give up power in favor of being a follower of the Stackelberg game, and the Nash game is always a strict downside for the game participants. Finally, the validity of the conclusions is further tested by case studies.

Keywords: Supply Chain Competition, Dual Channels, Stackelberg/Nash Game, Price Competition.

1. Introduction

Along with the rapid development and popularization of e-commerce, "more manufacturing enterprises sell goods directly through the Internet and sell their goods through traditional retail channels", forming a "dual-channel supply chain"[1]. In recent years, companies such as IBM, HP, and Nike have achieved great success by combining traditional sales channels with electronic direct sales. It can be seen that the dual-source channel architecture is a challenging supply chain channel model with great potential for development[2-3]. The issue of dual-source channels in supply chains has attracted much attention in the business and management communities.

In recent years, many scholars and managers from management, economics, marketing and other disciplines have conducted in-depth research on dual-channel supply chain management from various aspects. Taking dual-channel as the research object, this project adopts the methods of operations research and economics to establish the dual-channel competition model of dual-channel supply chain from the perspective of three levels (channel selection, channel conflict and coordination), taking into account the factors of product price, service quality, customer preference, and e-commerce execution level, and quantitatively analyzes its competition strategy by using the methods of optimization, game analysis, and so on[4-9]. As for marketing research, it focuses on qualitative analysis and case studies, exploring channel design, channel conflicts and price differences among different channels. However, so far, none of the literature has explored how the power gap affects the choice of supply chain structure in a supply chain[10-15].

In addition, this thesis also deals with the relative influence between the members of a supply chain. Producer and retailer power in a supply chain has a significant impact on the choice of supply chain structure, which directly determines the

position of supply chain members in the market (leader or follower), and thus influences the order of decision-making of market participants. In a previous study, Choi et al[16-20]. considered the issue of position in the supply chain as a Stackelberg dominator, follower, or dual conduct Nash response. However, with the emergence of large retailers such as Wal-Mart and Carrefour, retailers can also have some influence on business decisions[21-24].

Through the above studies, it is found that most of the existing dual-channel supply chain research focuses on competition, coordination and coping strategies under the dual demand of price/price-service, while there are relatively few studies that incorporate the differences in the discourse power of manufacturers and retailers in individual channels into the dual-channel model[25-29]. In view of this, this paper will try to construct three game models: the manufacturer-led Stackelberg game, the retailer-led Stackelberg game, and the Nash game in which the manufacturer and retailer have equal power, and focus on comparing and analyzing the advantages and disadvantages of the three game strategies under different cross-price elasticity of demand coefficients[30-31].

2. Problem Description and Modeling Section Headings

2.1. Description of the problem

Consider a two-tier supply chain consisting of a manufacturer and a retailer model, where the manufacturer not only sells products to customers through retailers, but also has an e-direct channel for selling its products online. The "two marketing approaches" is a common "two marketing approaches"[32]. It examines the significant differences between the position and voice of producers and retailers in the market under the two channels[33]. Under the dominance of strong producers, producers and retailers are dominated by suppliers and retailers are followers, forming the Stackelberg

game model, as evidenced by the competition between Yichang Iron and Steel Co. and its core retailers[34]; If the manufacturer and the retailer have equal power, the two sides will play a Vertical Nash game, such as Wal-Mart and Procter & Gamble (P & G)[35]; If retailers have more bargaining power than manufacturers, the two will play a Stackelberg game in which the retailer is the leader and the manufacturer is the follower[36]. Stackelberg game in which the retailer is the leader and the manufacturer is the follower, as in the case of Wal-Mart, the world's largest retailer, and most manufacturers. Wal-Mart, the world's largest retailer, and most manufacturers.

For the convenience of the study, this paper assumes that the manufacturer and the retailer are risk-neutral and perfectly rational decision makers; the information possessed by the manufacturer and the retailer are both is common knowledge; the manufacturer's wholesale price, w , is determined by a long-term contract and is an exogenous to the model, and the pricing in the direct channel cannot be lower than the wholesale price in the traditional retail channel. The manufacturer's wholesale price w is determined by the long-term contract, which is exogenous to the model. Otherwise, retailers will buy directly from the direct channel, which will lead to the failure of the wholesale mechanism.

2.2. Model construction

Assuming a linear relationship between product demand and price, and construct the following demand function the demand function is constructed as follows:

$$D_t = ak + bp_d - p_t \quad (1)$$

$$D_d = a(1 - k) + bp_t - p_d \quad (2)$$

where subscript t represents the traditional retail channel and subscript d represents the direct sales channel; D_t and D_d represent the market demand of the traditional retail channel and the direct sales channel, respectively; p_t represents the price of the traditional retail channel and p_d represents the price of the direct sales channel. a represents the overall market demand for the product, which reflects the overall market development level of the product, and for the general merchandise with dual channels, the scale of its total market demand is much bigger than its wholesale price w ; k is the market share of the traditional retail channel, and $1-k$ is the market share of the direct sales channel; and its wholesale price w ; k is the market share of the traditional retail channel, $1-k$ is the market share of the direct sales channel; b is the channel cross-price elasticity coefficient, and there are $0 \leq b \leq 1$, i.e., the impact of the price of this channel on demand is not less than the impact of the price of other channels on the demand of this channel. Without loss of generality, assume that the unit production cost of the manufacturer is 0. This assumption only simplifies the form of the analytical solution and has no substantial impact on the analysis of the results.

3. Decision Modeling Under the Stackelberg Game

3.1. Manufacturer-driven Stackelberg gaming

The manufacturer first decides the direct channel price p_d to maximize its profit π_m , and based on the direct channel price set by the manufacturer, the retailer decides the

traditional retail channel price p_t to maximize its own profit π_r . In the following, we solve for the optimal price in the direct sales channel and the optimal price in the traditional retail channel by backward induction. In order to distinguish the equilibrium solutions under different game strategies, the equilibrium solution under the manufacturer-dominated Stackelberg game is labeled with superscript M^* . Retailer The merchant profit function is:

$$\pi_r = (p_t - w) * (ka - p_t + bp_d) \quad (3)$$

From Eq. (3), it can be seen that the profit objective function is a concave function about the retail price in the traditional channel, therefore, the first-order condition on p_t for Eq. (3) can be used to obtain the optimal solution of the price under the retailer's profit maximization.

First-order conditions on the profit function π_r with respect to the traditional channel price p_t :

$$ak + bp_d - 2p_t + w = 0 \quad (4)$$

The traditional channel price equilibrium solution can be obtained from equation (4):

$$p_t = (1/2) * ka + (1/2) * bp_d + (1/2) * w \quad (5)$$

The manufacturer's profit function is:

$$\pi_m = w(a*k + bp_d - p_t) + p_d((1 - k)a - p_d + bp_t) \quad (6)$$

From equation (6), it can be seen that this profit objective function is related to the price in the direct sales channel, so the optimal pricing when the producer's interest is maximized can be obtained by calculating the primary condition related to p_d in equation (6).

Substituting Eq. (5) into Eq. (6) and taking the first-order derivative of the direct selling price p_d , we can obtain the direct sales channel price equilibrium solution:

$$p_d^{M^*} = \frac{2a(1-k) + kab + 2abk}{2(2-b^2)} \quad (7)$$

Substituting equation (7) into the traditional channel price equilibrium solution of equation (5) yields:

$$p_t^{M^*} = \frac{4ak + 4w + 2ab - akb^2 - 2abk}{4(2-b^2)} \quad (8)$$

In price equilibrium, demand in the traditional retail channel and demand in the direct selling channel respectively:

$$D_t^{M^*} = \frac{-akb^2 + 4ak + 4wb^2 - 4w + 2ab - 2abk}{4(2-b^2)} \quad (9)$$

$$D_d^{M^*} = \frac{a(bk - 2k + 2)}{4} \quad (10)$$

In price equilibrium, the retailer's profit and the manufacturer's profit are:

$$\pi_r^{M^*} = \left[\frac{(4w-2ab-4ak-4b^2w+2abk+ab^2k)}{4(b^2-2)} \right]^2 \quad (11)$$

$$\pi_m^{M^*} = \frac{-a^2b^2k^2+4a^2bk^2-4a^2bk-4a^2k^2+8a^2k}{8(b^2-2)} \quad (12)$$

3.2. 3.2.Retailer-driven Stackelberg gaming

The order of the Stackelberg game in which the retailer is oriented and the producer follows is as follows: first, the retailer determines the traditional retailer's pricing, p_r ; then, given the retail channel price set by the retailer, the producer determines the selling price, p_d , to maximize his or her profit. On this basis, the optimal pricing for the direct sales channel and the traditional retail channel is derived using the inverse derivation method. Under the retailer-dominated Steinberg response, the equilibrium solutions are denoted by superscript R^* markers for each equilibrium solution in order to better distinguish them. The profit function of the producer is:

$$\pi_m = w(a * k + bp_d - p_t) + p_d[(1 - k)a - p_d + bp_t] \quad (13)$$

The first order condition for the profit function π_m with respect to the direct channel price p_d is:

$$bw + (1 - k)a - 2p_d + bp_t = 0 \quad (14)$$

Solving Eq. (14) yields the following equilibrium prices for direct marketing channels:

$$p_d = \frac{bw + (1-k)a + bp_t}{2} \quad (15)$$

The retailer profit function is:

$$\pi_r = (p_t - w)(ka - p_t + bp_d) \quad (16)$$

Substituting Eq. (15) into Eq. (16) and solving for the first order traditional retail channel price condition is obtained:

$$\frac{2w + ab + 2ak - abk + (2b^2 - 4)p_t}{2} = 0 \quad (17)$$

The traditional retail channel equilibrium price is found from equation (17):

$$p_t^{R^*} = \frac{2w + ab + 2ak - abk}{4 - 2b^2} \quad (18)$$

Substituting Eq. (18) into Eq. (15) yields the price equilibrium solution for the direct sales channel:

$$p_d^{R^*} = \frac{4ak - 4a - 6bw + ab^2 + 2b^3w - 2abk - ab^2k}{4b^2 - 8} \quad (19)$$

In price equilibrium, demand in the traditional retail channel and demand in the direct selling channel respectively:

$$D_t^{R^*} = \frac{ab - 2w + 2ak + 2b^2w - abk}{4} \quad (20)$$

$$D_d^{R^*} = \frac{4ak - 4a + 2bw + ab^2 - 2b^3w - 2abk - ab^2k}{4b^2 - 8} \quad (21)$$

In price equilibrium, the retailer's profit and the manufacturer's profit are:

$$\pi_r^{R^*} = \frac{[ab - 2w + 2ak + 2b^2w - abk]^2}{8(2 - b^2)} \quad (22)$$

$$\pi_m^{R^*} = \frac{w(ab - 2w + 2ak + 2b^2w - abk)}{4} + \frac{(4a - 4ak - 2bw - ab^2 + 2b^3w + 2abk + ab^2k)(4a - 4ak + 6bw - ab^2 - ab^3w + 2abk + ab^2k)}{(4b^2 - 8)^2} \quad (23)$$

4. Decision Modeling under Nash Games

Nash countermeasures occur between producers and retailers in a supply chain when they have equal power. Under the Nash response, each member assumes that the other party's decision is already optimal. The sequence of the Nash game is as follows: the manufacturer decides the direct channel price p_d to maximize its profit π_m ; at the same time, the retailer decides the traditional retail channel price p_t to maximize its profit π_r . In order to distinguish the equilibrium solutions under different game strategies, the equilibrium solutions under the Nash game are marked with superscript N^* . The manufacturer's profit function is:

$$\pi_m = w(a * k + bp_d - p_t) + p_d((1 - k)a - p_d + bp_t) \quad (24)$$

The first order condition for the profit function π_m with respect to the direct channel price p_d is:

$$bw + (1 - k)a - 2p_d + bp_t = 0 \quad (25)$$

For pricing in the direct sales channel, the producer's profit function is a strictly concave function that maximizes the producer's profit only when the product is in equilibrium.

The retailer profit function is:

$$\pi_r = (p_t - w)(k * a - p_t + bp_d) \quad (26)$$

From Eq. (26), this profit function is a concave function of

the traditional channel retail price The first-order condition on p_t for Eq. (26) is a concave function of the retail price in the traditional channel, and thus the optimal price solution under retailer's profit maximization can be obtained. to the optimal price solution under the retailer's profit maximization. First-order conditions on the profit function π_r with respect to the traditional channel price p_t :

$$ka - 2p_t + bp_d + w = 0 \quad (27)$$

Equations (25) and (27) can be used to find the optimal price of the direct sales channel and the optimal price of the traditional retail channel. optimal price of direct sales channel and traditional retail channel:

$$p_t^{N^*} = \frac{2w+ab+2ak+b^2w-abk}{4-b^2} \quad (28)$$

$$p_d^{N^*} = \frac{2a-2ak+3bw+abk}{4-b^2} \quad (29)$$

In price equilibrium, demand in the traditional retail channel and demand in the direct selling channel respectively:

$$D_t^{N^*} = \frac{2w-ab-2ak-2b^2w+abk}{b^2-4} \quad (30)$$

$$D_d^{N^*} = \frac{2a-2ak-bw+b^3w+abk}{4-b^2} \quad (31)$$

In price equilibrium, the retailer's profit and the manufacturer's profit are:

$$\pi_r^{N^*} = \left[\frac{(ab-2w+2ak+2b^2w-abk)}{b^2-4} \right]^2 \quad (32)$$

$$\pi_m^{N^*} = \frac{a^2b^2k^2-4a^2bk^2+4a^2bk+4a^2k^2-8a^2k+4a^2+ab^4kw-ab^3kw+ab^3w-8abkw+8abw+8akw+b^4b^2+7b^2w^2-8w^2}{(b^2-4)^2} \quad (33)$$

5. Dual Channels under Different Competitive Structures Comparison of Supply Chain Equilibrium Solutions

(1)When the cross-price elasticity coefficient $b = 0$, under the three competitive structures comparison of supply chain equilibrium solutions under three competitive structures.

1.It was investigated that pricing did not differ from customer demand under three different competitive strategies with two different distribution channel models.

2.In a dual-channel supply chain, direct marketing under three game strategies channel prices and customer demands are undifferentiated.

3.In a dual-channel supply chain, retailer profits are the same under all three game strategies.

4.The effects of three different countermeasures on two distribution channels were investigated, resulting in different production strategies.

(2)When the cross-price elasticity coefficient is $0 < b \leq 1$, the three competitive configurations comparison of supply chain equilibrium solutions under three competitive structures.

1.Under the two different models, the RS response has the largest traditional retail channel price, the MS response has the second largest traditional retail channel price, and the MS response has the smallest traditional retail channel price.

2.Among the two different sales channels, the MS countermeasure has the largest direct selling price, the RS countermeasure the second largest, and the VN countermeasure the smallest.

3.Of the two channels, the MS response is the most demanding on the traditional retail channel, while the VN game is the second and the RS game is the least demanding on the traditional retail channel.

4.Under the two different sales methods, distributors have the greatest demand for direct sales channels, the second is the VN game, and the third is the MS game.

5.In a two-channel supply chain, the retailer's profit under the MS game is the largest, followed by the retailer's profit under the RS game, which is the smallest. profit is the largest, followed by the RS game, and the retailer's profit is the smallest under the VN game.

6.Two different types of supply chains were examined, with manufacturers experiencing the greatest gains under the RS countermeasure.

6. Conclusions

Under the e-commerce environment, the dual-channel model, in which direct sales channels and traditional channels coexist, can help manufacturers pool market forces, improve the overall performance of the supply chain, and win more market competitiveness. However, the addition of the dual-channel model exacerbates the intensity of competition among firms in the supply chain and leads to a different competitive landscape due to differences in the position of manufacturers and retailers in the market. In this context, this project intends to investigate both theoretically and empirically the impact of two different competitive approaches on the competitive equilibrium solution of a supply chain. Based on price-sensitive demand, this project establishes a two-tier supply chain model including producers and retailers, and based on this model, we study the impacts of the producer-dominated Stackelberg game, the retailer-dominated Stackelberg game, and the vertical Nash game with the same power on the price and demand of the channel and the interests of all parties in the game, respectively.

This project will explore both theoretically and empirically the impact of two different competitive strategies on each member of the supply chain and each distribution channel. However, there are several shortcomings in this area of research: first, the research in this project is mainly based on perfectly symmetric information, where

reas in reality, different decision makers have different levels of knowledge about the market, so we can extend it to the asymmetric information framework to conduct the research; Second, the model does not take into account the risk factor, so we attempt to study the game problem for producers and retailers with risk aversion. Of course, these shortcomings are exactly what deserve further improvement in future research direction.

References

- [1] Yancong Z , Jin F , Jie W ,et al. Pricing Decisions of a Dual-Channel Supply Chain considering Supply Disruption Risk[J]. *Discrete Dynamics in Nature and Society*, 2018, (2018-3-21), 2018, 2018:1-16.
- [2] Huang G , Ding Q , Dong C , et al. Joint optimization of pricing and inventory control for dual-channel problem under stochastic demand[J]. *Annals of Operations Research*, 2021, 298(1-2): 1-31.
- [3] Chen T H . Effects of the pricing and cooperative advertising policies in a two-echelon dual-channel supply chain[J].*Computers & Industrial Engineering*, 2015, 87(sep.): 250-259.
- [4] Tang C , Yang H , Cao E , et al.Channel competition and coordination of a dual-channel supply chain with demand and cost disruptions[J]. *Applied Economics*, 2018, 50(46-48): 4999-5016.
- [5] Yan B , Jin Z , Wang X , et al.Analyzing a Mixed Supply Chain with a WeChat Channel[J]. *Electronic Commerce Research & Applications*, 2018: S1567422318300334..
- [6] Zhang T , Wang X .The Impact of Fairness Concern on the Three-party Supply Chain Coordination[J]. *Industrial Marketing Management*, 2018, 73(AUG.): 99-115.
- [7] Tang C , Yang H , Cao E , et al.Channel competition and coordination of a dual-channel supply chain with demand and cost disruptions[J]. *Applied Economics*, 2018, 50(46-48): 4999-5016.
- [8] Kolay S. Manufacturer-provided services vs. Retailer-provided services: Effect on product quality, channel profits and consumer welfare[J]. *International Journal of Research in Marketing*, 2015, 32(2): 124-154.
- [9] Zheng L , Bin H ,Bangtong H , et al. Decision Optimization of Low-Carbon Dual-Channel Supply Chain of Auto Parts Based on Smart City Architecture[J]. *Complexity*, 2020.
- [10] Chen J ,Zhang W ,Liu Z .Joint pricing, services and quality decisions in a dual-channel supply chain[J].*RAIRO - Operations Research*, 2020,54(4):1041-1056.
- [11] Xu G , Qiu H .Pricing and Distribution Strategies in a Dual-Channel Supply Chain[J]. *International Journal of Information Systems and Supply Chain Management (IJSSCM)*, 2020, 13(3):23-37.
- [12] Li G ,Wu H , Xiao S .Financing strategies for a capital-constrained manufacturer in a dual-channel supply chain[J]. *International Transactions in Operational Research*, 2020, 27(5): 2317-2339.
- [13] Jiang Z , Zhao J ,Yi Z , et al. Inducing information transparency: The roles of gray market and dual-channel[J]. *Annals of Operations Research*. 2020, (prepublish): 1-30.
- [14] Gao J ,Xiao Z ,Wei H , et al. Dual-channel green supply chain management with eco-label policy: A perspective of two types of green products[J]. *Computers Industrial Engineering*, 2020, 146(prepublish) :
- [15] Li Z ,Yang W , Liu X , et al. Coupon promotion and its two-stage price intervention on dual-channel supply chain[J]. *Computers Industrial Engineering*, 2020,145(prepublish):
- [16] Yang Z , Jingyi L , Bing X . Designing Buy-Online-and-Pick-Up-in-Store (BOPS) Contract of Dual-Channel Low-Carbon Supply Chain considering Consumers' Low-Carbon Preference[J]. *Mathematical Problems in Engineering*, 2020, 2020
- [17] Huang L ,Zhang M .Conformance Quality of the Dual-Channel Tourism Supply Chain under Tourists' Quality Preference[J]. *Journal of China Tourism Research*, 2020, 18(1): 1-26.
- [18] Limin W ,Qiankun S , Zhenjiang Z .The Optimal Pricing of Dual-Channel Supply Chain with the Third Party Product Recovery and Sales Effort[J]. *Complexity*, 2020, 2020
- [19] K. K , A. K A ,B. N . Optimal pricing and remanufacturing decisions for a fuzzy dual-channel supply chain[J]. *International Journal of Systems Science: Operations Logistics*, 2020, 7(3): 248-261.
- [20] Qi D , Chengcheng L .Research on Dual-Channel Supply Chain Promotion Strategy[J]. *International Journal of Information Systems and Supply Chain Management (IJSSCM)*, 2021, 14(3): 79-106.
- [21] Wang R ,Chang Z ,Yan S . The pricing strategy of dual-channel supply chain with risk-averse agents and heterogeneous preference consumers[J]. *Kybernetes*, 2021, 51(4): 1413-1428.
- [22] Cheng C ,Yi C ,Xiaoguang Z , et al.Study on Emission Reduction Strategies of Dual-Channel Supply Chain Considering Green Finance[J]. *Frontiers in Environmental Science*, 2021, 9
- [23] Jingci X , Jianjian L , Xin H , et al. Fresh Food Dual-Channel Supply Chain Considering Consumers' Low-Carbon and Freshness Preferences[J]. *Sustainability*, 2021, 13(11): 6445-6445.
- [24] Chongfeng L , Zhongzhen M , Huanyong J . Strategic Analysis of Dual-Channel Green Supply Chain with an Unreliable and Competitive Supplier[J]. *Sustainability*, 2021, 13(10): 5371-5371.
- [25] Javad A ,Saeed Y , Fatemeh Z .Dual-channel supply chain coordination considering targeted capacity allocation under uncertainty[J]. *Mathematics and Computers in Simulation*, 2021, 187566-585.
- [26] Jin S , Sisi Z . Research on Pricing Strategy of Three-echelon Dual-channel Supply Chain under Market Equilibrium[J]. *Journal of Physics: Conference Series*, 2021, 1910(1):
- [27] Rufeng W , Xiongwei Z , Bo L . Pricing strategy of dual-channel supply chain with a risk-averse retailer considering consumers' channel preferences[J]. *Annals of Operations Research*, 2021, 309(1): 305-324 .
- [28] Ruchi C , Varun K , Kumar T J , et al. A Modified Customization Strategy in a Dual-Channel Supply Chain Model with Price-Sensitive Stochastic Demand and Distribution-Free Approach[J]. *Mathematical Problems in Engineering*, 2021, 2021.
- [29] Aida R , Tina S , Amir A , et al. Optimizing a bi-objective location-allocation-inventory problem in a dual-channel supply chain network with stochastic demands[J]. *RAIRO - Operations Research*, 2021, 55(5): 3245-3279.
- [30] Jiasen S , Pengpeng Y , Lianlian H .Pricing and financing strategies of a dual-channel supply chain with a capital-constrained manufacturer[J]. *Annals of Operations Research*, 2022, 329(1-2): 1241-1261.
- [31] Xu ,Lang, Luo , et al.Credit financing and channel encroachment: analysis of distribution choice in a dual-channel supply chain[J]. *Operational Research*, 2022, 22(4): 1-20.

- [32] Mengqi L ,Ke L ,Sandun P , et al. Game theoretical analysis of service effort timing scheme strategies in dual-channel supply chains[J]. *Transportation Research Part E*, 2022, 158
- [33] Lisha W , Jing C ,Yali L . Manufacturer's channel and logistics strategy in a supply chain[J]. *International Journal of Production Economics*, 2022, (prepublish):108415-.
- [34] Wei G , Bo H . Exploring Data Integrity of Dual-Channel Supply Chain Using Blockchain Technology[J]. *Computational Intelligence and Neuroscience*, 2022, 20223838282-3838282.
- [35] Mehran M G , Fariba G , Saeid M , et al. Investigating a Dual-Channel Network in a Sustainable Closed-Loop Supply Chain Considering Energy Sources and Consumption Tax[J]. *Sensors*, 2022, 22(9): 3547-3547.
- [36] Soleimani F , Pirayesh M, Dehghanian F. A Stackelberg game for ordering and pricing policies in a decentralised dual-channel supply chain[J]. *International Journal of Procurement Management*, 2022, 15(1): 93-112.