Hindawi
Discrete Dynamics in Nature and Society
Volume 2022, Article ID 3027249, 15 pages
https://doi.org/10.1155/2022/3027249

Research Article

Pricing Decisions and Online Channel Selection Strategies in Dual-Channel Supply Chains considering Block Chain

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Received 21 February 2022; Revised 26 March 2022; Accepted 7 April 2022; Published 31 May 2022

Academic Editor: Sundarapandian Vaidyanathan

Pricing decisions and online channel selection strategies are playing an increasingly important role in e-commerce. In this paper, we consider two different types of dual-channel supply chain sales models, namely, an online direct + online distribution sales model consisting of an online direct sales channel and online distribution sales channel and an online direct + delegation sales model consisting of an online direct sales channel and an online delegation sales channel. By introducing the customer sensitive coefficient and block chain technology into these dual-channel supply chain sales models, we analyzed pricing decisions and online channel selection strategies in dual-channel supply chains in terms of the adoption and nonadoption of block chain technology. In the two different dual-channel sales models, the results showed that (1) without block chain technology, retail prices increase when the manufacturer's unit retail cost increases; (2) with block chain technology, retail prices are higher than those of sales models that do not adopt block chain technology; and (3) with block chain technology, the manufacturer should choose the online direct + delegation sales model to sell its products.

1. Introduction

According to data released by the National Bureau of Statistics in China, in 2019, China's online sales revenue reached 10.63 trillion yuan, and the online sales revenue of physical goods reached 8.52 trillion yuan, which accounted for 20.7% of total retail sales of social consumer goods. The rapid development of e-commerce and information technology has greatly promoted the integrated development of the Internet and other domains, and the fast-paced advancement of the online platform economy has led it to become an important channel for selling new products. From the perspective of online sales models, the online platform sales model includes an online direct sales model (such as that adopted by Apple, Dell, and other manufacturers), online distribution sales model (e.g., Jingdong, Suning, and other e-commerce platform firms), and online delegation sales model (e.g., Tmall, Jingdong Flagship Store, and Suning Flagship Store) [1–4]. Thus, there are two different types of dual-channel sales models in a dual-channel supply chain. The online direct + online distribution sales model consists of an online direct sales channel and online distribution sales channel, and the online direct + delegation sales model consists of an online direct sales channel and online delegation sales channel.

To satisfy consumers' personalized preferences and consumption demand for product traceability, manufacturers should improve their profits and alleviate the channel conflict problem. Manufacturers should also address consumer fear and uncertainty with respect to the authenticity of products, as well as any product traceability problems that may exist. At present, in the process of product selling, certain problems persist with regard to the lack of transparency about product information, and difficulties are also encountered in determining the source of products and proving their authenticity. Block chain technology is capable of creating a unique label for each product, the details of which can be recorded and tracked, which therefore allows the customer to quickly trace the source of the product using this technology. For example, in 2016, Wal-Mart cooperated with IBM, and block chain technology was used to test the traceability of mangos in a Wal-Mart store. In just 2.2 seconds, the technology traced the origin of a mango, obtained all relevant information, and determined that this product was sourced from a particular farm [5]. Moreover, block chain technology can provide a higher level of visibility into the supply chain, and it allows participants to trace information within it. Therefore, this technology can enhance supply transparency and transparency throughout the supply chain. Behnke et al. pointed out that it can be successfully used with block chain to improve traceability and identify the boundary conditions for sharing information [6]. Tapscott and Tapscott believed that block chain has the potential to allow the exchange of data between multiple supply chain partners, and it can increase product transparency and traceability without the need for third-party maintenance [7]. Due to the widespread use of block chain technology in supply chains, this study aimed to examine the following research issue: What is the impact of block chain technology on pricing decisions and channel selection strategies in dual-channel supply chains?

To address the above research question, we considered a dual-channel supply chain consisting of one manufacturer and one e-commerce platform. We examined two dual-channel supply chain sales models. The online direct + online distribution sales model consisted of an online direct sales channel and online distribution sales channel, and the online direct + online delegation sales model consisted of an online direct sales channel and an online delegation sales channel. The paper aimed to (1) explore which dual-channel retail model is more beneficial for the manufacturer, (2) evaluate the impact of block chain technology on pricing decisions in two different dual-channel supply chain sales models, and (3) determine impact of block chain technology on the channel selection strategy in a dual-channel supply chain.

The main contributions of this paper are as follows: (1) we construct two different dual-channel retail models; that is, the online direct + online distribution sales model and the online direct + online delegation sales model; (2) we discuss the impact of block chain technology on pricing decisions in two different dual-channel supply chain sales models; and (3) we identify which kinds of dual-channel sales models are more beneficial for the manufacturer.

The remainder of this paper is organized as follows: Section 2 reviews the relevant literature; modeling descriptions and assumptions are described in Section 3; Section 4 outlines the theoretical model; Section 6 presents the results and analysis; and Section 8 concludes and proposes directions for future research.

2. Literature Review

Our work is mainly related to two streams of literature, namely, the dual-channel supply chain problem and the impact of block chain technology on the supply chain. In this section, we review relevant studies from both of these domains. The present study contributes to extant literature as it investigates pricing decisions and channel selection strategy problems that arise in a dual-channel supply chain and furthermore considers the impact of block chain technology on pricing decisions and channel selection strategies.

2.1. The Dual-Channel Supply Chain Problem. The dual-channel supply chain problem has been studied extensively in recent years. However, from the perspective of the supply chain structure, most of these studies considered online and offline channel structures or offline dual-channel structures. To the best of our knowledge, few studies have investigated the online dual-channel problem.

Many scholars investigated price competition between a retail channel and a direct channel, where one channel was an online channel and the other was an offline channel, or both consisted of offline channels. It is usually assumed that the products sold on the two channels are homogenous, and thus the price on one channel positively influences demand on the other channel. Problems that have been investigated in this group include price setting (Cao et al. [8]; and Liu et al. [9]), supply chain coordination (Cai et al. [10]; Chen et al. [11]; Ryan et al. [12]; and Xu et al. [13], and the strategic impact of introducing channels (Cai [14]; Chen et al. [15]; Chiang et al. [16]; Kim and Chun [17]; and Yuan et al. [18]), while considering various conditions.

Some scholars believe that it is necessary for manufacturers to introduce online channels. For example, Rodriguez and Aydin [19] pointed out that a dual-channel structure can attract more customers, so manufacturers can always benefit from this type of structure. Hsiao and Chen [20] found that the introduction of online channels by manufacturers or retailers can attract online consumers, encourage them to buy products in physical stores, and reduce the double marginalization caused by the introduction of online channels. Zhao and Cheng [21] proposed that the introduction of online direct marketing channels by manufacturers will generate benefits such as enhanced performance not only for manufacturers but also for retailers and the whole mixed channel supply chain.

However, manufacturers do not necessarily benefit from the introduction of online channels [22]. Chiangab [23] found that when the number of customers who prefer traditional retail channels and online channels is roughly similar and the willingness of customers to purchase from non-preferred channels is low, the selection of a mixed channel structure by manufacturers is the most effective, and in most cases, mixed channels are preferable to single channels. Xiao et al. [24] found that the smaller the manufacturer's unit production cost, the greater their motivation to adopt a dual-channel structure. However, with the increase in the retailer's marginal sales costs, the manufacturer is less motivated. Khouja et al. [25] found that the relationship between the sales costs of a direct channel and a retail channel is the key factor in determining the manufacturer's channel choice in a dual-channel supply chain.

Dumrongsiri [26] found that when the retailer's marginal costs are high and the wholesale price and the change in demand are low, the manufacturer will introduce an online channel. Wang et al. [27] pointed out that if the manufacturer's online channel unit operating costs or revenue distribution ratio in the third-party online channel is low enough, the manufacturer is motivated to increase the online channel. He et al. [28] considered a dual-channel closed-loop supply chain where a manufacturer could distribute new products through an independent retailer and sold remanufactured products via a third-party firm or platform (3P) in the presence of possible government subsidy. He et al. [29] investigated a buy-online-and-deliver-from-store (BODS) strategy where a manufacturer sold products through both online and offline channels and employed the offline retailer to deliver online orders from the retailer's warehouse. He et al. [30] studied a single-retailer-single-vendor dual-channel supply chain model, in which the vendor sold deteriorating products through its direct online channel and the indirect retail channel and established the model of centralized (i.e., the two firms make decisions jointly) and decentralized (i.e., the two firms make decisions separately, vendor as the Stackelberg leader) problems. Zhang et al. [31] studied the "preorder-online, pickup-in-store" (POPU) strategy for a dual-channel retailer. Under a monopoly case, they found that the POPU strategy decreased the retailer's market share and reduced his profits.

2.2. The Impact of Block Chain Technology on Supply Chain. Block chain technology is a sharing database that allows for the compilation and maintenance of distributed ledgers, in which stored data are secured to eliminate counterfeiting issues and ensure whole-process traceability, openness, transparency, and collective maintenance. This technology enables all parties to conduct their business securely and safely and creates a new model of trust for global connectivity. The impact of block chain technology on the supply chain is mainly manifested in three respects: logistics and supply chain finance, logistics tracking and product traceability, and process optimization and paperless [32].

In terms of logistics and supply chain finance, Choi et al. [33] compared the traditional supply chain finance model with the block chain supply chain finance model and found that when banking service fees are high enough, the block chain supply chain finance model is preferable. From the perspective of information disclosure, Chod et al. [34] found that block chain technology creates an opportunity to obtain favorable financing conditions for the supply chain at a lower signal cost. Yu et al. [35] compared the traditional supply chain finance model in terms of the credit guarantees of core enterprises with the self-guarantee supply chain finance model based on block chain technology for small- and medium-sized enterprises, and the results showed that the self-guarantee financing model is more efficient.

In terms of product traceability, Helo and Hao [36] explored a block chain-based logistics monitoring system that provides a solution for package-tracking in the supply chain to support an open and immutable historical record for each transaction. Based on existing food traceability schemes, George et al. [37] proposed a restaurant model to achieve more reliable food traceability using block chain and product identifiers. Based on block chain technology, Liu and Li [38] put forward a new global supply chain and cross-border e-commerce transaction information platform and theoretical framework of information flow to solve the product traceability problem in supply chain management from multiple aspects, such as data management, information anchoring, and key management. Kamanashis et al. [39] proposed that block chain technology allows for true traceability of goods throughout the supply chain, and it also supports the prevention of product fraud and counterfeit goods therein. Behnke and Jannsen [5] determined that block chain technology can enhance traceability in the food supply chain by considering five elements: business, supply chain processes, regulation, quality assurance, and traceability. Our study contributes to this stream of research by examining the impact of block chain technology on pricing decisions and online channel selection strategies.

3. The Model

3.1. Modeling Description. Here, we consider a dual-channel supply chain consisting of one manufacturer and one e-commerce platform. Depending on whether or not block chain technology is adopted and while considering the characteristics of the online channel, we evaluate four different kinds of dual-channel sales models (as shown in Figure 1).

3.2. Modeling Assumptions. Without affecting the conclusions and to better ensure that the game model corresponds to a real-world scenario, the following assumptions are made.

Assumption 1. To simplify the calculation, we assume that the manufacturer only sells the same product in the direct sales channel; in the delegation (distribution) sales channel, we simply consider basic market demand θ[27, 28].

Assumption 2. The manufacturer's unit retail cost in the online direct sales channel is c; moreover, the e-commerce platform's unit retail cost in the distribution or delegation sales channel is c[28].

Assumption 3. The strength of consumer preferences for the online direct sales channel is ϕ, where $0 < \phi < 1$.

Assumption 4. Both the manufacturer and e-commerce platform pursue their own profit maximization strategies, and the information is symmetric in respect to the retail cost or demand information.

Assumption 5. In the game model, the e-commerce platform is the leader, and the manufacturer is the follower.

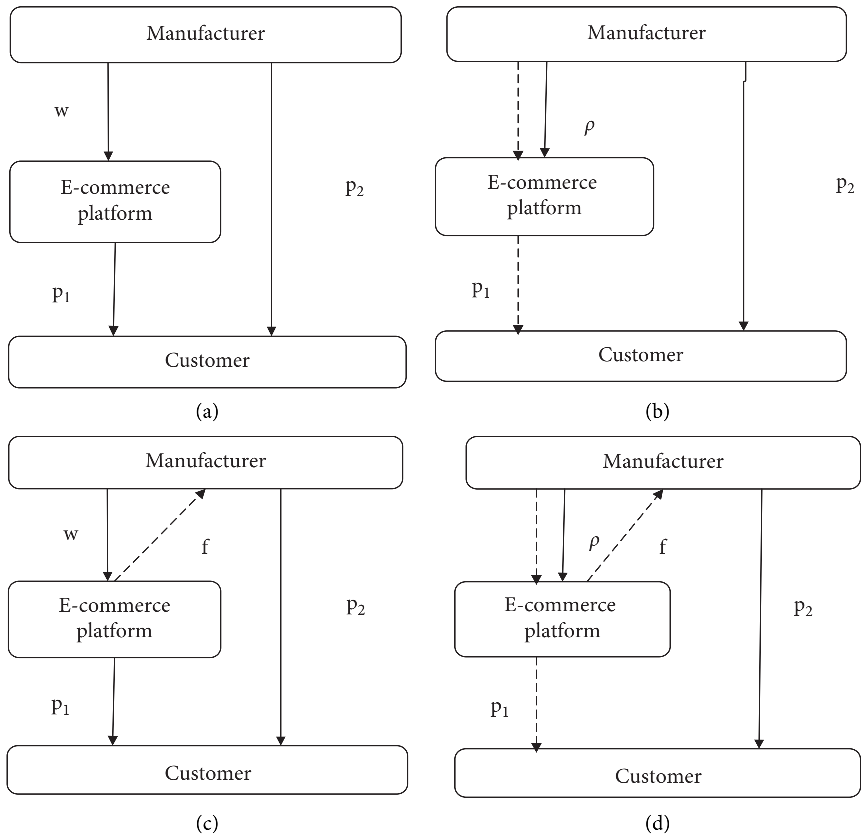

FIGURE 1: Dual-channel supply chain models. (a) Dual-channel supply chain models without block chain technology. (A) ND model: without block chain technology. On the one hand, in the distribution sales model, the manufacturer sells the product at wholesale price w to the e-commerce platform. Then, the e-commerce platform sells the products to the customer at the retail price p_1. On the other hand, in the direct sales model, the manufacturer sells the product directly to the customer at the retail price p_2. (B) NW model: without block chain technology, on the one hand, in the delegation sales model, the manufacturer sells the product to the customer at the retail price p_1. The e-commerce platform publishes the selling information to encourage customers to purchase the products, and it receives a certain sales commission ρp_1. On the other hand, in the direct sales model, the manufacturer sells the product directly to the customer at the retail price p_2. (b) Dual-channel supply chain models with blockchain technology. (C) YD model: with block chain technology, the manufacturer introduces block chain technology to transform the firm's original online platform, so that it acts as both an inspection platform and a sales platform at the same time. The e-commerce platform should pay the inspection fee to the manufacturer. On the one hand, in the distribution sales model, the manufacturer sells the product at the wholesale price w to the e-commerce platform. The e-commerce platform then sells the products to the customer at the retail price p_1. On the other hand, in the direct sales model, the manufacturer sells the products directly to the customer at the retail price p_2. (D) YW model: with block chain technology, the manufacturer introduces block chain technology to transform the firm's original online platform, so that it acts as both an inspection platform and a sales platform at the same time. Similarly, the e-commerce platform should pay the inspection fee for the manufacturer. On the one hand, in the delegation sales model, the manufacturer sells the product to the customer at the retail price p_1. The e-commerce platform publishes the selling information to encourage customers to purchase the products, and it receives a certain sales commission ρp_1. On the other hand, in the direct sales model, the manufacturer sells the product directly to the customer at the retail price p_2.

Assumption 6. It takes some time to test and evaluate the product; without block chain technology, the testing and evaluation time is t; with block chain technology, the testing and evaluation time is T and $t > T$.

Assumption 7. Without block chain technology, the authenticity of the product is represented by e and $1 - e$ represents the probability that the product will be certified as counterfeit. It can guarantee that the product is authentic by using block chain technology, i.e., $e = 1$.

Assumption 8. To simplify the analysis, it is assumed that the manufacturer's production costs are zero.

Assumption 9. To ensure the profitability of all members of the supply chain, it is necessary to satisfy the following: $\theta > A > B$, i.e., $A = \beta t + \gamma(1-e)$, $B = \beta T$, and $t > T$.

The meanings of the main parameters and variables adopted in this paper are shown in Table 1.

4. The Dual-Channel Sales Model without Block Chain Technology

4.1. Online Direct + Online Distribution Sales Model (ND Model). In this theoretical model, the manufacturer and e-commerce platform are subject to a two-stage Stackelberg game. The e-commerce platform is the leader, the manufacturer is the follower, and the decision sequence is such that the e-commerce platform decides the retail price p_1^{ND} to maximize their profit. Then, the manufacturer decides the wholesale price w^{ND} and the retail price p_2^{ND} in the online sales channel. The demand in the distribution and direct sales channels is as follows:

$$\begin{cases} D_e^{ND} = \theta - p_1^{ND} + \phi p_2^{ND} - \beta t - \gamma(1-e), \\ D_m^{ND} = \theta - p_2^{ND} + \phi p_1^{ND} - \beta t - \gamma(1-e). \end{cases} \tag{1}$$

The manufacturer's profit is as follows:

$$\prod_m^{ND} = \left(p_2^{ND} - c\right)D_m^{ND} + \left(w^{ND} - c\right)D_e^{ND}. \tag{2}$$

The e-commerce platform's profit is as follows:

$$\Pi_e^{ND} = \left(p_1^{ND} - w^{ND}\right)D_e^{ND}. \tag{3}$$

We can determine the demand, profit, and optimal pricing decisions of the manufacturer and the e-commerce platform using Theorem 1:

Theorem 1. *In the direct and distribution sales models, demand, profit, and optimal pricing decisions are summarized in Table 2 (the solving procedure can be found in Appendices).*

Proposition 1. *Without block chain technology, in the direct and distribution sales models, we have* $(\partial w^{ND^*}/\partial c) > 0$, $(\partial p_1^{ND^*}/\partial c) > 0$, $(\partial p_2^{ND^*}/\partial c) > 0$; $(\partial w^{ND^*}/\partial \beta) < 0$, $(\partial p_1^{ND^*}/\partial \beta) > 0$, $(\partial p_2^{ND^*}/\partial \beta) > 0$; $(\partial w^{ND^*}/\partial \gamma) < 0$, $(\partial p_1^{ND^*}/\partial \gamma) > 0$, *and* $(\partial p_2^{ND^*}/\partial \gamma) > 0$

Proposition 1 suggests that the retail price in the direct sales channel and the retail price in the distribution sales channel increase when the manufacturer's unit retail cost in the dual sales channels increases. Moreover, in the direct + distribution sales model, the wholesale price and the retail price decrease when the sensitivity coefficient is higher with respect to product inspection/evaluation and the probability of a negative product inspection result.

4.2. Online Direct + Online Delegation Sales Model (NW Model). In this theoretical model, the manufacturer and e-commerce platform are subject to a two-stage Stackelberg game. The e-commerce platform is the leader, the manufacturer is the follower, and the decision sequence is such that the e-commerce platform first announces the unit commission rate to maximize its profit. Then, the manufacturer sets the retail price p_1^{NW} in the online delegation sales channel and the retail price p_2^{NW} in the online direct sales channel. The demand in the delegation and direct sales channels is as follows:

$$\begin{cases} D_e^{NW} = \theta - p_1^{NW} + \phi p_2^{NW} - \beta t - \gamma(1-e), \\ D_m^{NW} = \theta - p_2^{NW} + \phi p_1^{NW} - \beta t - \gamma(1-e). \end{cases} \tag{4}$$

The manufacturer's profit is

$$\Pi_m^{NW} = \left(p_2^{NW} - c\right)D_m^{NW} + \left[p_1^{NW}(1-\rho) - c\right]D_e^{NW}. \tag{5}$$

The e-commerce platform's profit is

$$\Pi_e^{NW} = \rho p_1^{NW} D_e^{NW}. \tag{6}$$

We can determine the optimal pricing, demand, and profit of the manufacturer and e-commerce platform and derive Theorem 2:

Theorem 2. *Table 3 summarizes demand, profit, and optimal decisions in the direct and delegation dual-channel sales models (the solving procedure can be found in Appendices).*

Proposition 2. *Without block chain technology, in the direct and delegation sales models, we have* $(\partial p_1^{NW^*}/\partial c) > 0$, $(\partial p_2^{NW^*}/\partial c) > 0$; $(\partial p_1^{NW^*}/\partial \beta) < 0$, $(\partial p_2^{NW^*}/\partial \beta) < 0$; $(\partial p_1^{NW^*}/\partial \gamma) < 0$, *and* $(\partial p_2^{NW^*}/\partial \gamma) < 0$.

Proposition 2 suggests that the retail price in the direct sales channel and the retail price in the delegation sales channel increase when the manufacturer's unit retail cost in the dual sales channel increases. Moreover, the retail price in the direct and delegation sales models decreases when the sensitivity coefficient is higher with respect to product inspection/evaluation and the probability of a negative product inspection result.

5. The Dual-Channel Sales Model with Block Chain Technology

5.1. Online Direct + Online Distribution Sales Model (YD Model). In this theoretical model, with block chain technology, the manufacturer and e-commerce platform are subject to a two-stage Stackelberg game. The e-commerce platform is the leader and the manufacturer is the follower, and the decision sequence is such that the e-commerce platform sets the retail price p_1^{YD} to maximize its profit. Then, the manufacturer determines the wholesale price w^{YD} and the retail price p_2^{YD} in the online sales channel. In the distribution and direct sales channels, demand is as follows:

$$\begin{cases} D_e^{YD} = \theta - p_1^{YD} + \phi p_2^{YD} - \beta T, \\ D_m^{YD} = \theta - p_2^{YD} + \phi p_1^{YD} - \beta T. \end{cases} \tag{7}$$

The manufacturer's profit is

$$\Pi_m^{YD} = \left(p_2^{YD} - c\right)D_m^{YD} + \left(w^{YD} + f - c\right)D_e^{YD} - F_m. \tag{8}$$

Table 1: Description of main parameters and variables.

Symbols	Descriptions
θ	The basic potential market demand
ϕ	The cross-elasticity price coefficient between two channels
β	Sensitivity coefficient for product inspection and evaluation
γ	Sensitivity coefficient that the product inspection result is false probability
c	The manufacturer's unit retail cost in dual sales channels
ρ	The unit commission rate charged by the e-commerce platform
w^n	In model n, the product's wholesale price in the online distribution sales channel
u^n	In model n, the product's premium price in the online distribution sales channel
p_1^n	In model n, the retail price in the online distribution (delegation) sales channel
p_2^n	In model n, the retail price in the online direct sales channel
f	With block chain technology, the unit verification fee paid by the e-commerce platform to the manufacturer
F_m	The fixed fee paid by the manufacturer due to block chain technology
D_m^n	In model n, the market demand in the online direct sales channel
D_e^n	In model n, the market demand in the online distribution (delegation) sales channel
Π_m^n	In model n, the manufacturer's profit
Π_e^n	In model n, the e-commerce platform's profit
$n = ND, NW, YD, YW$	Model selection: ND represents the online direct + online distribution sales model without block chain technology, NW represents the online direct + online distribution sales model with block chain technology, YD represents the online direct + online delegation sales model without block chain technology, and YW represents the online direct + online delegation sales model with block chain technology

Table 2: Demand, profit, and optimal pricing decisions in the direct and distribution dual-channel retail models.

Variables	Value
w^{ND^*}	$(A(1+\phi)^2-\theta(1+\phi)^2+c(-3+\phi+\phi^2-\phi^3)/2(-2+\phi^2))$
$p_1^{ND^*}$	$((A-\theta)(3+2\phi)+c(-2+\phi^2)(-1+\phi)+c(-3+\phi+\phi^2-\phi^3)/2(-2+\phi^2))$
$p_2^{ND^*}$	$(-4(c+\theta)-3\theta\phi+c(-1+\phi)\phi+A(4+3\phi)/4(-2+\phi^2))$
$D_e^{ND^*}$	$(2A-2\theta-4(A+c)\phi+(-4A+\theta)\phi^2+\phi A(4+3\phi)-(-4+\phi^2)c(-1+\phi)-2c(-3+\phi+\phi^2-\phi^3)/4(-2+\phi^2))$
$D_m^{ND^*}$	$(8A+4c-4\theta+6A\phi-3\theta\phi-A(4+3\phi)+\phi(-5+2\phi^2)c(-1+\phi)+2\phi c(-3+\phi+\phi^2-\phi^3)/4(-2+\phi^2))$
$\Pi_m^{ND^*}$	$(p_2^{ND^*}-c)D_m^{ND^*}+(w^{ND^*}-c)D_e^{ND^*}$
$\Pi_e^{ND^*}$	$(p_1^{ND^*}-w^{ND^*})D_e^{ND^*}$

Table 3: Demand, profit, and optimal decisions in the direct and delegation sales models.

Variables	Value
$p_1^{NW^*}$	$(-2(c+\theta)+2\theta\rho+\theta(-2+\rho)\phi+2A(1+\phi)-A\rho(2+\phi)+c\phi(\rho+2\phi-\rho\phi)/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$p_2^{NW^*}$	$(A(-1+\rho)(-2+(-2+\rho)\phi)-\theta(-1+\rho)(-2+(-2+\rho)\phi)-c(-1+\phi)(-2(1+\phi)+\rho(2+\phi))/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$D_e^{NW^*}$	$((1+\phi)(A(2+\rho(-2+\phi)-2\phi)-c(-1+\phi)(2+(-2+\rho)\phi)+\theta(-2+2\rho+2\phi-\rho\phi))/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$D_m^{NW^*}$	$((1+\phi)(-c(2+\rho(-2+\phi)-2\phi)(-1+\phi)-A(-1+\rho)(2+(-2+\rho)\phi)+\theta(-1+\rho)(2+(-2+\rho)\phi))/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$\Pi_m^{NW^*}$	$(p_2^{NW^*}-c)D_m^{NW^*}+[p_1^{NW^*}(1-\rho)-c]D_e^{NW^*}$
$\Pi_e^{NW^*}$	$\rho p_1^{NW^*}D_e^{NW^*}$

The e-commerce platform's profit is

$$\Pi_e^{YD}=\left(p_1^{YD}-w^{YD}-f\right)D_e^{YD}. \tag{9}$$

We can determine the demand, profit, and optimal pricing of the manufacturer and e-commerce platform and derive Theorem 3.

Theorem 3. *In the direct and distribution sale models, the optimal decisions, the demand, and profit are summarized in Table 4 (the solving procedure can be found in Appendices).*

Proposition 3. *With block chain technology,* $(\partial w^{YD^*}/\partial f)<0$, $(\partial p_1^{YD^*}/\partial f)=(\partial p_2^{YD^*}/\partial f)=0$; $(\partial w^{YD^*}/\partial\beta)<0$, $(\partial p_1^{YD^*}/\partial\beta)<0$, $(\partial p_2^{YD^*}/\partial\beta)<0$; $(\partial\Pi_m^{YD^*}/\partial F_m)<0$

Proposition 3 suggests that with block chain technology, the wholesale price in the distribution sales model decreases when the unit verification fee paid by the e-commerce platform to the manufacturer increases. However, the retail price in the direct and distribution sales models is not impacted by the unit verification fee. The wholesale price and the retail price in the direct and distribution sales

Table 4: The demand, profit, and optimal decisions in the direct and distribution dual-channel retail models.

Variables	Value
w^{YD^*}	$(2c - B(1+\phi)^2 + \theta(1+\phi)^2 + 2f(\phi^2-2) + (\phi^2-1)c(\phi-1)/2(2-\phi^2))$
$p_1^{YD^*}$	$(2c + 3\theta + 2\theta\phi - B(3+2\phi) + c(\phi-1)/2(2-\phi^2))$
$p_2^{YD^*}$	$(2f\phi + 2c(-2+\phi)(1+\phi) - \theta(4+\phi) + B(4+3\phi) - 2(\theta\phi + f\phi) - \phi c(-1+\phi)/4(-2+\phi^2))$
$D_e^{YD^*}$	$(8B + 4c - 2\theta + 4\theta\phi - 2\theta\phi^2 + 4(\theta - B)\phi^2 - 2B(3+2\phi) + \phi B(4+3\phi) + 2\phi(1+\phi)c(\phi-2) - (\phi^2-2)c(\phi-1) - \phi\theta(4+\phi)/4(-2+\phi^2))$
$D_m^{YD^*}$	$(8\theta - 2\theta\phi + 4c\phi + 6\theta\phi + 4B(\phi^2-2) - 2B\phi(3+2\phi) + B(4+3\phi) + 2(1+\phi)c(\phi-2) + \phi c(\phi-1) - \theta(4+\phi)/4(2-\phi^2))$
$\Pi_m^{YD^*}$	$(p_2^{YD^*} - c)D_m^{YD^*} + (w^{YD^*} + f - c)D_e^{YD^*}$
$\Pi_e^{YD^*}$	$(p_1^{YD^*} - w^{YD^*} - f)D_e^{YD^*}$

models decrease when the sensitivity coefficient is higher with respect to product inspection/evaluation. Moreover, higher fixed fees paid by the manufacturer as a result of block chain technology adoption lead to a decrease in the manufacturer's profit.

5.2. Online Direct + Online Delegation Sales Model (YW Model). In this theoretical model, the manufacturer and e-commerce platform are subject to a two-stage Stackelberg game. The e-commerce platform is the leader, the manufacturer is the follower, and the decision sequence is such that the e-commerce platform first announces the unit commission rate with a view to maximizing its profit. Then, the manufacturer sets the retail price p_1^{YW} in the online delegation sales channel, as well as the retail price p_2^{YW} in the online direct sale channel. In the delegation and direct sales channels, demand is as follows:

$$\begin{cases} D_e^{YW} = \theta - p_1^{YW} + \phi p_2^{YW} - \beta T, \\ D_m^{YW} = \theta - p_2^{YW} + \phi p_1^{YW} - \beta T. \end{cases} \tag{10}$$

The manufacturer's profit is

$$\Pi_m^{YW} = \left(p_2^{YW} - c\right) D_m^{YW} + \left[p_1^{YW}(1-\rho) + f - c\right] D_e^{YW} - F_m. \tag{11}$$

The e-commerce platform's profit is

$$\Pi_e^{YW} = \left(\rho p_1^{YW} - f\right) D_e^{YW}. \tag{12}$$

We can determine the demand, profit, and optimal pricing of the manufacturer and e-commerce platform and derive Theorem 4.

Theorem 4. *Demand, profit, and optimal decisions in the direct and delegation dual-channel sales models are summarized in Table 5 (the solving procedure can be found in Appendices).*

Proposition 4. *With block chain technology,* $(\partial p_1^{YW^*}/\partial f) < 0$, $(\partial p_2^{YW^*}/\partial f) < 0$; $(\partial p_1^{YW^*}/\partial \beta) < 0$, $(\partial p_2^{YW^*}/\partial \beta) < 0$; $(\partial \Pi_m^{YW^*}/\partial F_m) < 0$

Proposition 4 suggests that, with block chain technology, retail prices in the direct and delegation sales models decrease when the unit verification fee paid by the e-commerce platform to the manufacturer increases. Also, retail prices in the direct and delegation sale models decrease when the sensitivity coefficient of product inspection/evaluation increases. Moreover, the manufacturer's profit decreases when the fixed fee paid by the manufacturer, as a result of block chain technology adoption, increases.

6. Result Analysis

In this section, we mainly analyze the impact of block chain technology adoption on pricing decisions and online channel selection strategies in a dual-channel supply chain.

Proposition 5. *In the direct and distribution sales models, comparing the ND model with the YD model, we have (1) when* $\beta > (2f(2-\phi^2)/(1+\phi)^2(t-T)) - (\gamma(1-e)/(t-T))$, $w^{YD^*} > w^{ND^*}$; *when* $\beta < (2f(2-\phi^2)/(1+\phi)^2(t-T)) - (\gamma(1-e)/(t-T))$, $w^{YD^*} < w^{ND^*}$;*(2)* $p_1^{YD^*} > p_1^{ND^*}$;*(3)* $p_2^{YD^*} > p_2^{ND^*}$ *(the proofing procedure can be found in Appendices).*

Proposition 5 suggests that, in the direct and distribution sales models, (1) when the sensitivity coefficient of product inspection/evaluation is larger than a threshold value, the wholesale price is higher with block chain technology adoption than without block chain technology adoption.

(2) In the direct and distribution sales models, retail prices are higher with block chain technology adoption than without block chain technology adoption. This is because, when the sensitivity coefficient of product inspection/evaluation is much higher, customers are very concerned about the cost of product inspection practices and are willing to pay a higher price in return for a better and faster service.

Proposition 6. *In the direct and delegation sales models, comparing the NW model with the YW model, we have (1)* $p_1^{YW^*} > p_1^{NW^*}$; *(2)* $p_2^{YW^*} > p_2^{NW^*}$ *(the proofing procedure can be found in Appendices).*

Proposition 6 suggests that, in the direct and delegation sales models, retail prices are much higher with block chain technology adoption than without block chain technology adoption. This is because block chain technology shortens inspection times, the authenticity of products can be guaranteed, and customers are willing to pay higher fees, all of which contribute to higher retail prices.

7. Numerical Analysis

In this section, we analyze the impact of β and γ on the profits of the manufacturer and e-commerce platform in different dual-channel sales models. Assuming that $\theta = 100, e = 0.5, t = 2, T = 1, f = 10, c = 10$, and $F_m = 1000$, the impact of β and γ on the firm's profits is seen in Figures 2–9.

As can be seen from Figures 2–5, in the direct + distribution sales models, as β increases, the profits of both the manufacturer and e-commerce platform decrease. As γ continues to increase, the profits of both the manufacturer and e-commerce platform also continue to increase. Both the manufacturer and e-commerce platform make more money with block chain technology adoption than without block chain technology adoption. This also shows that the introduction of block chain technology has led to higher profits for both the manufacturer and e-commerce platform.

As can be seen from Figures 6 and 7, in the direct + delegation sales models, as β increases, the profits of both the manufacturer and e-commerce platform decrease. As γ continues to increase, the profits of both the manufacturer and e-commerce platform also continue to increase. The profits of both the manufacturer and e-commerce

Table 5: Demand, profit, and optimal decisions in the direct and delegation sales models.

Variables	Value
$p_1^{YW^*}$	$(2(B+f+\theta(-1+\rho)-B\rho+c(-1+\phi))+(-2+\rho)\phi(-B+c+\theta-c\phi+f\phi)/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$p_2^{YW^*}$	$(2(c+\theta)(-1+\rho)-(\theta(-2+\rho)(-1+\rho)+(c-f)\rho)\phi-c(-2+\rho)\phi^2+B(-1+\rho)(-2+(-2+\rho)\phi)/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$D_e^{YW^*}$	$((1+\phi)(-2(f+\theta-\theta\rho)+B(2+\rho(-2+\phi)-2\phi)+2(f+\theta)\phi-\theta\rho\phi-c(-1+\phi)(2+(-2+\rho)\phi))/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$D_m^{YW^*}$	$(-B(\rho-1)(1+\phi)(2+(\rho-2)\phi)-c(2+\rho(\phi-2)-2\phi)(\phi^2-1)+(1+\phi)(f(\rho-2)(-1+\phi)\phi+\theta(\rho-1)(2+(\rho-2)\phi))/4(-1+\rho)+(-2+\rho)^2\phi^2)$
$\Pi_m^{YW^*}$	$(p_2^{YW^*}-c)D_m^{YW^*}+[p_1^{YW^*}(1-\rho)+f-c]D_e^{YW^*}$
$\Pi_e^{YW^*}$	$(\rho p_1^{YW^*}-f)D_e^{YW^*}$

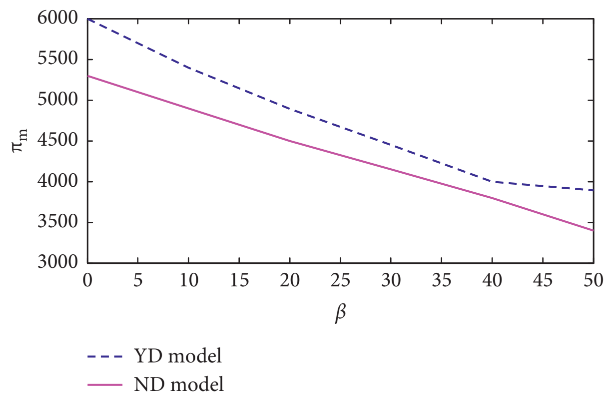

Figure 2: The impact of β on the manufacturer's profit under the ND model and YD model.

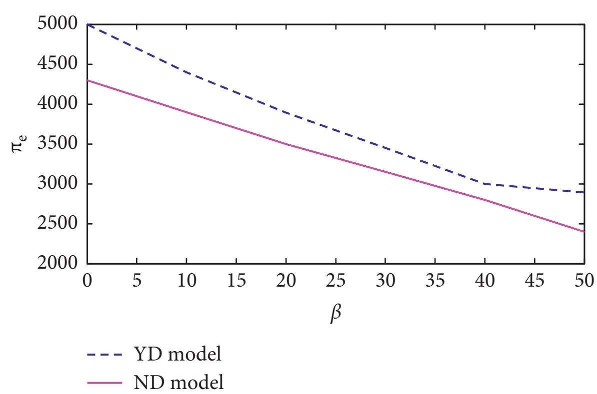

Figure 3: The impact of β on the e-commerce platform's profit under the ND model and YD model.

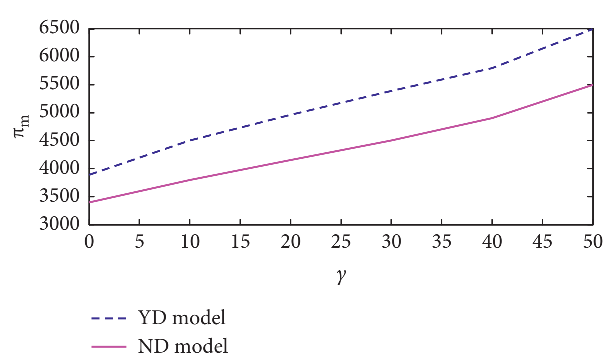

Figure 4: The impact of γ on the manufacturer's profit under the ND model and YD model.

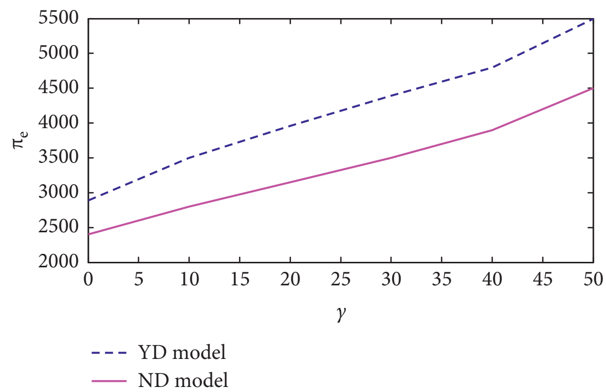

FIGURE 5: The impact of γ on the e-commerce platform's profit under the ND model and YD model.

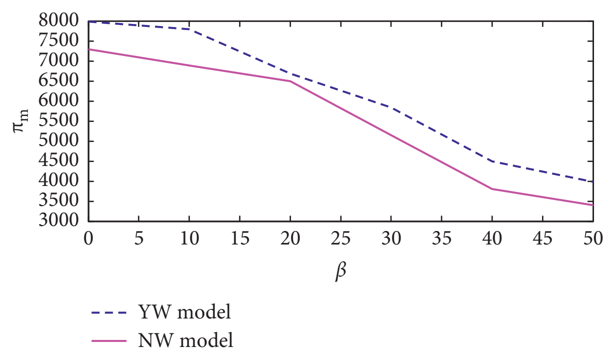

FIGURE 6: The impact of β on the manufacturer's profit under the NW model and YW model.

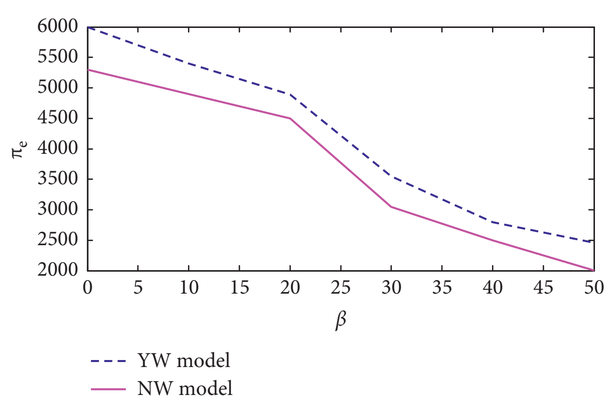

FIGURE 7: The impact of β on the e-commerce platform's profit under the NW model and YW model.

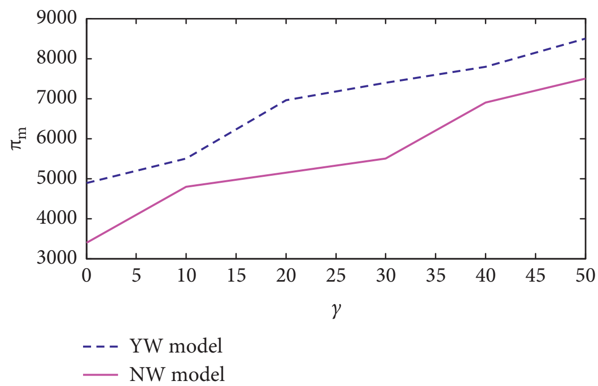

FIGURE 8: The impact of γ on the manufacturer's profit under the NW model and YW model.

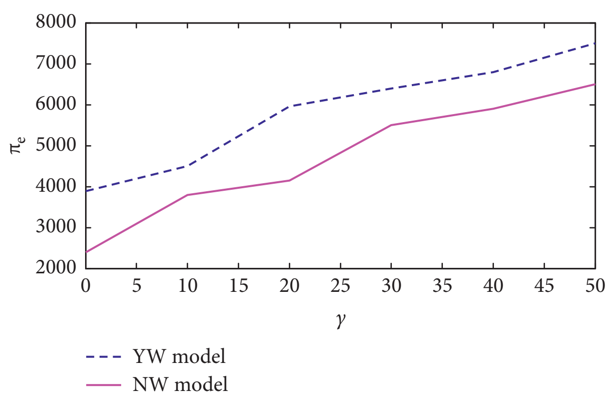

FIGURE 9: The impact of γ on the e-commerce platform's profit under the NW model and YW model.

platform are higher with block chain technology adoption than without block chain technology adoption. This also shows that the profits of both the manufacturer and e-commerce platforms in the direct and delegation sales models are much higher than those arising from the direct and distribution sales models.

8. Conclusion and Future Research

This paper examined the impact of block chain technology adoption on pricing decisions and online channel selection strategies in dual-channel supply chains consisting of a direct and distribution dual-channel sales model and a direct and delegation dual-channel sales model. Depending on whether or not block chain technology is adopted, this study analyzed the following scenarios: an online direct and online distribution sales model without block chain technology (ND model), an online direct and online delegation sales model (NW model) without block chain technology, an online direct and online distribution sales model with block chain technology (YD model), and an online direct and online delegation sales mode with block chain technology (YW model). We compared and evaluated optimal pricing decisions and the firm's profit under these different scenarios. The following conclusions were reached:

(1) Without block chain technology, in the two different dual-channel sales models, retail prices increase when the manufacturer's unit retail cost increases. The retail price in the two different dual-channel sales models decreases when the sensitivity coefficient is higher with respect to product inspection/evaluation and the probability of a negative product inspection result.

(2) With the block chain technology, in the two different dual-channel sales models, retail prices decrease when the unit verification fee paid by the e-commerce platform to the manufacturer increases. Retail prices in the two different dual-channel sales models are higher with block chain technology adoption than without block chain technology adoption.

(3) In the two different dual-channel sale models, as β increases, the profits of both the manufacturer and e-commerce platform decrease. As γ continues to increase, the profits of both the manufacturer and e-commerce platform also continue to increase.

The analysis provides the following management insights: (1) the adoption of block chain technology offers manufacturers better and faster product traceability. By adopting block chain technology, manufacturers can improve their retail prices in dual-channel sales models, and manufacturers should choose an online direct and delegation sales model to sell their products. (2) In the case of block chain technology adoption, e-commerce platforms should choose an online direct and delegation sales model to sell their products, so that they can generate higher profits.

Within the context of block chain technology adoption, the present study analyzed pricing decisions and online channel selection strategies in dual-channel supply chains. In the future, we aim to analyze the impact of block chain technology on social welfare.

Appendices

Proof. Proof of Theorem 1.

Based on equation (2), the authors can determine $(\partial\Pi_m^{ND}/\partial w^{ND}) = c - u^{ND} - 2w^{ND} - \beta t - (1-e)\gamma + \theta + (-c+q)\phi + \phi p_2^{ND}$, $(\partial\Pi_m^{ND}/\partial p_2^{ND}) = c - 2p_2^{ND} - \beta t - (1-e)\gamma + \theta + (u^{ND} + w^{ND})\phi$, $(\partial^2\Pi_m^{ND}/\partial (w^{ND})^2) = -2$, $(\partial^2\Pi_m^{ND}/\partial w^{ND}\partial p_2^{ND}) = \phi$, $(\partial^2\Pi_m^{ND}/\partial p_2^{ND}\partial w^{ND}) = \phi$, and $(\partial^2\Pi_m^{ND}/\partial (p_2^{ND})^2) = -2$. Manufacturer's Hessian matrix is $H_m^{ND} = \begin{bmatrix} -2 & \phi \\ \phi & -2 \end{bmatrix}$. The Hessian matrix is negative. $(\partial\Pi_m^{ND}/\partial w^{ND}) = 0$ and $(\partial\Pi_m^{ND}/\partial p_2^{ND}) = 0$, and the reaction functions are $p_2^{ND}(u^{ND}) = (2(c+\theta) + (c+u^{ND}+\theta)\phi - c\phi^2 - A(2+\phi)/2(2-\phi^2))$.

$w^{ND}(u^{ND}) = (c - A(1+\phi) + (1+\phi)(\theta + u^{ND}(\phi - 1))/2 - \phi^2)$. Substituting the above reaction functions into the e-commerce platform's profit function, $(\partial\Pi_e^{ND}/\partial u^{ND}) = 0$, the optimal premium per unit of product sold to customers is $u^{ND^*} = (\theta + c(-1+\phi) - A/2)$. Substituting it into the reaction functions, the optimal decision variables are $w^{ND^*} = (A(1+\phi)^2 - \theta(1+\phi)^2 + c(-3+\phi+\phi^2-\phi^3)/2(-2+\phi^2))$ and $p_2^{ND^*} = (-4(c+\theta) - 3\theta\phi + c(-1+\phi)\phi + A(4+3\phi)/4(-2+\phi^2))$.

Substituting $p_1^{ND^*}, p_2^{ND^*}$, and w^{ND^*} into equations (2) and (3), the authors can determine the optimal profits of the manufacturer and the e-commerce platform. □

Proof. Proof of Theorem 2.

Based on equation (5), the authors can determine $(\partial\Pi_m^{NW}/\partial p_1^{NW}) = c - p_1^{NW}(1-\rho) + (-c+p_2^{NW})\phi + (1-\rho)(-A - p_1^{NW} + \theta + p_2^{NW}\phi)$, $(\partial\Pi_m^{NW}/\partial p_2^{NW}) = -A + c - 2p_2^{NW} + \theta + p_1^{NW}\phi + (-c + p_1^{NW}(1-\rho))\phi$, $(\partial^2\Pi_m^{NW}/\partial(p_1^{NW})^2) = -2+2\rho$, $(\partial^2\Pi_m^{NW}/\partial p_1^{NW}\partial p_2^{NW}) = \phi + (1-\rho)\phi$, $(\partial^2\Pi_m^{NW}/\partial p_2^{NW}\partial p_2^{NW}) = \phi + (1-\rho)\phi$, and $(\partial^2\Pi_m^{NW}/\partial(p_2^{NW})^2) = -2$. Manufacturer's Hessian matrix is $H_m^{NW} = \begin{bmatrix} -2+2\rho & \phi+(1-\rho)\phi \\ \phi+(1-\rho)\phi & -2 \end{bmatrix}$.

The Hessian matrix is negative. $(\partial\Pi_m^{NW}/\partial p_1^{NW}) = 0$ and $(\partial\Pi_m^{NW}/\partial p_2^{NW}) = 0$, and the optimal solutions are that

$$\begin{aligned} p_1^{NW^*} &= \frac{-2(c+\theta) + 2\theta\rho + \theta(-2+\rho)\phi + 2A(1+\phi) - A\rho(2+\phi) + c\phi(\rho + 2\phi - \rho\phi)}{4(-1+\rho) + (-2+\rho)^2\phi^2}, \\ p_2^{NW^*} &= \frac{A(-1+\rho)(-2+(-2+\rho)\phi) - \theta(-1+\rho)(-2+(-2+\rho)\phi) - c(-1+\phi)(-2(1+\phi)+\rho(2+\phi))}{4(-1+\rho) + (-2+\rho)^2\phi^2}. \end{aligned} \tag{A.1}$$

Substituting the $p_1^{NW^*}$ and $p_2^{NW^*}$ into equations (5) and (6), the authors can determine the optimal profits of the manufacturer and e-commerce platform. □

Proof. Proof of Theorem 3.

Based on equation (8), the authors can determine $(\partial\Pi_m^{YD}/\partial w^{YD}) = -B + c - f - u^{YD} - 2w^{YD} + \theta + (-c + p_2^{YD})\phi + \phi p_2^{YD}$, $(\partial\Pi_m^{YD}/\partial p_2^{YD}) = -B + c - 2p_2^{YD} + \theta + (u^{YD} + w^{YD})\phi$, $(\partial^2\Pi_m^{YD}/\partial(w^{YD})^2) = -2$, $(\partial^2\Pi_m^{YD}/\partial w^{YD}\partial p_2^{YD}) = \phi$, $(\partial^2\Pi_m^{YD}/\partial p_2^{YD}\partial w^{YD}) = \phi$, and $(\partial^2\Pi_m^{YD}/\partial(p_2^{YD})^2) = -2$. Manufacturer's Hessian matrix is $H_m^{YD} = \begin{bmatrix} -2 & \phi \\ \phi & -2 \end{bmatrix}$. The Hessian matrix is negative. $(\partial\Pi_m^{YD}/\partial w^{YD}) = 0$ and $(\partial\Pi_m^{YD}/\partial p_2^{YD}) = 0$, and the reaction functions are $w^{YD}(u^{YD}) = (-c + f + B(1+\phi) - (\theta + u^{YD}(-1+\phi))(1+\phi)/-2+\phi^2)$ and $p_2^{YD}(u^{YD}) = (-2(c+\theta) - (c - f + u + \theta)\phi + c\phi^2 + B(2+\phi)/\ 2(-2+\phi^2))$. Substituting the above reaction functions into the e-commerce platform's profit function, $(\partial\Pi_e^{YD}/\partial u^{YD}) = 0$; the optimal premium per unit of product sold to customers is $u^{YD^*} = (2f + \theta + c(-1+\phi) - B/2)$. Substituting it into the reaction functions, the optimal decision variables are $w^{YD^*} = (2c - B(1+\phi)^2 + \theta(1+\phi)^2 + 2f(\phi^2-2) + (\phi^2-1)c(\phi-1)/2(2-\phi^2))$ and $p_2^{YD^*} = (2f\phi + 2c(-2+\phi)(1+\phi) - \theta(4+\phi) + B(4+3\phi) - 2(\theta\phi + f\phi) - \phi c(-1+\phi)/4(-2+\phi^2))$. Substituting $p_1^{YD^*}, p_2^{YD^*}$, and w^{YD^*} into equations (8) and (9), rhe authors can determine the optimal profits of the manufacturer and the e-commerce platform. □

Proof of Theorem 4

Based on equation (11), the authors can determine $(\partial\Pi_m^{YW}/\partial p_1^{YW}) = c - f - p_1^{YW}(1-\rho) + (-c + p_2^{YW})\phi + (1-\rho)(-B - p_1^{YW} + \theta + p_2^{YW}\phi)$, $(\partial\Pi_m^{YW}/\partial p_2^{YW}) = -B + c - 2p_2^{YW} + \theta + p_1^{YW}\phi + (-c + f + p_1^{YW}(1-\rho))\phi$, $(\partial^2\Pi_m^{YW}/\partial(p_1^{YW})^2) = -2+2\rho$, $(\partial^2\Pi_m^{YW}/\partial p_1^{YW}\partial p_2^{YW}) = \phi + (1-\rho)\phi$, $(\partial^2\Pi_m^{YW}/\partial p_2^{YW}\partial p_2^{YW}) = \phi + (1-\rho)\phi$, and $(\partial^2\Pi_m^{YW}/\partial(p_2^{YW})^2) = -2$. Manufacturer's Hessian matrix is $H_m^{YW} = \begin{bmatrix} -2+2\rho & \phi+(1-\rho)\phi \\ \phi+(1-\rho)\phi & -2 \end{bmatrix}$.

The Hessian matrix is negative. $(\partial\Pi_m^{YW}/\partial p_1^{YW}) = 0$ and $(\partial\Pi_m^{YW}/\partial p_2^{YW}) = 0$, and the optimal solutions are that

$$\begin{aligned} p_1^{YW^*} &= \frac{2(B + f + \theta(-1+\rho) - B\rho + c(-1+\phi)) + (-2+\rho)\phi(-B + c + \theta - c\phi + f\phi)}{4(-1+\rho) + (-2+\rho)^2\phi^2}, \\ p_2^{YW^*} &= \frac{2(c+\theta)(-1+\rho) - (\theta(-2+\rho)(-1+\rho) + (c-f)\rho)\phi - c(-2+\rho)\phi^2 + B(-1+\rho)(-2+(-2+\rho)\phi)}{4(-1+\rho) + (-2+\rho)^2\phi^2}. \end{aligned} \tag{A.2}$$

Substituting $p_1^{YW^*}$ and $p_2^{YW^*}$ into equations (11) and (12), the authors can determine the optimal profits of the manufacturer and e-commerce platform.

Proof of Proposition 5

$$
\begin{aligned}
& w^{YD^*} - w^{ND^*} \\
& = \frac{2c - B(1+\phi)^2 + \theta(1+\phi)^2 + 2f\left(\phi^2 - 2\right) + \left(\phi^2 - 1\right)c(\phi - 1)}{2\left(2 - \phi^2\right)} + \frac{A(1+\phi)^2 - \theta(1+\phi)^2 + c\left(-3 + \phi + \phi^2 - \phi^3\right)}{2\left(2 - \phi^2\right)} \\
& = \frac{(\beta t + \gamma(1-e) - \beta T)(1+\phi)^2 + 2f\left(\phi^2 - 2\right)}{2\left(2 - \phi^2\right)}.
\end{aligned} \tag{A.3}
$$

When $\beta > (2f(2-\phi^2)/(1+\phi)^2(t-T)) - (\gamma(1-e)/(t-T))$, $w^{YD^*} > w^{ND^*}$; when $\beta < (2f(2-\phi^2)/(1+\phi)^2(t-T)) - (\gamma(1-e)/(t-T))$, $w^{YD^*} < w^{ND^*}$; $p_1^{YD^*} - p_1^{ND^*} = (\beta(t-T) + \gamma(1-e)/2(2-\phi^2)) > 0$; $p_2^{YD^*} - p_2^{ND^*} = ((A-B)(4+3\phi)/4(2-\phi^2)) > 0$.

Proof. Proof of Proposition 6.

$$
\begin{aligned}
p_1^{YW^*} - p_1^{NW^*} &= \frac{(A-B)(2(1-\rho) + \phi(2-\rho)) - f\left(2 + \phi^2\rho - 2\phi^2\right)}{4(1-\rho) - (\rho - 2)^2\phi^2} > 0, \\
p_2^{YW^*} - p_2^{NW^*} &= \frac{(A-B)(1-\rho)(2 + (2-\rho)\phi) - f\phi\rho}{4(1-\rho) - (\rho - 2)^2\phi^2} > 0.
\end{aligned} \tag{A.4}
$$

□

Data Availability

The data used to support the findings of this study are available upon request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

L. Q. conceptualized the study and wrote the original study. L. H. L. reviewed and edited the article.

References

[1] A. Hagiu and J. Wright, "Marketplace or reseller?" *Management Science*, vol. 61, no. 1, pp. 184–203, 2015.

[2] V. Abhishek, K. Jerath, and Z. J. Zhang, "Agency selling or reselling? Channel structures in electronic retailing," *Management Science*, vol. 62, no. 8, pp. 2259–2280, 2016.

[3] L. Tian, A. J. Vakharia, Y. R. Tan, and Y. Xu, "Marketplace, reseller, or hybrid: strategic analysis of an emerging E-commerce model," *Production and Operations Management*, vol. 27, no. 8, pp. 1595–1610, 2018.

[4] P. Li and H. Wei, "Distribution. Platform or Hybrid?--Research on retailers' business modelSelection," *Journal of Management Science in China*, vol. 21, no. 9, pp. 50–75, 2018.

[5] K. Behnke and M. F. W. H. A. Janssen, "Boundary conditions for traceability in food supply chains using blockchain technology," *International Journal of Information Management*, vol. 52, no. 3, pp. 101969–102016, 2020.

[6] H. Feng, X. Wang, Y. Duan, J. Zhang, and X. Zhang, "Applying blockchain technology to improve agri-food traceability: a review of development methods, benefits and challenges," *Journal of Cleaner Production*, vol. 260, no. 3, pp. 121031–121091, 2020.

[7] D. Tapscott and A. Tapscott, "How blockchain will change organizations," *MIT Sloan Management Review*, vol. 58, no. 2, pp. 10–13, 2017.

[8] E. Cao, Y. Ma, C. Wan, and M. Lai, "Contracting with asymmetric cost information in a dual-channel supply chain," *Operations Research Letters*, vol. 41, no. 4, pp. 410–414, 2013.

[9] H. Liu, M. Lei, H. Deng, G. Keong Leong, and T. Huang, "A dual channel, quality-based price competition model for the WEEE recycling market with government subsidy," *Omega*, vol. 59, no. 4, pp. 290–302, 2016.

[10] G. Cai, Z. G. Zhang, and M. Zhang, "Game theoretical perspectives on dual-channel supply chain competition with price discounts and pricing schemes," *International Journal of Production Economics*, vol. 117, no. 1, pp. 80–96, 2009.

[11] J. Chen, H. Zhang, and Y. Sun, "Implementing coordination contracts in a manufacturer stackelberg dual-channel supply chain," *Omega*, vol. 40, no. 5, pp. 571–583, 2012.

[12] J. K. Ryan, D. Sun, and X. Zhao, "Coordinating a supply chain with a manufacturer-owned online channel: a dual channel model under price competition," *IEEE Transactions on Engineering Management*, vol. 60, no. 2, pp. 247–259, 2013.

[13] G. Xu, B. Dan, X. Zhang, and C. Liu, "Coordinating a dual-channel supply chain with risk-averse under a two-way revenue sharing contract," *International Journal of Production Economics*, vol. 147, no. 3, pp. 171–179, 2014.

[14] G. Cai, "Channel selection and coordination in dual-channel supply chains," *Journal of Retailing*, vol. 86, no. 1, pp. 22–36, 2010.

[15] J. Chen, L. Liang, D.-Q. Yao, and S. Sun, "Price and quality decisions in dual-channel supply chains," *European Journal of Operational Research*, vol. 259, no. 3, pp. 935–948, 2017.

[16] W.-y. K. Chiang, D. Chhajed, and J. D. Hess, "Direct marketing, indirect profits: a strategic analysis of dual-channel supply-chain design," *Management Science*, vol. 49, no. 1, pp. 1–20, 2003.

[17] J.-C. Kim and S.-H. Chun, "Cannibalization and competition effects on a manufacturer's retail channel strategies: i," *Decision Support Systems*, vol. 109, no. 3, pp. 5–14, 2018.

[18] X. Yuan, X. Zhang, and D. Zhang, "Research on the dynamics game model in a green supply chain: government subsidy strategies under the retailer's selling effort level," *Complexity*, vol. 2020, Article ID 3083761, 15 pages, 2020.

[19] B. Rodríguez and G. Aydın, "Pricing and assortment decisions for a manufacturer selling through dual channels," *European Journal of Operational Research*, vol. 242, no. 3, pp. 901–909, 2015.

[20] L. Hsiao and Y.-J. Chen, "Strategic motive for introducing internet channels in a supply chain," *Production and Operations Management*, vol. 23, no. 1, pp. 36–47, 2014.

[21] L. X. Zhao and M. B. Cheng, "Pricing strategy of supply chain based on manufacturer'smarketing channel selection," *Systems Engineering-Theory & Practice*, vol. 36, no. 9, pp. 2310–2016, 2019.

[22] Q. Lu and N. Liu, "Effects of e-commerce channel entry in a two-echelon supply chain: a comparative analysis of single- and dual-channel distribution systems," *International Journal of Production Economics*, vol. 165, no. 4, pp. 100–111, 2015.

[23] W. Y. K. Chiangab, "Managing inventories in a two-echelon dual-channel supply chain.European, 2003," *Journal of Operational Research*, vol. 162, no. 2, pp. 325–341, 2003.

[24] T. Xiao, T.-M. Choi, and T. C. E. Cheng, "Product variety and channel structure strategy for a retailer-stackelberg supply chain," *European Journal of Operational Research*, vol. 233, no. 1, pp. 114–124, 2014.

[25] M. Khouja, S. Park, and G. Cai, "Channel selection and pricing in the presence of retail-captive consumers," *International Journal of Production Economics*, vol. 125, no. 1, pp. 84–95, 2010.

[26] A. Dumrogsiri, M. Fan, and A. Jain, "A supply chain model with direct and retail channels," *European Journal of Operational Research*, vol. 87, no. 3, pp. 691–718, 2006.

[27] C. Wang, M. Leng, and L. Liang, "Choosing an online retail channel for a manufacturer: direct sales or consignment?" *International Journal of Production Economics*, vol. 195, no. 4, pp. 338–358, 2018.

[28] P. He, Y. He, and H. Xu, "Channel structure and pricing in a dual-channel closed-loop supply chain with government subsidy," *International Journal of Production Economics*, vol. 213, pp. 108–123, 2019.

[29] P. He, Y. He, and H. Xu, "Buy-online-and-deliver-from-store strategy for a dual-channel supply chain considering retailer's location advantage," *Transportation Research Part E: Logistics and Transportation Review*, vol. 144, Article ID 102127, 2020.

[30] Y. He, H. Huang, and D. Li, "Inventory and pricing decisions for a dual-channel supply chain with deteriorating products," *Operational Research*, vol. 20, no. 3, pp. 1461–1503, 2020.

[31] P. Zhang, Y. He, and X. Zhao, "Preorder-online, pickup-in-store" strategy for a dual-channel retailer," *Transportation Research Part E: Logistics and Transportation Review*, vol. 122, pp. 27–47, 2019.

[32] Y. Duan, J. S. Edwards, and Y. K. Dwivedi, "Artificial intelligence for decision making in the era of Big Data - evolution, challenges and research agenda," *International Journal of Information Management*, vol. 48, no. 5, pp. 63–71, 2019.

[33] T.-M. Choi, S. Guo, N. Liu, and X. Shi, "Optimal pricing in on-demand-service-platform-operations with hired agents and risk-sensitive customers in the blockchain Era," *European Journal of Operational Research*, vol. 284, no. 3, pp. 1031–1042, 2020.

[34] J. Chod, N. Trichakis, G. Tsoukalas, H. Aspegren, and M. Weber, "On the financing benefits of supply chain transparency and blockchain adoption," *Management Science*, vol. 66, no. 10, pp. 4378–4396, 2020.

[35] Y. Yu, G. Huang, and X. Guo, "Financing strategy analysis for a mulit-sided platform with blockchain technology," *International Journal of Production Research*, vol. 34, no. 3, pp. 5–14, 2020.

[36] P. Helo and Y. Hao, "Blockchains in operations and supply chains: a model and reference implementation," *Computers & Industrial Engineering*, vol. 136, no. 10, pp. 242–251, 2019.

[37] R. V. George, H. O. Harsh, P. Ray, and A. K. Babu, "Food quality traceability prototype for restaurants using blockchain and food quality data index," *Journal of Cleaner Production*, vol. 240, no. 6, pp. 118021–118025, 2019.

[38] Z. Liu and Z. Li, "A blockchain-based framework of cross-border e-commerce supply chain," *International Journal of Information Management*, vol. 52, no. 3, pp. 102059–102146, 2020.

[39] B. Kamanashis, M. Vallipuram, and T. L. Wee, "Blockchain based wine supply chain traceability system," in *Proceedings of the Future Technologies Conference*, Sanya, China, 2018.