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INFORMATION DISCLOSURE: THE ROLES OF BLOCKCHAIN AND SPILLOVER EFFECTS ON AN E-COMMERCE PLATFORM WITH DIFFERENT SALES MODES

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Abstract. To solve the problems caused by the increasing information credibility issue on platforms, we consider the situation in which a cross-channel supplier determines BT adoption strategies and a platform chooses sales modes. Then, we examine the influence of the cross-channel spillover effect on interaction decisions. We show that the supplier chooses BT to disclose more product information under the agency mode, even if the disclosure cost coefficient of BT is high. Namely, a positive spillover effect leads to higher profit margins and demand in dual channels. However, when the negative spillover effect is salient and the disclosure cost coefficient of BT is low, the wholesale mode improves the position of the supplier that adopts BT, but the supplier discloses less product information to reduce costs. As the product market size and/or spillover effect increase(s), the agency mode not only increases the information disclosure level but also decreases the retail price, which leads to win–win outcomes for firms and multi-win outcomes for firms and consumers. In contrast, since a negative spillover effect and BT exacerbate the DMP (double marginalization problem), firms and consumers achieve a multi-win situation under the wholesale format.

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1. Introduction

Consumers are increasingly concerned about product information (*e.g.*, the greenness of raw materials, product provenance and sustainability) in light of improvements in their product quality awareness and health and environmental consciousness [1, 2]. Moreover, more suppliers are disclosing product information to the public because information transparency is an important factor that affects consumer demand [3]. For example, each Heidi garment produced by a famous Swiss apparel company features a tag that enables customers to review the entire process of production, processing and sale [1]. The Kering Group discloses product information regarding the emissions generated by all suppliers from assembly operations to raw material production. Although a great

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deal of product information is disclosed, consumers still doubt the credibility of such information because of the lack of an effective verification mechanism [4].

Blockchain technology (BT), a decentralized digital ledger technology known for its immutability, visibility and validation, effectively and efficiently records transaction information among participants [5]. Moreover, BT is a promising approach to the task of solving the information credibility problem [6]. At present, many suppliers use BT to verify supply chain information and decide what information to record and disclose to consumers. For example, Louis Vuitton applies BT to track upstream information, such as design, raw material, and manufacturing information. Some suppliers disclose production sustainability metrics through the Everledger blockchain. Credible information can improve consumer trust and expand market demand. However, the disclosure of more product information through BT incurs higher costs, including checking, auditing and updating fees, to ensure information authenticity [4]. Therefore, a key tradeoff exists between the benefits and costs of disclosing information, and an in-depth exploration of how a supplier determines its BT adoption strategy and disclosure level is needed.

In addition to focusing on BT with information transparency, previous studies have explored the optimal sales mode selection of platforms under different operating circumstances [7,8]. Two common sales modes – ency mode – exist on e-commerce platforms. Under the wholesale mode, the platform purchases products from suppliers and then resells those products to consumers; thus, the platform determines the retail price under the mode, which may be characterized by a double marginalization problem (DMP). Under the agency mode, suppliers have absolute control over the retail price. In practice, we observe that many suppliers sell their products *via* platforms under different sales modes and employ different BT adoption strategies. For example, Yili, one of the largest dairy companies in China, has signed a wholesale contract with JD.com and discloses product production and logistics information *via* BT. However, Guangming, another well-known dairy company in China, has not adopted BT to disclose product information under the wholesale mode on JD.com. Similarly, Nike has signed an agency contract with Amazon.com and uses BT to deliver the patent data of shoes to customers. However, Adidas has not chosen to provide blockchain-based information. Therefore, how suppliers select BT adoption strategies and information disclosure levels under different sales modes remains unclear.

Suppliers often sell their products on offline channels and platforms simultaneously. Platforms have a cross-channel spillover effect on offline channels owing to sufficiently large network externality [9], and the spillover effect can be either negative or positive [10, 11]. A negative spillover effect refers to the phenomenon in which online demand negatively affects offline sales [12,13], whereas a positive spillover effect refers to the phenomenon in which online demand improves offline sales [11]. Specifically, compared with a non-BT-enabled platform, the spillover effect may be more prominent in contexts involving a BT-enabled platform. For example, because of improved product transparency, BT incentivizes more consumers to shift from offline channels to platforms for purchasing fresh foods and beverages [14, 15], while some consumers may purchase personal accessories at offline channels following their purchase with BT-based online products or exposure to product attributes *via* BT [16, 17]. Therefore, the spillover effect increases the complexity of suppliers' decision regarding whether to adopt BT, which, in turn, impacts the sales mode choice of platforms and sales on the offline channel and, ultimately, firm performance. Importantly, with respect to BT adoption, the question of how the spillover effect affects the information disclosure level of suppliers remains unanswered.

Motivated by the aforementioned points – the considerable value of BT in terms of improving information credibility, the interaction between supplier BT adoption strategies and platform sales mode selection, and the role of the spillover effect on the BT adoption strategy – we address the following research questions:

(1) How do firms (*i.e.*, the supplier and the platform) determine the optimal pricing and information disclosure level?
(2) How does the spillover effect between the online channel and the offline channel affect the supplier's BT adoption strategies? How do the conclusions vary with the sales mode choice of the platform?
(3) Do firms and consumers benefit from the interaction between BT adoption strategies and sales mode choices simultaneously?

To address these three questions, we explore a game theoretic model in which a cross-channel supplier cooperates with an e-commerce platform to sell products and the supplier plays a Stackelberg game with the platform. All four scenarios, including supplier BT adoption strategies and platform sales mode selections, are investigated. We examine two types of spillover effects (*i.e.*, negative spillover effects and positive spillover effects), BT cost effectiveness and different consumer types (*i.e.*, information-sensitive consumers and information-insensitive consumers). Moreover, we analyze the equilibrium outcomes under four scenarios to explore the optimal strategy choice for the two participants in this game, after which we obtain the equilibrium strategy and explore its effect on consumers. Subsequently, we extend our work to encompass study settings with a fixed BT adoption fee, the supplier's decision on sales modes, and a variable offline retail price. The important findings are summarized below.

The information disclosure decision in each scenario depends mainly on the disclosure cost coefficient of BT and the spillover effect. When the spillover effect is negative (positive), the supplier discloses more information to expand market demand under the wholesale (agency) format once the disclosure cost of BT is low or high. The reason for this disclosure is the larger amount of product information, which not only hampers the negative spillover effect under the wholesale mode but also amplifies the positive spillover effect under the agency mode. In contrast, if the disclosure cost of BT is moderate, the supplier that adopts BT, in turn, discloses less verified information to mitigate the DMP (double marginalization problem) under the wholesale format.

These two sales modes help the supplier adopt BT, which varies with the spillover effect, commission rate and disclosure cost coefficient of BT. Specifically, in the context of a low disclosure cost coefficient and a negative spillover effect, the supplier can adopt BT to cover the adverse impact of the negative spillover effect under the agency mode. When the spillover effect is positive, owing to the higher retail price and demands across dual channels, the supplier that adopts BT also obtains the highest profit under the agency mode. This mode may hurt the platform under such conditions. However, owing to the negative spillover effect and higher commission rate, the supplier is inclined to adopt BT under the wholesale mode, despite the fact that the spillover effect may exacerbate the DMP. Interestingly, the platform also chooses the wholesale mode to resell products under such conditions, whereas the platform chooses the agency mode when the commission rate is at a moderate level because of the inverted U-shaped relationship between the commission rate and optimal profit.

Sales modes and BT adoption strategies may lead to a win–win outcome for the two firms. Surprisingly, owing to a positive spillover effect, a higher commission rate improves the position of both firms under the agency mode. Therefore, a win–win outcome can easily be achieved under this mode. Moreover, a higher disclosure level improves the demand and welfare of information-sensitive consumers; thus, the equilibrium strategies leading to a win–win outcome may achieve a triple-win outcome among the supplier, platform, and information-sensitive consumers. Furthermore, under each sales mode, when the disclosure cost coefficient is moderate, BT creates a multi-win outcome for the supplier, platform, and consumers.

The results of the extensions show that the findings of the baseline model are robust and reveal the following additional findings: (1) The supplier is incentivized to adopt BT, even if the fixed BT adoption fee is high; (2) the event sequence reflects the power contrast between the supplier and the platform, which always benefits the supplier but decreases the probability of a win–win outcome; and (3) regardless of whether the offline retail price is low or high, the offline channel can be viewed as a showroom that can raise product awareness and drive incremental sales for the platform, thus improving the profits obtained by supply chain members and expanding the area in which win–win outcomes can be achieved.

The remainder of the paper is organized as follows. Section 2 reviews the related literature. Section 3 presents the formulation of the problem. In Section 4, we build analytical models and obtain equilibrium solutions under different scenarios. We compare these solutions and obtain the equilibrium strategies for supply chain members in Section 5. Section 6 discusses the effects of these strategies on consumer surplus. Some extensions are presented in Section 7. The conclusions of this research are summarized in Section 8. All proofs are provided in the Appendix. The proof process is available upon request by contacting the corresponding author.

2. Literature review

Our work is related to three streams of literature pertaining to (i) sales mode selection and the spillover effect of e-commerce platforms, (ii) information disclosure decisions, and (iii) blockchain-enabled supply chains.

2.1. Sales mode selection and the spillover effect of e-commerce platforms

The choice of sales mode between wholesale selling and agency selling has received a great deal of attention in academia. The literature on this stream can be classified into two categories: one that explores the choice of platform modes without the spillover effect and the other that analyzes such operational decisions with the spillover effect.

Early studies focused on how to choose the sales mode without considering the spillover effect. For instance, Geng *et al.* (2018) examine a platform's distribution contract choice (*i.e.*, agency and wholesale contract) on the basis of an upstream firm's add-on strategy and reveal that the distribution contract choice depends on the commission rate and the market potential [18]. Ha *et al.* (2022) investigate the selling mode problem of a platform and derive equilibrium conditions under each of the three different online modes (agency, wholesale and mixed modes) [8]. Hu *et al.* (2022) report that a platform's choice regarding sales modes is critically affected by cross-brand pass-through behavior and that a shift to the agency mode benefits the platform but harms suppliers [19].

Furthermore, many studies have investigated the role of the spillover effect in sales mode choice, since product sales on the online channel have a negative/positive spillover effect on the demand of the offline channel [9, 10, 20]. On the one hand, many studies have considered how upstream firms choose different sales modes. For example, Yan *et al.* (2018) demonstrate that a manufacturer prefers the agency mode with an increasing spillover level [9]. In accordance with Yan *et al.* (2018), Yu *et al.* (2022) discuss whether the manufacturer should introduce a marketplace channel under cap-and-trade and carbon tax regulations and then show that when the environmental damage coefficient is low, the company should use a marketplace mode to gain optimal profit [21]. Yi *et al.* (2024) reveal that when considering online sales, if there is a significant positive spillover effect, the manufacturer is more suited to adopt the agency mode [20]. On the other hand, few studies have considered the strategic interaction between the sales mode choice of a platform and the operation decision of firms – an approach that is similar to the methodology employed in our study and more consistent with the real world. For instance, Abhishek *et al.* (2016) first incorporate the spillover effect of online demand into game-theoretic models and reveal that a negative spillover effect drives platform preference for the agency mode over the wholesale mode [10]. Yang *et al.* (2021) examine the pricing and sales mode decisions of platforms in competing supply chains [22]. Zhao *et al.* (2025) examine sales mode selection strategies in retailer-led perishable goods supply chains incorporating blockchain-based traceability systems, among offline modes and both types of online-to-offline [23].

Previous studies have rarely explored the impact of the sales mode on the information disclosure level in the presence of a cross-channel spillover effect. In practice, firms that employ different sales channels often have different levels of information transparency. Therefore, we focus on the cross-channel spillover effect and explore the impact of the strategic interaction of supply chain members on firms' decisions regarding the level of information disclosure.

2.2. Information disclosure decisions

Information disclosure is a classic topic in the literature on supply chain management. Many studies have focused on product information disclosure. For example, Sodhi and Tang (2019) provide a comprehensive review of the importance and potential benefits of product information [1]. Zhang *et al.* (2018) examine how to disclose horizontal product information (*e.g.*, product sustainability) under consumer uncertainty regarding the degree of product matching and reveal that sellers can disclose more information through an information system developed by an intermediary [24]. Cao *et al.* (2019) explore the impacts of voluntary and mandatory disclosure on product quality information acquisition [25]. Furthermore, Wu *et al.* (2023) report that the agency contract of a platform can lead to greater product transparency [26]. Yu *et al.* (2024) argue that more accurate information signals and intensified competition motivate suppliers to disclose high-quality information [27]. From an empirical research perspective, Wang and Xing (2025) find that corporate ESG disclosure exerts a positive impact on enhancing firm value, and digital transformation further amplifies this positive relationship [28]. These studies have assumed that the information disclosure decision is exogenous. However, our study considers the information disclosure level as a decision variable for suppliers. This approach necessitates that suppliers balance the benefits and costs of disclosing information to achieve an optimal disclosure level. A unique aspect of our work is its application within the context of the spillover effect, BT adoption strategy decisions and sales mode choices.

2.3. Blockchain-enabled supply chain

The ability of BT to create an immutable and traceable digital record of a product makes it an attractive option for information disclosure and verification [5, 29]. Recently, owing to the unique advantages of the blockchain, some studies have examined how to employ this technology to disclose information in the context of operations management [30]. Liu *et al.* (2021) show that the supplier adopts BT to disclose product quality under price parity clauses when the service effect coefficient is high [31]. Zhang *et al.* (2024) point out that quality information asymmetry erodes the profit margins of high-quality manufacturers, and blockchain technology (BCT) serves as an effective mitigation strategy to eliminate such informational frictions [32]. Wu and Yu (2023) argue that BT is a powerful tool that can be used to address demand information asymmetry in a hybrid-mode supply chain and that suppliers adopting BT in different sales modes are better off than are suppliers without BT [33]. Wang *et al.* (2022) investigate the optimal information disclosure decision under different BT adoption strategies and reveal that when the adoption cost is moderate, only one platform uses BT to disclose more information [4]. Wang *et al.* (2026) employ a game-theoretic model to analyze the interactive relationship between supply chain structure and blockchain deployment strategies in competitive supply chain settings [34]. Zhao *et al.* (2026) explore the application of blockchain technology in agricultural supply chains and conclude that supply chain transparency enables farmers to effectively differentiate their products and build consumer trust, thereby safeguarding the integrity of the entire agricultural supply chain ecosystem [35]. Unlike the preceding studies, we characterize the information credibility difference without BT and with BT in sales models and subsequently examine the information disclosure level decisions and BT adoption strategies of suppliers.

Few studies have examined the strategic interaction between the sales mode choice and the BT adoption strategy. Inspired by supply chain sustainability and the advantages of BT, Ma and Hu (2022) examine the optimal combination of sales modes and BT adoption strategies [7]. Xu *et al.* (2023) explore the spillover effects on this strategic interaction across various contexts, such as remanufacturing, carbon cap-and-trade policy, and delivery time decisions [36].

However, these studies do not differentiate among various consumer types – a gap that our study aims to address. Building on real-world cases, we divide consumers into information-insensitive and information-sensitive categories. By incorporating this distinction into cross-channel spillover effects, our analysis demonstrates how consumer types influence firms' blockchain strategies, sales mode selection, and the profits obtained by both parties. We observe that a higher retail price, in turn, improves the welfare of information-sensitive consumers, and the agency mode creates a triple-win outcome for the supplier, the platform and information-sensitive consumers.

To our knowledge, our study is the first to quantitatively incorporate the information disclosure level and cross-channel spillover effect into the interaction decision between BT adoption strategies and the sales mode choices of firms. Academically, our study differs from the extant literature by considering the degree of information credibility, the disclosure cost efficiency of BT, and the information disclosure level decision. We highlight the impacts of the spillover effect on the information disclosure level and the interaction decision. Specifically, we capture the conditions in which win–win, multi-win, and triple-win outcomes occur among the supplier, the platform, and the different types of consumers. Therefore, our study not only provides important solutions in the context of determining BT adoption strategies and sales mode choices but also offers theoretical guidance regarding the BT information disclosure level and operation decisions with the aim of achieving multi-win outcomes in the context of spillover effects.

3. Formulation of the problem

3.1. Supplier and platform

We consider a two-echelon supply chain that consists of a supplier and an e-commerce platform. The supplier sells its product through the platform and its own offline channel. The following two sales modes exist on the platform: wholesale selling and agency selling. Under the wholesale mode, the platform orders products from the supplier at wholesale price w and resells them to consumers at retail price p. Under the agency mode, the supplier sells products directly to consumers at the retail price p and is charged the commission rate δ by the platform. In practice, the commission rate ranges from 5% to 12% of the sale price for most product categories on JD.com; the rate, depending on the product category, ranges from 6% to 25% on Amazon [37]; and the rate is 30% on Google Play and the Apple App Store [38]. In general, platforms charge the same δ for each product category and commit to δ before negotiating contracts with suppliers. Thus, we assume that δ is exogenous and that $\delta \in [0, 0.5]$ [8, 38]. For the sake of expositional clarity, we use "he" to refer to the supplier and "she" to refer to the platform.

To improve product information transparency, the supplier needs to determine the information disclosure level b [4]. However, in the presence of misinformation on the platform, the supplier can decide whether to adopt BT to enhance information credibility. Thus, he can choose between two BT adoption strategies: nonadoption (N) and adoption (B). The information disclosure cost of BT includes mainly implementation and operation fees [39–41]. In reality, the marginal disclosure cost efficiency of BT may be higher or lower than the corresponding cost efficiency of non-BT. For instance, Kumar *et al.* (2020) and Zhou *et al.* (2022) suggest that the disclosure cost is higher when BT is adopted by firms [3, 40]. However, as the technology matures, the IBM blockchain delivers more business benefits, including cost savings for information disclosure. Li *et al.* (2023) also consider a low disclosure cost coefficient of BT in their models [42]. Without loss of generality, we assume that the disclosure cost coefficient without BT is $t = 1$ and that the disclosure cost is $b^2/2$, whereas the disclosure cost with BT is $tb^2/2$, where $t > 0$ denotes the disclosure cost coefficient of BT [43]. Thus, the disclosure cost efficiency of BT is greater if $t \in (0, 1)$; otherwise, it is lower if $t > 1$.

3.2. Time sequence

We develop a three-stage game between the platform and the supplier. The sequence of events is presented below.

In the first stage, the supplier determines whether to adopt BT on the platform. In the second stage, the platform chooses a sales mode, *i.e.*, wholesale selling or agency selling. In the third stage, if the platform chooses the wholesale mode, the supplier determines the information disclosure level b and wholesale price w, and then, the platform determines the retail price p. If the platform chooses the agency mode, the supplier simultaneously determines b and p and pays a commission fee to the platform.

This sequence of decisions is motivated by operational practices. The BT adoption strategy is a long-term decision because technology implementation takes a long time and is costly [7]. The sales mode choice is a moderate-term decision, and it can occasionally change. Platforms usually insist on contractual agreements that last for one year or more because of specific collaboration commitments. Pricing and information disclosure decisions change more frequently than sales mode decisions do, and determining the price and disclosure level after strategic decisions are made is sensible [44]. In addition, we consider an alternative sequence of events in extensions.

Given the BT adoption strategies of the supplier and the sales mode choices of the platform, we consider four scenarios, *i.e.*, scenarios NW, NA, BW, and BA, in which the first and second letters represent the BT adoption strategy and the sales mode choice, respectively. We then employ backward induction to obtain solutions in each scenario.

3.3. Demand specification

According to a report from IBM, 71% of the consumers surveyed view traceability information as very important. Thus, we assume that a proportion of consumers ($\lambda \in (0,1)$) do not care about product information and its authenticity (referred to as information-insensitive consumers). The remaining consumers $1-\lambda$ are information-sensitive consumers on the platform, and their attitude is the opposite of that exhibited by information-insensitive consumers.

Without BT, owing to the lack of effective verification measures, product information authenticity is always suspected by consumers; thus, the degree of information credibility k is low, and $0 < k < 1$. To facilitate a comparison with the non-blockchain scenario, we assume that $k = 1$ when BT is adopted. Two reasons underlie this assumption: (1) it facilitates direct comparison and supports model computation and optimization, and (2) in reality, as BT is adopted, information credibility is enhanced, thus improving consumer trust in products [1,5]. This parameter setting is empirically exemplified by two dominant e-commerce platforms in China: JD.com and Pinduoduo. JD.com has integrated blockchain technology into its entire sales process, whereas Pinduoduo has not yet adopted such technology. Consequently, information-sensitive consumers, facing reduced information asymmetry and more credible product signals on JD.com, exhibit a higher purchase intention on this platform [45]. To characterize the demand function of each consumer type, we develop a utility function of a representative consumer introduced by Ingene and Parry (2004), which has been applied extensively in the fields of marketing and operations management [36, 46]. Thus, for information-sensitive consumers, the demand functions under the wholesale mode and agency mode are as follows:

$$\begin{aligned}&\text{Scenario NW/NA: } q_2^{\text{NW/NA}} = (1-\lambda)a + kb^{\text{NW/NA}} - p^{\text{NW/NA}},\\&\text{Scenario BW/BA: } q_2^{\text{BW/BA}} = (1-\lambda)a + b^{\text{BW/BA}} - p^{\text{BW/BA}},\end{aligned}$$

where a denotes the potential market size and is sufficiently large [47]. These models capture the unique features of BT in terms of information disclosure and focus on exploring the effect of BT on the demand of information-sensitive consumers.

For information-insensitive consumers, the demand function is always $q_1^z = \lambda a - p^z$, $z \in \{\text{NW}, \text{NA}, \text{BW}, \text{BA}\}$. The total market demand of the product on the platform is $q^z = q_1^z + q_2^z$.

In addition to the platform channel, the supplier also sells on the offline channel. On the basis of Dong *et al.* (2025) and Xu *et al.* (2023), the product demand on the offline channel is $Q + \gamma q^z$, where $Q > 0$ is the base demand, and $\gamma \in [-1, 1]$ represents the spillover effect of online sales on offline demand [11]. Note that $\gamma < 0$ ($\gamma > 0$) indicates that the spillover is negative (positive); that is, online sales have a negative or positive spillover effect on offline demand. To focus on the spillover effect of online sales, the offline retail price is normalized to 1 [9, 10]. We extend this assumption to study settings that feature the variable offline retail price in extensions. To ensure the verified information credibility and non-negative equilibrium solutions, t is not too small; *i.e.*, $t > (1-\delta)/4$, and λ is less than 5/8. The corresponding notations are summarized in Table 1.

4. Model setup

In this section, we first examine the pricing and disclosure level decisions in the third stage. We describe the profits of a supplier and a platform and then obtain the equilibrium outcome under different sales modes. In addition, we analyze the effects of important factors on the outcome.

TABLE 1. Summary of notations.

Notation	Definition
Main parameters	
a	Market size
γ	Spillover effect
t	Disclosure cost coefficient of BT
δ	Commission rate under agency mode
λ	Proportion of information-insensitive consumers
k	Information credibility degree without BT
q_1^z	Market demand of information-insensitive consumers
q_2^z	Market demand of information-sensitive consumers
q^z	Total market demand on the platform
π_i^z	Profit of supply chain member i, $i = \{S, P\}$
Decision variables	
w	Wholesale price of the product
p	Retail price of the product
b	Information disclosure level of the product
Superscripts	
z	Four scenarios: NW, NA, BW, and BA

4.1. Scenario NW

Under the wholesale mode without BT, the supplier does not adopt BT. Thus, the profits of the parties are, respectively, as follows:

$$\pi_S^{\mathrm{NW}}(w,b) = wq^{\mathrm{NW}} + 1\cdot(Q+\gamma q^{\mathrm{NW}}) - \frac{(b^{\mathrm{NW}})^2}{2}, \pi_P^{\mathrm{NW}}(p) = (p-w)q^{\mathrm{NW}}, \tag{1}$$

where $q^{\mathrm{NW}} = q_1^{\mathrm{NW}} + q_2^{\mathrm{NW}}$. We then obtain the equilibrium solutions presented below.

Lemma 1. *The equilibrium prices and information disclosure level are* $w^{\mathrm{NW}^*} = \frac{2a-\gamma(4-k^2)}{8-k^2}$, $p^{\mathrm{NW}^*} = \frac{3a-\gamma(2-k^2)}{8-k^2}$, *and* $b^{\mathrm{NW}^*} = \frac{k(a+2\gamma)}{8-k^2}$. *The equilibrium market demands are* $q_1^{\mathrm{NW}^*} = \lambda a - p^{\mathrm{NW}^*}$, $q_2^{\mathrm{NW}^*} = \frac{a\left(5-(8-k^2)\lambda\right)+(2+k^2)\gamma}{8-k^2}$, *and* $q^{\mathrm{NW}^*} = \frac{2(a+2\gamma)}{8-k^2}$. *The equilibrium profits of the supplier and platform are* $\pi_S^{\mathrm{NW}^*} = \frac{(a+2\gamma)^2}{2(8-k^2)} + Q$, *and* $\pi_P^{\mathrm{NW}^*} = \frac{2(a+2\gamma)^2}{(8-k^2)^2}$.

Lemma 1 illustrates that with increasing γ, the supplier sets a lower wholesale price; thus, the platform also decreases the retail price to stimulate online demand, which indirectly increases product sales and the supplier's revenue on the offline channel. Interestingly, although the degree of information credibility (k) without BT is low, as γ increases, the supplier still discloses more information. Eventually, firms' profit increases with γ. These results indicate that increasing γ not only alleviates the DMP but also increases the payoffs of both firms.

4.2. Scenario NA

Under the agency mode without BT, the profits of the supplier and platform are, respectively, as follows:

$$\pi_S^{\mathrm{NA}}(p,b) = (1-\delta)pq^{\mathrm{NA}} + 1\cdot(Q+\gamma q^{\mathrm{NA}}) - \frac{(b^{\mathrm{NA}})^2}{2}, \quad \pi_P^{\mathrm{NA}} = \delta p q^{\mathrm{NA}}, \tag{2}$$

where $q^{\mathrm{NA}} = q_1^{\mathrm{NA}} + q_2^{\mathrm{NA}}$. We then obtain the equilibrium solutions presented below.

Lemma 2. *The equilibrium prices and information disclosure level are* $p^{\mathrm{NA}^*} = \frac{(1-\delta)a-\left(2-(1-\delta)k^2\right)\gamma}{(1-\delta)\left(4-(1-\delta)k^2\right)}$ *and* $b^{\mathrm{NA}^*} = \frac{k\left(a(1-\delta)+2\gamma\right)}{4-(1-\delta)k^2}$. *The equilibrium market demands are* $q_1^{\mathrm{NA}^*} = \lambda a - p^{\mathrm{NA}^*}$, $q_2^{\mathrm{NA}^*} = \frac{a(1-\delta)\left(\left(4-(1-\delta)k^2\right)\lambda-3\right)+\left(2+(1-\delta)k^2\right)\gamma}{(1-\delta)\left(4-(1-\delta)k^2\right)}$, *and* $q^{\mathrm{NA}^*} = \frac{2\left(a(1-\delta)+2\gamma\right)}{(1-\delta)\left(4-(1-\delta)k^2\right)}$. *The equilibrium profits of the supplier and platform are* $\pi_S^{\mathrm{NA}^*} = \frac{\left(a(1-\delta)+2\gamma\right)^2}{2(1-\delta)\left(4-(1-\delta)k^2\right)} + Q$ *and* $\pi_P^{\mathrm{NA}^*} = \frac{2\delta\left(\left(\gamma k^2+a\right)(1-\delta)-2\gamma\right)\left(2\gamma+a(1-\delta)\right)}{(1-\delta)^2\left(4-(1-\delta)k^2\right)^2}$.

Lemma 2 shows that a larger γ improves the supplier's profit under the agency mode without BT, which is similar to the result in Lemma 1. However, owing to a lower retail price, the profit of the platform decreases with γ. Furthermore, combining the findings in Lemma 1, we observe that regardless of the sales mode chosen, an increasing degree of information credibility benefits both supplier and platform, even in the absence of BT adoption. This result implies that the supplier without BT can take other measures to improve information credibility and profit. For example, revenue from Unilever Lipton Tea has increased dramatically since Rainforest Alliance certified the company's tea-growing information and sustainability efforts. In addition, the impact of the commission rate (δ) on the equilibrium solutions is as follows:

Corollary 1. (1) *When* $\gamma \in [-1, 0]$, *if* $a \in (0, a_1]$ *or* $a \in (a_1, a_2]$ *and* $\delta \in (\delta_1, 1/2]$, *then* $\frac{\partial p^{\mathrm{NA}^*}}{\partial \delta} > 0$; *if* $a \in (a_1, a_2]$ *and* $\delta \in [0, \delta_1]$ *or* $a > a_2$, *then* $\frac{\partial p^{\mathrm{NA}^*}}{\partial \delta} < 0$. *However,* $\frac{\partial q^{\mathrm{NA}^*}}{\partial \delta} < 0$. (2) *When* $\gamma \in (0, 1]$, $\frac{\partial p^{\mathrm{NA}^*}}{\partial \delta} < 0$; *however, if* $a \in (0, a_3]$ *or* $a \in (a_3, a_4]$ *and* $\delta \in (\delta_2, 1/2]$, *then* $\frac{\partial q^{\mathrm{NA}^*}}{\partial \delta} > 0$; *if* $a \in (a_3, a_4]$ *and* $\delta \in [0, \delta_2]$ *or* $a > a_4$, *then* $\frac{\partial q^{\mathrm{NA}^*}}{\partial \delta} < 0$.

Corollary 1 shows that the effect of δ on the optimal retail price and total demand depends not only on itself but also on the spillover effect (γ) and market size (a). Corollary 1(1) shows that when the spillover effect is negative, if a on the platform is low, or a is moderate and γ is high, then as δ increases, the supplier increases the retail price to weaken the negative spillover effect. In contrast, if a is high, or a is moderate and γ is low, as δ increases, he decreases the retail price on the platform, but the demand on the platform always decreases, which also increases the demand on the offline channel.

Interestingly, Corollary 1(2) indicates that when the spillover effect is positive, the supplier always decreases the retail price, and if a is low, or a is moderate and γ is high, then as δ increases, a reduced retail price increases market demand on both channels. Some real-world examples have corroborated these results. For instance, although well-known platforms (*e.g.*, Amazon and eBay) charge high commission rates for everyday items such as groceries and gourmet food, suppliers still sell these products at a low retail price under the agency mode. In addition, although Ha *et al.* [8] report that a lower commission rate always benefits product sales, this theory may not hold in some cases. We find that if a is high, or a is moderate and γ is low, then product sales decrease with δ despite the lower retail price.

In particular, previous studies have shown that the platform's profit always increases with δ [9,11]. However, we observe that the impact of δ on the platform's profit is not monotonic but depends on market size a and spillover effect γ, as illustrated in Figure 1. Figure 1 depicts the influence of the commission rate on the platform's profit when the market size (a) and the spillover effect (γ) change, where $k = 0.5$ [7,42]. In the presence of γ, when either the negative or positive spillover effect is pronounced (*i.e.*, $\gamma < \gamma_1$ or $\gamma > \gamma_1$, respectively), the platform should establish a moderate commission rate to maximize profit. Namely, as δ increases, δ and γ have positive interaction effects on the retail price and online product demand.

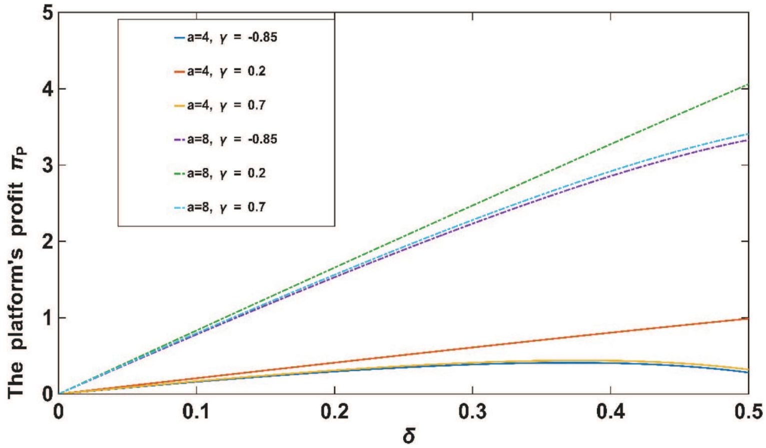


FIGURE 1. Influence of the commission rate (δ) on the platform's profit (π_p).

4.3. Scenario BW

Under the wholesale mode, the supplier adopts BT to disclose product information. The profits of the supplier and platform are, respectively, as follows:

$$\pi_S^{\mathrm{BW}}(w,b) = wq^{\mathrm{BW}} + 1\cdot(Q+\gamma q^{\mathrm{BW}}) - \frac{t(b^{\mathrm{BW}})^2}{2}, \quad \pi_P^{\mathrm{BW}}(p) = (p-w)q^{\mathrm{BW}}, \tag{3}$$

where $q^{\mathrm{BW}} = q_1^{\mathrm{BW}} + q_2^{\mathrm{BW}}$. We thus derive the following equilibrium solutions:

Lemma 3. *The equilibrium prices and information disclosure level are* $w^{\mathrm{BW}^*} = \frac{2ta+(1-4t)\gamma}{8t-1}$, $b^{\mathrm{BW}^*} = \frac{a+2\gamma}{8t-1}$, *and* $p^{\mathrm{BW}^*} = \frac{3at+(1-2t)\gamma}{8t-1}$. *The equilibrium market demands are* $q_1^{\mathrm{BW}^*} = \lambda a - p^{\mathrm{BW}^*}$, $q_2^{\mathrm{BW}^*} = \frac{\lambda a+\gamma+(2\gamma+a(5-8\lambda))t}{8t-1}$, *and* $q^{\mathrm{BW}^*} = \frac{2t(a+2\gamma)}{8t-1}$. *The equilibrium profits of the supplier and platform are* $\pi_S^{\mathrm{BW}^*} = \frac{(a+2\gamma)^2 t}{2(8t-1)} + Q$, $\pi_P^{\mathrm{BW}^*} = \frac{2t^2(a+2\gamma)^2}{(8t-1)^2}$.

Lemma 3 shows that b^{BW^*}, q^{BW^*}, $\pi_s^{\mathrm{BW}^*}$ and $\pi_p^{\mathrm{BW}^*}$ increase with γ, which is similar to Lemma 1. Thus, a stronger spillover effect under the wholesale mode always encourages the supplier to disclose more information, increases total demand on the online channel, and ultimately improves the profit of both firms. However, the influence of γ on product pricing differs from the corresponding influence without BT, as shown in Corollary 2.

Corollary 2. *If* $t \in ((1-\delta)/4, 1/4]$, *then* $\frac{\partial w^{\mathrm{BW}^*}}{\partial \gamma} \geq 0$ *and* $\frac{\partial p^{\mathrm{BW}^*}}{\partial \gamma} > 0$; *if* $t \in (1/4, 1/2]$, *then* $\frac{\partial w^{\mathrm{BW}^*}}{\partial \gamma} < 0$ *and* $\frac{\partial p^{\mathrm{BW}^*}}{\partial \gamma} \geq 0$; *and if* $t > 1/2$, *then* $\frac{\partial w^{\mathrm{BW}^*}}{\partial \gamma} < 0$ *and* $\frac{\partial p^{\mathrm{BW}^*}}{\partial \gamma} < 0$.

Interestingly, when the information disclosure cost coefficient of BT is low, product pricing increases with γ. Thus, the supplier and platform can derive higher marginal profits from unit sales, which may exacerbate the DMP. If the disclosure cost coefficient is moderate, then as γ increases, the supplier hopes that the platform will reduce the retail price and increase online sales by setting a lower wholesale price. However, owing to fierce channel competition, the platform sets a higher price to maximize profit. Surprisingly, if the supplier pays a higher cost to verify information, then as γ increases, the two firms, in turn, set lower prices. The reason for these findings may be that in the presence of a positive spillover effect, the two firms hope to expand market demand across channels through low-price behavior, which mitigates the DMP.

In Lemma 3, the demand of information-sensitive consumers increases with γ, whereas the impact of γ on the demand of information-insensitive consumers is the opposite. This result differs from that reported by Xu and Choi (2021), who observe that the influence of γ on demand with BT is the same as the corresponding influence on demand without BT [47]. By combining Lemma 3 and Corollary 2, we conclude that although the diminished DMP decreases the demand of information-insensitive consumers, it neither affects the demand of information-sensitive consumers nor deters the supplier from disclosing more verified information. This result implies that the total product demand on the platform is mainly the result of information-sensitive consumers.

4.4. Scenario BA

Under the agency mode with BT, the profits of firms are as follows:

$$\pi_S^{\mathrm{BA}}(p,b) = (1-\delta)pq^{\mathrm{BA}} + 1(Q+\gamma q^{\mathrm{BA}}) - \frac{t(b^{\mathrm{BA}})^2}{2}, \pi_P^{\mathrm{BA}} = \delta p q^{\mathrm{BA}}, \tag{4}$$

where $q^{\mathrm{BA}} = q_1^{\mathrm{BA}} + q_2^{\mathrm{BA}}$. We derive the equilibrium solutions presented below.

Lemma 4. *The equilibrium prices and information disclosure level are* $p^{\mathrm{BA}^*} = \frac{(1-\delta)at-(2t+\delta-1)\gamma}{(1-\delta)(4t+\delta-1)}$, $b^{\mathrm{BA}^*} = \frac{(1-\delta)a+2\gamma}{4t+\delta-1}$. *The equilibrium market demands are* $q_1^{\mathrm{BA}^*} = \lambda a - p^{\mathrm{NA}^*}$, $q_2^{\mathrm{BA}^*} = \frac{a(1-\delta)((4t+\delta-1)\lambda-3t)+(2t+1-\delta)\gamma}{(1-\delta)(4t+\delta-1)}$, *and* $q^{\mathrm{BA}^*} = \frac{2t(a-a\delta+2\gamma)}{(1-\delta)(4t+\delta-1)}$. *The equilibrium profits of supply chain members are* $\pi_S^{\mathrm{BA}^*} = \frac{(a(1-\delta)+2\gamma)^2 t}{2(1-\delta)(4t+\delta-1)} + Q$, $\pi_P^{\mathrm{BA}^*} = \frac{2t\delta((1-\delta)(\gamma+at)-2\gamma)(2\gamma+a(1-\delta))}{(1-\delta)^2(4t+\delta-1)^2}$.

In this scenario, the effect of δ on the retail price and profits is similar to the corresponding effect under scenario NA, thus implying that even if BT is adopted, the disclosure cost of BT does not change the role of the commission rate. Thus, combining the market size of the product and the spillover effect, the platform should set a commission rate flexibly to expand online market demand and improve performance.

Corollary 3. (1) *If* $t \in ((1-\delta)/4, (1-\delta)/2]$, *then* $\frac{\partial p^{\mathrm{BA}^*}}{\partial \gamma} \geq 0$; *if* $t > (1-\delta)/2$, *then* $\frac{\partial p^{\mathrm{BA}^*}}{\partial \gamma} < 0$. (2) *If* $t \in ((1-\delta)/4, (1-\delta)/2]$ *and* $\gamma \in [-1, \gamma_3]$ *or* $t > (1-\delta)/2$ *and* $\gamma \in (\gamma_3, \min\{\gamma_3, 1\}]$, *then* $\frac{\partial \pi_P^{\mathrm{BA}^*}}{\partial \gamma} \leq 0$; *if* $t \in ((1-\delta)/4, (1-\delta)/2]$ *and* $\gamma \in (\gamma_3, \min\{\gamma_3, 1\}]$ *or* $t > (1-\delta)/2$ *and* $\gamma \in [-1, \gamma_3]$, *then* $\frac{\partial \pi_P^{\mathrm{BA}^*}}{\partial \gamma} > 0$, *where* $\gamma_3 > 0$.

This corollary shows that the influence of γ on the online retail price and the platform's profit is related to the disclosure cost efficiency of BT. Specifically, if the disclosure cost efficiency is greater, *i.e.*, if $t \in ((1-\delta)/4, (1-\delta)/2)$, owing to the negative spillover effect of the online channel and increasing retail price, more online demand is transferred to the offline channel, thus degrading the platform's position. In contrast, when γ is significantly positive ($\gamma \in (\gamma_3, \min\{\gamma_3, 1\}]$), increasing the retail price and demand improves the platform's position. As a result, when BT has a greater cost advantage ($t < (1-\delta)/2$), the platform gains the lowest profit in the presence of a positive spillover effect. Furthermore, when BT has a lower cost advantage ($t > (1-\delta)/2$)), although the retail price decreases with γ, the platform gains the highest profit in the presence of a positive spillover effect.

5. Equilibrium results

5.1. Comparison results of the decision variables

In this subsection, we compare the equilibrium wholesale price, retail price, disclosure level, and market demand under the four scenarios.

Proposition 1. (1) *If* $t \in \left((1-\delta)/4, 1/k^2\right]$, *then* $w^{\mathrm{NW}^*} \leq w^{\mathrm{BW}^*}$, $p^{\mathrm{NW}^*} \leq p^{\mathrm{BW}^*}$ *and* $p^{\mathrm{NA}^*} \leq p^{\mathrm{BA}^*}$; *if* $t > 1/k^2$, *then* $w^{\mathrm{NW}^*} > w^{\mathrm{BW}^*}$, $p^{\mathrm{NW}^*} > p^{\mathrm{BW}^*}$ *and* $p^{\mathrm{NA}^*} > p^{\mathrm{BA}^*}$. (2) *If* $a \leq 6 - k^2$ *and* $\delta \in \left(\delta_1^{\mathrm{NW-NA}}, 1/2\right]$, *when* $\gamma \in [-1, \gamma_1^{\mathrm{NW-NA}}]$, *then* $p^{\mathrm{NW}^*} \leq p^{\mathrm{NA}^*}$. *However,* $p^{\mathrm{NW}^*} > p^{\mathrm{NA}^*}$ *in other cases, where* $\gamma_1^{\mathrm{NW-NA}} < 0$. (3) *If* $t \in ((1-\delta)/4, 1/2]$ *and* $\delta \in \left[0, \delta_2^{\mathrm{BW-BA}}\right]$, *when* $\gamma \leq \gamma_1^{\mathrm{BW-BA}}$, *then* $p^{\mathrm{BW}^*} \geq p^{\mathrm{BA}^*}$; *when* $\gamma > \gamma_1^{\mathrm{BW-BA}}$, *then* $p^{\mathrm{BW}^*} < p^{\mathrm{BA}^*}$. *However, if* $t \in ((1-\delta)/4, 1/2]$ *and* $\delta \in \left(\delta_2^{\mathrm{BW-BA}}, 1/2\right]$ *or* $t > 1/2$, *when* $\gamma \leq \gamma_1^{\mathrm{BW-BA}}$, *then* $p^{\mathrm{BW}^*} \leq p^{\mathrm{BA}^*}$; *when* $\gamma > \gamma_1^{\mathrm{BW-BA}}$, *then* $p^{\mathrm{BW}^*} > p^{\mathrm{BA}^*}$.

This proposition compares the pricing decision of each firm in terms of sales modes and BT adoption strategies. Proposition 1(1) reveals that compared with the case without BT, if the disclosure cost coefficient of BT is low ($t \in ((1-\delta)/4, 1]$), then both members set higher retail prices to derive a larger profit margin. Intuitively, worse disclosure cost efficiency ($t \in (1, 1/k^2]$) enables the two firms to set higher prices to cover the cost. However, despite the enormous disclosure cost coefficient ($t > 1/k^2$), both members still set lower prices.

Intuitively, the retail price under the wholesale mode is higher than the corresponding price under the agency mode. However, Proposition 1(2) shows that in the absence of BT, this result may not hold. For instance, owing to a small market size ($a \leq 6 - k^2$) and a prominent negative spillover effect ($\gamma \in [-1, \gamma_1^{\mathrm{NW-NA}}]$), the supplier raises the retail price to ensure a positive profit margin when the commission fee is high ($\delta \in (\delta_1^{\mathrm{NW-NA}}, 1/2]$). Thus, the retail price is higher under the agency mode than under the wholesale mode.

According to Proposition 1(3), if the disclosure cost coefficient is low ($t \in ((1-\delta)/4, 1/2)$), despite the commission rate also being low ($\delta \in [0, \delta_2^{\mathrm{BW-BA}}]$), the retail price is still higher under the agency mode in the context of a spillover effect ($\gamma > \gamma_1^{\mathrm{BW-BA}}$). This situation occurs because as the spillover effect becomes positive, on the one hand, the supplier sets a higher retail price to expand demand on dual channels and derives a higher profit margin; on the other hand, the platform, in turn, sets a lower retail price to improve online channel sales under the wholesale mode. However, p^{BW^*} is greater than p^{BA^*} under other conditions. For instance, if $t \in ((1-\delta)/4, 1/2)$ and $\gamma \leq \gamma_1^{\mathrm{BW-BA}}$, the supplier sets a higher retail price to cover the high commission rate ($\delta \in (\delta_2^{\mathrm{BW-BA}}, 1/2]$). As t further increases ($t > 1/2$), he also sets a higher retail price to weaken the negative spillover effect and cover information disclosure costs. Because of the DMP, p^{BW^*} is greater than p^{BA^*} when $\gamma > \gamma_1^{\mathrm{BW-BA}}$ and $t > 1/2$.

Proposition 1 also reveals an important and practical managerial implication for platforms and suppliers adopting blockchain technology (BT): a clear distinction should be drawn between "cost efficiency" and "absolute cost". Even if the unit implementation cost of BT is substantial, a premium pricing strategy can still yield positive economic returns, provided that the technology significantly enhances consumer trust and supports a high-end product positioning strategy. Conversely, the adoption of low-cost BT without delivering differentiated consumer value may inadvertently compress the profit margins of both platforms and suppliers.

Proposition 2. (1) *If* $t \in \left((1-\delta)/4, t^{\mathrm{NW-BW}}\right]$, *when* $\gamma \in \left(-1, \gamma_2^{\mathrm{BW-BA}}\right]$, *then* $b^{\mathrm{NA}^*} < b^{\mathrm{NW}^*} < b^{\mathrm{BA}^*} \leq b^{\mathrm{BW}^*}$; *when* $\gamma \in \left(\gamma_2^{\mathrm{BW-BA}}, \gamma_2^{\mathrm{NW-NA}}\right]$, *then* $b^{\mathrm{NA}^*} \leq b^{\mathrm{NW}^*} \leq b^{\mathrm{BW}^*} \leq b^{\mathrm{BA}^*}$; *when* $\gamma \in \left(\gamma_2^{\mathrm{NW-NA}}, 1\right]$, *then* $b^{\mathrm{NW}^*} < b^{\mathrm{NA}^*} < b^{\mathrm{BW}^*} < b^{\mathrm{BA}^*}$, *where* $\gamma_2^{\mathrm{BW-BA}} < \gamma_2^{\mathrm{NW-NA}} < 0$. (2) *If* $t \in \left(t^{\mathrm{NW-BW}}, t^{\mathrm{NA-BA}}\right]$, *when* $\gamma \in \left(-1, \gamma_2^{\mathrm{BW-BA}}\right]$, *then* $b^{\mathrm{NA}^*} \leq b^{\mathrm{BA}^*} \leq b^{\mathrm{BW}^*} < b^{\mathrm{NW}^*}$; *when* $\gamma \in \left(\gamma_2^{\mathrm{BW-BA}}, \gamma_2^{\mathrm{NW-NA}}\right]$, *then* $b^{\mathrm{BW}^*} < b^{\mathrm{NA}^*} \leq b^{\mathrm{BA}^*} < b^{\mathrm{NW}^*}$; *when* $\gamma \in \left(\gamma_2^{\mathrm{NW-NA}}, 1\right]$, *then* $b^{\mathrm{BW}^*} < b^{\mathrm{NW}^*} < b^{\mathrm{NA}^*} \leq b^{\mathrm{BA}^*}$. (3) *If* $t > t^{\mathrm{NA-BA}}$, *when* $\gamma \in \left(-1, \gamma_2^{\mathrm{BW-BA}}\right]$, *then* $b^{\mathrm{BA}^*} \leq b^{\mathrm{BW}^*} < b^{\mathrm{NA}^*} < b^{\mathrm{NW}^*}$; *when* $\gamma \in \left(\gamma_2^{\mathrm{BW-BA}}, \gamma_2^{\mathrm{NW-NA}}\right]$, *then* $b^{\mathrm{BW}^*} < b^{\mathrm{BA}^*} < b^{\mathrm{NW}^*} \leq b^{\mathrm{NA}^*}$; *when* $\gamma \in \left(\gamma_2^{\mathrm{NW-NA}}, 1\right]$, *then* $b^{\mathrm{BW}^*} < b^{\mathrm{BA}^*} < b^{\mathrm{NW}^*} < b^{\mathrm{NA}^*}$.

Proposition 2 compares the information disclosure levels across the four scenarios, which depend on the BT disclosure cost coefficient and the spillover effect. Intuitively, a low (high) cost coefficient prompts the supplier with (without) BT to disclose more information (*i.e.*, $t \in ((1-\delta)/4, t^{\mathrm{NW-BW}})$ ($t > t^{\mathrm{NA-BA}}$). However, a salient negative spillover effect ($\gamma \leq \gamma_2^{\mathrm{BW-BA}}$) leads to higher levels of disclosure under the wholesale mode than under the agency mode, peaking in BW (NW). Conversely, a salient positive spillover effect ($\gamma > \gamma_2^{\mathrm{BW-BA}}$) shifts this advantage to the agency mode, in which context the highest levels of disclosure are observed in BA (NA). The rationale is that transparency curbs negative spillovers in the wholesale mode but strengthens positive spillovers across channels in the agency mode.

According to Proposition 2(2), with a moderate BT disclosure cost coefficient ($t \in (t^{\mathrm{NW-BW}}, t^{\mathrm{NA-BA}}]$), the supplier that adopts BT discloses less information if $\gamma \in (-1, \gamma_2^{\mathrm{NW-NA}}]$ under the wholesale mode but more information under scenario NW.Two factors explain this difference. First, higher disclosure costs deter the supplier from adopting BT. Second, the lower retail price in the wholesale mode can intensify the negative spillover from the online channel. To mitigate this effect, the supplier is inclined to disclose more information, thereby shifting demand to the offline channel and alleviating the adverse effect. In contrast, as the spillover effect becomes stronger ($\gamma > \gamma_2^{\mathrm{NW-NA}}$), the positive spillover under the agency mode not only encourages a price reduction but also prompts BT adoption to enhance information credibility. Consequently, the supplier sets the maximum disclosure level to stimulate demand across both channels.

The conclusions of Proposition 2 are also corroborated by real-world management cases. For example, Tmall employs Ant Chain to enable agricultural product traceability, which not only boosts the sales of Dangshan Pear and Wuchang Rice but also significantly enhances their brand equity. Under Tmall's agency sales model, this positive spillover effect of BT has further incentivized suppliers to proactively engage in high-quality product information disclosure.

Corollary 4. (1) *Information-insensitive consumers purchase low-price products.* (2) *Information-sensitive consumers are more inclined to purchase high-price products as the level of information disclosure improves. Moreover, the demand of information-sensitive consumers dominates the total demand of the platform.*

Corollary 4(1) reveals that when the information disclosure cost of BT is low (high), the demand of information-insensitive consumers is lower (higher) in the case with BT than in that without BT. These results are the opposite of those concerning the optimal retail price because such consumers always purchase low-price products, regardless of whether the level of information credibility is low or high.

Corollary 4(2) highlights the fact that information-sensitive consumers purchase premium products with information transparency, and their demand dominates the market demand on the platform channel. This situation implies that the effect of important parameters (*e.g.*, the disclosure cost coefficient of BT and the spillover effect) on the demand of such consumers is the same as their effect on total demand. Therefore, suppliers and platforms should pay more attention to the requirements of such consumers in terms of information disclosure. These results explain why suppliers such as Heidi and Kering Group disclose detailed product information to consumers.

Proposition 3. *With respect to total demand on the platform, we obtain the following results. (1) If* $t \in \left((1-\delta)/4, 1/k^2\right]$, *when* $\gamma \in \left[-1, \gamma_3^{NW-BA}\right]$, *then* $q^{\mathrm{NA}^*} \leq q^{\mathrm{BA}^*} \leq q^{\mathrm{NW}^*} \leq q^{\mathrm{BW}^*}$*; when* $\gamma \in \left(\gamma_3^{NW-BA}, \gamma_3^{\mathrm{BW-BA}}\right]$, *then* $q^{\mathrm{NA}^*} < q^{\mathrm{NW}^*} \leq q^{\mathrm{BA}^*} \leq q^{\mathrm{BW}^*}$*; when* $\gamma \in \left(\gamma_3^{\mathrm{BW-BA}}, \gamma_3^{\mathrm{NW-NA}}\right]$, *then* $q^{\mathrm{NA}^*} \leq q^{\mathrm{NW}^*} \leq q^{\mathrm{BW}^*} < q^{\mathrm{BA}^*}$*; when* $\gamma \in \left(\gamma_3^{\mathrm{NW-NA}}, \gamma_3^{NA-BW}\right]$, *then* $q^{\mathrm{NW}^*} < q^{\mathrm{NA}^*} \leq q^{\mathrm{BW}^*} < q^{\mathrm{BA}^*}$*; when* $\gamma \in \left(\gamma_3^{NA-BW}, 1\right]$, *then* $q^{\mathrm{NW}^*} \leq q^{\mathrm{BW}^*} < q^{\mathrm{NA}^*} \leq q^{\mathrm{BA}^*}$. *(2) If* $t > 1/k^2$, *when* $\gamma \in \left[-1, \gamma_3^{NA-BW}\right]$, *then* $q^{\mathrm{BA}^*} < q^{\mathrm{NA}^*} \leq q^{\mathrm{BW}^*} < q^{\mathrm{NW}^*}$*; when* $\gamma \in \left(\gamma_3^{NA-BW}, \gamma_3^{\mathrm{NW-NA}}\right]$, *then* $q^{\mathrm{BA}^*} < q^{\mathrm{BW}^*} < q^{\mathrm{NA}^*} \leq q^{\mathrm{NW}^*}$*; when* $\gamma \in \left(\gamma_3^{\mathrm{NW-NA}}, \gamma_3^{\mathrm{BW-BA}}\right]$, *then* $q^{\mathrm{BA}^*} \leq q^{\mathrm{BW}^*} < q^{\mathrm{NW}^*} < q^{\mathrm{NA}^*}$*; when* $\gamma \in \left(\gamma_3^{\mathrm{BW-BA}}, \gamma_3^{NW-BA}\right]$, *then* $q^{\mathrm{BW}^*} < q^{\mathrm{BA}^*} \leq q^{\mathrm{NW}^*} < q^{\mathrm{NA}^*}$*; when* $\gamma \in \left(\gamma_3^{NA-BW}, 1\right]$, *then* $q^{\mathrm{BW}^*} < q^{\mathrm{NW}^*} < q^{\mathrm{BA}^*} < q^{\mathrm{NA}^*}$, *where these threshold values are negative with respect to* γ.

According to Proposition 3(1), when the disclosure cost coefficient of BT is low, the total demand with BT is higher than the corresponding demand without BT. Proposition 3(2) shows that under a high disclosure cost coefficient of BT ($t \in (1, 1/k^2)$), compared with non-BT, BT increases the total demand of the platform. This result is similar to that of the optimal pricing in Proposition 1(1) and to that of the optimal information disclosure level in Proposition 2(1) and is related to the structural characteristics of total demand. On the one hand, the demand of information-sensitive consumers dominates the total demand on the platform, as shown in Corollary 4(2). On the other hand, according to the demand function of consumers under the four scenarios, although a higher retail price decreases the demand of information-insensitive consumers, it can increase the demand of information-sensitive consumers under a high level of information disclosure; in this case, the increased rate eventually outweighs the decreased rate. However, when the disclosure cost coefficient of BT is very high ($t > 1/k^2$), BT leads to lower total demand on the platform because of an expensive retail price. Therefore, in the practical application of BT, platforms should dynamically adjust the timing of BT adoption and their information disclosure strategies based on the heterogeneous composition of consumer segments. Interestingly, regardless of the BT adoption strategy, when the spillover effect is negative, owing to a lower retail price charged by the platform and a higher level of information disclosure, total demand is higher under the wholesale mode than under the agency mode. Thus, if the disclosure cost of BT is relatively low, the total demand is highest under scenario BW and lower under scenarios NA and NW; otherwise, the total demand is highest under scenario NW and lower under scenarios BA and BW. In contrast, when the spillover effect is positive, the opposite occurs.

5.2. Equilibrium strategy of supply chain members

In this subsection, we compare the profits of supply chain members under different scenarios and then derive the equilibrium strategy of each firm.

Proposition 4. (1) (i) *If* $\gamma \leq \gamma_P^{\mathrm{NW-NA}}$ $\left(\gamma > \gamma_P^{\mathrm{NW-NA}}\right)$, *when* $\delta \in \left[0, \delta_{P_1}^{\mathrm{NW-NA}}\right]$ *and* $\delta \in \left(\delta_{P_2}^{\mathrm{NW-NA}}, 1/2\right]$ $\left(\delta \in \left[0, \delta_{P_1}^{\mathrm{NW-NA}}\right]\right)$, *then* $\pi_P^{\mathrm{NW}^*} \geq \pi_P^{\mathrm{NA}^*}$; *when* $\delta \in \left(\delta_{P_1}^{\mathrm{NW-NA}}, \delta_{P_2}^{\mathrm{NW-NA}}\right]$ $\left(\delta \in \left(\delta_{P_1}^{\mathrm{NW-NA}}, 1/2\right]\right)$, *then* $\pi_P^{\mathrm{NW}^*} < \pi_P^{\mathrm{NA}^*}$. (ii) *If* $\gamma \leq \gamma_P^{\mathrm{BW-BA}}$ $\left(\gamma > \gamma_P^{\mathrm{BW-BA}}\right)$, *when* $\delta \in \left[0, \delta_{P_1}^{\mathrm{BW-BA}}\right]$ *or* $\delta \in \left(\delta_{P_2}^{\mathrm{BW-BA}}, 1/2\right]$, *then* $\pi_P^{\mathrm{BW}^*} \geq \pi_P^{\mathrm{BA}^*}$; *when* $\delta \in \left(\delta_{P_1}^{\mathrm{BW-BA}}, \delta_{P_2}^{\mathrm{BW-BA}}\right]$ $\left(\delta \in \left(\delta_{P_1}^{\mathrm{BW-BA}}, 1/2\right]\right)$, *then* $\pi_P^{\mathrm{BW}^*} < \pi_P^{\mathrm{BA}^*}$. (iii) *These threshold values with respect to* δ *increase with the spillover effect* (γ). (2) *When* $t \in \left((1-\delta)/4, 1/k^2\right]$, $\pi_P^{\mathrm{NW}^*} \leq \pi_P^{\mathrm{BW}^*}$ *and* $\pi_P^{\mathrm{NA}^*} \leq \pi_P^{\mathrm{BA}^*}$; *when* $t > 1/k^2$, $\pi_P^{\mathrm{NW}^*} > \pi_P^{\mathrm{BW}^*}$ *and* $\pi_P^{\mathrm{NA}^*} > \pi_P^{\mathrm{BA}^*}$.

Proposition 4(1) characterizes the platform's optimal sales mode choice, which depends on the spillover effect and the commission rate. Specifically, a weak spillover effect, especially a salient negative effect, leads the platform to prefer the wholesale mode at both low and high commission rates, regardless of BT adoption. This preference arises because the intensified negative spillover shifts demand online, thus allowing the gains from greater disclosure and online sales to outweigh the costs of the DMP. For example, against the backdrop of fierce inter-channel competition and a large user base on the platform, Tmall has launched its own flagship brand store (Mao Xiang), despite the existence of product overlap between Mao Xiang's offerings and those of offline brick-and-mortar stores on the platform. In contrast, when the commission rate is moderate, the platform tends to choose the agency mode to mitigate the DMP and increase supplier sales. Furthermore, in the context of a significant positive spillover effect, the platform is driven to select the agency (wholesale) mode under a higher (lower) commission rate and a growing market demand. Consequently, platforms should carefully consider the spillover effect and commission rates when selecting a sales mode. Notably, the preceding analysis also reveals that an excessively high commission rate can backfire, potentially reducing platform profits; hence, the wholesale mode is a more viable option in some scenarios.

Proposition 4(2) explains the effect of BT adoption strategies on the platform. We find that with a low disclosure cost coefficient of BT, BT improves the platform's situation because more credible product information leads to greater online sales. In contrast, when the disclosure cost coefficient is high, BT reduces platform profit. Thus, many e-commerce platforms can help suppliers who are adopting BT reduce disclosure costs by inducing foot traffic to online stores. For instance, Amazon and JD.com have implemented BT systems that provide efficient product traceability services for sellers.

Proposition 5. (1) *If* $t \in \left((1-\delta)/4, 1/k^2\right]$, *when* $\gamma \in [-1, 0]$ *and* $\delta \in \left[0, \min\{\delta_S^{\mathrm{NW-NA}}, \delta_S^{\mathrm{BW-BA}}\}\right]$, *or* $\gamma \in (0, 1]$, *then* $\pi_S^{\mathrm{BA}^*} > \pi_S^{\mathrm{NA}^*} > \pi_S^{\mathrm{BW}^*} > \pi_S^{\mathrm{NW}^*}$; *when* $\gamma \in [-1, 0]$ *and* $\delta \in \left(\min\{\delta_S^{\mathrm{NW-NA}}, \delta_S^{\mathrm{BW-BA}}\}, 1/2\right]$, *then* $\pi_S^{\mathrm{BW}^*} > \pi_S^{\mathrm{NW}^*} > \pi_S^{\mathrm{BA}^*} > \pi_S^{\mathrm{NA}^*}$. (2) *If* $t > 1/k^2$, *when* $\gamma \in [-1, 0]$ *and* $\delta \in \left[0, \min\{\delta_S^{\mathrm{NW-NA}}, \delta_S^{\mathrm{BW-BA}}\}\right]$, *or* $\gamma \in (0, 1]$, *then* $\pi_S^{\mathrm{NA}^*} > \pi_S^{\mathrm{BA}^*} > \pi_S^{\mathrm{NW}^*} > \pi_S^{\mathrm{BW}^*}$; *when* $\gamma \in [-1, 0]$ *and* $\delta \in \left(\min\{\delta_S^{\mathrm{NW-NA}}, \delta_S^{\mathrm{BW-BA}}\}, 1/2\right]$, *then* $\pi_S^{\mathrm{NW}^*} > \pi_S^{\mathrm{BW}^*} > \pi_S^{\mathrm{NA}^*} > \pi_S^{\mathrm{BA}^*}$. (3) *These threshold values with respect to* δ *increase with* γ *and* a.

We explain the optimal BT adoption strategy of the supplier in Proposition 5. First, the supplier adopts BT if the information disclosure cost is low, especially under conditions of excellent BT disclosure cost efficiency. However, different sales modes affect the profit of the supplier that adopts BT, which depends on the spillover effect and commission rate. In particular, under a negative spillover effect, the supplier prefers to adopt BT under the agency mode when the commission rate is low. This preference arises because the benefit from credible information and flexible product pricing can compensate for the loss caused by the negative spillover effect. In addition, since the positive spillover effect increases market demand in dual channels, the supplier is also incentivized to adopt BT under the agency mode and to set a higher retail price and may disclose less verified information to cover the disclosure cost and commission fee. Intuitively, a higher commission rate decreases the supplier's profit under the agency mode. Thus, under a negative spillover effect and a higher commission rate, the wholesale mode enables the supplier with BT to set a higher wholesale price and disclose more information to mitigate the negative spillover effect, thus ultimately obtaining the highest profit.

As the disclosure cost coefficient of BT exceeds a threshold value, weak disclosure cost efficiency hinders the supplier from adopting BT, as shown in Proposition 5(2). The supplier without BT benefits from the agency mode under a negative spillover effect and a low commission rate. As the commission rate increases, the wholesale mode becomes preferable. Furthermore, regardless of the commission rate, the positive spillover effect helps the supplier maximize his profit in this mode.

Interestingly, Proposition 5(3) indicates that the increased spillover effect and market size can soften fierce channel competition and mitigate the DMP. Thus, the space of the agency mode is expanded. This result implies that the agency mode produces a better situation for the supplier than the wholesale mode does.

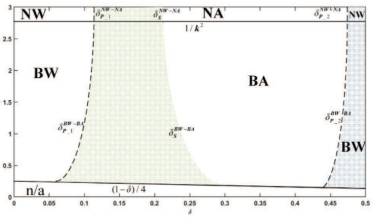
Furthermore, we discuss the equilibrium strategy results for firms in multistage games, as illustrated in Figure 2. Figure 2 highlights the effect of the commission rate (δ) and disclosure cost coefficient (t) of BT on the equilibrium strategies of supply chain members when the market size (a) and the spillover effect (γ) change. We observe that both sales modes can lead to a win–win outcome for the supplier and the platform under certain conditions. Specifically, Figure 2a shows that with a small market size and a negative spillover effect, a moderate commission rate (high commission rate) can help firms achieve a win–win outcome under the agency mode (wholesale mode). On the one hand, owing to the stronger competitiveness on the online channel, the platform obtains the highest profit by designating a moderate commission rate. On the other hand, this mode can weaken the negative spillover effect and DMP and ultimately maximize the supplier's profit. In addition, since a high commission rate decreases the retail price and market demand, the wholesale mode improves the position of both firms. However, as the market size and/or spillover effect increase, the expanded demand in dual channels and the flexible pricing of the supplier benefit both firms; thus, only the agency mode can lead to the win–win outcome, as depicted in Figures 2b and 2e.

Interestingly, under conditions involving a positive spillover effect, the agency mode with a high commission rate can improve firms' position, as depicted in Figures 2c and 2e. The reason is that the prominent positive spillover effect expands market demand, and the supplier can flexibly set the retail price; thus, these benefits surpass the adverse effect of a high commission rate, even if the retail price is low. This result implies that under the agency mode, suppliers should adopt BT to disclose product information to achieve a positive spillover effect on the platform. For example, many firms and buyers can trace and track the creation information of the artwork process *via* BT. Moreover, platforms can establish a higher commission rate when they observe the adoption strategies used by suppliers.

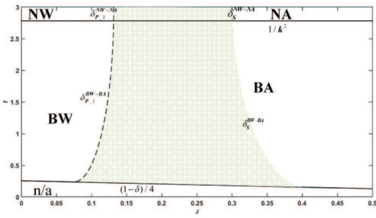
6. Consumer surplus

In this section, we analyze information-insensitive and information-sensitive consumer surpluses under different scenarios. Following Ha *et al.* [8], the consumer surplus is $\mathrm{CS}_j^z = \int_0^{q_j^{z*}} (p_j^z - p_j^{z*}) dq_j^z$, where $z = \{NW, NA, WB, AB\}$ and $j = \{1, 2\}$. We obtain the following results.

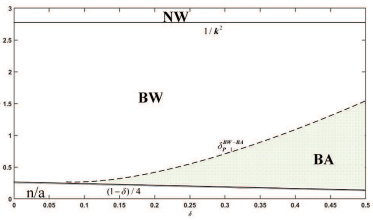
Corollary 5. (1) CS_1^z *increases with* λ*, whereas* CS_2^z *decreases with* λ. (2) *For information-insensitive consumers, a higher retail price decreases their welfare.*



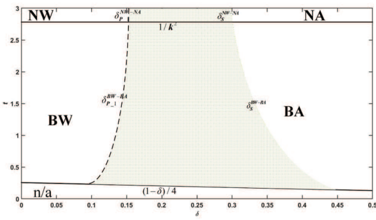
(a) $a = 3.5,\ \gamma = -0.85$



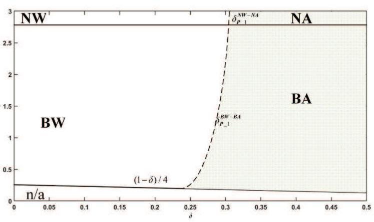
(b) $a = 3.5,\ \gamma = -0.5$



(c) $a = 3.5,\ \gamma = 0.5$



(d) $a = 10,\ \gamma = -0.85$



(e) $a = 10,\ \gamma = 0.5$

FIGURE 2. Equilibrium strategies of supply chain members. Notes. Shadow areas depict the win–win outcome between the supplier and the platform.

Corollary 5(1) reveals that the larger the information-insensitive (information-sensitive) consumer market is, the more welfare is derived by such consumers, thus implying that each consumer's payoff depends on the size of different consumer type groups. Thus, firms, including suppliers and platforms, should investigate the proportions of each consumer group in the market and establish a reasonable price and information disclosure level to improve consumer welfare. Essentially, as shown in Corollary 5(2), the surplus of information-insensitive consumers depends on the retail price because higher retail prices always decrease demand and further damage their welfare.

Proposition 6. *In equilibrium, a triple-win outcome for the supplier, the platform and information-insensitive consumers emerges in the following cases:* (1) *If* $t \in \left(\frac{1}{2}, \frac{1}{k^2}\right)$ *and* $\gamma \leq \gamma_1^{\mathrm{BW-BA}}$*, scenario BW can achieve the outcome.* (2) *If* $t \in \left(\frac{1}{2}, \frac{1}{k^2}\right)$ *and* $\gamma > \gamma_1^{\mathrm{BW-BA}}$*, scenario BA can achieve the outcome.*

Interestingly, BT adopted by the supplier benefits information-insensitive consumers under certain conditions. For example, if the disclosure cost coefficient of BT is moderate and the spillover effect is low, BT under the wholesale mode not only results in higher profits for firms but also creates additional welfare for such consumers. This situation leads to a triple-win situation for firms and such consumers. Similarly, as the spillover effect increases, the three parties under the agency mode benefit from BT. Thus, the effect of BT on pricing indirectly benefits information-insensitive consumers.

Proposition 7. *For information-sensitive consumers, we obtain the following results.* (1) *If* $a \le 6 + k^2$ *and* $\delta \in \left(\delta_{\mathrm{CS}}^{\mathrm{NW-NA}}, \frac{1}{2}\right]$, *when* $\gamma \in [-1, \gamma_{\mathrm{CS}}^{\mathrm{NW-NA}}]$, *then* $\mathrm{CS}_2^{\mathrm{NW}^*} \ge \mathrm{CS}_2^{\mathrm{NA}^*}$*; however,* $\mathrm{CS}_2^{\mathrm{NW}^*} < \mathrm{CS}_2^{\mathrm{NA}^*}$ *in other cases.* (2) *If* $a < \frac{1+6t}{t}$ *and* $\delta \in \left(\delta_{\mathrm{CS}}^{\mathrm{BW-BA}}, \frac{1}{2}\right]$, *when* $\gamma \in \left[-1, \gamma_{\mathrm{CS}}^{\mathrm{BW-BA}}\right]$, *then* $\mathrm{CS}_2^{\mathrm{BW}^*} \ge \mathrm{CS}_2^{\mathrm{BA}^*}$*. However,* $\mathrm{CS}_2^{\mathrm{BW}^*} < \mathrm{CS}_2^{\mathrm{BA}^*}$ *in other cases.* (3) *If* $t \in \left(\frac{1-\delta}{4}, \frac{1}{k^2}\right]$, $\mathrm{CS}_2^{\mathrm{NW}^*} \le \mathrm{CS}_2^{\mathrm{BW}^*}$ *and* $\mathrm{CS}_2^{\mathrm{NA}^*} \le \mathrm{CS}_2^{\mathrm{BA}^*}$*; otherwise,* $\mathrm{CS}_2^{\mathrm{NW}^*} > \mathrm{CS}_2^{\mathrm{BW}^*}$ *and* $\mathrm{CS}_2^{\mathrm{NA}^*} > \mathrm{CS}_2^{\mathrm{BA}^*}$.

Proposition 7 compares the surpluses of information-sensitive consumers across different scenarios. We observe that sales modes and BT adoption strategies can benefit such consumers depending on the market size, spillover effect, commission rate and disclosure cost coefficient of BT. Specifically, given a small market size, a high commission rate and a negative spillover effect, the wholesale mode is more beneficial for such consumers than the agency mode is. However, when the market size is large or the commission rate is low, such consumers benefit from the agency mode.

In contrast to conventional wisdom, a higher retail price improves the welfare of information-sensitive consumers. The rationale underlying this improvement is that the transparent and credible product information verified by BT helps such consumers understand product authenticity and improve product matching; these benefits compensate for losses in the premium price charged by firms and ultimately improve these consumers' welfare.

Furthermore, the welfare of information-sensitive consumers increases with their market size, and their demand dominates the total demand on the platform (see Cor. 4(2)). Hence, firms can expand their information-sensitive consumer base by disclosing additional credible information to improve their welfare. In combination with Figure 2, the proposition emphasizes the fact that the equilibrium strategies leading to a win–win outcome may further lead to a triple-win situation among the supplier, the platform and these consumers, thus implying that any equilibrium strategy is more beneficial for firms and information-sensitive consumers.

In summary, in Propositions 6 and 7, we reveal that when the information disclosure coefficient of BT is moderate, a multi-win outcome may be obtained among the supplier, the platform and the two types of consumers under scenarios BW or BA. This finding prompts the supplier to adopt BT appropriately to disclose more credible product information when the platform applies the second-mover advantage to choose an optimal sales mode, which is beneficial for supply chain members and consumers even when the information disclosure cost efficiency of BT is poor.

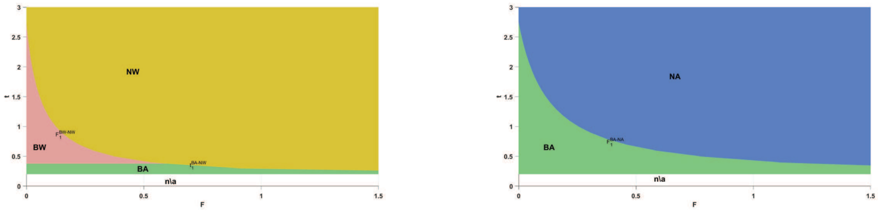
7. Extensions

We extend the baseline model in three ways. First, we explore the impact of a fixed BT adoption fee on the equilibrium strategy in further detail. Second, we change the time sequence of game events and further consider the case in which the supplier determines the sales mode. Third, instead of assuming that the retail price on the offline channel is fixed, we consider a variable offline retail price to verify the robustness of the results.

7.1. Fixed BT adoption fee

In the baseline model, we consider the information disclosure cost of BT. However, before BT is adopted, suppliers need to pay a large amount of money to deploy the necessary equipment, such as resource-enhanced devices, sensor devices, and cloud servers [48]. We assume that the fixed BT adoption fee is F. Then, we obtain the following proposition.

Proposition 8. *The fixed BT adoption fee reduces the supplier's profit; that is,* $\pi_S^{\mathrm{E1\_BW}} < \pi_S^{\mathrm{BW}}$ *and* $\pi_S^{\mathrm{E1\_BA}} < \pi_S^{\mathrm{BA}}$.



(a) $\gamma = -0.5$ **(b)** $\gamma = 0.5$

FIGURE 3. The highest supplier profit.

According to Proposition 10, the profit obtained by the supplier through BT adoption decreases once the fixed adoption fee increases, which reduces the supplier's willingness to adopt BT. In practice, many platforms and governments have recognized this problem in the initial stage of BT adoption. Accordingly, to expand BT application, Amazon.com provides free trial services and price discounts for BT products, and governments in China and the U.S. offer subsidy policies for those firms adopting BT.

Proposition 9. (1) *The supplier obtains the highest profit under scenario NW(BW) if* $\gamma \leq \gamma_1$, $t > t_1^{\mathrm{BA-NW}}$ *and* $F > F_1^{\mathrm{BW-NW}}$ ($F \leq F_1^{\mathrm{BW-NW}}$)*.* (2) *The supplier obtains the highest profit under scenario NA (BA) if* $\gamma > \gamma_1$ *and* $F > F_1^{\mathrm{BA-NA}}$ (*if* $\gamma \leq \gamma_1$ *and* $t \leq t_1^{\mathrm{BA-NW}}$ *or if* $\gamma > \gamma_1$ *and* $F \leq F_1^{\mathrm{BA-NA}}$)*.*

According to Proposition 9, BT adoption strategies and sales modes lead to the highest profit for the supplier. These results are depicted graphically in Figure 3, where $a = 10$ and $\delta = 0.1$. As shown in Figure 3a, if the spillover effect and the disclosure cost coefficient are low, the supplier adopts BT to maximize his profit under the agency mode, even if the fixed BT adoption fee is high. The reason is that more consumers will purchase products verified by BT from the platform; thus, the supplier is incentivized to charge a higher retail price to cover BT disclosure costs and fixed adoption fees. As the disclosure cost coefficient of BT increases, a higher wholesale price prevents some consumers from purchasing from the platform. Thus, the supplier benefits from the wholesale mode and earns the highest profit in both channels. However, the optimal BT adoption strategy for the supplier is related to the fixed BT adoption fee. Furthermore, if the spillover effect is strong, the supplier benefits from the agency mode because of higher marginal profits on the online channel and greater sales volume on the offline channel.

Although the fixed BT adoption fee reduces the supplier's profit and is detrimental to his willingness to adopt BT, the optimal BT adoption strategy under different sales modes is robust and remains valid, which is consistent with Proposition 5. The equilibrium strategies of supply chain members in this subsection are similar to those featured in the baseline model.

7.2. Supplier decision on sales mode

In the baseline model, we assume that the platform chooses the sales mode. In practice, some powerful suppliers, such as Nike and Yili, can choose the sales mode to sell products on e-commerce platforms. Moreover, Amazon.com offers third-party sellers the option to choose between the wholesale mode and the agency mode [49]. Thus, in this extension, we consider the time sequence in which suppliers decide the BT adoption strategy and the sales mode simultaneously.

The optimal BT adoption strategy of the supplier under different sales modes is consistent with that presented in Proposition 5. Intuitively, owing to the changed time sequence, the equilibrium strategies of supply chain members are the same as the optimal BT adoption strategies of the supplier. Thus, the equilibrium strategies hurt the platform but are always beneficial to the supplier. Nevertheless, the supplier and the platform still achieve a win–win outcome, although the area that indicates the outcome shrinks.

7.3. Alternative time sequence

In reality, compared with suppliers, platforms are characterized by enormous reach and a large number of consumers. Thus, we provide an alternative sequence of events in a multistage game. First, the platform chooses the wholesale selling mode or the agency selling mode, after which the supplier determines whether to adopt BT when observing the sales mode selection of the platform. Then, the pricing decision sequence is the same as that in Section 3.2. In equilibrium, BT adoption strategies, sales format selections, and equilibrium results leading to a win–win or multi-win outcome in this subsection are similar to those indicated in the baseline model.

Interestingly, analyzing the equilibrium results in the baseline model reveals that when the platform becomes the first mover, the win–win outcome area for firms and the multi-win outcome area for firms and consumers expand as a and γ increase. The rationale underlying this finding is that the DMP is moderated when the platform first chooses the agency format, and the supplier with pricing power can raise the retail price to increase the profit margin.

7.4. Variable offline retail price

The offline retail price is normalized to 1 in the baseline model. In practice, in addition to the online retail price, suppliers also determine the offline retail price. For example, Nike's distribution channel includes brick-and-mortar stores and e-commerce platforms such as Amazon, and it sets different retail prices for each channel. Therefore, without loss of generality, the offline retail price is p_o, which is a variable parameter because suppliers often set the retail price for consumers flexibly to promote products at brick-and-mortar stores.

The demand function for the offline channel under different scenarios is $q_o^{\mathrm{E3\_z}} = a - p_o + p^{\mathrm{E3\_z}}$. However, for the online channel, the demand function of information-insensitive consumers is $q_1^{\mathrm{E3\_z}} = \lambda a - p^{\mathrm{E3\_z}} + p_o$; the demand functions of information-sensitive consumers under scenarios NW and NA are $q_2^{\mathrm{E3\_NW/NA}} = (1-\lambda)a + kb^{\mathrm{E3\_NW/NA}} - p^{\mathrm{E3\_NW/NA}} + p_o$ and $q_2^{\mathrm{E3\_BW/BA}} = (1-\lambda)a + b^{\mathrm{E3\_BW/BA}} - p^{\mathrm{E3\_BW/BA}} + p_o$, respectively.

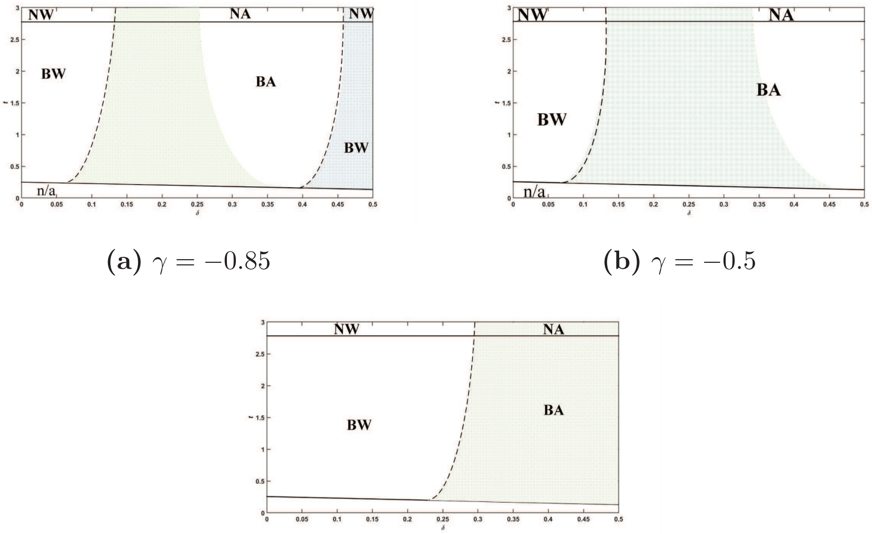
Proposition 10. *The optimal profits of supply chain members increase with p_o.*

According to Corollary 5, the increased offline retail price improves the positions of both the supplier and the platform. The reason underlying this result is that firms can set higher prices, including the wholesale price and the retail price, to earn higher profits on the platform. This result may explain the phenomenon whereby an expensive selling price at brick-and-mortar stores causes some consumers to transfer to the platform to purchase products. Therefore, platforms such as JD.com and Amazon.com earn higher profits by raising the retail price or obtaining more commission revenue, even when the offline channel and the platform are in a competitive relationship.

Proposition 11. $\pi_S^{\mathrm{E3\_z}} > \pi_S^{z}$ *and* $\pi_P^{\mathrm{E3\_z}} > \pi_P^{z}$ *when the supplier flexibly sets the offline retail price.*

According to Proposition 11, the supplier and the platform benefit from variable (rather than fixed) offline pricing. The rationale underlying this finding is related to Corollary 5; that is, the optimal profits of supply members under different scenarios increase with p_o. In particular, when the offline retail price is lower than the online retail price, more consumers purchase products from the offline channel, which incentivizes the platform to reduce the retail price or to provide premium BT traceability services to expand demand and increase revenue. In contrast, when the offline retail price is higher, more consumers purchase products from the platform, which can incentivize firms to adjust the online retail price with the goal of increasing marginal revenue. In practice, owing to low-level operational efficiency, expensive rent, etc., the offline retail price may be high, and many suppliers open offline showrooms to intensify product awareness. In this way, these suppliers may not only earn revenue from the offline channel but also drive incremental sales on the platform [50]. Hence, suppliers can flexibly set the offline retail price to improve performance of the whole supply chain.

Under conditions involving a variable offline retail price, we investigate the equilibrium strategies of supply chain members *via* numerical studies, where $a = 2$ and $p_o = 2$. As shown in Figure 4, the market size has no effect on the equilibrium results, and the win–win outcome between the platform and the supplier is robust.



(a) $\gamma = -0.85$ **(b)** $\gamma = -0.5$

(c) $\gamma = 0.5$

FIGURE 4. Equilibrium strategies of supply chain members. Notes. Shadow areas depict the win–win outcome between the supplier and the platform.

Importantly, the shaded area expands in this subsection. Therefore, a variable offline retail price has a positive influence on the equilibrium strategies of supply chain members.

8. Conclusions

This work considers a supply chain that consists of a supplier and an e-commerce platform, in which context, in addition to the offline channel, the supplier sells products through a platform that operates under either the wholesale mode or the agency mode. Owing to the issue of product information credibility, we examine the supplier's decisions on information disclosure level and pricing in the scenario with or without BT. We investigate the optimal BT adoption strategy of the supplier, the optimal sales mode choice of the platform, and the equilibrium strategy interaction between the two parties. Our study explores the influence of various important factors on strategy interaction, and we analyze the disclosure level and consumer surplus in equilibrium strategies. We derive important managerial implications of our findings below.

First, the supplier that adopts BT benefits from both sales modes, a situation that is related to the spillover effect, commission rate, disclosure cost coefficient of BT, and market size. In the context of a high disclosure cost coefficient and a negative spillover effect, the supplier should leverage BT to improve information credibility under the agency mode but should also disclose less verified product information to save on disclosure costs. For example, suppliers, such as Heidi and Kering Group, share only easy-to-analyze product data metrics (*e.g.*, environmental metrics, product greenhouse degree and quality) with consumers. Furthermore, owing to the prominent positive spillover effect, a larger market size on the platform weakens dual-channel competition; thus, the supplier should adopt BT to disclose less product information and set a higher retail price to obtain the highest profit under this mode. In contrast, excellent disclosure cost efficiency of BT (*i.e.*, low disclosure cost coefficient) encourages the supplier to implement BT under the wholesale mode, thus requiring the supplier to disclose more verified information and to set a higher wholesale price to dampen the negative spillover effect. Therefore, regardless of the low or high disclosure cost of BT, suppliers with dual channels can use BT to improve information credibility under both sales modes, but they should recognize that less disclosure of credible information is a better choice under the agency mode because of the lower profit margin. Importantly, suppliers should be aware of the fact that adopting BT is not always an optimal strategy, even if the disclosure cost efficiency is excellent; instead, they can reexamine the interactions between BT adoption strategies and sales modes on the basis of various important market factors.

Second, under conditions involving a negative spillover effect and excellent disclosure cost efficiency of BT, a higher commission rate damages the platform, but a moderate commission rate enables the platform to maximize revenue. As a result, when the commission rate is low or high, the platform should choose the wholesale mode to resell products. Furthermore, after observing that the supplier uses BT to verify information, the platform can respond to the positive spillover effect by lowering the retail price, which improves online sales and may diminish the DMP. However, under conditions involving a negative spillover effect, the platform should increase the retail price to obtain the highest profit. These results imply that the platform can choose different sales modes and set different retail prices to reap greater payoffs from a specific spillover effect. For example, by targeting products with a negative spillover effect, Amazon and JD.com provide BT traceability services to sellers under the wholesale mode. Therefore, e-commerce platforms should recognize that owing to the influence of the spillover effect and the BT adoption strategy, a higher commission rate may negatively affect their payoffs. Moreover, after observing the spillover effect feature of products, platforms can encourage suppliers to either adopt or not adopt BT to maximize their profits by designing a commission mechanism.

Third, a larger product market size and positive spillover effect improve the situation of both firms under the agency mode compared with the wholesale mode. Furthermore, in the presence of information-sensitive consumers, the agency mode leads to a triple-win outcome that increases profits for both the supplier and the platform and improves consumer welfare. Under certain conditions, both firms and consumers can benefit from BT, thereby indirectly ensuring the stable channel operations of suppliers and directly promoting the sustainable development of the supply chain. Consequently, to achieve multi-win situations, firms should develop a clear understanding of critical parameters such as product market size, consumer types, spillover effects, and BT-related disclosure costs to inform their choices of BT adoption strategies and sales modes. Illustratively, firms such as Idealo invest heavily in research on consumer preferences regarding information authenticity and transparency. Crucially, cross-channel suppliers need a profound understanding of how offline retail pricing shapes the payoffs for supply chain members.

Our research offers important managerial insights for platform businesses. High-end luxury products on online platforms may exhibit a "negative spillover effect" because the offline experience of these products weakens the impulse for online purchases. These online platforms should adopt the wholesale mode and proactively strengthen BT collaboration with suppliers to achieve mutual benefits. Furthermore, our research provides practical guidance for suppliers on platforms under the agency mode. When an emerging cosmetic brand opens a store on Tmall and uses BT to verify product information, it does not need to disclose every detail, such as by ensuring full ingredient traceability or entirely clear production processes. Instead, it can selectively disclose the most critical and easily verifiable information, such as organic or cruelty-free certifications. In this way, BT can build foundational trust for consumers while minimizing information disclosure costs, thereby ultimately maximizing profit for both suppliers and platforms under the agency mode.

This work has several limitations that suggest directions for future research. First, in practice, many firms sell products through different channels, such as brick-and-mortar stores, direct channels (*e.g.*, official websites), and e-commerce platforms. We can further consider several factors, such as consumer preference for different channels, and explore how firms decide on BT adoption strategies and information disclosure levels in these channels. Second, in reality, consumers are sensitive to the selling price and the information disclosure levels of both platform channels and brick-and-mortar stores; future research can thus investigate how consumers choose sales channels in the context of spillover effects. Finally, while our model assumes that blockchain adoption fully resolves consumer trust issues, future research should relax this assumption by dividing consumers into multiple categories to examine corporate strategies in scenarios in which distrust persists.

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Data availability statement

No new data/codes were created or analyzed in this study.

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