Hindawi
Mathematical Problems in Engineering
Volume 2022, Article ID 7255653, 8 pages
https://doi.org/10.1155/2022/7255653

Research Article

Optimized Demand Information Sharing Model of Dual-Channel Supply Chain in E-Commerce

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Received 10 May 2022; Revised 18 June 2022; Accepted 1 July 2022; Published 30 September 2022

Academic Editor: Amandeep Kaur

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In the dual-channel supply chain, the relationship between the electronic direct selling channel and the traditional selling channel is situated in an antagonistic game. The present study used the master-slave game model to analyze the dual-channel supply chain structure, where the manufacturer is the leader of the game, and the seller is the follower of the game. Based on the game analysis theory, the game order of manufacturer and seller is analyzed in the state of demand information sharing. The decision model of each member in the dual-channel supply chain is constructed, and the optimal production decision and product price decision under the demand information sharing between the seller and the manufacturer are determined by the reverse induction method. The expected economic benefits of both are calculated, respectively. The experimental results showed that the economic benefit of the model is higher than that of the traditional demand information nonsharing model, which could enhance the economic benefit of the manufacturer and the seller at the same time and alleviate the contradiction between the electronic direct selling channel and the traditional selling channel.

1. Introduction

With the rapid development of the globalization and the intensive popularization of the Internet technology and logistics industry, e-commerce has become one of the main forms of business trading [1]. In the field of e-commerce, relevant research has proposed dual-channel supply chain strategies to study the development trend of economy. Dual channel refers to two approaches to link the manufacturers with the consumers, that is, the traditional selling channels (i.e., products are sold by manufacturer to consumers through sellers) and electronic direct selling channels (i.e., products are directly sold by manufacturers to consumers) [2, 3]. This strategy has a significant advantage in both improving the market share of enterprises and meeting the needs of consumers. However, most of the sellers in traditional selling channels have a hostile attitude toward electronic direct selling channel. At the same time, different information in the dual-channel supply chain (such as consumers' information, selling information of the products, and product demand forecast information) may have a great impact on the producing decisions of stakeholders involved in this process. Moreover, the information held by each member is not comprehensive, and therefore, every stakeholder hopes to obtain relevant information held by other stakeholders to improve the reliability of their own producing decisions. Therefore, the opposing and antagonistic game relationship between members has becoming increasingly concerning [4].

Several well-known companies in developed countries have applied dual-channel supply chain strategies to actual business operations. For example, Nike, IBM, and Estee

Lauder have used different methods to deal with the conflicts between electronic direct selling channels and traditional selling channels, aiming to reach a harmonious state between the two different approaches. In this way, they tend to increase the market share of the products while also brings a new value transfer model for the company [5]. More specifically, the "demand information sharing" among members in a dual-channel supply chain is the main solution to solve the abovementioned problem [6]. The accuracy of predicting the amount of product sold can be improved through the sharing of demand information. Therefore, manufacturers and sellers in traditional selling channels can quickly and flexibly arrange the amount of production and increase the inventory according to the actual number of sold products. Thus, the operating performance of each member in the dual-channel supply chain can be effectively improved. Based on the abovementioned discussion, it is important to explore a dual-channel supply chain demand information sharing model in e-commerce, as it would provide scientific suggestions for the decision making of members in the dual-channel supply chain.

Previous literature has extensively discussed this topic, especially about Chinese markets. Reference [7] analyzed the impact of reducing costs for research and development in dual-channel supply chain on information sharing of retailers and considered the situation when manufacturers reduced the costs for research and development and when they did not. The study found that no matter whether the manufacturer invested in research and development to reduce production costs, and the profits of the manufacturer would always increase if retailers shared their market demand information with manufacturer. However, if manufacturers do not invest in research and development to reduce production costs, retailers would not share their market demand information with manufacturers, which was in line with existing ideas in this field. If the manufacturers invest in research and development to reduce production costs and when their research and development efficiency is high, the retailer will share their market demand information with the manufacturers. Otherwise, the retailers will still not share their market demand information with the manufacturer. In addition, the Nash information compensation mechanism is designed to encourage retailers to share their market demand information with manufacturers.

Chi et al. [4] further included the variable service level and established a Stackelberg game model based on the two-level optimization theory. It estimated the equilibrium pricing and optimal service level of manufacturers and retailers, and based on the optimal results, it studied the impact of changes of the free rider coefficient on deciding the price and service level, dual-channel demand, and profit of members in the supply chain. The study found that the free-riding phenomenon inhibited retailers' enthusiasm in providing services, lowered market demand, and negatively affected the profits of manufacturers and retailers. Based on the negative impact of the free riding, a coordination mechanism model based on revenue sharing was established, and the conditions for finding equilibrium solutions were given. The statistical results showed that under certain conditions, the adoption of the revenue sharing mechanism would increase the level of services provided by retailers, expand market demand, and improve profits for both manufacturers and retailers.

He [5] conducted relevant analysis and research on the supply chain management of large global circulation organizations and summarized the advantages of the current retail manufacturing industry. According to the limitations of the retail manufacturing industry, it combined the intermediate demand for reverse integration of the supply chain and analyzed the specific significance and mechanism of the division of labor and cooperation in improving the overall efficiency of the circulation industry. From the perspective of supply chain channel, it analyzed the solutions for differentiation and transformation of circulation organizations and restructured the circulation organizations. Furthermore, a new circulation manufacturing model was proposed to supplement and optimize traditional circulation organizations. Reference [6] proposed the information disclosure strategy of manufacturers in a dual-channel supply chain, considering the impact of information acquisition. This study described the demand for branded and nonbranded products in markets where consumers of different quality preference were involved. It concluded the final pricing and pricing strategy of the wholesale products of the brand manufacturer with or without information acquisition, and further come put with the quality information disclosure strategy and analyzed the impact of information acquisition on brand manufacturer pricing and information disclosure decisions. This study found that brand manufacturers were more willing to disclose information to high-type consumers than low-type consumers; the willingness of brand manufacturers to disclose information decreased as retailers increased the cost of acquiring nonbranded products; information acquisition was not beneficial for retailers, and its impact on brand manufacturers was related to market capacity; and taking information acquisition actions would increase brand manufacturers' willingness to disclose information to high-type consumers, whereas their disclosure willingness to low-type consumers depended on market capacity.

Fu et al. [8] studied the impact of economies of scale on information trading decisions in supply chain. On the one hand, supply chain information sharing enabled manufacturers to adjust wholesale prices based on demand information, resulting in an increasement in the double marginalization effect in supply chain; on the other hand, both parties making decisions based on symmetrical demand information would increase the stability of retailer's order. If the manufacturer is a producer of economies of scale, its average production cost decreases with an increase in order stability. When the manufacturer's basic cost is high, the cost-saving effect of information sharing would be greater than the double marginalization effect, and the supply chain profits would increase; information sharing can be achieved through information transactions. However, if the manufacturer's marginal production cost is constant, the average cost does not change with changes in order stability; information sharing therefore cannot be implemented due to reduced supply chain profits. Reference [9] proposed a manufacturing supply chain information interaction method. Through the application of Handle logo analysis, this study tried to find a breakthrough in the intelligent supply chain management model, where the system information interaction drives the efficient coordination of supply chain business. This could help the manufacturing industry achieving the value-adding in the whole supply chain and would improve the overall competitiveness of the supply chain.

Liu et al. [10] studied the impact of retailer information sharing on the corporate social responsibility (CSR) of enterprises in the supply chain, as well as their CSR performance and economic performance under an uncertain market demand. The CSR configuration was described based on whether manufacturers and retailers actively implement CSR behaviors, and a dynamic game model was established and solved for a total of 8 situations, including information sharing and different CSR configuration combinations. The study found that under equilibrium conditions, both manufacturers and retailers would actively implement CSR behaviors, and this CSR configuration was optimal for the CSR performance and economic performance of related enterprises. Both parties conducting CSR behaviors would keep the CSR implementation efficiency at a high level, and retailers would voluntarily share predicting information. In this case, information sharing would be considered as a "win-win strategy" (i.e., information sharing would simultaneously improve the economic performance of manufacturers and retailers); at a low level of CSR implementation efficiency, retailers would have little incentive to voluntarily share predicting information [11–15].

However, there are many deficiencies in the current research, which are mainly reflected in the low expected economic benefits of sellers and manufacturers when the model adopts dual-channel supply chain strategy to make product sales decisions [16–21]. For example, scholars in developed countries such as Batarfi et al. [22], Modak and Kolle [23], and Soleimani et al. [24] explored and studied the demand information sharing of dual-channel supply chain after a long time of analysis and discussion. References [14, 25] applied Stackelberg game and designed an outsourcing contract between a supplier and a buyer, and determined the optimal outsourcing price, retail price, and outsourcing quality under the condition of uncertain demand. In the design of outsourcing contracts, the demand prediction of both supply and demand parties is private, resulting in information asymmetry. Three different prediction scenarios were studied, including noninformation sharing, information sharing, and buyer prediction, and the optimal values of outsourcing price, retail price, and outsourcing quality level were obtained. Furthermore, it compared the best strategies in the three scenarios and drew some insights for management. Reference [26] discussed the impact of three different methods on demand prediction and pricing decision making for combining the products of national brands and store brands in the era of big data. Based on the demand prediction under three different scenarios, that is, noninformation sharing (N), information sharing (I), and retailer prediction (R), the balanced wholesale price and retail price of national brand products and the balanced retail price of store brand were derived. The effects of information collection, information sharing, and prediction accuracy on prices and profits of enterprises in the era of big data were comprehensively discussed.

Based on above discussion, scholars have also found that the existing supply chain strategy has the deviation of expected economic benefits and manufacturers expected economic benefits. Meanwhile, in the context of China, through literature review, it can also be found that information sharing is of great help to optimal production decision making, product price decision making, and economic benefit calculation. Therefore, this paper believes that further discussion is necessary. Therefore, this paper proposes and constructs a dual-channel supply chain demand information sharing model under the e-commerce environment.

2. Methodology

2.1. A Framework of Demand Information Sharing Model of Dual-Channel Supply Chain. By referring to the dual-channel model proposed in previous studies [27–29], the following dual-channel supply chain is presented in this paper includes a manufacturer and a seller [8], as shown in Figure 1. The manufacturer acts as the leader of the game, and the seller is the follower of the game [9]. The following assumptions are made: each member is rational; each member undertakes neutral risk; each member independently determines the decision variables to maximize its economic benefits; and both the demand function and the benefit function are positive.

In model estimation, h and g refer to the production cost of each product of the manufacturer, and the price of each product sold to the seller that is determined by the bargaining ability of the manufacturer, respectively. In addition, p_e and p_r refer to price of each product sold to the consumers by the manufacturer through the electronic direct selling channel, and the price of each product sold to the consumers by the seller through the traditional selling channel. Therefore, the strategy of dual-channel supply chain can be describe as [10]: the manufacturer sold products with a unit price of h to the seller with the price of g, and meanwhile sold the product directly to the consumers with the price p_e through e-commerce; the seller sold the products to the consumers through a traditional selling channel with a price of p_r, based on the price of g and p_e.

Based on the above analysis, equations (1) and (2) can be used to calculate the demand function x_r (through traditional selling channel) and x_e (through electronic selling channel), respectively:

$$x_r = \theta m - p_r + n p_e, \tag{1}$$

$$x_e = (1-\theta)m - p_e + n p_r, \tag{2}$$

where $\theta (0 < \theta < 1)$, $m (m > 0)$, and $n (0 < n < 1)$ refer to the market share of traditional selling channel, total market

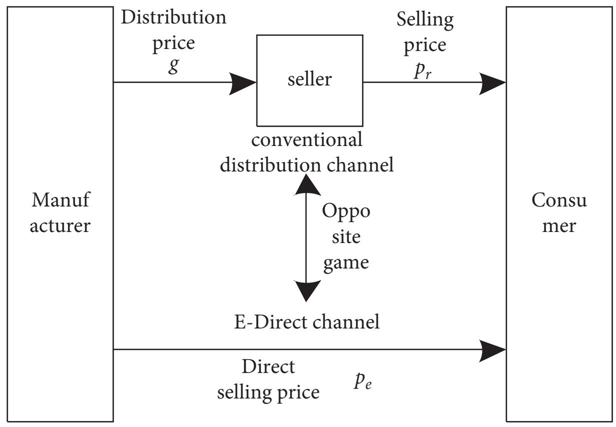

Figure 1: Structure of the dual-channel supply chain.

demand, and the cross-price elasticity coefficient between traditional selling channel and electronic direct selling channels under the dual-channel supply chain strategy. The total market demand is volatile due to the influences of different factors [25], and therefore, m is a random variable, represented by $m = m_0 + \delta$. In this equation, m_0 is constant and represents the fixed part in the market demand, that is, the seller's prediction of the total t market demand; and δ is a random variable representing the random factors in market demand (i.e., factors that stably affect market demand). The expected value and variance of δ are 0 and v, respectively (a higher v value indicates a lower stability of market demand).

Meanwhile, in the abovementioned equation, both $\theta m - p_r$ and $(1 - \theta)m - p_e$ are higher than 0, indicating that these two different selling channels both have their own consumer loyalty.

2.2. Decision-Making Model of Dual-Channel Supply Chain. One of the pioneers of game theory is Gintis [30], whom analyzed the consciousness, habits, behaviors, interests, and psychological states of market designers, predators, and prey from a game perspective, and furthermore analyzed the nature of the market. The game theory proposes to apply well-developed theories in fields such as gambling, art of war, and psychology to find out the internal laws of the market and analyze the problems in trading concept, mentality, and habits, so that traders can trade calmly and produce stable income [31, 32]. Therefore, based on the game analysis theory, this paper analyzed the gaming order in the dual-channel supply chain strategy where the manufacturer and the seller share demand information [26]: (1) the manufacturer decides the prices through direct selling channel (decision variable) after negotiating with the seller when they share demand information (e.g., the sellers' prediction for total market demand) with the manufacturer; (2) the seller decides the prices for traditional selling channel and sells products (decision variable) based on the manufacture's bargaining ability and the private information the seller have.

According to the game between the members under different information sharing states of the dual-channel supply chain strategy, the decision-making model of the members in the dual-channel supply chain is constructed, and the optimal production decision and product price decision under the information sharing between the seller and the manufacturer are determined by the reverse induction [33]. Within the game order (2), y and ∂ refer to the sellers' overall potential demand for the market (seller's private information) and the proportionate relationship between g and p_e (i.e., manufacturers' bargaining ability). The value of ∂ ranges between 0 and 1, and a higher value indicates a higher bargaining ability of the manufacturer. When the value of ∂ is higher than 1, the manufacturer could sell all the products to the seller and there is no need to conduct electronic selling. Based on the above discussion, the following equation could be used to describe the seller's optimal production decision and product price decision in traditional selling channel:

$$\max_{p_r} E(\lambda_r|y) = (p_r - \partial p_e)[E(m|y) - p_r + p_e], \tag{3}$$

$$p_r = \frac{p_e + (1 - s)m_0 + sy + \partial p_e}{2}. \tag{4}$$

In the above equation, λ_r, $E(m|y)$, and $s \in (0, 1)$ refer to the economic efficiency function of the seller, the predicting results of market demand, and measuring indicator of prediction of market demand, among which a higher value of s indicate a higher accuracy in predicting market demand [34].

Within the game order (1), manufacturers employ demand information sharing to understand the seller's prediction of market demand before setting the selling price in electronic direct selling channel [35]. ∂ refers to the manufacturer's bargaining power, with a value ranged between 0 and 1. A smaller value indicates that a lower bargaining power of the manufacturer. When the value is less than 1, the manufacturer can sell all products to the seller, and there is no need to conduct electronic direct selling. Based on the above discussion, the following equations are used to describe the manufacturer's optimal production decision and the product decision price in the electronic direct selling channel:

$$\max_{p_e} E(\lambda_e) = g[E(m) - E(p_r) + p_e] + p_e[E(m) - p_e + E(p_r)], \quad (5)$$

$$p_e = \frac{[(1-s)m_0 + sy](2\partial^2 + 6\partial) - 1}{4\partial^3 - 6\partial^2 + 2\partial}, \quad (6)$$

where λ_e refers to the function of economic benefits of the manufacturers.

Combining equations (6) with (4), the sellers' selling price can be calculated as follows:

$$p_r = \frac{(1-t)m_0 + sy}{2} + \frac{[(1-s)m_0 + sy](2\partial^2 + 6\partial) - 1}{4\partial^3 - 6\partial^2 + 2\partial} + \frac{\partial\{[(1-s)m_0 + sy](2\partial^2 + 6\partial) - 1\}}{4\partial^3 - 6\partial^2 + 2\partial}. \quad (7)$$

Combining equations (6) with (3), and combining equations (7) with (5), the expected economic benefits of manufacturer and seller can be calculated, respectively:

$$E(\pi_r) = \frac{m_0^2 + vs}{4} + \frac{(1+\partial^2)(m_0^2 + vs)(2\partial^2 + 6)^2 + 2 - 2m_0(2\partial^2 + 6)(1+\partial)}{4\partial^3 - 6\partial^2 + 2\partial} - \frac{(m_0^2 + vs)(2\partial^2 + 6)(1+\partial)}{2(4\partial^3 - 6\partial^2 + 2\partial)},$$

$$E(\pi_e) = \frac{3(2\partial^2 + 6)(m_0^2 + vs) - 3m_0/2 + \left[(m_0^2 + vs)(2\partial^2 + 6)^2 + 1 - 2m_0(2\partial^2 + 6)\right](\partial - 1)/2(4\partial^3 - 6\partial^2 + 2\partial)}{4\partial^3 - 6\partial^2 + 2\partial} + \frac{\partial\left\{(2\partial^2 + 6)(m_0^2 + vs) - m_0/2 + \left[(m_0^2 + vs)(2\partial^2 + 6)^2 + 1 - 2m_0(2\partial^2 + 6)\right](\partial - 1)/2(4\partial^3 - 6\partial^2 + 2\partial)\right\}}{4\partial^3 - 6\partial^2 + 2\partial}. \quad (8)$$

3. Experimental Analysis

In order to evaluate the effectiveness of demand information sharing model of the dual-channel supply chain proposed in this paper, an experiment was designed in the present study to compare the traditional demand information nonsharing model with the model proposed in this paper. Company A is a manufacturer in food industry with a dual-channel market and is in the forefront of the industry, ranking third in the industry and first in Sichuan province. It has high-quality product power, C-end channel power, and management capabilities for upstream and downstream. In recent years, the company has continuously launched new products, putting around 1–5 new products in market every year, and half of the increase in profit comes from selling new products. Therefore, taking Company A and Company B, one of its fixed sellers, as the research object, the traditional nonsharing model of demand information and the model proposed in this article are used to simulate the process of selling products through the dual-channel supply chain strategy. Furthermore, the expected economic benefit and the manufacturer's expected economic benefit are analyzed. The estimated parameters of the economic benefit of the research objects are shown in Table 1.

Figure 2 shows the changes in economic benefits when sellers' manufacturers make decisions with using our proposed model and when they make decisions with traditional demand information nonsharing models. Figure 2(a) shows the seller's economic benefits from making decisions based on our model and based on the traditional demand information nonsharing model under the conditions of different prediction accuracy of market demand. Adopting our model in decision making led to a decline in the economic benefits of the seller as the accuracy of market demand prediction declines. For decision making using the traditional nonsharing model of demand information, the economic benefits of the sellers tend to decline first and rise afterward as the prediction accuracy of market demand decreases, and the economic benefits are generally lower than benefits from the model proposed in this paper. One of the reasons is that in the selling market, the traditional selling channel has a higher market share than the electronic direct selling channel. Therefore, without sufficient information in decision making, manufacturers tended to predict the market demand based on the amount of sold products from electronic direct selling channel. When the accuracy of the sellers' prediction for market demand is higher/lower than that of the manufacturer, their economic benefits would show a decline/rising trend as the prediction accuracy decreases. At the same time, under the condition that the sellers accurately predict the market demand, the economic benefit of using the traditional demand information nonsharing model in decision making is higher than the economic benefit obtained by using our model. The explanation is that the market share of the traditional selling channel is higher than the electronic direct selling channel, and therefore, the prediction accuracy of sellers is higher than the prediction accuracy of manufacturers. However, due to the

Table 1: Estimated parameters of economic benefits.

Fixed parameters in market demand during the calculation of economic benefits	Value
The market share of traditional selling channel	60% (range 10%–100%)
Cross-channel price elasticity coefficient between different channels	1
Producing cost per product/RMB (also called: Yuan)	10
Price of each product sold to the seller by the manufacturer/RMB	16
Price of each product sold through electronic direct selling channel/RMB	17.5
Price of each product sold by sellers through traditional selling channel/RMB	19
Accuracy of prediction for market demand by the seller	(Range 0%–100%)
Variance of market demand	50 (range 0–800)

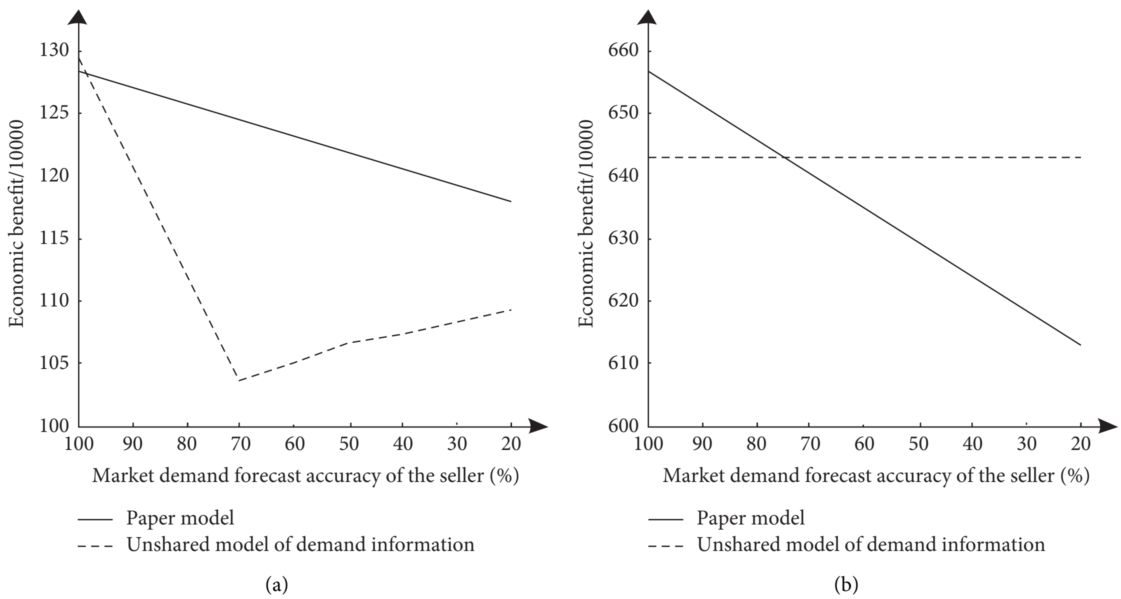

Figure 2: Changes in the expected economic benefits of members in the dual-channel supply chain: (a) expected economic efficiency of sellers; (b) expected economic benefits of manufacturer.

presence of various uncertainties in predicting the market demand, it is unrealistic to predict the market demand with a 100% accuracy.

Figure 2(b) shows the economic benefits of the manufacturer and how it is influenced by sellers' decisions made based on our model, and traditional demand information nonsharing model under the conditions of different prediction accuracy of market demand. The seller adopting the traditional demand information nonsharing model in decision making did not have an effect on the manufacturer's economic benefit, indicating that there is no significant correlation between the manufacturer's economic benefit and the seller's prediction. The reason is that under the condition of the traditional demand information nonshared model, manufacturers predict market demand based on the amount of sold products through electronic direct selling channel and make decisions accordingly, which has nothing to do with the predicting accuracy of the market demand of the sellers. In case that the sellers adopting our model in decision making, there was a positive relationship between the manufacturer's economic benefit and the seller's prediction accuracy for market demand, which was significantly higher than the economic benefits in the traditional demand information nonsharing model. This is because in our model, manufacturers use the demand information shared by sellers as the main reference for decision making. A lower predicting accuracy of market demand by the sellers would lead to a decrease in the economic benefits of the manufacturers.

Combining the results from Figures 2(a) and 2(b), it can be found that using the model proposed in this paper in decision making would, the economic benefits of both sellers and manufacturers were higher than those obtained by using traditional demand information nonsharing models for decision making. The effectiveness of the model proposed in the present study is therefore proved.

4. Conclusion

In the era of e-commerce, the dual-channel supply chain strategy, where the traditional selling channels and electronic direct selling channels co-exist, has become the main selling strategy in the field of processing and manufacturing commerce. The gaming and conflicts between channels raised by competition for prices also bring problems for the theoretical research and practical application of the theory in management in the field of e-commerce. Based on this, the present study developed a dual-channel supply chain demand information sharing model under the e-commerce environment. Based on the structure of dual-channel supply chain, game analysis is used to calculate the expected economic benefits of the seller and the manufacturer under the condition of sharing sellers' prediction for market demand. By comparing the model proposed by the present study with the traditional demand information nonsharing model in an experimental design, the economic benefits of sellers and manufacturers were estimated. The results showed that using our proposed model in decision making of producing and deciding prices would increase the economic benefits of both sellers and manufacturers.

However, there are still some problems in implementing the proposed model as follows:

First, sufficient information sharing of market demand in dual-channel supply chain is a prerequisite for establishing an information control platform of product supply chain. However, in practice, each member of the supply chain would deliberately hide their cost, output, purchase price, and other information for their own benefit. Sales data, especially detailed data for each transaction, are considered as highly confidential business data. Even for staff inside enterprises, access to these data is monitored, let alone disclosing such information to individuals outside the enterprise. Under this circumstance, there are still risks in sharing demand information in the dual-channel supply chain, and the willingness of the members in the supply chain to share information timely may be doubted.

Second, one of the characteristics of the product supply chain is the large number of participants and that each participant differs in economic strength and production capacity. This has caused two phenomena. First, the share of the cost of using advanced predicting technology and information technology may differ across members. Second, there are uneven distributions of profits due to information sharing and information control. In the product supply chain, information is mainly controlled by downstream companies, and the increase in costs is mainly undertaken by downstream companies as well, whereas the increase in profits mainly goes to upstream companies. This situation results in the resistance of some of the enterprises toward building a cooperative relationship between members of the supply chain and may therefore increase the difficulty of running the platform.

Last, the establishment and application of the abovementioned platforms are supported by advanced management concepts and information technology, and at the same time, it requires the corresponding technology application level and market capacity. Although the aforementioned information sharing technologies have been developed to a certain extent, the application of these technologies in industry in China is still relatively weak. Furthermore, the source of the product supply chain is generally small-scale, and the related product information technology is relatively at infancy. The demand for information sharing and control platforms is also relatively weak as well. These are issues that need to be considered in actual application.

However, this paper is based on information sharing in the e-commerce environment of dual-channel supply chain members how to develop information sharing strategy and investigate the influence mechanism of supply chain members' decision and profit. However, there are some shortcomings in our work. First, due to space constraints, we did not delve into other ways to achieve information symmetry in a two-channel supply chain. In addition, this paper only considers retailers in a single industry, but in a real business environment, the variety of manufacturers is often diverse. Therefore, in the future research, the situation of adding multiple industries can be comprehensively considered for comparison.

Data Availability

The datasets used during the current study are available from the corresponding author on reasonable request.

Disclosure

Yiming Song and Shun Wu are co-first authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

Yiming Song and Shun Wu contributed equally to this paper. Yiming Song and Shun Wu performed conceptualization and formal analysis and developed the methodology. Yang Zhou collected data and performed the formal analysis. Yiting Pan performed the formal analysis and wrote the original draft and performed the supervision. Sudhir Kumar performed conceptualization, wrote the final draft, performed the supervision, and reviewed and edited the article.

References

[1] M. P. Rodríguez Bolívar, "Policy makers' perceptions on the transformational effect of Web 2.0 technologies on public services delivery," *Electronic Commerce Research*, vol. 17, no. 2, pp. 227–254, 2017.

[2] S. Y. Shi and J. C. Sun, "Pricing decisions of a dual-Channel supply chain with a risk-averse supplier and a budget constraint retailer," *Forecasting*, vol. 38, no. 02, pp. 90–96, 2019.

[3] J. Wei, S. Seedorf, P. B. Lowry, C. Thum, and T. Schulze, "How increased social presence through co-browsing influences user engagement in collaborative online shopping," *Electronic Commerce Research and Applications*, vol. 24, pp. 84–99, 2017.

[4] F. Y. Chi, Q. Xu, and T. T. Chen, "Two - channel supply chain benefit sharing contract design under hitchhiking effect," *Practice and Understanding of Mathematics*, vol. 18, pp. 39–53, 2018.

[5] Y. He, "Double channel supply chain based on 'pull' model research on reverse integration," *Business and Economic Research*, vol. 1, pp. 38–40, 2017.

[6] L. Deng, J. G. Zheng, and R. J. Zhao, "Double channel supply chain manufacturer information disclosure strategy considering the influence of information acquisition," *Industrial Engineering & Management*, vol. 23, no. 4, pp. 137–144, 2018.

[7] C. L. Shi and J. J. Nie, "The effect of dual channel supply chain on retailer information sharing," *Industrial Engineering & Management*, vol. 4, pp. 81–89, 2018.

[8] H. Fu, M. Jian, and Y. F. Fan, "Study on the influence of scale economy on supply chain information transaction decision," *Journal of Systems Science*, vol. 2, pp. 111–116, 2018.

[9] T. T. Wang and Q. Q. Ji, "Handle system in manufacturing supply chain information interaction," *Technology Innovation and Application*, vol. 8, pp. 66-67, 2019.

[10] J. Liu, J. J. Nie, and H. P. Yuan, "The influence of information sharing on corporate social responsibility allocation in supply chain," *Industrial Engineering & Management*, vol. 3, pp. 164–170, 2019.

[11] J. N. Wu, N. X. Wang, and Z. N. Wang, "Impact of information technology capability on financial performance during the period of economic downturn: the case of Chinese listed companies," *Electronic Commerce Research*, vol. 17, no. 3, pp. 403–423, 2017.

[12] M. Vanderroost, P. Ragaert, J. Verwaeren, B. De Meulenaer, B. De Baets, and F. Devlieghere, "The digitization of a food package's life cycle: existing and emerging computer systems in the pre-logistics phase," *Computers in Industry*, vol. 87pp. 1–14, C, 2017.

[13] Y. Li, "Predictions model of customer churn in E-commerce based on online sequential optimization extreme learning machine," *Journal of Nanjing University of Science and Technology*, vol. 43, no. 01, pp. 108–114, 2019.

[14] Z. J. Kong and Z. Y. Li, "Pricing decision in dual-Channel supply chain with the retailer's E-market," *Industrial Technology & Economy*, vol. 36, no. 3, pp. 116–122, 2017.

[15] J. H. Gerdes, C. T. Huang, and M. A. Sharaf, "Incorporating biometrics into veiled certificates: preventing unauthorized use of anonymous certificates," *Electronic Commerce Research*, vol. 17, no. 2, pp. 289–316, 2017.

[16] A. Khalid, P. Kirisci, Z. H. Khan, Z. Ghrairi, K. D. Thoben, and J. Pannek, "Security framework for industrial collaborative robotic cyber-physical systems," *Computers in Industry*, vol. 97, no. 4, pp. 132–145, 2018.

[17] A. Huang, "A risk detection system of e-commerce: researches based on soft information extracted by affective computing web texts," *Electronic Commerce Research*, vol. 18, no. 1, pp. 143–157, 2018.

[18] X. Tian and L. Liu, "Does big data mean big knowledge? Integration of big data analysis and conceptual model for social commerce research," *Electronic Commerce Research*, vol. 17, no. 1, pp. 169–183, 2017.

[19] R. Alguliyev, Y. Imamverdiyev, and L. Sukhostat, "Cyber-physical systems and their security issues," *Computers in Industry*, vol. 100, no. 1, pp. 212–223, 2018.

[20] F. Huang and X. G. Zheng, "Incentives of logistics service lever in retail drop-shipping double channel supply chain," *Computer Integrated Manufacturing Systems*, vol. 25, no. 05, pp. 1296–1306, 2019.

[21] K. Sun, Z. F. Wang, and Z. H. Yan, "Classification and theoretical models of sharing economy business models: based on studies of three typical cases," *Management Review*, vol. 31, no. 07, pp. 97–109, 2019.

[22] R. Batarfi, M. Y. Jaber, and S. Zanoni, "Dual-channel supply chain: a strategy to maximize profit," *Applied Mathematical Modelling*, vol. 40, no. 21-22, pp. 9454–9473, 2016.

[23] N. M. Modak and P. Kelle, "Managing a dual-channel supply chain under price and delivery-time dependent stochastic demand," *European Journal of Operational Research*, vol. 272, no. 1, pp. 147–161, 2019.

[24] F. Soleimani, A. Arshadi Khamseh, and B. Naderi, "Optimal decisions in a dual-channel supply chain under simultaneous demand and production cost disruptions," *Annals of Operations Research*, vol. 243, no. 1-2, pp. 301–321, 2016.

[25] X. W. Zhu, "Outsourcing management under various demand Information Sharing scenarios," *Annals of Operations Research*, vol. 257, no. 1-2, pp. 449–467, 2017.

[26] T. Zhang, X. Zhu, and Q. Gou, "Demand forecasting and pricing decision with the entry of store brand under various information sharing scenarios," *Asia Pacific Journal of Operational Research*, vol. 34, no. 02, Article ID 1740018, 2017.

[27] D. Fang and Q. Ren, "Optimal decision in a dual-channel supply chain under potential information leakage," *Symmetry*, vol. 11, no. 3, p. 308, 2019.

[28] Y. Dai, L. Dou, H. Song, L. Zhou, and H. Li, "Two-way information sharing of uncertain demand forecasts in a dual-channel supply chain," *Computers & Industrial Engineering*, vol. 169, Article ID 108162, 2022.

[29] R. Qiu, L. Hou, Y. Sun, M. Sun, and Y. Sun, "Joint pricing, ordering and order fulfillment decisions for a dual-channel supply chain with demand uncertainties: a distribution-free approach," *Computers & Industrial Engineering*, vol. 160, Article ID 107546, 2021.

[30] H. Gintis, *The Bounds of Reason: Game Theory and the Unification of the Behavioral Sciences*, Princeton University Press, Princeton, New Jersey, 2014.

[31] X. Pan, W. Zhang, and L. Chou, "The theory on the environmental emission trading under the concept of two-tired earning," *Ekoloji*, vol. 28, no. 107, pp. 1659–1663, 2019.

[32] G. Pu, Y. Zhang, and L. C. Chou, "Estimating financial information asymmetry in real estate transactions in China-An application of two-tier Frontier model," *Information Processing & Management*, vol. 59, no. 2, Article ID 102860, 2022.

[33] V. Turkulainen and M. L. Swink, "Supply chain personnel as knowledge resources for innovation a contingency view," *Journal of Supply Chain Management*, vol. 53, no. 3, pp. 41–59, 2017.

[34] M. R. Gholamian and A. H. Taghanzadeh, "Integrated network design of wheat supply chain: a real case of Iran," *Computers and Electronics in Agriculture*, vol. 140, pp. 139–147, 2017.

[35] G. M. P. Wanderley, M. H. Abel, E. C. Paraíso, and J. P. A. Barthes, "MBA: a system of systems architecture model for supporting collaborative work," *Computers in Industry*, vol. 100pp. 31–42, C, 2018.