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The Implications of Socially Responsible Retailing Platform on Channel Structure Choice and Product Quality Decisions

Fangchao Xu ^{1,*}, Xin Lu ² and Xiukun Zhao ³ 

¹ Business School, Nankai University, Tianjin 300071, China

² Department of National Defense Transportation, Army Military Transportation University, Tianjin 300161, China; 1120140783@mail.nankai.edu.cn

³ School of Management Science and Engineering, Tianjin University of Finance and Economics, Tianjin 300222, China; zhaoxiukun@tjufe.edu.cn

* Correspondence: xufc@mail.nankai.edu.cn

Abstract: At present, corporate social responsibility has been widely mentioned by the international society, especially platform enterprises. For a platform that assumes social responsibilities, consumer surplus is a rather critical aspect, and product quality is one of the most important factors directly related to consumers. This paper studies a supply chain consisting of a manufacturer and a retailing platform, in which the retailing platform procures products from the manufacturer. The manufacturer produces the products and decides the product quality. We consider two channel structures of the manufacturer and the retailing platform in the reseller mode and marketplace mode. Based on the model analysis and discussions, we obtain some managerial insights that are helpful in commercial practice. For the retailing platform, it has to suffer a loss in economic profit to care more about consumer surplus and become a social responsibility platform. In addition, its social responsibility plays different roles in different channel structures. In the marketplace mode, a social responsibility retailing platform helps to improve product quality. In the reseller mode, the retailing platform's social responsibility does not make a change in product quality. Furthermore, the product quality in the reseller mode is always higher than that in the marketplace mode. From the perspective of economic profits, the manufacturer obtains higher profits in the reseller mode than the marketplace mode. The retailing platform obtains higher profits in the marketplace mode than the reseller mode.

Keywords: social responsibility; channel structure; product quality



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1. Introduction

Supported by digital technology, the platform is far superior to traditional enterprises in terms of the scope of connection, service and information (Gawer & Cusumano, 2014) [1]. The platform is the center of the whole commercial system, connecting related enterprises and consumers, and all of the participants of the system influence each other. For example, Alibaba, the world's largest retailing platform, had 100 million customers and 11,000 retailers in 2017 (Zhang et al., 2020) [2]. The organizational form of platform enterprises makes the platform deeply integrate with the interests and values of participants (Xu, 2020) [3]. It means that the strategies, corporate governance and related behaviors of platform enterprises not only represent their own interests but also guide the value orientation of other participants on their platforms to some extent. As the collection center of commercial resources, it has become an inevitable trend for platforms to assume social responsibilities. Daniel Zhang, Chairman and CEO of Alibaba Group, says: "The platform is not Alibaba. The platform is a collection of all the stakeholders. A platform may be a business, but when it gets big enough, it doesn't just "belong" to a single company, it becomes social. The platform itself also provides more convenience and benefits for consumers." Therefore, the social responsibility of platforms is very important in today's society worldwide (Van et al., 2018) [4].

In recent years, the government has gradually paid more attention to the social attributes of platform enterprises and introduced relevant policies and regulations. The governments worldwide work hard to focus more on social values and collective interests, not barely the economic values and corporate interests (Van et al., 2018) [4]. The State Administration for Market Regulation has placed on file an investigation into Alibaba Group Holding Co. Ltd.'s alleged monopoly practices, such as "Alternative or Alternative". The People's Bank of China, China Banking and Insurance Regulatory Commission, China Securities Regulatory Commission and other departments interviewed Ant Group and urged and guided Ant Group to implement the requirements of fair competition and protection of consumers' legitimate rights and interests in accordance with the principles of marketization and rule of law. In Europe, European officials fined Alphabet USD 2.7 billion for unfairly favoring some of its own services and products for its users (Van et al., 2018) [4].

For a platform that assumes social responsibilities, consumer surplus is a rather critical aspect. As an emerging industry, e-commerce still has various problems in its development; in particular, the protection of consumers' rights and interests is limited, which makes many consumers turn away from online shopping. For retailing platforms, product quality is one of the most important factors directly related to consumers (Zhang et al., 2019) [5]. Bad product quality not only prevents consumers from purchasing the product but also harms the reputation of the retailing platform. Most retailing platforms, at the beginning of their development, usually pay more attention to their profits. For instance, Pinduoduo is known as having poor quality and a low price. However, as the retailing platform develops and enlarges, the retailing platform pays more attention to the quality of the products sold on it. For example, in the early development period of Pinduoduo and Taobao, both retailing platforms were under-evaluated due to product quality problems, which reduced consumers' satisfaction with the platforms, seriously affecting the long-term development of the platforms. With the development and growth, both Pinduoduo and Taobao platforms have established and improved the supervision of merchants and their product quality on the platform. The protection of consumers' interests has become the top priority of many online shopping platforms. Strengthening the protection of consumers' interests is not only the promotion of industrial development but also an embodiment of the platform enterprises' active fulfillment of their social responsibilities. Therefore, product quality is a very important factor for a retailing platform (Zhang et al., 2019) [5].

Socially responsible platforms not only take their own profit as the optimization goal but also take into account the interests of consumers (Quezado et al., 2022; Katsamakos et al., 2022) [6,7] and always take measures to decrease the selling price of products and improve the product quality. Retailing platforms take different strategies in different operation modes to achieve the above. In this research, we considered two main operation modes of a retailing platform: marketplace mode and reselling mode (Abhishek et al., 2016) [8]. Some retailing platforms, such as Jingdong self-run and Amazon self-run, act as intermediaries by reselling the products they purchase from manufacturers to consumers. However, other retailing platforms, such as Taobao and eBay, sell directly to buyers via a platform. Retailing platforms in the marketplace mode, to care more about consumer surplus, can only decrease the commission rate to encourage the manufacturers to decrease the selling price accordingly. Retailing platforms in the marketplace mode tend to decrease the selling price directly. However, in both of the above conditions, the influences on product quality are still unclear.

Therefore, this study aimed to explore the social responsibility of the platform. For a retail platform, it is increasingly the responsibility of the platform to pay attention to the quality of the products sold on the platform so as to ensure the interest of consumers. Thus, can retail platforms improve product quality by focusing more on the interests of consumers? Can different types of platform mechanics achieve the same results? This paper studies the two channel structures of a retailing platform: reseller mode and marketplace mode. This paper studies the implications of a socially responsible retailing platform on channel structure choice and product quality decisions. We try to answer the following questions:

1. What impact will social responsibility have on the supply chain and its enterprises in the operation of the platform? What is the impact on product quality and the manufacturer's and the platform's profits?
2. In the presence of a socially responsible platform, how does the enterprise in the supply chain price its products and determine product quality?
3. Which channel structure (the reseller mode and the marketplace mode) between the platform and manufacturers is more conducive to the socially responsible platform?

The rest of this article is organized as follows. Section 2 provides a literature review, and Section 3 describes our research problem and model. Section 4 analyzes the optimal decisions of the manufacturer and the retailing platform in the reseller mode and the marketplace mode with an exogenous quality. Section 5 explores the optimal decisions in two modes with the endogenous quality, which is decided by the manufacturer. Finally, key results and directions for future research are summarized in Section 7.

2. Literature Review

Our paper is closely related to the literature on three aspects: channel structure of platform retailing, the impact of a platform on product quality and social responsibility of the platform.

In the platform retailing literature, channel structure is a classical research field. Brick-and-mortar retailing (Endo et al., 2012; Carling et al., 2015) [9,10], e-retailing (Chen & Chen, 2017; Yun et al. 2020) [11,12], reselling (Hagiu & Wright, 2015; Abhishek et al., 2016; Li et al., 2019) [8,13,14], marketplace (also called agency selling, Ryan et al., 2012, Abhishek et al., 2016; Foros et al., 2013) [8,15,16] and omnichannel retailing (Akturk et al., 2018; Brynjolfsson et al., 2013) [17,18] are the main channel structures in both commercial practice and academic research. Many research studies focus on the modeling and comparison of various channel structures of retailing (Hagiu & Wright, 2015; Gans, 2012; Foros et al., 2013; Johnson, 2013, 2014; Abhishek et al., 2016) [8,13,16,19,20]. Hagiu and Wright (2015) [13] explored whether control rights over a noncontractible decision variable are better held by manufacturers (the marketplace mode) or by the intermediary (the reseller mode). Abhishek et al., (2015) [8] studied e-tailers' pricing decisions in the context where they compete with a traditional (brick-and-mortar retailing) channel. They found that e-tailers favor reselling format when the e-channel substantially stimulates the demand of the traditional channel, whereas they tend to use platform selling when the e-channel cannibalizes the traditional channel.

Our paper also relates to research on product quality decisions. In the research field of product quality decisions, one stream of research is on product quality decisions in product line design (Shen et al., 2020; Chung & Lee, 2017; Xu & Dukes, 2019) [21–23]. The second stream of research focuses on quality decisions in a competitive environment (Li et al., 2020; Chakraborty et al., 2019) [24,25]. Another stream of research on product quality decisions, which is the most relevant to our research, is explored from the perspective of the supply chain (Zhang et al., 2019; Xu, 2009; Chen et al., 2017; Ha et al., 2016; Shi et al., 2013; Lin et al., 2014) [5,26–30]. For instance, Zhang et al., (2019) [5] explored the contract and product quality in platform selling. Specifically, they addressed the question of why and under what conditions a platform should claim a fixed fee or a revenue sharing rate to induce the manufacturer's product quality.

Our work differs from the above two streams of papers. The above literature only focuses on the operation decisions and strategies of for-profit firms but does not consider other objective goals, especially the CSR goal. Our research explores the channel structure choice and product quality decisions, with the consideration of the retailing platform's social responsibility in its operation optimization. We highlight the concern degree of the retailing platform's social responsibility in the research problem and study the channel choice and product quality decisions in a new background.

This paper also relates to the stream of literature on the social responsibility of enterprises in the supply chain. Some empirical evidence supports this positive relationship between CSR and firm profitability or valuation (Albuquerque et al., 2019; Freeman, 2010; Servaes

& Tamayo, 2013; McWilliams & Siegel 2001; Iyer & Soberman, 2019) [31–35]. Servaes and Tamayo (2013) [33] found that enterprises with strong consumer awareness and active social responsibility can obtain greater corporate value by empirical research; consumers' positive attitude toward CSR behavior will be transformed into product demand and potential value. Freeman (2010) [32] believed that enterprises' CSR behavior plays a positive role in improving the overall financial performance of their own and their stakeholders. Some research focuses on the operations decisions and coordination mechanisms under CSR behavior in the supply chain (Panda, 2012; Wang & Li, 2021; Kraft et al., 2020; Gao 2020; Luo & Bhattacharya 2006; Hu et al., 2021; Ni et al., 2010) [36–42]. For instance, Panda (2012) [36] believed that CSR is the social responsibility behavior that enterprises should not only pay attention to the interests of shareholders but also take full account of the interests of stakeholders, such as consumers, business partners and the environment, in their decisions. Wang and Li (2021) [37] studied manufacturer encroachment in which the retailer is a dual-purpose corporation that pursues its own profit as well as consumer surplus. Hu et al., (2021) [41] considered the decisions faced by a newsvendor whose objective is modeled as a weighted average of the expected profit and consumer surplus, with the weight on consumer surplus referred to as the corporate social responsibility (CSR) level. Based on the research on CSR enterprises, this paper studies the implications of a socially responsible retailing platform on channel structure choice and product quality decisions.

3. Model Formulation

In this research, we focused on a supply chain consisting of a manufacturer (supplier) and a retailing platform. The manufacturer produces a product and sells it on the retailing platform. We considered two channel structures between the manufacturer and the retailing platform: (1) reseller mode and (2) marketplace mode. In the reseller mode, the retailing platform purchases products (with wholesale price w) from the manufacturer and sells them to consumers. They take ownership and control over products from manufacturers and choose how to sell them. In the marketplace mode, the manufacturer sells their products directly to consumers on the platform and pays certain proportional (λ) commissions to the retailing platform. The manufacturer reaches the consumers on the retailing platform directly.

We adopted a two-stage game-theoretical approach to explore the influence of socially responsible retailing platforms on channel structure choice and product quality decisions. This setting is consistent with the commercial practice that large e-commerce platforms, such as Amazon and Taobao, usually have mature commercial modes, including reseller mode or marketplace mode. Thus, for manufacturers, the operation modes of retailing platforms are given. Based on the operation modes of the retailing platform, manufacturers decide their product quality and prices. Therefore, the sequence of the game is as follows. In the first stage, the platform chooses the operation modes (reseller mode or marketplace mode) and decides the commission rate λ if the marketplace mode is chosen. In the second stage, the manufacturer decides the quality s ; in the reseller mode, the manufacturer decides the wholesale price, and then the retailing platform sets the selling price; in the marketplace mode, the manufacturer decides the selling price.

The manufacturer supplies products and decides the quality s of the products. The production cost of products is determined by the quality s , $c(s) = \frac{\beta}{2}s^2$, where $\beta > 0$. In this cost function, the total production cost is increasingly raised by the product quality s . The selling price of the product is p . The selling cost and fixed cost of the platform are not taken into account.

The retailing platform in this research is considered to be socially responsible. The social responsibility retailing platform makes its decisions to maximize the combination of its profit and consumer surplus (CS). In the maximization goal, the coefficient of consumer surplus (CS) is α . If $\alpha = 0$, the retailing platform is a traditional platform, which purely maximizes its profit. The larger the α is, the more attention the platform pays to consumer surplus.

From the perspective of consumers, V is the perceived value of the product's quality, which is uniformly distributed in $(0, 1)$. The utility of buying the product is: $U = sV - p$.

The indifferent consumer between buying the product or not lies in $\bar{V} = \frac{p}{s}$. Therefore, the demands of high-quality and low-quality products are: $q = 1 - \frac{p}{s}$.

The decision consequence is as follows. In the reseller mode, the manufacturer decides the product quality s (if endogenous) and the wholesale price w first, and then the retailing platform sets the selling price p . In the marketplace mode, the retailing platform sets the commission rate λ , and the manufacturer decides the product quality s (if endogenous) and the selling price p .

4. Exogenous Quality

In this section, we consider the quality of products supplied by the manufacturer to be exogenous. We aim to explore the impact of the retailing platform's dual purpose in both reseller mode and marketplace mode.

1. Reseller Mode

In the reseller mode, the manufacturer's and the retailing platform's profit functions are given as follows.

$$\pi_M^R(w) = \left(w - \frac{\beta}{2}s^2\right) \frac{s-p}{s-\gamma} \quad (1)$$

$$\pi_P^R = (p-w) \frac{s-p}{s-\gamma} \quad (2)$$

Because the retailing platform can be socially responsible, the utility function of the retailing platform also includes consumer surplus, besides its own profit. CS represents the consumer surplus. The utility function of the retailing platform is:

$$\begin{aligned} U_P^R(p) &= (p-w) \frac{s-p}{s-\gamma} + \alpha CS \\ &= (p-w) \frac{s-p}{s-\gamma} + \frac{\alpha}{2} \frac{(s-p)^2}{s-\gamma} \end{aligned} \quad (3)$$

We analyze the model by using backward induction. Firstly, we explore the optimal selling price p of the retailing platform. Then, we analyze the optimal wholesale price decided by the manufacturer, based on the decision of the retailing platform.

We can obtain the optimal decisions of both the manufacturer and the retailing platform. With exogenous quality, the optimal wholesale price and selling price in the reseller mode are:

$$w^{R*} = \frac{1}{4}s(2 + s\beta), \quad p^{R*} = \frac{s(6 - 4\alpha + s\beta)}{4(2 - \alpha)}$$

Based on the above results, we discuss this in detail to provide some managerial insights into the reseller mode with exogenous quality.

Proposition 1. For the manufacturer, to achieve positive profit, the product quality $s \in \left(\frac{4\alpha-6}{\beta}, \frac{2}{\beta}\right)$, and the lower bound increases with the weight of CS on the platform's utility.

Proposition 1 shows that, cooperating with a social responsibility retailing platform, which considers consumer surplus in its operation goal, the manufacturer has to control its product quality to obtain positive profits. The lower bound is determined by the weight of CS on the platform's utility. When the weight of CS is higher, which means that the retailing platform pays more attention to consumer surplus, the manufacturer has to improve its quality. Otherwise, the manufacturer cannot gain any profit in producing and selling. If the weight α is low ($\alpha < \frac{3}{2}$), there is no lower bound for the manufacturer's product quality. If the weight of CS of the platform is high enough ($\alpha > \frac{3}{2}$), when the quality of products is too low ($s < \frac{4\alpha-6}{\beta}$), the selling price of products will decrease to zero; when the quality of products is too high ($s > \frac{4\alpha-6}{\beta}$), the selling price will be so high that the selling quantity will decrease to zero.

Proposition 2. *With an exogenous quality, in the reseller mode, the higher the weight of CS on the platform's utility, the lower the selling price of the product; in the reseller mode, the platform's social responsibility decreases the profit of the retailing platform but increases the profit of the manufacturer.*

The above result shows that the main way to pay attention to consumer surplus is by decreasing the selling price for the retailing platform in the reseller mode. Intuitively, if the platform decides to consider higher consumer surplus, then the value of α increases, the selling pricing decreases accordingly, and the selling quantity increases at the same time. However, in the reseller mode with an exogenous quality, the wholesale price does not change with the weight of consumer surplus. Therefore, the influence of the retailing platform's social responsibility on the manufacturer in the reseller mode is selling quantity. Furthermore, in the reseller mode, we can observe that the retailing platform's attention to the consumer surplus benefits the manufacturer but decreases its own economic benefits. The reason is that when the retailing platform is socially responsible, the wholesale pricing does not change, the selling quantity increases, and therefore, the manufacturer's profit increases. On the other hand, for the retailing platform, the selling quantity increases, but the selling price decreases. The combined effect of the above two factors decreases the manufacturer's profit. This result shows that for a retailing platform, to be a CSR platform means that it has to sacrifice some part of its profit. However, it improves the welfare of the manufacturer and consumers.

2. Marketplace Mode

In the marketplace mode, the manufacturer's and the retailing platform's profit functions are given as follows.

$$\pi_M^M(p) = \left((1 - \lambda)p - \frac{\beta}{2}s^2 \right) \left(1 - \frac{p}{s} \right) \quad (4)$$

$$\pi_P^M = \lambda p \left(1 - \frac{p}{s} \right) \quad (5)$$

The utility function of the socially responsible retailing platform also includes consumer surplus, besides its own profit. The utility function of the retailing platform is:

$$U_P^M(\lambda) = \lambda p \left(1 - \frac{p}{s} \right) + \frac{\alpha}{2} \left(s + \frac{p^2}{s} - 2p \right) \quad (6)$$

We analyze the model by using backward induction. Firstly, we explore the optimal selling price p of the manufacturer on the platform. Then, we analyze the optimal commission rate λ of the retailing platform, based on the decision of the manufacturer. We can obtain the optimal decisions of both the manufacturer and the retailing platform.

With exogenous quality, the optimal wholesale price and selling price in the marketplace mode are:

$$\lambda = 1 - \hat{\lambda}, \quad p = \frac{s(s\beta + 2\hat{\lambda})}{4\hat{\lambda}}$$

$$\hat{\lambda} \text{ satisfies } -4\hat{\lambda}^3 + 2\hat{\lambda}s\alpha\beta - s^2(-2 + \hat{\lambda} + \alpha)\beta^2 = 0.$$

Theorem 1. *With an exogenous quality, the platform's optimal profit and utility and the manufacturer's price and profit in both the reseller mode and the marketplace mode are summarized in Table 1.*

Table 1. Optimal decisions and profits in the reseller mode and the marketplace mode.

	Selling Price	Platform's Profit	Utility of the Platform	Manufacturer's Profit
The reseller mode	$\frac{s(6-4\alpha+s\beta)}{4(2-\alpha)}$	$\frac{s(1-\alpha)(-2+s\beta)^2}{16(-2+\alpha)^2}$	$\frac{s(-2+s\beta)^2}{32(2-\alpha)}$	$\frac{s(-2+s\beta)^2}{16(2-\alpha)}$
The marketplace mode	$\frac{s(s\beta+2\hat{\lambda})}{4\hat{\lambda}}$	$\frac{s(-1+\hat{\lambda})(s^2\beta^2-4\hat{\lambda}^2)}{16\hat{\lambda}^2}$	$\frac{s(s\beta-2\hat{\lambda})(s(-2+\alpha)\beta+2\hat{\lambda}(-2-\alpha+s\beta+2\hat{\lambda}))}{32\hat{\lambda}^2}$	$\frac{s(s\beta-2\hat{\lambda})^2}{16\hat{\lambda}}$

5. Endogenous Quality

In this section, we consider the quality of products supplied by the manufacturer to be endogenous. It is decided by the manufacturer. We also explore the impact of the retailing platform's dual purpose in both reseller mode and marketplace mode. Firstly, we explore the reseller mode with the endogenous quality. Secondly, the marketplace mode with the endogenous quality is analyzed. Then, the two modes are compared in different dimensions.

(1) Reseller Mode

Because the retailing platform can be socially responsible, the utility function of the retailing platform also includes consumer surplus, besides its own profit. CS represents the consumer surplus. In the reseller mode with the endogenous quality, the manufacturer decides the product quality and the wholesale price. The retailing platform decides the selling price. Therefore, the manufacturer's and the retailing platform's profit and utility functions in the reseller mode are given as follows.

$$\pi_S^R(w, s) = \left(w - \frac{\beta}{2}s^2\right) \left(1 - \frac{p}{s}\right) \quad (7)$$

$$\begin{aligned} U_p^R(p) &= (p - w) \left(1 - \frac{p}{s}\right) + \alpha CS \\ &= (p - w) \left(1 - \frac{p}{s}\right) + \frac{\alpha}{2} \left(s + \frac{p^2}{s} - 2p\right) \end{aligned} \quad (8)$$

We analyze the model by using backward induction. Firstly, we explore the optimal selling price p of the retailing platform. Then, we analyze the optimal product quality s and the wholesale price w decided by the manufacturer, based on the decision of the retailing platform.

We can obtain the optimal decisions of both the manufacturer and the retailing platform.

Proposition 3. *With endogenous quality, the optimal product quality, the wholesale price and selling price in the marketplace mode are: $w^{R*} = \frac{4}{9\beta}$, $s^{R*} = \frac{2}{3\beta}$, $p^{R*} = \frac{10-6\alpha}{18\beta-9\alpha\beta}$.*

Based on the above results, we can learn that, in the reseller mode, when the manufacturer can decide its product quality, the retailing platform's social responsibility has no impact on the product quality. The reason is that, based on the anticipation of the retailing platform's pricing, the optimization of the manufacturer's profit is linear in the weight of consumer surplus. Therefore, when the manufacturer optimizes its product quality and wholesale price, it does not need to take the platform's social responsibility into account. Thus, for a retailing platform that pays much attention to the consumer surplus, if the channel structure is reselling, its social responsibility cannot influence the product quality.

We discuss this in detail to provide more managerial insights into the reseller mode with exogenous quality.

Corollary 1. *With the endogenous quality, in the reseller mode, as the weight of consumer surplus on a platform's utility increases, the selling price of the product decreases, the profit of the retailing platform decreases, but the profit of the manufacturer increases.*

According to the optimal decisions illustrated in Proposition 3, we can obtain Corollary 1. With the endogenous quality, in the reseller mode, when the retailing platform considers the consumer surplus more, the intuitive way to achieve it is to decrease the selling pricing from the perspective of the retailing platform. At the same time, according to Proposition 3, the product quality and the wholesale price do not change with this weight, and the selling quantity increases. Therefore, the profit of the manufacturer increases. For the retailing platform, the increased selling quantity cannot cover the decrement in selling pricing. Thus, the comprehensive effect of the above changes on the profits is: the profit of the retailing platform decreases, but the profit of the manufacturer increases.

(2) Marketplace Mode

In the marketplace mode with the endogenous quality, the manufacturer decides the product quality and the selling price. The retailing platform decides the commission rate paid to the manufacturer which sells products on it. In the marketplace mode, the manufacturer's and the retailing platform's profit and utility functions are given as follows.

$$\pi_S^M(s, p) = \left((1 - \lambda)p - \frac{\beta}{2}s^2 \right) \left(1 - \frac{p}{s} \right) \quad (9)$$

$$U_P^M(\lambda) = \lambda p \left(1 - \frac{p}{s} \right) + \frac{\alpha}{2} \left(s + \frac{p^2}{s} - 2p \right) \quad (10)$$

We analyze the model by using backward induction. Firstly, we determine the optimal product quality s and the selling price p decided by the manufacturer. Then, we analyze the optimal commission rate λ of the retailing platform, based on the decision of the manufacturer. We can obtain the optimal decisions of both the manufacturer and the retailing platform.

Proposition 4. *With an endogenous quality, the optimal product quality, the wholesale price and selling price in the marketplace mode are: $\lambda^{M*} = \frac{4-\alpha}{8}$, $p^{M*} = \frac{4+\alpha}{18\beta}$, $s^{M*} = \frac{4+\alpha}{12\beta}$.*

Based on the above results, we can learn that, in the reseller mode, when the manufacturer can decide its product quality, the retailing platform's social responsibility can impact all the optimal decisions, including the product quality, the commission rate and the selling price. The specific effects of the weight of consumer surplus on the above decision are illustrated in Corollary 2.

Corollary 2. *With the endogenous quality, in the marketplace mode, the retailing platform's social responsibility influences the product quality. As the weight of consumer surplus on the platform's utility increases, the product quality increases, the selling price increases, and the commission rate decreases. The platform's social responsibility decreases the profit of the retailing platform but increases the profit of the manufacturer.*

According to the optimal decisions illustrated in Proposition 4, we can obtain Corollary 2. With the endogenous quality, in the marketplace mode, when the retailing platform considers the consumer surplus more, it will directly decrease the commission rate to encourage the manufacturer on it to provide more surplus for consumers by sacrificing its own economic profits. Reacting to this change, the manufacturer will choose to increase the product quality but increase the product selling price at the same time. It means that when the retailing platform cares more about the consumer surplus, its direct effect on products is the improvement in quality, and the selling price increases accordingly. In other words, a "high-quality-high-price" scene emerges, which is the effect the weight of consumer surplus has on the profits of the retailing platform and the manufacturer. According to the results in Corollary 2, we can further analyze the effect on profits. For the retailing platform, as the weight of consumer surplus on the platform's utility increases, the commission rate decreases, the market size stays unchanged, and the profit of the platform decreases accordingly. For the manufacturer, the selling price increases, but the higher quality needs higher costs, and the combined effect of these two factors is improvement in profits. The results are identical to those in the case of exogenous quality.

(3) Comparison

Based on the analysis and the results in the above sections, this section compares the two modes in different dimensions.

Corollary 3. *With the endogenous quality, the product quality is always higher in the reseller mode than the marketplace mode.*

Corollary 3 provides managerial insights into the impact of the retailing platform on product quality decisions. It shows that the product quality is always higher in the reseller mode than the marketplace mode, although the retailing platform's concern about consumer surplus helps to improve product quality. In the reseller mode, the manufacturer just produces the products and sells them to the platform. The retailing platform holds and sells the products to consumers. Therefore, the manufacturer has to set a higher quality to ensure the product quality and increase the wholesale price because its wholesale price is directly relevant to its product quality. Therefore, the manufacturer always sets a high product quality in the reseller mode. On the other hand, in the marketplace mode, the retailing platform just operates as an intermediary and earns the commission; its control power and influence on the manufacturer and its product quality are limited. The manufacturer has more flexibility in its product quality decision, even though the retailing platform cares much about consumer surplus in product purchasing. It means that the retailing platform can improve the product quality by caring about consumer surplus and decreasing the commission rate, but it cannot offset the relatively low quality in the marketplace.

Corollary 4. *With the endogenous quality, when $0 < \alpha < 5 - \sqrt{13}$, the selling price of products is higher in the reseller mode; otherwise ($5 - \sqrt{13} < \alpha < 2$), it is higher in the marketplace mode. When $0 < \alpha < 1$, the market size in the marketplace mode is larger; when $1 < \alpha < 2$, the market size in the reseller mode is larger.*

By Corollary 4, we can realize that the selling price and the market size (selling quantity) in the two modes with the endogenous quality depend on the weight of consumer surplus on the retailing platform. When the weight α is relatively low, which means that the platform pays less attention to consumers, the selling price in the reseller mode is higher, and the market size is accordingly smaller, compared to those in the marketplace mode. On the other hand, when the weight α is relatively high, the selling price in the reseller mode is lower, and the market size is accordingly larger, compared to those in the marketplace mode. It means that, for a high-CSR platform, the reseller mode always leads to the case of "low price, high market size", while the marketplace mode leads to the case of "high price, low market size". For a low-CSR platform, the reseller mode always leads to the case of "high price, low market size", while the marketplace mode leads to the case of "low price, high market size".

Corollary 5. *With the endogenous quality, the manufacturer obtains higher profits in the reseller mode than the marketplace mode. The retailing platform obtains higher profits in the marketplace mode than the reseller mode.*

Corollary 5 illustrates the profits of the manufacturer and the retailing platform in the reseller mode and the marketplace mode. It means that the manufacturer prefers the reseller mode to the marketplace mode. However, the retailing platform obtains higher profits in the marketplace mode than the reseller mode. Therefore, in the reseller mode, the platform's social responsibility aggravates the double marginalization. However, in the marketplace mode, the platform's social responsibility mitigates the double marginalization in the supply chain consisting of the manufacturer and the retailing platform. In commercial practice, the operations mode is always decided by the platform, and it is easily understood that the marketplace mode is more popular in platform selling. However, product quality is a critical issue for both the platform and manufacturer.

6. Extensions

In Section 6, we extend some rules in the main analysis and explore some new commercial scenarios to reassure our conclusions. In the first part, we extend the one product to two products in our model. In the second part, we consider that there are two competitive manufacturers in the model. We find that the main results are consistent with the insights in the main model.

(1) Two products

In this part, we consider that the manufacturer produces and sells two kinds of products with different qualities, s_H, s_L . The selling prices of the two kinds of products are p_H and p_L , respectively. V is the perceived value of the product's quality; V is uniformly distributed in $(0, 1)$. The utility of buying high-quality and low-quality products is: $U_H = s_H V - p_H$, $U_L = s_L V - p_L$. When $U_H = U_L$, the consumer is indifferent about buying high-quality and low-quality products. The indifferent consumer between buying the high-quality and low-quality products lies in $\bar{V} = \frac{p_H - p_L}{s_H - s_L}$. In addition, the indifferent consumer between buying the low-quality product and not buying any products lies in $\bar{V} = \frac{p_L}{s_L}$. Therefore, the demands of high-quality and low-quality products are:

$$q_H = 1 - \frac{p_H - p_L}{s_H - s_L}, \quad q_L = \frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}$$

In the reseller mode, the manufacturer's and the retailing platform's profit and utility functions are given as follows.

$$\pi_S(w_H, w_L, s_H, s_L) = \left(w_H - \frac{\beta}{2}s_H^2\right) \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) + \left(w_L - \frac{\beta}{2}s_L^2\right) \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) \quad (11)$$

$$U_{PC}(p_H, p_L) = (p_H - w_H) \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) + (p_L - w_L) \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) + \frac{\alpha}{2} \left(s_H + \frac{(p_H - p_L)^2}{s_H - s_L} + \frac{p_L^2}{s_L} - 2p_H\right) \quad (12)$$

In the marketplace mode, the manufacturer's and the retailing platform's profit and utility functions are given as follows.

$$\pi_S(s_H, s_L, p_H, p_L) = \left((1 - \lambda)p_H - \frac{\beta}{2}s_H^2\right) \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) + \left((1 - \lambda)p_L - \frac{\beta}{2}s_L^2\right) \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) \quad (13)$$

$$U_{PC}(\lambda) = \lambda p_H \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) + \lambda p_L \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) + \frac{\alpha}{2} \left(s_H + \frac{(p_H - p_L)^2}{s_H - s_L} + \frac{p_L^2}{s_L} - 2p_H\right) \quad (14)$$

We can obtain the optimal decisions of both the manufacturer and the retailing platform in both modes. We find that the main results do not change in the case of two products. In the reselling mode, we compare the optimal decisions to the research results in Section 5 (1). As the weight of consumer surplus on the platform's utility increases, the selling price of the product decreases, the profit of the retailing platform decreases, but the profit of the manufacturer increases. However, the quality of both high-quality and low-quality products does not change with the weight of consumer surplus. The main results are consistent with the insights in the case of one product. In the marketplace mode, as the weight of consumer surplus on the platform's utility increases, the product quality increases, and the quality of high-quality products increases more than that of low-quality products. In addition, the selling price increases, and the commission rate decreases. At the same time, the profit of the retailing platform decreases, but the profit of the manufacturer increases.

(2) Manufacturer competition

In this part, we consider that there are two manufacturers in the model. Each manufacturer produces one kind of product, and the two kinds of products have different qualities.

One of them produces high-quality products, and the other one produces low-quality products. Similar to the modeling in the first extension, the demands of high-quality and low-quality products from the two manufacturers are: $q_H = 1 - \frac{p_H - p_L}{s_H - s_L}$, $q_L = \frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}$.

In the reseller mode, the two manufacturers' and the retailing platform's profit and utility functions are given as follows.

$$\pi_{MH}(w_H, s_H) = \left(w_H - \frac{\beta}{2}s_H^2\right) \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) \quad (15)$$

$$\pi_{ML}(w_L, s_L) = \left(w_L - \frac{\beta}{2}s_L^2\right) \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) \quad (16)$$

$$U_{PC}(p_H, p_L) = (p_H - w_H) \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) + (p_L - w_L) \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) + \frac{\alpha}{2} \left(s_H + \frac{(p_H - p_L)^2}{s_H - s_L} + \frac{p_L^2}{s_L} - 2p_H\right) \quad (17)$$

We analyze the model by using backward induction. Firstly, we explore the optimal selling prices (p_H, p_L) of the retailing platform. Then, we analyze the optimal product quality and the wholesale price (w_H, s_H) and (w_L, s_L) , decided by the two manufacturers, based on the decision of the retailing platform.

In the marketplace mode, the manufacturer's and the retailing platform's profit and utility functions are given as follows.

$$\pi_{MH}(s_H, p_H) = \left((1 - \lambda)p_H - \frac{\beta}{2}s_H^2\right) \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) \quad (18)$$

$$\pi_{ML}(s_L, p_L) = \left((1 - \lambda)p_L - \frac{\beta}{2}s_L^2\right) \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) \quad (19)$$

$$U_{PC}(\lambda) = \lambda p_H \left(1 - \frac{p_H - p_L}{s_H - s_L}\right) + \lambda p_L \left(\frac{p_H - p_L}{s_H - s_L} - \frac{p_L}{s_L}\right) + \frac{\alpha}{2} \left(s_H + \frac{(p_H - p_L)^2}{s_H - s_L} + \frac{p_L^2}{s_L} - 2p_H\right) \quad (20)$$

We can obtain the optimal decisions of both the manufacturer and the retailing platform. In the reselling mode, the main results do not change in the case of two manufacturers. As the weight of consumer surplus on the platform's utility increases, the selling price of the product decreases, the profit of the retailing platform decreases, but the profits of both manufacturers increase. In addition, the product quality of both manufacturers does not change with the weight of consumer surplus. In the marketplace mode, the main results are consistent with the insights in the case of one product. As the weight of consumer surplus on the platform's utility increases, the product quality increases, and the quality of the high-quality manufacturer increases more than that of the low-quality manufacturer. Furthermore, the selling price increases, and the commission rate decreases. At the same time, the profit of the retailing platform decreases, but the profit of the manufacturer increases.

7. Conclusions

Extant studies in the retailing platform literature typically focus on the operation decisions and strategies of for-profit firms but do not consider other objective goals, especially the CSR goal. Our research explored the platform and product quality decisions, with the consideration of the retailing platform's social responsibility in its operation optimization. This research focused on the concern degree of the retailing platform's social responsibility in the research problem and studied the implications of a socially responsible retailing platform on channel structure choice and product quality decisions in a new background.

This paper studied a supply chain consisting of a manufacturer and a retailing platform. The manufacturer produces products and sells them on the retailing platform. We considered two channel structures between the manufacturer and the retailing platform in the reseller mode and marketplace mode. This paper proposed mathematical models

to explore the following questions. What impact will social responsibility have on the supply chain and its enterprises in the operation of the platform? What is the impact on product quality and the manufacturer's and the platform's profits? In the presence of a socially responsible platform, how does the enterprise in the supply chain price its products and determine product quality? Which channel structure between the platform and manufacturers is more conducive to the socially responsible platform?

Based on the model analysis and discussions, we obtained some managerial insights which are helpful in commercial practice. Focusing on the product quality, with the endogenous quality, in the reseller mode, the retailing platform's social responsibility has no impact on the product quality; however, in the marketplace mode, the retailing platform's social responsibility influences the product quality. The product quality is always higher in the reseller mode than the marketplace mode. Regarding the selling price and the market size, for a high-CSR platform, the reseller mode always leads to the case of "low price, high market size", and the marketplace mode leads to the case of "high price, low market size". For a low-CSR platform, the reseller mode always leads to the case of "high price, low market size", and the marketplace mode leads to the case of "low price, high market size". From the perspective of the impact on social responsibility, the platform's social responsibility decreases the profit of the retailing platform but increases the profit of the manufacturer. Regarding the operations mode choice, the manufacturer obtains higher profits in the reseller mode than the marketplace mode. The retailing platform obtains higher profits in the marketplace mode than the reseller mode. The main results keep robustness in the two extensions.

The results of this research provide guidelines for enterprises in commercial practice, including the manufacturers and the retailing platform. For the manufacturer, to obtain higher profits, it is always recommended to choose a retailing platform in the reseller mode, which pays much attention to the consumer surplus. For the retailing platform, it has to suffer a loss in economic profit to care more about consumer surplus and become a social responsibility platform. In addition, its social responsibility plays different roles in different channel structures. In the marketplace mode, a social responsibility retailing platform helps to improve product quality. In the reseller mode, the retailing platform's social responsibility does not make a change in product quality. Furthermore, the product quality in the reseller mode is always higher than that in the marketplace mode. In future studies, we will take more consumer characteristic factors and enterprise strategies into account.

In this research, we considered the responsible platform to be concerned with only the consumers' welfare. In fact, the platform connects related enterprises and consumers and all of the participants of the system. Future research could consider a multi-objected platform, which concerns interests of more members, including suppliers and other complementary members. In addition, this research only studied the simplest method to influence product quality. Future studies could further explore some more electronic policies and tools to improve the product quality of a retailing platform.

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