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RESEARCH PAPER

How does consumer quality preference impact blockchain adoption in supply chains?

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Abstract

Blockchain technology is increasingly used to ensure the authenticity of product information in supply chains. As digital transparency becomes a key factor in modern commerce, the evaluation of blockchain's value becomes important. In this paper, we model a supply chain with a manufacturer and an online retailer to study the role of blockchain in the marketplace and wholesale price models. Particularly, we take consumer quality preference into account and examine its impact on blockchain adoption. We discuss how blockchain ensures the authenticity of quality information shared between the manufacturer and retailer while improving consumers' perceived product value. Our findings indicate that blockchain enhances information transparency and reduces the impact of commissions on pricing in the wholesale price model, which is beneficial to both the manufacturer and the retailer. This is significantly advantageous when quality-conscious consumers dominate the marketplace model. We recommend that the manufacturer and retailer should assess consumer preferences for product quality and carefully weigh the cost of implementing blockchain. Blockchain reduces constraints from commission-driven pricing, offering greater flexibility in business model selection. Additionally, transparency improvements are crucial when implementing blockchain in the marketplace model.

Keywords Blockchain · Marketplace model · Wholesale price model · Quality preference

JEL Classifications C7 · L8 · M31

Introduction

Trust in product quality affects both cooperation among supply chain members and consumer purchasing decisions (Treiblmaier & Garaus, 2023; Fan et al., 2024). However, traditional quality inspection methods, such as process control and survey sampling, often struggle to thoroughly ensure product quality (Witt & Schoop, 2023; Liu et al., 2023). Consumers also sometimes find it difficult to understand the true quality of products, especially those sourced globally (Li et al., 2023). Consequently, blockchain has become a solution to increase information transparency in supply chains (Bons et al., 2020; Ying et al., 2023; Gramlich et al., 2023). Retailers, positioned between upstream manufacturers and downstream consumers, have become the most active in adopting this disruptive technology. For example, Walmart partners with IBM Food Trust, a blockchain provider, to trace food origins and monitor supply chains.[1] Likewise, JD.com offers blockchain services to manufacturers for product quality certification.[2]

The quality information disclosure empowered by blockchain can resolve trust issues in the supply chain, as indicated by prior research (Choi & Luo, 2019; Beck et al., 2023). However, other studies have found that consumer awareness of blockchain technology is quite limited (Liu et al., 2022; Xu & He, 2022; Shen et al., 2022), especially when product quality is not a primary concern, resulting in reduced effectiveness in its adoption. Considering the high cost of implementing blockchain (Kumar et al., 2020), it is critical

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[1] Supply Chain Intelligence Suite: Food Trust. Available at https://www.ibm.com/products/supply-chain-intelligence-suite/food-trust, accessed on September 5, 2023.

[2] JD Launches Blockchain Open Platform. Available at https://jdcorporateblog.com/jd-launches-blockchain-open-platform/, accessed on November 20, 2023.

to evaluate whether the benefits it brings to supply chain operations are truly significant. This naturally leads to our first research question. How can blockchain be leveraged to create intrinsic value and improve supply chain profitability?

Previous studies have indicated that blockchain can reduce distrust between supply chain members, such as when retailers rely on manufacturers adopting blockchain to guarantee product quality (Qiao et al., 2023; Wang et al., 2021). This is undoubtedly a key benefit of blockchain. Additionally, earlier studies have highlighted blockchain's role in fostering greater consumer trust in products sold by retailers (Xu et al., 2023a; Choi, 2019), thereby influencing their purchasing decisions. However, no research has explored blockchain's value in both the production and retail stages simultaneously. We propose that blockchain not only improves production transparency but also boosts consumer trust in product quality. Then, our second research question comes out. How does blockchain influence supply chain decision-making when considering its role in different relationships? In this paper, we focus on the relationship between the manufacturer and the retailer and also between the product and consumers.

Additionally, surveys show that consumer perceptions of blockchain's value are diverse (Pun et al., 2021; Liu et al., 2023). However, previous studies mainly model consumer heterogeneity as binary, either opting for blockchain-enhanced products or not. In this paper, we extend the model by introducing a new perspective on heterogeneity, recognizing that even among those who purchase blockchain-enhanced products, attitudes towards blockchain differ. Lastly, we consider a potential downside of blockchain, called consumer privacy concerns, to further validate the robustness of our findings.

To answer the above questions, we model a supply chain comprising a manufacturer and an online retailer. We first consider the benchmark case where blockchain is not adopted and then introduce blockchain into our model. Since there are currently two popular business models in online retail, thus in each case, we consider both the *wholesale price* and the *marketplace* models. In the wholesale price model, the retailer buys products directly from the manufacturer at a wholesale price and sells them to consumers at a retail price. In the marketplace model, the retailer serves as a platform that connects the manufacturer with customers and earns a commission from the manufacturer. Following an analysis of the manufacturer's and retailer's optimal pricing decisions and profits, we examine the value of blockchain technology under each business model and the optimal strategy for business model selection.

We derive several key findings. First, under the wholesale price model, blockchain enhances manufacturer profitability by targeting quality-conscious consumers, while under the marketplace model, both the manufacturer and the retailer can benefit from blockchain when such consumers dominate the market, despite the adoption costs. Interestingly, as the perceived benefits of blockchain improve, the required proportion of quality-conscious consumers for achieving profitability decreases. Second, without blockchain, prices are higher under the wholesale price model if commissions are high. However, blockchain reduces the influence of commissions, keeping prices high regardless of commission levels and allowing both parties to eliminate the impact of commissions on pricing. Third, the wholesale price model offers greater product transparency than the marketplace model, though this gap narrows with higher commissions and production costs. Lastly, results from extended models confirm the robustness of these findings.

We make three contributions in this paper. First, to the best of our knowledge, we are the first to investigate the choice of business models in the supply chain, particularly focusing on blockchain adoption led by an online retailer. Specifically, Xu and Choi (2021); Fang et al. (2024), and our paper all study the impact of blockchain on the choice of business model. However, in their models, blockchain is implemented by the manufacturer, whereas we propose that the retailer is responsible for launching blockchain, as observed in practice. Consequently, we derive different insights regarding the impact of commissions on business model choice when using blockchain. Second, we derive some counter-intuitive and intriguing results, which challenge early studies. For example, both the manufacturer and retailer can raise prices without hurting profits, which contrasts (Zhang et al., 2022). Third, our conclusions complement current research results on how to employ blockchain to increase consumers' utility in purchasing products and thus make profits. We discover that blockchain adoption can lead to a *sales improvement effect*, particularly beneficial for the retailer. This finding suggests that the retailer is more likely to choose to take on a "reseller" role.

We organize the remainder of the paper as follows. In "Literature review," we review related works, compare our findings with those of others, and identify research gaps. In "Models and equilibrium," we describe the problem and develop the basic models. In "Value of blockchain" and "Choice of supply chain structure," we analyze the models and make extensive comparisons. In "Extensions," we consider model extensions. Finally, in "Conclusion," we conclude the paper and suggest directions for future research. We provide proofs for all results and supplementary information in the Supplementary material.

Literature review

Recent research has extensively explored the value of blockchain in supply chains. For example, Wang et al. (2021) delved into the practical implications of blockchain technology for supply chains. Van Nguyen et al. (2023) conducted a comprehensive review of blockchain applications in supply chain management. They suggest that future research on the integration of blockchain and supply chains should focus on its environmental and social impacts. This conclusion aligns with the findings in Liu et al. (2023), who argued that while blockchain presents opportunities for the development of green products, its adoption in green product supply chains is not necessarily profitable and depends on many other factors, such as product characteristics. Liu et al. (2022) developed analytical models to illustrate the strategies for tracing food information with blockchain, while Casino et al. (2021) used a case study approach to develop an information traceability framework for the food supply chain. Beyond these, the role of blockchain in different supply chains has been investigated, including the pharmaceutical (Ghadge et al., 2023), automotive (Reddy et al., 2021), fashion (Choi, 2023), vaccine (Liu et al., 2024), and business value (Witt & Schoop, 2023) sectors.

Although blockchain has shown many advantages, such as improving information transparency, enhancing consumer trust, and reducing product quality risks, the evaluation of this cutting-edge technology is not complete, especially when involving heterogeneous consumers in the market. This study explores a general supply chain system comprising the manufacturer, retailer, and consumers, with a focus on two business models: marketplace and wholesale price. Both of the business models are prevalent and widely observed in practice, and some related works have explored their impacts on blockchain adoption. For example, Xu and Choi (2021) focused on the cross-channel effect between offline and online platforms. They argued that blockchain always benefits the online platform under the agency mode but may reduce its profitability under the reselling mode. This finding contrasts with Xu et al. (2023a), who argued that blockchain can enhance profitability in both the marketplace and reselling modes, provided the network effect is low. Xu et al. (2023a) also introduced the network effect as a key determinant, suggesting that blockchain promotes greener products and supply chain coordination, a point that Xu and Choi (2021) do not consider, as they emphasized the interplay between cross-channel effects and platform power. Ma and Hu (2022), on the other hand, took a broader perspective and examined blockchain's impact on economic, social, and environmental performance. They introduced the brand premium effect and argued that blockchain enhances consumer trust, leading to higher prices, especially when the brand effect dominates demand. This stands in contrast to Xu and Choi (2021), who highlighted that blockchain's profitability is highly sensitive to cross-channel dynamics rather than brand perception. Furthermore, Xu et al. (2023b) suggested that blockchain can facilitate supply chain coordination across the manufacturer, third-party firm, and online platform, but only under specific contractual arrangements. This contrasts with Xu and Choi (2021), who focused on blockchain's varying impacts depending on the sales mode, and with Ma and Hu (2022), who emphasized its broader strategic value for enhancing brand trust and ESE performance.

In addition, the benefits of blockchain in a competitive market environment have been examined. Numerous studies have explored how blockchain adoption influences the competitive landscape. For example, by using an analytical model, Naoum-Sawaya et al. (2023) contradicted others by questioning the financial benefits of blockchain, particularly highlighting that its adoption may not always be advantageous for manufacturers due to high costs. This contrasts with the conclusions in Tan (2022) and Zhu et al. (2023), which suggest that blockchain generally improves competitiveness, whether through consumer-to-consumer trading or supply chain transparency. However, Tan (2022) and Zhang et al. (2022) are aligned on the point that blockchain's value depends on consumer behavior. Both emphasize that blockchain adoption can be beneficial only when transparency outweighs concerns—whether in virtual goods resale, as indicated by Tan (2022), or retail environments, as indicated by Zhang et al. (2022). Both recognize the importance of managing privacy risks and consumer trust for blockchain to confer a competitive advantage.

Based on the above review, we identify the following research gaps. First, while previous studies have examined the value of blockchain in various business models, they predominantly assume that the manufacturer leads its implementation. This perspective overlooks scenarios where the retailer provides blockchain services, a practice increasingly observed in real-world settings. Therefore, our paper investigates retailer-led blockchain implementation and its implications for both the manufacturer-retailer relationship and the product-consumer interaction. Second, prior research often ignores the diversity of consumer segments, which may lead to an overestimation of blockchain's overall value as not all consumers are sensitive to product quality. To bridge this gap, we consider both quality-conscious and quality-indifferent consumers in the market, enabling a more nuanced assessment of blockchain's impact. Third, even among quality-conscious consumers, there is significant heterogeneity in how individuals value the additional benefits brought by blockchain. Existing studies rarely consider this variation. Our paper incorporates this aspect, exploring how differing valuations influence consumer behavior and, consequently, the overall effectiveness of blockchain adoption.

Models and equilibrium

This section outlines the model setup and the sequence of events. We derive the equilibrium results for each business

Table 1 Main notations

Variable	Explanation
v	Consumers' perceived value for the product
q	The announced quality of the product
w	Wholesale price of the product
p	Retail price of the product
b	Information transparency level driven by blockchain
θ	Marginal perception of extra benefit brought by blockchain adoption
α	Proportion of quality-conscious consumers in the market
c	The production cost
k	The cost coefficient of adoption blockchain
s	The manufacturer's unit cost of using blockchain
t	The penalty charged by the retailer for unqualified products
μ	Probability that the retailer detects quality fraud
λ	The commission charged by the retailer under the marketplace model
β	The increase in consumers' perceived value due to blockchain adoption
h	Privacy hassle due to blockchain adoption
D_i	The demand of $i, i = r, m$
π_i	The profit of $i, i = r, m$
Superscript	**Explanation**
B	The case with blockchain adoption
N	The case without blockchain adoption
WB	The case of the wholesale price model with blockchain
WN	The case of the wholesale price model without blockchain
MB	The case of the marketplace model with blockchain
MN	The case of the marketplace model without blockchain
T	The case of considering consumer privacy concern
H	The case of considering heterogeneous θ in blockchain adoption

model, shown in Table A1 (see Supplementary material). Table 1 provides the notations used in this paper.

Model setup

We consider a manufacturer, an online retailer, and consumers in the supply chain. The product is produced by the manufacturer and sold by the retailer. The business model (*wholesale price* or *marketplace*) is determined by the retailer because it has significantly stronger market power than the manufacturer. In particular, the retailer provides blockchain for product quality certification, such as tracing the authenticity of products. For example, JD.com, as a retailer, has offered blockchain to assist in verifying product quality information along the supply chain. By adopting blockchain, product information becomes transparent and trustworthy, which eliminates the concerns about product quality among both the retailer and consumers. In this paper, the role of blockchain is to record production information. Specifically, with the use of blockchain, consumers can gain more knowledge about the product, increasing their perceived value (this will be discussed in detail in "Consumer utility"). Additionally, retailers develop greater trust in the quality of the products provided by manufacturers, which transforms the quality inspection mechanisms for online retailers.

Normally, the manufacturer produces the product with quality q. To focus on the impact of blockchain on the supply chain, we assume that the quality q is fixed, which is in line with early studies, such as Pun et al. (2021) and Shen et al. (2022). To acquire blockchain-enhanced product information disclosure, the retailer charges a technology cost s from the manufacturer for each product sold. Traditionally, without blockchain, the product quality information between the retailer and the manufacturer is asymmetric. Thus, the retailer would conduct a quality inspection for quality management and to avoid false disclosures. This is a tedious process and a risk of selling products that do not meet quality standards. For example, JD.com introduced the *merchant violation management rules* to impose penalties on merchants who sell substandard products on its platform.[3] This conven-

[3] JD.com Quality Management. Available at https://about.jd.com/compliancechild?name=api2, accessed on August 8, 2023.

tional approach can be modeled as follows. A quality penalty t is levied against the manufacturer for every substandard product, and there is a probability of μ that the retailer will identify instances of substandard products.

In the case of using blockchain, the manufacturer can verify product quality through blockchain, incurring a unit cost c, which ensures the authenticity and reliability of quality information. Consequently, the quality management mechanisms mentioned in the supply chain are no longer necessary.

Consumer utility

A direct benefit of blockchain adoption for consumers is the level of information disclosure, denoted as b. This is because blockchain technology effectively addresses consumer concerns regarding counterfeit goods and substandard quality, thereby augmenting the utility they obtain from their purchases (Choi, 2019; Cai et al., 2021). However, heterogeneous consumers have various attitudes towards the role of blockchain. On the one hand, consumers can enjoy the added benefits of blockchain by confirming the quality when they buy the product. For example, they can scan the QR code attached to the product and learn about the authentic product information. On the other hand, consumers may overlook the effectiveness of blockchain and view the blockchain-enhanced product as a regular one, i.e., blockchain does not improve their utility. For example, if consumers are indifferent to product quality, then blockchain is useless.

In this paper, we consider two segments of consumers in the market, which are called *quality-conscious* and *quality-indifferent* consumers, respectively. We denote the proportion of quality-conscious consumers as α, who recognize the product quality confirmed by blockchain; thus, the proportion of quality-indifferent consumers is $1-\alpha$, who are indifferent to product quality and ignore the benefits of blockchain. This assumption is in line with practice. In addition, normalizing exogenous consumer segments helps us uncover its effect on the manufacturer's and the retailer's decisions. Moreover, it reflects reality in a rational manner within our online retailing framework because consumers' top reason for using blockchain is the ability to understand product quality immediately. Since the segmentation of consumers is exogenous, the emergence of blockchain does not alter consumers' concerns regarding quality. While blockchain enhances the perceived value of products for quality-sensitive consumers, it holds little significance for those who are not quality-sensitive. The exogenous setting also allows for identifying the sales improvement effect due to blockchain adoption. This assumption aligns with early studies such as Sun and Ji (2022) and Liu et al. (2023). In addition, consumers' attitudes towards using blockchain are their private information, and the retailer cannot discriminate against consumers by identifying consumer type. This assumption allows the retailer to charge a flat price to all the consumers.

The consumers are heterogeneous in their valuation of the product quality q. We use v to denote a consumer's valuation, which follows the uniform distribution between zero and one, i.e., $v \sim U[0,1]$, with the probability density function $f(v)=1$. Finally, the number of consumers can be normalized to one and each consumer makes a unit purchase.

Market demand

As discussed above, quality-conscious consumers will buy the product if their net utility $U_c = vq + \theta b - p$ is non-negative, where θ denotes the marginal perception of extra benefit brought by blockchain adoption. To focus on analyzing the value of blockchain adoption, we first assume that all quality-conscious consumers perceive the extra benefit brought by using blockchain as the same. In "Extensions," we will consider a more realistic case where quality-conscious consumers are heterogeneous in θ. As a result, the marginal valuation between purchasing and not purchasing the product is $\widetilde{v}_c = \frac{p-\theta b}{q}$, and the corresponding market demand is given as follows:

$$D_c = (1 - \frac{p-\theta b}{q})\alpha. \tag{1}$$

For quality-indifferent consumers, they will purchase the product if their net utility $U_i = vq - p$ is non-negative. Thus, the marginal valuation between purchasing and not purchasing the product is $\widetilde{v}_i = \frac{p}{q}$, and the corresponding market demand is as follows:

$$D_i = (1 - \frac{p}{q})(1-\alpha). \tag{2}$$

Then, we know the total demand of the product is as follows:

$$D_t = D_c + D_i = \frac{q - p + \theta b \alpha}{q}. \tag{3}$$

One of the benefits of blockchain adoption, as seen in D_t, is the increase in sales driven by consumers' greater trust in product quality and increased value due to blockchain transparency.

Timeline of events

In this paper, we consider two business models. The wholesale price model involves the manufacturer selling products to a retailer at a fixed wholesale price, and the retailer determines the final price for consumers. The manufacturer has no control over the retail price. In contrast, the marketplace model allows the manufacturer to sell directly to consumers through the retailer's platform, with the retailer taking a commission.

Under the wholesale price model, the manufacturer announces the product quality at the beginning, and then the retailer sets the penalty t for quality fraud. When blockchain is adopted, the retailer determines the unit cost of using blockchain. Next, the manufacturer sells the product to the retailer at the wholesale price w, while the retailer resells the product to consumers at the retail price p. The retailer provides blockchain and decides on production information disclosure b.

Under the marketplace model, the manufacturer determines the retail price and sells the product on the platform provided by the retailer. The manufacturer is charged a proportion (denoted by λ) of revenue by the retailer as a commission, which is assumed to be exogenous. This makes sense as the platform will commit to a commission rate before negotiating channel agreements with the manufacturer. More arguments about this assumption can be found in Li et al. (2021) and Ha et al. (2022b).

Figure 1 presents the timeline of events under two business models.

Benchmark: Without blockchain

In the benchmark, we consider the case where blockchain is not adopted (denoted by the superscript N). Consumers will purchase the product if their net utility $U^N = vq - p$ is nonnegative. Then, it is straightforward to know that the market demand is $D^N = 1 - p/q$. Here, the retailer will implement a quality inspection mechanism to prevent potential quality fraud from the manufacturer.

Under the wholesale price model without blockchain (denoted by the superscript WN), the manufacturer's profit and the retailer's profit are as follows:

$$\text{Max } \pi_m^{WN}(w^{WN}) = (w^{WN} - c - \mu t)D^N, \tag{4}$$

$$\text{Max } \pi_r^{WN}(p^{WN}) = (p^{WN} - w^{WN} + \mu t)D^N. \tag{5}$$

Under the marketplace model without blockchain (denoted by the superscript MN), the retailer charges a commission from the manufacturer. The manufacturer's profit and the retailer's profit are as follows:

$$\text{Max } \pi_m^{MN}(p^{MN}) = [(1-\lambda)p^{MN} - c - \mu t]D^N, \tag{6}$$

$$\text{Max } \pi_r^{MN} = (\lambda p^{MN} + \mu t)D^N. \tag{7}$$

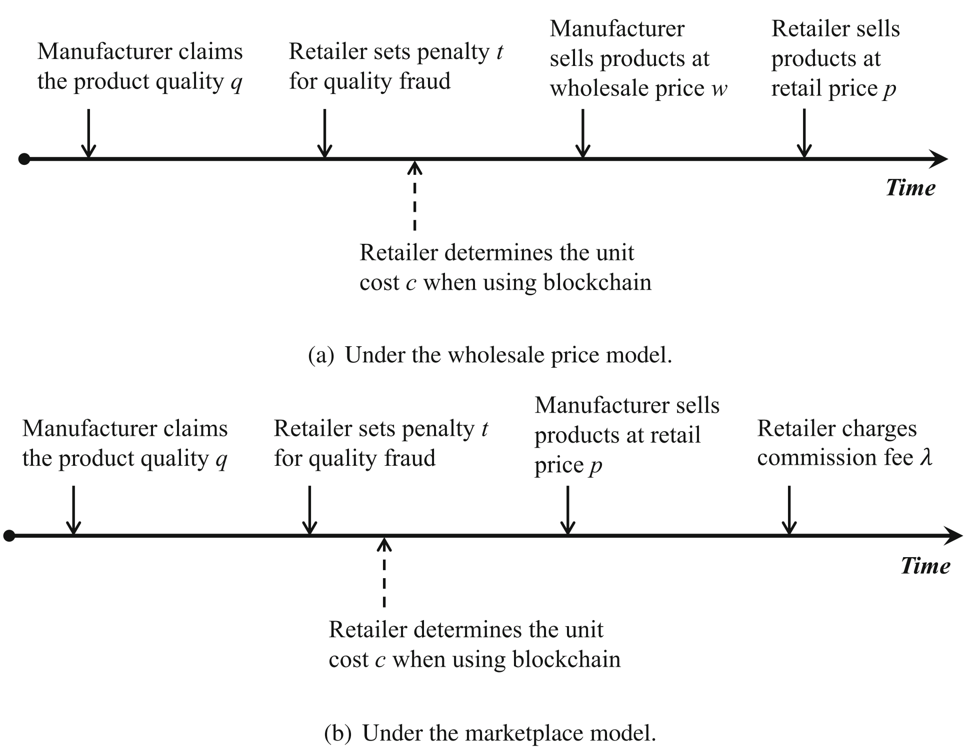


Fig. 1 Timeline of events under two business models

With blockchain

When blockchain is adopted, the manufacturer pays the retailer a unit cost of using blockchain.

Under the wholesale price model with blockchain (denoted by the superscript WB), the manufacturer's profit and the retailer's profit are as follows:

$$\text{Max } \pi_m^{WB}(w^{WB}) = (w^{WB} - c - s)D_t^B, \quad (8)$$

$$\text{Max } \pi_r^{WB}(p^{WB}, b^{WB}) = (p^{WB} - w^{WB} + s)D_t^B - kb^{WB^2}. \quad (9)$$

Under the marketplace model with blockchain (denoted by the superscript MB), the manufacturer's profit and the retailer's profit are as follows:

$$\text{Max } \pi_m^{MB}(p^{MB}) = [(1-\lambda)p^{MB} - c - s]D_t^B, \quad (10)$$

$$\text{Max } \pi_r^{MB}(b^{MB}) = (\lambda p^{MB} + s)D_t^B - kb^{MB^2}. \quad (11)$$

Equilibrium results

We summarize all the equilibrium results in Table A1 (see Supplementary material). It shows that the blockchain adoption strategy is quite different under different business models. We summarize the results as follows.

Lemma 1 *(i) Under the wholesale price model, the supply chain adopts blockchain only when the product quality is high, i.e.,* $b^{WB*} > 0$ *when* $q > c$. *(ii) Under the marketplace model, the supply chain inevitably adopts blockchain, i.e.,* $b^{MB*} > 0$ *necessarily holds.*

Lemma 1 indicates that under the wholesale price model, when the product quality is inadequate or the production cost is excessively high, neither the manufacturer nor the retailer utilizes blockchain technology. Under the marketplace model, the manufacturer and the retailer will use blockchain to make supply chain information more transparent. The reason behind this could be that the entity selling the product is different in the two business models. Consumers have different trust in products sold by the manufacturer and by the retailer (platform), as indicated by Abhishek et al. (2016); Tian et al. (2018), and Ha et al. (2022a), leading to different blockchain adoption strategies under different business models. Under the wholesale price model, the platform sells the product to consumers. In this case, we find that blockchain is not necessary. This is because the platform, as a sophisticated retailer, is more likely to gain consumer trust (Abhishek et al., 2016; Tian et al., 2018; Xu et al., 2023a). As a result, the supply chain is less motivated to use blockchain.

We will continue to analyze the value of blockchain in eliminating information asymmetry in "Value of blockchain." To focus on that, we impose that blockchain is used in both business models, i.e., $q > c$.

Value of blockchain

This section elucidates the advantages of using blockchain under each business model. We demonstrate, in an intriguing manner, that the utility of blockchain technology differs across business models. Specifically, the wholesale price model benefits the supply chain with blockchain technology. However, blockchain is not an effective tool for making the supply chain more profitable under the marketplace model. We summarize these findings as follows.

Proposition 1 (Wholesale price model)
The supply chain necessarily benefits from blockchain adoption under the wholesale price model, i.e., $w^{WB*} > w^{WN*}$, $p^{WB*} > p^{WN*}$, $\pi_m^{WB*} > \pi_m^{WN*}$, *and* $\pi_r^{WB*} > \pi_r^{WN*}$.

Our results contrast with Zhang et al. (2022), who believe that blockchain adoption reduces the retailer's price and profit. We have the following explanation for this difference. Zhang et al. (2022) assume that consumers are concerned about personal information leakage via using blockchain, thereby reducing demand. However, based on our analysis, we find a sales improvement effect arising from added values facilitated by blockchain in product purchases. In addition, the results in Proposition 1 have been observed in practice. For instance, JD.com found that the implementation of a blockchain-driven anti-counterfeit traceability system has increased the sales of nourishing items by 29.40%.[4]

With blockchain, both the manufacturer and the retailer can increase the price without hurting their profits. This is due to the advantages associated with blockchain, particularly the sales improvement effect. The logic behind this effect is that blockchain adoption leads to a higher price. However, why are both the higher wholesale price and retail price acceptable? For the supply chain members, the conventional quality assurance contracts are replaced by blockchain, which enhances information transmission efficiency. As a result, the retailer accepts the higher wholesale price because it can also raise the retail price, benefiting from the increased

[4] JD Blockchain traceability data is disclosed for the first time! Traceable product sales increased by nearly 30%. Available at https://blocking.net/jd-blockchain-traceability-data-is-disclosed-for-the-first-time-traceable-product-sales-increase-by-nearly-30.html, accessed on August 14, 2023.

sales. In addition, blockchain reduces production and operational costs, partially offsetting the impact of price increases and indirectly boosting profits. For the manufacturer, the cost of using blockchain is passed on to the wholesale price, resulting in a higher wholesale price.

We show that the increased price does not hurt the profit. From the perspective of consumers, blockchain offers assurance regarding product quality, thereby fostering greater trust. The transparency and immutability of blockchain enable consumers to trace the product's information and origin, confirming its quality and authenticity. Consequently, consumers may be more willing to pay a higher price when they are aware of enhanced assurance of product quality. Furthermore, blockchain positively impacts the firm's brand value, which in turn becomes evident in product pricing.

Proposition 2 (Marketplace model)
(i) For any given $s \in (s_1, t\mu]$, the price is higher with blockchain than that without blockchain, i.e., $p^{MB*} > p^{MN*}$;

(ii) For any given $s \in (0, t\mu]$, if $\alpha > \alpha_1$, the manufacturer benefits from adopting blockchain, i.e., $\pi_m^{MB*} - \pi_m^{MN*} > 0$;

(iii) For any given $s \in (0, t\mu]$, if $\alpha > \alpha_2$, the retailer benefits from adopting blockchain, i.e., $\pi_r^{MB*} - \pi_r^{MN*} > 0$;

(iv) Fewer quality-conscious consumer base does not mean that the value of the blockchain is necessarily limited, i.e., $\frac{\partial \alpha_1}{\partial \theta} < 0$ and $\frac{\partial \alpha_2}{\partial \theta} < 0$.

Proposition 2 underscores the advantages of using blockchain under the marketplace model, suggesting that blockchain yields greater benefits for the manufacturer and retailer in specific conditions. First, it is shown that if the cost of blockchain is high, i.e., $s > s_1$, the manufacturer will increase the price. However, when the cost of adopting blockchain is low, the benefits offset its expenses. In this case, it is interesting to find that the manufacturer decreases the price. This is because the platform typically serves as an intermediary, connecting the manufacturer with consumers. When the cost of blockchain is low, the manufacturer can enhance transparency and efficiency, thereby reducing its transaction costs with the platform, allowing it to lower the price. Furthermore, the information recorded by blockchain ensures its authenticity, allowing both the retailer and consumers to trust the actual product quality. Without blockchain, the manufacturer may rely on the information advantage to adopt high-pricing strategies due to limited consumer understanding of product quality. Therefore, the effect of increased consumers' value of purchasing the product driven by blockchain is likely to reduce the price.

Interestingly, we find that if the quality-conscious consumer base is high, both the retailer and manufacturer can benefit from blockchain adoption, even with a high adoption cost. The introduction of blockchain does not necessarily enhance the overall effectiveness of the supply chain, particularly when consumers pay less attention to product quality. If consumers are content with the minimum quality standard, then the transparency offered by blockchain may not significantly influence their purchasing decisions. Therefore, the potential role of blockchain to enhance trust in the supply chain may be limited, especially when faced with quality issues, as consumer disregard for low quality does not imply it won't pose potential problems. This perspective suggests that the actual utility of blockchain remains contingent on consumer demand for quality information. So, how can the manufacturer and retailer benefit from blockchain?

We show that a larger θ lowers the threshold for the proportion of quality-conscious consumers to make blockchain adoption profitable, i.e., $\frac{\partial \alpha_1}{\partial \theta} < 0$ and $\frac{\partial \alpha_2}{\partial \theta} < 0$. It means that the manufacturer and retailer should increase the marginal value of blockchain for consumers. For instance, on one hand, the supply chain can employ enhanced visualization techniques to illustrate the process of quality traceability, facilitating consumers' comprehension of the role of blockchain. This initiative also aids the manufacturer and retailer in making consumers understand the product information more effectively. On the other hand, the manufacturer and retailer should mitigate privacy concerns by emphasizing the privacy protection attributes of blockchain. In summary, when there is a limited consumer base concerned about product quality, the direct benefits for the supply chain from adopting blockchain might be restricted. Nevertheless, the adoption of blockchain could still yield advantages in a market with fewer quality-conscious consumers, especially if it enhances the marginal perceived value of blockchain for consumers.

Our results are different from Xu et al. (2023a) who argue that, under the marketplace model, the manufacturer benefits from adopting blockchain with a low variable cost. In our study, s denotes the variable cost of adopting blockchain, and we show that a relatively higher s is acceptable when α is high, i.e., when there are considerable quality-conscious consumers in the market. Thus, based on the results in Xu et al. (2023a) and this study, it is worth noting that the consumer segment will affect the value of blockchain. In addition, Shen et al. (2020) suggest that the retailer benefits more from adopting blockchain when selling low-quality products, which differs from our findings. In this paper, we assume that product quality is sufficiently high. In this case, it is still possible for the retailer to profit from implementing blockchain. The reason for the difference could be attributed to that Shen et al. (2020) focus on the retailer selling second-hand products.

Corollary 1 *(i) Under the wholesale price model, the manufacturer benefits more from blockchain adoption, i.e., $\pi_m^{WB*} - \pi_m^{WN*} > \pi_r^{WB*} - \pi_r^{WN*}$;*

(ii) Under the marketplace model, if $c > max\{c_1, c_2\}$, the manufacturer is able to access a broader range of profitable opportunities with blockchain adoption than the retailer, i.e., $\alpha_1 < \alpha_2$.

Interestingly, as indicated by Corollary 1(ii), we find that blockchain makes it easier for the manufacturer to profit from fewer quality-conscious consumers, compared to the retailer. This is because, under the marketplace model, the manufacturer can have direct contact with the consumer market. Blockchain is particularly effective in helping consumers develop trust through the manufacturer rather than the platform. The high production cost, which typically signals high quality, further supports this dynamic. Therefore, breaking down information barriers between the manufacturer and consumers through blockchain is crucial in this context. Moreover, regardless of a reduction in the number of quality-conscious consumers, blockchain still enables manufacturers to execute competitive differentiation strategies. It allows them to enhance brand reputation and product reliability, especially when high production costs are involved, thereby attracting a larger consumer base. In the marketplace model, the retailer does not gain additional benefits from blockchain beyond its provision as a technological infrastructure and sales platform.

In addition, with blockchain, the manufacturer is not allowed to engage in deceptive practices regarding product quality because of the transparent information between the manufacturer and the retailer. This enables the manufacturer to avoid expected penalties for quality fraud. We show that this result necessarily holds when the production cost incurred by the manufacturer is elevated. The rationale underlying this outcome is also attributed to the fact that elevated production expenses entail increased margin constraints and diminished competitiveness for the manufacturer. In this particular scenario, there is a greater inclination towards embracing innovative technologies, such as blockchain.

Choice of supply chain structure

In this section, we compare the results under the wholesale price and the marketplace model to determine the optimal supply chain structure. We also compare the results under the two scenarios, i.e., without and with blockchain, respectively. By doing so, we show the impact of blockchain on the choice of supply chain structure. We summarize the findings as follows.

Proposition 3 *Without blockchain,*

(i) $p^{WN*} > p^{MN*}$ when the commission is high, i.e., $\lambda > max\{0, \lambda_1\}$;

(ii) $\pi_m^{WN*} > \pi_m^{MN*}$ when the commission is low, and the expected penalty of quality fraud is high, i.e., $\lambda < \lambda_2$ and $t\mu > \overline{t\mu}_1$;

(iii) $\pi_r^{WN*} > \pi_r^{MN*}$ when the commission is moderate, and the expected penalty of quality fraud is high, i.e., $\lambda_4 < \lambda < \lambda_5$ and $t\mu > \overline{t\mu}_2$.

Proposition 3 highlights the case where the wholesale price model is preferred for the manufacturer and the retailer. Since extensive previous research has shown the results of the choice of supply chain structure, we therefore focus on comparing our findings with those of others.

Our results are consistent with previous research findings that one business model is not absolutely superior to another, such as Abhishek et al. (2016); Tian et al. (2018); Shen et al. (2019), and Ha et al. (2022a). We provide different reasons to explain why such a result holds. For example, Abhishek et al. (2016) show the interplay between online and offline channels significantly influences the selection of a business model for the supply chain. However, we ignore the traditional sales channel because we focus on an e-commerce supply chain and investigate the role of blockchain. It is worth highlighting that ignoring the traditional sales channel does not materially change the result of business model selection. We also contrast our results with those in Tian et al. (2018), who uncover that the marketplace model is encouraged when upstream competition in a platform is low, and Shen et al. (2019), who characterize the impact of the slotting fee on the choice of supply chain structure. In our case, as the expected penalty of quality fraud increases, there is a shift from the marketplace model to the wholesale price model with a certain range of commission. Similarly, Ha et al. (2022a) also indicate that the equilibrium depends on the commission rate, while we show that the commission and the expected penalty of quality fraud are complimentary in deciding the optimal business models for the manufacturer and the retailer.

Moreover, a new finding different from the above-mentioned research is that if $q > c + 2t\mu$, for any given λ, $p^{WN*} > p^{MN*}$ necessarily holds (see Proof of Proposition 3 for details in the Supplementary material). This result is counter-intuitive as it indicates that the commission does not impact the price. In this case, higher quality results in a higher price under the wholesale price model.

Proposition 4 *With blockchain,*

(i) $p^{WB*} > p^{MB*}$ when the cost of using blockchain is low, i.e., $s < s_2$;

(ii) $\pi_m^{WB*} > \pi_m^{MB*}$ when both the cost of using blockchain and the commission are high, i.e., $s > s_3$ and $\lambda > \lambda_6$;

(iii) $\pi_r^{WB*} > \pi_r^{MB*}$ when both the cost of using blockchain and the production cost are high, i.e., $s > s_5$ and $c > c_3$, and the commission is low, i.e., $\lambda < \lambda_7$.

The price under the wholesale price model is higher than that under the marketplace model when the cost of using blockchain is low, as shown in Proposition 4(i). Interestingly, the commission does not impact this result, i.e., whether there is a high or low commission, the price under the wholesale price model is always higher than that under the marketplace model (i.e., $p^{WB*} > p^{MB*}$), which is different from the result shown in Proposition 3(i). First, recall that the retailer provides blockchain technology in the supply chain. If the retailer charges the manufacturer less for the use of blockchain, the retailer would sell the product at an elevated price (under the wholesale price model). Such a high-price strategy helps the retailer mitigate the expenses associated with blockchain development. It might be argued that when the retailer imposes a reduced commission, there is a corresponding increase in the selling price to maintain adequate profitability. Nevertheless, our findings contradict this common belief. The introduction of blockchain allows the retailer to disregard the influence of commissions on the pricing tactic. The reason is attributed to that we point out the sales improvement effect due to blockchain adoption.

Under the blockchain-free scenario (from Proposition 3(ii)), we can see that even if the manufacturer benefits from a lower commission, it still gains more margins under the wholesale price model. However, in Proposition 4(ii), we know this result does not hold when blockchain is employed. We find that a higher commission does not necessarily cause the manufacturer to shift from the marketplace model to the wholesale price model. With a high commission, the manufacturer will only profit from the wholesale price model if it is also costly to use blockchain. This outcome may elicit a sense of astonishment. The reasons are as follows: With blockchain, the retailer benefits more from transparent information between itself and consumers because the retailer dominates blockchain adoption. For example, in practice, JD.com, functioning as a retailer, employs blockchain to facilitate the verification of product information, hence enhancing consumer confidence in the platform. Further, blockchain adoption results in a sales improvement effect. Thus, the manufacturer has an incentive to choose the marketplace model even if it has to share substantial revenue with the retailer. However, when the marginal cost of using blockchain is high, the manufacturer tends to sell the product by itself. In this case, the benefits derived from the deployment of blockchain are not significant. In other words, the high commission does not necessarily lead the manufacturer to opt for the wholesale price model. The manufacturer's decision-making is influenced by both the high commission and the substantial cost associated with implementing blockchain.

Surprisingly, we find that, with blockchain, despite the presence of a low commission, the retailer does not necessarily choose the wholesale price model. This is in contrast to the results obtained in early studies (Xu & Choi, 2021; Ma & Hu, 2022), which indicated that the retailer is more likely to adopt the wholesale price model only when it can obtain a limited proportion of the manufacturer's revenue. This is because, as indicated by Proposition 4(iii), due to the accessibility of blockchain, the retailer prefers to be a reseller. The increase in sales resulting from blockchain adoption encourages the retailer to sell the product directly to customers, especially when the production cost is high.

Corollary 2 *(i) The level of transparency pertaining to product information is greater under the wholesale price model compared to that under the marketplace model, i.e.,* $b^{WB*} > b^{MB*}$ *when* $s < s_6$.

(ii) The difference in the level of transparency under the two models decreases in the commission and the production cost, i.e., $\frac{\partial \Delta b^*}{\lambda} < 0$ *and* $\frac{\partial \Delta b^*}{c} < 0$.

The logic behind the results in Corollary 2 is that greater transparency could assist in enhancing the cooperation between the manufacturer and the retailer under the wholesale price model. Recall that consumers trust the retailer more because the retailer dominates blockchain adoption. As a result, the wholesale price model, where the manufacturer is more willing to be more cooperative, means that the manufacturer should eliminate more information asymmetry. Moreover, the lower blockchain adoption cost also increases the value of the blockchain, further facilitating the adoption of blockchain. In addition, it is observed that both higher values of λ and c lead to reductions in the disparity in the transparency level between the two models.

Extensions

In this section, we first incorporate consumers' privacy concerns into our analysis to uncover the benefits of using blockchain. Next, unlike the basic models, we account for consumer heterogeneity in their valuation of the additional benefits provided by blockchain. Finally, we examine the impact on consumer surplus.

Consumer privacy concern

In this extension, we examine the trade-off between the increased perceived utility and privacy concerns (denoted by the superscript T). Specifically, blockchain increases the consumer's perceived value from v to $(1 + \beta)v$, where β $(0 < \beta < 1)$ measures the degree of utility enhancement due to blockchain adoption. This assumption is reasonable because increased transparency regarding product information generally leads to greater consumer utility, as noted by Zhang et al. (2022). However, consumers often express concerns about the potential unauthorized disclosure of their information and data when using blockchain (Pun et al., 2021; Shen et al., 2022). Consequently, we assume that consumers who purchase the blockchain-enhanced product will also incur a privacy hassle h, which negatively impacts their overall utility. We can see that such a trade-off between the increased perceived utility and the privacy hassle affects the manufacturer's and retailer's demand.

In this case, quality-conscious consumers will buy the product if their net utility $U_c^T = (1+\beta)vq + \theta b - p - h$ is non-negative. Then, the demand from quality-conscious consumers is $D_c^T = (1 - \frac{p+h-\theta b}{(1+\beta)q})\alpha$. The demand from quality-indifferent consumers remains the same as in the basic models, i.e. $D_i^T = (1-\frac{p}{q})(1-\alpha)$. The timeline of events and the optimization problems of the manufacturer and the retailer are consistent with the basic models. The equilibrium results are derived in the same manner, as detailed in the Supplementary material.

As shown in Fig. 2, blockchain adoption does not necessarily benefit the supply chain when accounting for the trade-off between increased perceived utility and privacy concerns. This finding confirms the robustness of the results derived from the basic models. Figure 1 answers three questions. First, when do the manufacturer and retailer adopt blockchain under the wholesale price model (region I)? Second, when do the manufacturer and retailer adopt blockchain under the marketplace model (region II)? Third, when are both business models profitable with blockchain adoption (regions III and VI) and what is the optimal supply chain structure? Specifically, when both h and β are relatively moderate, blockchain implementation in any business model is profitable for the manufacturer and retailer. However, in this case, we show that the feasible range of adopting blockchain under the wholesale

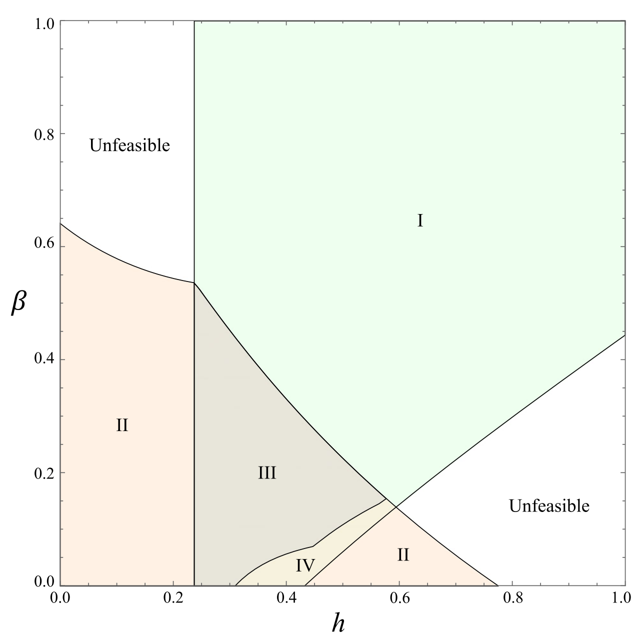


Fig. 2 The equilibrium blockchain adoption strategy under Model T ($k=0.05$, $q=0.5$, $\alpha=0.8$, $\theta=0.9$, $\lambda=0.1$, $c=0.8$, $s=0.2$, $t=0.09$, $\mu=0.9$)

price model (region III) is larger than that under the marketplace model (region IV). The logic behind this observation is as follows.

Typically, the retailer displays a greater degree of sensitivity towards market dynamics in comparison to the manufacturer. The implementation of blockchain facilitates information communication between the retailer and consumers, hence augmenting the retailer's capacity to perceive and respond to market fluctuations effectively. Furthermore, under the wholesale price model, the effective exchange of information between the retailer and the manufacturer plays a pivotal role. Blockchain adoption has the potential to strengthen collaboration and facilitate information transfer between the retailer and the manufacturer, hence enhancing the effectiveness and dependability of the supply chain. In the marketplace model, it is worth noting that despite the manufacturer's direct interaction with consumers, the responsiveness to market dynamics is comparatively sluggish. This poses limitations on the potential value that blockchain offers.

In addition, when the combination of h and β is polarized, i.e., both extremely high or low, blockchain adoption is non-profitable in any business model. Although blockchain has the potential to enhance trust significantly, consumers may exhibit hesitancy in embracing the transparency that blockchain provides, particularly if their concerns about personal privacy are more salient. In this particular scenario, the manufacturer and retailer should seek alternate measures in order to mitigate the presence of information asymmetry. In contrast, the cost-effectiveness of utilizing blockchain is hindered by the limited impact on improving consumers' perception of the product, hence diminishing the potential added value it offers. Despite the limited privacy concerns of customers, adopting blockchain is deemed futile.

Heterogeneous θ

In the basic models, we assume that all quality-conscious consumers have the same perception of the extra benefit brought by using blockchain. Here, we consider a more realistic case where quality-conscious consumers are heterogeneous in their valuation of the extra benefit brought by using blockchain (denoted by the superscript H), following the uniform distribution between zero and $\overline{\theta}$ with the probability density function $f(\theta) = \frac{1}{\overline{\theta}}$, i.e., $\theta \sim U[0, \overline{\theta}]$. We assume that $\overline{\theta}$ is sufficiently high to include all quality-conscious consumers. Then, the demand from quality-conscious consumers is $D_c^H = \alpha \int_0^{\overline{\theta}} \int_{\frac{b}{q}\theta + \frac{p}{q}}^{1} f(\theta)\, d\theta\, f(v)\, dv$. The demand from quality-indifferent consumers is the same as in the basic models, i.e., $D_i^H = (1-\alpha)(1-\frac{p}{q})$. We derive the equilibrium results in the same way as in the basic models, shown in the Supplementary material.

In Fig. 3, the combination of regions I, II, and III represents the feasible range where the manufacturer and the retailer adopt blockchain under the wholesale price model. This result is in line with Proposition 1, which indicates that the supply chain necessarily benefits from blockchain under the wholesale price model. The sum of regions II and III represents the feasible range where the manufacturer and the retailer adopt blockchain under the marketplace model, which is similar to Proposition 2. Specifically, we observe that when both s and c are low, under the marketplace model, the manufacturer and the retailer cannot agree on whether or not to use blockchain. However, when s is high, the manufacturer is more likely to use blockchain instead. This observation is intriguing. The logic behind this result is that the low manufacturing cost typically signifies a high level of efficiency within the production process. Therefore, the manufacturer may assume that implementing blockchain will add unneeded expenses. Blockchain deployment and maintenance may require financial and human resources, potentially surpassing the anticipated advantages it offers, even if the cost of using blockchain is low.

In addition, regions II and III also indicate that the manufacturer and retailer benefit from blockchain adoption under both business models, and region III represents that the manufacturer and retailer benefit more from the wholesale price model in this case. The logic behind this observation is the same as shown in Fig. 2, so we do not go into it again here.

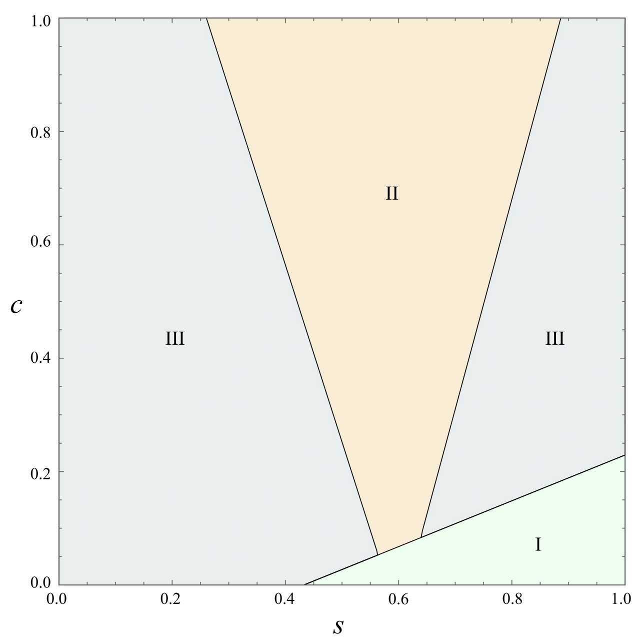


Fig. 3 The equilibrium blockchain adoption strategy under Model H ($k = 0.02$, $q = 0.6$, $\alpha = 0.875$, $\lambda = 0.1$, $t = 0.994$, $\mu = 0.575$, $\overline{\theta} = 0.9$)

Consumer surplus

In this extension, we focus on consumer surplus (denoted as CS). Although blockchain has the potential to deliver additional value to consumers, the conditions under which consumers gain greater surplus require further investigation. First, we analyze the scenarios where blockchain increases consumer surplus in both wholesale price and marketplace models. Then, we compare both cases—with and without blockchain—to determine in which business model consumers can achieve greater surplus. Consumer surplus can be calculated as follows.

Under the wholesale price model, the consumer surplus is as follows:

$$CS^{WN^*} = \int_{\widetilde{v}^{N^*}}^{1} (vq - p^{WN^*})\mathrm{d}v, \tag{12}$$

$$CS^{WB^*} = \alpha \int_{\widetilde{v_c}^*}^{1} (vq + \theta b - p^{WB^*})\mathrm{d}v + (1-\alpha)\int_{\widetilde{v_i}^*}^{1} (vq - p^{WB^*})\mathrm{d}v. \tag{13}$$

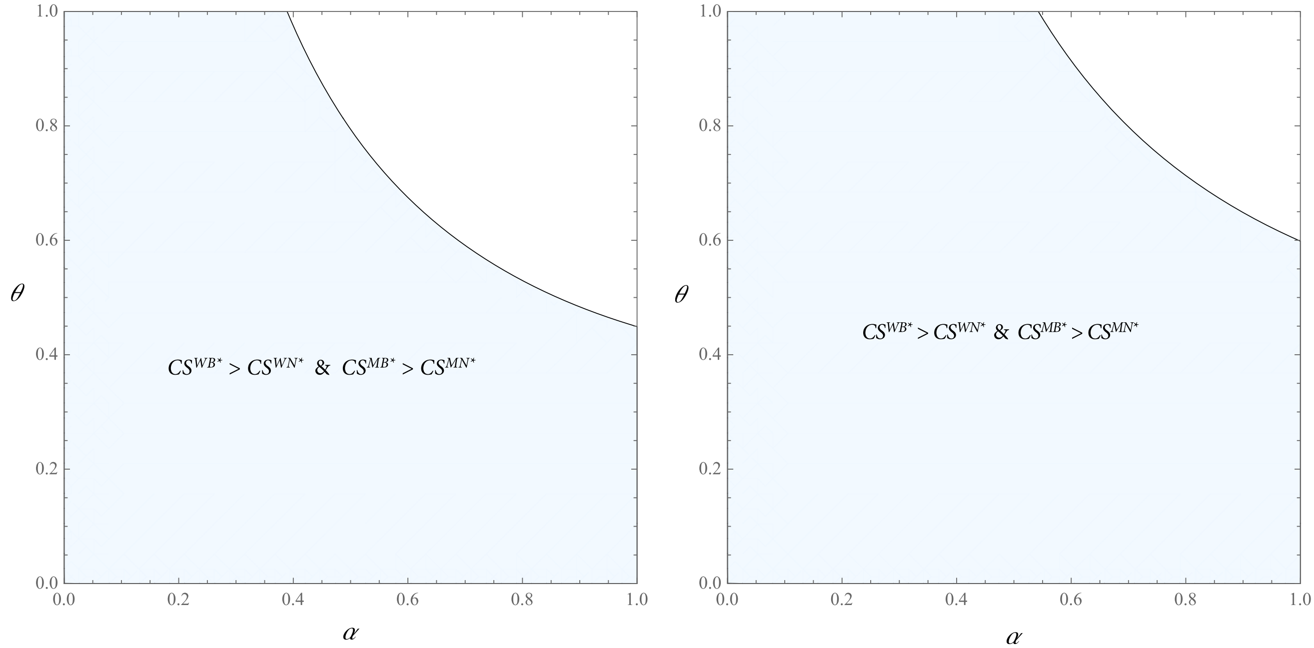
Under the marketplace model, the consumer surplus is as follows:

$$CS^{MN^*} = \int_{\widetilde{v}^{N^*}}^{1} (vq - p^{MN^*})\mathrm{d}v, \tag{14}$$

$$CS^{MB^*} = \alpha \int_{\widetilde{v_c}^*}^{1} (vq + \theta b - p^{MB^*})\mathrm{d}v + (1-\alpha)\int_{\widetilde{v_i}^*}^{1} (vq - p^{MB^*})\mathrm{d}v. \tag{15}$$

The equilibrium results are shown in Table A1 (see Supplementary material).

In Fig. 4, the blue regions represent blockchain consistently leads to higher consumer surplus under both the wholesale price and marketplace models. This pattern occurs when α is relatively low to moderate, and θ is also moderate. This suggests that blockchain enhances consumer surplus when there are fewer quality-sensitive consumers and when the benefit from blockchain is moderate. As θ continues to increase, the blue region shrinks, implying that more blockchain benefits do not expand the surplus advantage further. This is because blockchain can lead to a higher price. We show that blockchain delivers added value to consumers while driving prices up. To some extent, this benefit offsets the influence of price increases, thus not significantly impacting consumer surplus. However, if prices rise too steeply, the

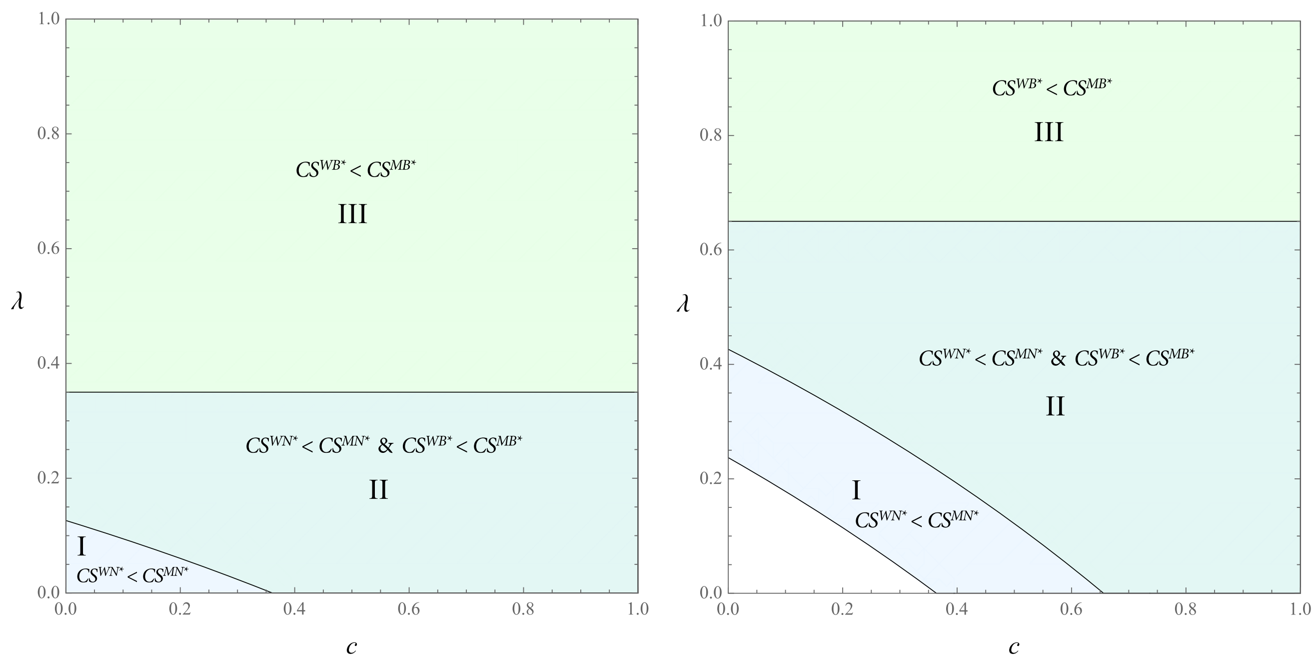


(a) When q is low. (b) When q is high.

Fig. 4 CS is higher with blockchain than without blockchain

balance tips, resulting in consumer detriment from its adoption.

In Fig. 4b, where product quality is higher, the broader shaded area indicates that blockchain significantly enhances consumer surplus, especially when the blockchain benefit is at a moderate level. In contrast, Fig. 4a, which represents lower product quality, shows a relatively smaller shaded area, suggesting that the impact of blockchain diminishes as product quality decreases. The key takeaway is that blockchain provides greater value to consumers in high-quality product



(a) When q is low. (b) When q is high.

Fig. 5 CS is higher in the marketplace model than in the wholesale price model scenarios. This result holds in both the wholesale price and marketplace models.

Figure 5 compares consumer surplus between the wholesale price and marketplace models, both with and without blockchain. In region I, without blockchain, the consumer surplus in the wholesale price model is lower than in the marketplace model. Region II highlights the overlap where, with or without blockchain, the consumer surplus under the wholesale price model remains lower than in the marketplace model. In region III, only with blockchain does the marketplace model yield a higher consumer surplus than the wholesale price model. However, in Fig. 5b, the shrinking of region III, where blockchain has a significant impact, suggests that blockchain's advantage in the marketplace model diminishes when product quality is high.

In Fig. 5, when product quality is low (Fig. 5a), the marketplace model consistently yields higher consumer surplus across a larger portion of the parameter space. When product quality is high (Fig. 5b), the dominance of the marketplace model becomes even more pronounced, particularly without blockchain. This indicates that as product quality increases, the marketplace model brings more benefits for consumers, regardless of blockchain adoption. Thus, blockchain's contribution to consumer surplus is more impactful in low-quality product scenarios, whereas high product quality can decrease the need for blockchain to create significant surplus advantages.

Conclusion

Managerial implications

From our findings, we derive some helpful managerial implications.

Regarding the applicability of blockchain, (i) in the wholesale price model, the manufacturer should evaluate whether the product primarily appeals to quality-conscious consumers. If it does, adopting blockchain can enhance profitability. In such cases, both the retailer and manufacturer may find it advantageous to utilize blockchain to provide credible quality information. (ii) In the marketplace model, especially when there is a significant proportion of quality-focused consumers, both the retailer and manufacturer can benefit from blockchain adoption. However, the cost of implementation must be carefully considered. As the added value of blockchain increases, earlier adoption may become viable, highlighting the importance of understanding consumer preferences and market dynamics.

These implications apply to online retailers and upstream manufacturers. For instance, JD.com and its suppliers, as well as Amazon, can conduct market research to gauge the emphasis their consumers place on product quality. If enough quality-conscious consumers are found, adopting blockchain becomes a viable option to enhance transparency and provide more quality-related information. Additionally, Amazon can analyze its sales data and user feedback to identify demand. If present, Amazon may introduce blockchain on its platform and require its suppliers to use it for better transparency and traceability of quality information. In addition, the reliable information provided by the supply chain about the origin of their products increases consumers' willingness to pay. Therefore, the supply chain should invest more in mechanisms, such as blockchain, that enable customers to feel confident they have all the necessary information to assess product quality.

In terms of the business model selection, the implications of our research findings are as follows: (i) Blockchain has altered the role of commissions in business model selection. In the absence of blockchain, the wholesale price model tends to result in higher prices, particularly when commissions are substantial. However, with blockchain adoption, prices under the wholesale price model remain relatively elevated, and the level of commissions no longer exerts a significant influence on pricing strategies. (ii) The retailer and manufacturer can leverage blockchain to mitigate the impact of commissions on pricing strategies.

This suggests that manufacturers can set prices more flexibly without being limited by commissions. For example, manufacturers entering online retail or launching their own platforms can re-assess the role of commissions in their business models based on market positioning and competition. If commissions negatively affect pricing strategies, they may adjust pricing or adopt blockchain to mitigate this impact. However, as commission rates and production costs rise, the transparency gap between the marketplace and wholesale price models narrows. Therefore, blockchain adoption can focus on enhancing transparency in the marketplace model to better meet consumer demands.

Contributions and limitations

We construct a supply chain framework comprising a manufacturer and an online retailer, where blockchain technology is employed to certify product information. Specifically, we develop two distinct business models: one incorporating blockchain and the other without, both analyzed under the marketplace and wholesale price models. This approach allows us to evaluate the value of blockchain and its influence on the choice of supply chain structure. The robustness of our findings is further validated through extended analyses. This paper makes several contributions to the existing literature. First, we demonstrate that blockchain mitigates the impact of commission fees on the selection of business models. Additionally, we highlight blockchain's unique value in enabling higher product prices without reducing profitability. These findings contrast with previous research, such as Xu and Choi (2021); Zhang et al. (2022); Xu et al. (2023a), and Shen et al. (2020), etc.

One limitation of this paper is the lack of consideration for the presence of multiple manufacturers on the platform, which may influence price competition. Furthermore, as blockchain continues to gain widespread adoption, it is essential to investigate the competitive dynamics among multiple manufacturers operating within a single online retail platform that harnesses the capabilities of blockchain technology. In addition, future research could consider price discrimination based on product features. It would be interesting to explore the benefits of blockchain when the prices of blockchain products and regular products are inconsistent.

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Data Availability The authors confirm that the data supporting the findings of this study are available within the article and/or its supplementary materials.

Declarations

Conflict of Interest The authors declare no competing interests.

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