

RETURN COMPENSATION STRATEGY OF ONLINE RETAILER FOR ONLINE REVIEWS

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Abstract. With the development of the Internet, consumers tend to go online shopping. Online reviews have become an important reference for consumers to make purchase decisions, and they contain reliable and rich information about products and needs that influence consumers' and companies' decisions. However, consumers are sometimes unable to accurately judge product quality through online reviews, resulting in the quality of the product not meeting the expectations of consumers. Then, consumers sometimes choose to return products and make negative reviews about the product, which can damage the retailer's interests. To reduce the damage to profits, online retailers have adopted a return compensation policy. In this paper, we establish a two-stage model based on the retailer's return compensation policy. Meanwhile, considering the effects of customer returns and online reviews, we construct two scenarios with and without return compensation policies to compare the equilibrium results of the game in different scenarios, and to analyze the effects of online reviews and product mismatch on retailers' profits. The results indicate that: (1) return compensation compensates consumers for the loss of utility due to product mismatch, promotes positive consumer reviews of that product, and leads to an increase in both product sales and total profits. (2) Product mismatch is negatively associated with the number of positive reviews and positively associated with the number of negative reviews in the case where an online retailer offers return compensation.

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1. INTRODUCTION

According to the 51st statistical report on Internet development in China reported by China Internet Network Information Center [8], as of December 2022, China has 1067 million Internet users and the Internet penetration rate is 75.6%. Thereinto, 845 million users, about 79.2% of the total, do shopping online. This shows that e-commerce is developing rapidly in the era of information technology. However, the utility of the product does not match the consumers' expectation utility, so there are a large number of returns in the online orders. If the product quality is lower than consumers' expectations, it will lead to consumers' return behavior [9]. In order to know more information about the product, many consumers now read online reviews left by previous customers before making purchasing decisions. Although online reviews contain a lot of information that consumers concern, consumers still cannot accurately judge the quality of products through these reviews. When

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consumers find that the products do not meet their expectations, they will consider returning them. Despite that Consumer returns impose a cost on the online retailer, online retailers' return policies have a strategic impact on consumer behavior [56]. So, the online retailers still offer return service to attract consumers. Many consumers choose to return products because products do not meet their expectations. So, online retailers try to release as much detailed information as possible about their products. Online reviews of products are one type of this information. In order for later customers to know more about the product, previous customers would post pictures of the product in online reviews. The combination of pictures can make consumers more aware of the product so that consumers can make the right decision [4, 10]. Ultimately, product returns decrease. In addition, on platforms such as Taobao, some online retailers offer return compensation to reduce returns. When consumers are not satisfied with the product, they can contact the retailer online and get return compensation. Therefore, to identify the impact of online reviews on product returns, online retailers, and consumers, and analyze the influences of return compensation on online reviews and online retailers' profits, this article constructs a two-stage model by considering return compensation. In the first stage, the consumers buy the product according to the price and previous consumers' online reviews. After receiving the product, the consumer decides whether to return it or not according to the color and size of the product. In the second stage, the online retailer sets a new price based on the first stage of online reviews and the volume of returns. By analyzing the return compensation strategy of the online retailer, this article finds out the changes in consumers' online reviews and online retailers' profits.

The structure of this article is as follows: in Section 2, we combine the related literatures. In Section 3, we formalize the problem and analyze the impact of the return compensation policy offered by an online retailer. In Section 4, we use a numerical case to illustrate the reasonableness of our insights. Finally, in Section 5, we put forward our conclusions.

2. LITERATURE REVIEW

Focusing on the research target of this paper, we will discuss the existing research from two types of online reviews and return policy.

2.1. Online reviews

With the development of the Internet, e-commerce began to emerge and provide consumers with a shopping experience without leaving their homes. However, it is difficult for consumers in e-commerce to assess the material, smell, and fit of products through touch, smell, and others, which can create uncertainty about the products and consequently lead to frequent return problems [11, 36]. Consumer uncertainty about products is considered one of the major barriers to online sales [41], and online reviews can help reduce consumer uncertainty about products and help consumers make better purchasing decisions [40]. Therefore, online reviews have an important impact on customers' purchasing decisions [21, 27]. Online reviews usually include consumers' affirmation, dissatisfaction, and content of purchasing and using experience [3]. As a free "sales assistant" [5], online reviews not only influence the purchase decision of customers, but also have a significant impact on product sales and, consequently, corporate profits [6, 39, 48]. In particular, positive online reviews have a positive impact on online retailers' profits, while negative online reviews have a negative impact on product sales [43]. To help consumers and online retailers make sound and effective decisions from different perspectives, such as stakeholders (consumers and retailers), many scholars and experts have analyzed the impact of online reviews on consumers' purchase decisions and online retailers' product sales and profits, and investigated the influence mechanism of online reviews on consumers and online retailers.

From the perspective of consumers, online reviews can help them understand the pros and cons of products and find the right products [31]. At the same time, online reviews can stimulate consumers to shop online. There is a snowball effect between the number of consumers and the number of product reviews [38]. However, not all consumers are willing to review online. Customers with bad experiences are more likely to post online reviews than those with good ones [14]. In addition, different people have different opinions about different online

reviews. Young consumers pay more attention to such information as product attributes, average scores, and single positive reviews when making purchase decisions, while older consumers are more vulnerable to negative reviews [15]. Subjective norms, perceived behaviors, and retaliations all have significant effects on consumers' comments [12]. In addition, many researchers have explored the impact of review dispersion [50], time-sensitive reviews [42], and review inconsistency [51] on consumer purchase decisions. For consumers, easy-to-read online reviews are more credible and better to help them make purchasing decisions [18]. If the content of online reviews includes previous consumer views and details on the product, consumers will be more willing to take them as a reference. In other words, they have become an important reference for potential consumers to make their purchase decisions [13, 24]. As for the value of online reviews, it is related to age differences and risk types of consumers [15]. For example, negative online comments are more useful than positive ones for those with high-risk aversion [4].

From the perspective of online retailers, the value of online reviews depends on whether the online reviews can help potential consumers make purchasing decisions and improve the product sales. Especially, online reviews including numbers and pictures have an impact on product sales [45]. In addition, the higher ratings and scores of online reviews can improve product sales [25, 32]. However, studies show that negative online comments are not entirely worthless [44] and they have a negative impact on product sales [2]. In fact, moderately negative evaluations can increase consumer trust in the validity of online reviews. Online reviews have different impacts on searches of products and experiential goods [33], and revealed product information has different impacts on retailers in both quality and demand dimensions [22]. If online reviews reduce product uncertainty, retailers' return probability can be accordingly reduced [40]. So in order to get more online reviews, online retailers take different approaches to encourage consumers to leave more online reviews. For example, monetary incentives can effectively increase the number of online reviews, but reduce their quality [47]. The rebate strategy has a significant effect on expanding consumers' demand and brings more profits to online retailers [26]. Moreover, management's response also has a significant and positive impact on the number of subsequent customer reviews [6].

In conclusion, a large number of empirical studies have analyzed the impact of online reviews on consumer behavior and product sales, but not many studies have focused on the impact of online reviews on customer returns and merchant return policies, especially on return policy decisions under the influence of online reviews through optimization models, and the research in this paper can provide more references for subsequent related studies.

2.2. Return policy

With the rapid growth of e-commerce, nowadays consumers are demanding more attributes from their products and they are also paying more attention to return policies. As more and more products are released in the marketplace, consumer uncertainty has increased [49, 52]. The high return rate from the online shopping scenario can no longer be ignored. However, little in-depth research has been conducted in the existing literature on this topic. The existing literature has mainly focused on the factors influencing consumers' willingness or behavior to return goods in online shopping [30, 40, 46]. In terms of consumer behavior, it can be divided into consumer purchase behavior and consumer return behavior. Therefore, in addition to the problem of consumer purchase, the problem of consumer return also attracts the attention of online retailers. Not to mention, the return policy can affect the return behavior of consumers [1]. For consumers, the return policy is a kind of promise, which can increase consumers' trust in the online retailer and guarantee consumers' utility [37]. So appropriate return policies have a positive impact on consumer behavior [20]. In addition, the return policy can reduce the risk of consumers' purchase decisions to some extent. This is because there is an interactive relationship among return policy, pricing strategy, and product quality risk [16]. Moreover, different brand products will have different return policies. So, consumers can learn about product brands, product warranties, and prices to some extent through return policy [53]. Therefore, return policy has important meaning to consumers.

In the face of the challenge of high returns, especially the rising number of defect-free returns, it is worth studying how online merchants should develop a reasonable return strategy. For an online retailer, return policies

have impacts on consumers' return decisions, the number of returned products, and sales [34, 57]. Therefore, retailers need to establish appropriate return policies. Zhao and Hu [54] focus on the return shipping cost-bearing problem by comparing three strategies: the consumer bears the return shipping cost, the merchant bears the return shipping cost, and both parties share the return shipping cost, and explore the optimal pricing and profitability of online retailers under different strategies. Li and Liu [23] examine return policies from both manufacturer and retailer perspectives. Martínez-López *et al.* [29] described how return policies can be handled to improve the seller-buyer relationship. Zhao *et al.* [55] studied two types of return shipping policies, freight paid by the consumer and freight paid by the retailer, comparing the applicability and effectiveness of the two return shipping policies. An appropriate return policy potentially increases product sales and consumers' willingness to purchase products [17]. However, different return policies have different effects on consumers. For example, Narayan *et al.* [35] demonstrated that a loose return policy has a positive impact on consumers' purchasing intention, and Janakiraman *et al.* [19] studied that loose return policies offered by retail stores can encourage consumer purchases. Although a reasonable return policy can improve the relationship between sellers and buyers, Lu and Chen [28] pointed out that product uncertainty is the main reason for consumer returns in online shopping. Wang *et al.* [46] found that online reviews with matching validity and matching references influenced return behavior by reducing customers' pre-purchase matching uncertainty. Therefore, the relationship between uncertainty about products and return policies remains to be studied.

According to the above discussion and analysis, many interesting insights and results have been obtained. However, there are still some shortcomings as follows: (1) The existing researches mainly focus on the usefulness and credibility of online reviews, their impact on consumers' purchasing decisions and retailers' sales. In fact, consumers often choose to return products because of product mismatch, so online retailers' profits are reduced. In order to reduce the volume of returns, on platforms such as Taobao, some online retailers have adopted return compensation strategies to maximize profits. (2) The existing researches mainly treat online review and return policy as two independent research issues, and ignore the mutual influence relationship between online review and return policy, and then they fail to analyze and discuss the mechanism of return policy's impact on consumers and online retailers. To overcome the above shortcomings and well analyze online reviews and return policies, we establish a two-stage model based on the retailer's return compensation policy and discuss the effects of online reviews and product mismatch on retailers' profits.

3. A RETURN POLICY THROUGH COMPENSATION FOR ONLINE REVIEWS

With the rapid development of network technology, consumers find the convenience of online shopping, and then more and more consumers like shopping online. As a result, many e-commerce platforms have emerged such as Amazon, Taobao, Jingdong, and Suning. What's more, these platforms also offer return services. Online retailers use these platforms to sell products to consumers. After receiving the products, consumers will decide whether to return them or not according to product mismatch, that is, the difference between the products and consumers' expectations. Then consumers will make online reviews based on their expectations of the products and shopping experiences. In particular, when the product mismatch is high, consumers will choose to return the product and make corresponding negative reviews. Potential consumers make purchasing decisions based on these reviews. The number and the valence of consumer reviews have a certain impact on consumer purchase decisions [38]. What's more, negative online reviews have a negative impact on retail sales [2]. From what has been discussed above, sales return directly influences retailers' sales and profits. In addition, consumers choose to return the goods and receive a refund (the fee returned by the retailers). To reduce the impact and urge consumers to give positive online reviews, online retailers adopt a return compensation policy. In this return compensation policy, consumers who choose to return the products will receive compensation from the online retailer. And the compensation is equivalent to the online retailer's cost. In order to study the influence of the return compensation policy, we establish a two-stage theoretical model. We analyze the effects of return compensation policy on product mismatch, the number of online reviews, and online retailers' profits.

3.1. Model hypothesis

In real life, consumers are heterogeneous. They depend on their views, income, or level of knowledge of the product to measure its value. When the consumer's utility is positive, they will consider making buying decisions. On the market, consumers can only choose to purchase in one of two stages. According to the above analysis and discussion, we give some assumptions as follows.

Assumption 1. *Assume that there exists a monopolistic online retailer on an online shopping platform. The online retailer sells a product in the two stages through an online shopping platform. Therefore, there are two stages in an e-commerce platform considering online reviews. At different stages, the prices of the product, consumers' utility and demand for the product are different. Meanwhile, consumers' utilities are jointly influenced by product price, online reviews, product mismatch, the retailer's refund, return compensation, and perceived utility.*

Assumption 2. *Assume that the total market capacity for a product is 1 and the online retailer's silence cost is zero. Let p_1, p_2 represent the product price in the first and second stages, respectively, and $v_i, U_i, d_i (i = 1, 2)$ stand for the consumers' perceived utility, consumers' utility, and product demand at different stages. And let d_r, h, g express return demand, the retailer's refund, and return compensation. To describe consumers' heterogeneity, assume that the valuation v_i is uniformly distributed over $[0, 1]$ within the customer population from 0 to 1 with a density of 1, which catches the individual difference in product valuation [7].*

Assumption 3. *Assume that there is a Stackelberg master-slave game relationship between the retailer and the consumer, and the information between them is completely symmetrical, and they both pursue the goal of maximizing their own interests.*

Assumption 4. *In the online shopping process, consumers make purchase decisions by combining the retailer's advertising of the product with their own utility. After consumers get the product, there is a demand matching problem due to factors such as the quality attributes and subjective preferences of the product. And consumers make positive online reviews or negative online reviews due to the loss of purchase utility caused by the demand mismatch of the product. Let $\lambda (\lambda \in (0, 1))$ be the consumer's demand mismatch for a unit product, and q_1, q_2 be the positive and negative online review information provided by the consumer, respectively.*

Assumption 5. *Assuming that all consumers will provide online reviews after they purchase products, positive online review information has a facilitating effect on the potential consumer's purchase decisionmaking, while negative online review information has the opposite effect. When retailers manage responses to online reviews provided by consumers, they all have a facilitating effect on potential consumers' purchase decisions.*

3.2. Some basic models

In the first stage, consumers' utility is related with product price, product mismatch, and perceived utility. To begin with, consumers only consider consumers' perceived utility and product price to buy the product, and then their utility can be written as follows. $v_1 - p_1$. When $v_1 - p_1 \geq 0$, consumers will buy it. That is to say, all consumers with valuations in the interval $[p_1, 1]$ will make purchasing decisions, and the consumers' demand in the first stage can be expressed as follows:

$$d_1 = \int_{v_1}^1 1 \, dv = 1 - p_1. \quad (1)$$

For example, if the online retailer adopts the return compensation policy, after receiving the product, the consumers think over the retailer's refund and return compensation, and then they will make online reviews. By taking a linear function to measure consumers' utility, the expression of consumers' utility can be written as follows:

$$U_1 = v_1 - p_1 - \lambda + h + g. \quad (2)$$

Considering the cost of the return compensation, without adopting the return compensation policy, when the consumer's utility in the first stage is positive, that is $U_1 = v_1 - p_1 - \lambda \geq 0$, the consumer will give a positive review, otherwise they will consider returning the product. If the consumer's utility after adding the retailer's refund is still positive, that is $U'_1 = v_1 - p_1 - \lambda + h \geq 0$, then the consumer will give a positive review, otherwise they give a negative review.

Due to the online reviews in the first stage will affect the product sale in the second stage, assume that ω_1, ω_2 stand for the coefficient of influence of positive and negative reviews generated in the first stage, respectively. According to the literature [4], these consumers think that negative reviews are more credible than positive ones. So assume ω_1, ω_2 satisfy $0 < \omega_1 < \omega_2 < 1$, $\omega_1 + \omega_2 = 1$. By taking linear function to measure consumers' utility, the expression of consumers' utility in the second stage is:

$$U_2 = v_2 - p_2 + \omega_1 q_1 - \omega_2 q_2. \quad (3)$$

3.3. The online retailer does not offer a return compensation policy

In this part, we analyze the condition when the online retailer does not offer return compensation. In the first stage, the online retailer announces the product's price and the consumer decides whether to buy the product based on the difference between the perceived utility and the price. After receiving the product, the consumer has a better understanding of the product. Then it will judge whether the product meets his expectations and decide whether to return the product and comment later. At this time, the consumer's utility will change and become $U_1 = v_1 - p_1 - \lambda$. If U_1 is non-negative, the consumer will hold it and give a positive review. Then the number of positive reviews can be expressed as follows:

$$q_1 = \int_{p_1 + \lambda}^1 1 \, dv = 1 - \lambda - p_1. \quad (4)$$

If $U_1 < 0$ and $U'_1 = v_1 - p_1 - \lambda + h \geq 0$, the consumer will choose to return the product and not to comment the product. Therefore, the return demand can be expressed as follows:

$$d_r = \int_{p_1 + \lambda - h}^1 1 \, dv = 1 - \lambda - p_1 + h. \quad (5)$$

If $U_1 < 0$ and $U'_1 = v_1 - p_1 - \lambda + h < 0$, the consumer will hold the product with bad purchase experience. To vent his dissatisfaction, the consumer gives the online retailer a negative review. Since the number of online reviews and the number of returned products in the first stage are unlikely to exceed the product sales, the number of negative reviews is as follows:

$$q_2 = d_1 - q_1 - d_r = 2\lambda - 1 + p_1 - h. \quad (6)$$

In the second stage, consumers can decide whether to purchase the product through the reviews given by consumers in the first stage. At this time, the market demand in the second stage is:

$$d_2 = 1 - p_2 + \omega_1 q_1 - \omega_2 q_2. \quad (7)$$

Assume that π_2, π_T stand for the second stage's retailer's profits and total profits. So, the online retailer's profits in the second stage satisfy:

$$\begin{aligned} \max \pi_2 &= p_2 d_2 \\ \text{s.t. } 0 &< p_2 < 1 + \omega_1 q_1 - \omega_2 q_2. \end{aligned} \quad (8)$$

The total profits of the online retailer are:

$$\max \pi_T = p_1 d_1 - h d_r + p_2 d_2$$

$$\text{s.t. } 0 < p_1 < 1 - \lambda. \tag{9}$$

By using reverse induction, we can solve the two-stage model. From the analysis above, the online retailer can obtain the maximum profits through reasonable pricing of its product in the second stage. By letting $\partial\pi_2/\partial p_2 = 0$, the price of the product in the second stage is as follows:

$$p_2 = \frac{1}{2}\omega_1(1 - \lambda - p_1) + \frac{1}{2} + \frac{1}{2}\omega_2(h - p_1 - 2\lambda + 1). \tag{10}$$

By putting the expression (10) into expression (9) and solving $\partial\pi_T/\partial p_1 = 0$, the price of the product in the first stage is as follows:

$$p_1 = \frac{(1 - \lambda)\omega_1^2 + (1 + (h - 3\lambda + 2)\omega_1)\omega_2 + (h - 2\lambda + 1)\omega_2^2 + \omega_1 - 2h - 2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{11}$$

By putting (11) into (10), we can get:

$$p_2 = \frac{(h + 2\lambda - 1)\omega_1 - 2 + (-h + 4\lambda - 1)\omega_2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{12}$$

Theorem 1. *When the online retailer does not provide return compensation, the online retailer’s price in the first stage p_1 is positively correlated with the comprehensive product mismatch λ . While the price of the second stage p_2 is negatively correlated with the comprehensive product mismatch λ .*

Proof. In order to obtain the relationship between the price and the comprehensive product mismatch in the absence of return compensation, we take the partial derivatives of p_1 and p_2 with respect to λ . Then we obtain the following results:

$$\frac{dp_1}{d\lambda} = -\frac{\omega_1^2 + 3\omega_1\omega_2 + 2\omega_2^2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)} \tag{13}$$

$$\frac{dp_2}{d\lambda} = \frac{2\omega_1 + 4\omega_2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{14}$$

Due to the fact that $0 < \omega_1 < \omega_2 < 1$, $\omega_1 + \omega_2 = 1$, we have $\omega_1 + \omega_2 - 2 < 0$, $2\omega_1 + 4\omega_2 > 0$, $\omega_1^2 + 3\omega_1\omega_2 + 2\omega_2^2 > 0$, and $\frac{dp_1}{d\lambda} > 0$, $\frac{dp_2}{d\lambda} < 0$. Therefore, the conclusion in Theorem 1 follows. \square

According to Theorem 1, in the first stage, consumers are sometimes unable to make accurate judgments based solely on online reviews. In general, the higher the price of similar products, the higher the expectations of consumers. After receiving the product, premium prices bring high mismatches to all. Therefore, fewer and fewer consumers will buy the product. In order to attract consumers, online retailers will cut prices in the second stage.

Theorem 2. *When the online retailer does not provide return compensation, the product demand in the first stage d_1 and return demand d_r are negatively correlated with comprehensive product mismatch λ .*

Proof. From the two-stage product prices in equations (11) and (12), we can respectively get the product demand of the first stage and return demand:

$$d_1 = \frac{\lambda\omega_1^2 + (-1 + (-h + 3\lambda)\omega_1)\omega_2 + (2\lambda - h)\omega_2^2 - \omega_1 + 2h - 2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)} \tag{15}$$

$$d_r = \frac{h\omega_1^2 + (-1 + (h + \lambda)\omega_2)\omega_1 + \lambda\omega_2^2 - \omega_2 - 2h - 2 + 4\lambda}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{16}$$

To obtain the said relationship, we take the partial derivatives of d_1 and d_r with respect to λ respectively. Then we can get the following results:

$$\frac{dd_1}{d\lambda} = \frac{\omega_1^2 + 2\omega_2^2 + 3\omega_1\omega_2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)} \tag{17}$$

$$\frac{dd_r}{d\lambda} = -1 + \frac{\omega_1^2 + 2\omega_2^2 + 3\omega_1\omega_2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{18}$$

Since $0 < \omega_1 < \omega_2 < 1, \omega_1 + \omega_2 = 1$, we have $\omega_1 + \omega_2 - 2 < 0, \omega_1^2 + 3\omega_1\omega_2 + 2\omega_2^2 > 0$, and $\frac{dd_1}{d\lambda} < 0, \frac{dd_r}{d\lambda} < 0$. Therefore Theorem 2 follows. \square

According to Theorem 2, when the online retailer does not offer compensation for returns, he first resorts to various methods to attract consumers to buy products. However, after receiving the product, consumers will find that the product does not meet their expectations, and then fewer consumers will choose to buy the product. In order to make up for the loss caused by product mismatch, consumers will choose to return the products. So, the product mismatch will decrease with the increase in the number of returned products.

Theorem 3. *When the online retailer does not provide return compensation, the number of positive reviews q_1 is negatively correlated with the comprehensive product mismatch λ , while the number of negative reviews q_2 is positively correlated with the comprehensive product mismatch λ .*

Proof. From equations (11) and (12), we can get the following results:

$$q_1 = \frac{(\lambda - h)\omega_2^2 + (-1 + (\lambda - h)\omega_1)\omega_2 + 2h + 4\lambda - \omega_1 - 2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)} \tag{19}$$

$$q_2 = \frac{(\lambda - h)\omega_1^2 + (1 + (\lambda - h)\omega_2)\omega_1 + 2h - 8\lambda + \omega_2 + 2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{20}$$

Then by taking the partial derivatives of q_1, q_2 with respect to λ , we can obtain:

$$\frac{dq_1}{d\lambda} = -1 + \frac{\omega_1^2 + 3\omega_1\omega_2 + 2\omega_2^2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)} \tag{21}$$

$$\frac{dq_2}{d\lambda} = 2 - \frac{\omega_1^2 + 3\omega_1\omega_2 + 2\omega_2^2}{(\omega_1 + \omega_2 + 2)(\omega_1 + \omega_2 - 2)}. \tag{22}$$

Because $0 < \omega_1 < \omega_2 < 1, \omega_1 + \omega_2 = 1$, we have $\omega_1 + \omega_2 - 2 < 0, \omega_1^2 + 3\omega_1\omega_2 + 2\omega_2^2 > 0$, and $\frac{dq_1}{d\lambda} < 0, \frac{dq_2}{d\lambda} > 0$. Therefore Theorem 3 follows. \square

In real life, consumers express their inner dissatisfaction through negative reviews. When the product mismatch increases, more consumers tend to make negative reviews. When the online retailer does not offer compensation for returns, the consumer’s dissatisfaction is not remedied. So, the number of negative reviews will increase and the number of positive reviews will decrease.

3.4. The online retailer offers a return compensation policy

In the actual online shopping platform, some retailers adopt return compensation policy to boost product sales and get more positive reviews. That is, when consumers choose to return the product, they will get compensation from the online retailers. Therefore, the consumers’ utility will increase and their dissatisfaction will ease, which can reduce the number of negative reviews and increase the number of positive reviews.

According to the above analysis and assumptions of the model, assume that $p_{Ri}, d_{Ri}, U_{Ri} (i = 1, 2)$ stand for the product price, product demand, and consumer utility in two stages when the online retailer adopts return

compensation policy, respectively. Let $h, g, q_{R1}, q_{R2}, \nabla q$ stand for the retailer's refund, return compensation, the number of positive reviews, the number of negative reviews, and the number of increased positive reviews, respectively, and $g \in [0, 1]$.

From the previous analysis, when the consumer's utility is $v_1 - p_{R1} \geq 0$, the consumer will purchase the product. Therefore, the market demand in the first stage is:

$$d_{R1} = 1 - p_{R1}. \quad (23)$$

The number of consumer reviews can be divided into the following three cases:

- (1) If $U_{R1} = v_1 - p_{R1} - \lambda \geq 0$, the consumer will hold the product and will give a positive review. In this case, the number of positive reviews could be written as:

$$q''_{R1} = 1 - \lambda - p_{R1}. \quad (24)$$

- (2) If $U_{R1} = v_1 - p_{R1} - \lambda < 0, U'_{R1} = v_1 - p_{R1} - \lambda + h + g \geq 0$, the consumer gives a positive review. When $v_1 - p_{R1} - \lambda < 0$, the consumer's utility is negative, the consumer will consider the return. When the online retailer offers the return compensation, the consumer will consider whether the return compensation can make up for his loss. If the compensation can make up for the loss, the consumers will hold the product and give a positive review. At this time, the number of the consumer reviews increases and could be written as:

$$\nabla q = 1 - \lambda - p_{R1} + h + g. \quad (25)$$

- (3) If $U_{R1} = v_1 - p_{R1} - \lambda < 0, U'_{R1} = v_1 - p_{R1} - \lambda + h + g < 0$, the consumer will give a negative review. When $v_1 - p_{R1} - \lambda < 0$, the consumer's utility is negative, the consumer will consider the return. At this time, the consumer will consider whether the return compensation can make up for his loss. If not, the consumer will make a negative review to express his dissatisfaction. The number of negative reviews could be written as:

$$q_{R2} = d_{R1} - q_{R1} = 2\lambda - 1 + p_{R1} - h - g. \quad (26)$$

In summary, under the condition of adopting the return compensation policy, the number of positive reviews and negative reviews are, respectively:

$$q_{R1} = q''_{R1} + \nabla q = 2 - 2\lambda - 2p_{R1} + h + g \quad (27)$$

$$q_{R2} = 2\lambda - 1 + p_{R1} - h - g. \quad (28)$$

From the previous analysis, the consumers' utility in the second stage is $U_{R2} = v_2 - p_{R2} + \omega_1 q_{R1} - \omega_2 q_{R2}$, and the product demand in this stage is:

$$d_{R2} = 1 - p_{R2} + \omega_1 q_{R1} - \omega_2 q_{R2}. \quad (29)$$

Assume that π_{2R}, π_{TR} stand for the profits of online retailers in the second stage and the total profits respectively. The formulas can be obtained as follows:

$$\begin{aligned} \max \pi_{2R} &= p_{R2} d_{R2} \\ \text{s.t. } &0 < p_{R2} < 1 + \omega_1 q_{R1} - \omega_2 q_{R2}. \end{aligned} \quad (30)$$

And the total profits of the online retailer are:

$$\begin{aligned} \max \pi_{TR} &= p_{R1} d_{R2} + p_{R2} d_{R2} \\ \text{s.t. } &0 < p_{R1} < 1 - \lambda. \end{aligned} \quad (31)$$

By using reverse induction, we can solve the two-stage model. In the second stage of sales, the online retailer obtains the maximum profits through reasonable pricing of its product. By solving $\partial\pi_{2R}/\partial p_{R2} = 0$, we can get the following results:

$$p_{R2} = \frac{1}{2}\omega_1(2 - 2\lambda - 2p_{R1} + h + g) + \frac{1}{2} + \frac{1}{2}\omega_2(g + h - p_{R1} - 2\lambda + 1). \quad (32)$$

By putting (32) into (31) and solving $\partial\pi_{TR}/\partial p_{R1} = 0$, we can get the price in the first stage:

$$p_{R1} = \frac{(2g + 2h - 4\lambda + 4)\omega_1^2 + (2 + (3g + 3h - 6\lambda + 4)\omega_2)\omega_1 - 2 + (g + h - 2\lambda + 1)\omega_2^2 + \omega_2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \quad (33)$$

By putting (33) into (32), we can get the price in the second stage:

$$p_{R2} = \frac{(-2g - 2h + 4\lambda - 2)\omega_1 - 2 + (-2g - 2h + 4\lambda - 1)\omega_2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \quad (34)$$

Moreover, the online retailer is pursuing to maximize its profits through return compensation of its product. By solving $\partial\pi_{TR}/\partial g = 0$, we can get the return compensation can be determined as follows:

$$g = \frac{(-h + 2\lambda + 2p_{R1} - 2)\omega_1 - 1 + (-h + 2\lambda + p_{R1} - 1)\omega_2}{\omega_1 + \omega_2}. \quad (35)$$

Theorem 4. *When the online retailer provides the return compensation, the price in the first stage p_{R1} is positively correlated with the comprehensive product mismatch λ . While the price in the second stage p_{R2} is negatively correlated with it.*

Proof. In order to obtain the said relationship, by taking the partial derivatives of p_{R1} and p_{R2} with respect to λ respectively, we can get the following results:

$$\frac{dp_{R1}}{d\lambda} = -\frac{4\omega_1^2 + 6\omega_1\omega_2 + 2\omega_2^2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \quad (36)$$

$$\frac{dp_{R2}}{d\lambda} = \frac{4\omega_1 + 4\omega_2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \quad (37)$$

Due to the fact that $0 < \omega_1 < \omega_2 < 1$, $\omega_1 + \omega_2 = 1$, we have $4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4 < 0$, $4\omega_1^2 + 6\omega_1\omega_2 + 2\omega_2^2 > 0$, $4\omega_1 + 4\omega_2 > 0$, and $\frac{dp_{R1}}{d\lambda} > 0$, $\frac{dp_{R2}}{d\lambda} < 0$. Therefore Theorem 4 follows. \square

According to Theorem 4, when the online retailer offers return compensation, the compensation increases the utility of the consumer. In the first stage, the higher the price, the higher the consumer's expectation for the product. Therefore, consumers' perception of the product mismatch increases. However, when consumers accept return compensation, their utility increases and their perceived product mismatch decreases. So online retailers can raise prices in the second stage.

Theorem 5. *When the online retailer provides the return compensation, the potential consumers in the first stage d_{R1} and in the second stage d_{R2} are negatively correlated with the comprehensive product mismatch λ .*

Proof. From equations (33) and (34), the demands for the product of the two stages are as follows:

$$d_{R1} = \frac{(-g - h + 2\lambda)\omega_2^2 + (-2 + (-3g - 3h + 6\lambda)\omega_2)\omega_1 - 2 + (-2g - 2h + 4\lambda)\omega_1^2 - \omega_2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \quad (38)$$

$$d_{R2} = \frac{(-2g - 2h + 4\lambda - 2)\omega_1 - 2 + (-2g - 2h + 4\lambda - 1)\omega_2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \quad (39)$$

In order to obtain the said relationship, we take the partial derivatives of d_{R1} and d_{R2} with respect to λ respectively. We can get the following results:

$$\frac{dd_{R1}}{d\lambda} = \frac{4\omega_1^2 + 6\omega_1\omega_2 + 2\omega_2^2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \tag{40}$$

$$\frac{dd_{R2}}{d\lambda} = \frac{4\omega_1 + 4\omega_2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \tag{41}$$

Due to the fact that $0 < \omega_1 < \omega_2 < 1$, $\omega_1 + \omega_2 = 1$, we have $4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4 < 0$, $4\omega_1^2 + 6\omega_1\omega_2 + 2\omega_2^2 > 0$, $4\omega_1 + 4\omega_2 > 0$, and $\frac{dd_{R1}}{d\lambda} < 0$, $\frac{dd_{R2}}{d\lambda} < 0$. Therefore Theorem 5 follows. \square

According to Theorem 5, when the online retailer offers return compensation, the compensation increases the utility of the consumer. When the product mismatch increases, the product demand will decrease in the first stage. However, when consumers accept return compensation, their perceived product mismatch decreases to some extent. And the number of positive reviews increases, which can encourage consumers to buy the product. So the demand will increase in the second stage.

Theorem 6. *When the online retailer provides the return compensation, the number of positive reviews and positive additional reviews q_{R1} , ∇q are negatively correlated with the comprehensive product mismatch λ , while the number of negative reviews q_{R2} is positively correlated with it.*

Proof. From equations (33) and (34), the number of positive online reviews, increased positive online reviews and negative online reviews are as follows:

$$q_{R1} = \frac{(-g - h + 2\lambda)\omega_2^2 + (-2 + (-2g - 2h + 4\lambda)\omega_1)\omega_2 - 4g - 4h + 8\lambda - 4\omega_1 - 4}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \tag{42}$$

$$\nabla q = \frac{(2g + 2h)\omega_1^2 + (-2 + (g + h + 2\lambda)\omega_2)\omega_1 + \lambda\omega_2^2 - 4g - 4h + 4\lambda - \omega_2 - 2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \tag{43}$$

$$q_{R2} = \frac{(-2g - 2h + 4\lambda)\omega_1^2 + (2 + (-g - h + 2\lambda)\omega_2)\omega_1 + 4g + 4h - 8\lambda + \omega_2 + 2}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \tag{44}$$

In order to obtain the said relationship, we take the partial derivatives of q_{R1} , ∇q , q_{R2} with respect to λ respectively. We can get the following results:

$$\frac{dq_{R1}}{d\lambda} = \frac{4\omega_1\omega_2 + 2\omega_2^2 + 8}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \tag{45}$$

$$\frac{d\nabla q}{d\lambda} = \frac{2\omega_1\omega_2 + \omega_2^2 + 4}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4} \tag{46}$$

$$\frac{dq_{R2}}{d\lambda} = \frac{4\omega_1^2 + 2\omega_1\omega_2 - 8}{4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4}. \tag{47}$$

Due to the fact that $0 < \omega_1 < \omega_2 < 1$, $\omega_1 + \omega_2 = 1$, we have $4\omega_1^2 + 4\omega_1\omega_2 + \omega_2^2 - 4 < 0$, $2\omega_2^2 + 4\omega_1\omega_2 + 8 > 0$, $2\omega_1\omega_2 + \omega_2^2 + 4 > 0$, $4\omega_1^2 + 2\omega_1\omega_2 - 8 < 0$, and $\frac{dq_{R1}}{d\lambda} < 0$, $\frac{d\nabla q}{d\lambda} < 0$, $\frac{dq_{R2}}{d\lambda} > 0$. Therefore Theorem 6 follows. \square

According to Theorem 6, consumers make online reviews based on product mismatches. When the product mismatch increases, the number of positive reviews decreases and the number of negative reviews increases. In addition, consumers will also consider the return compensation. If the return compensation can cover the loss of consumers, they will make positive online reviews. When the online retailer offers a corresponding compensation for returned goods, consumers judge whether the compensation makes up for their loss, and finally make a final evaluation. Therefore, if the consumer's perception of product mismatch increases, and the return compensation provided by the online retailer reduces the consumer's perception of product mismatch to some extent, then the number of positive reviews increases and the number of negative reviews decreases.

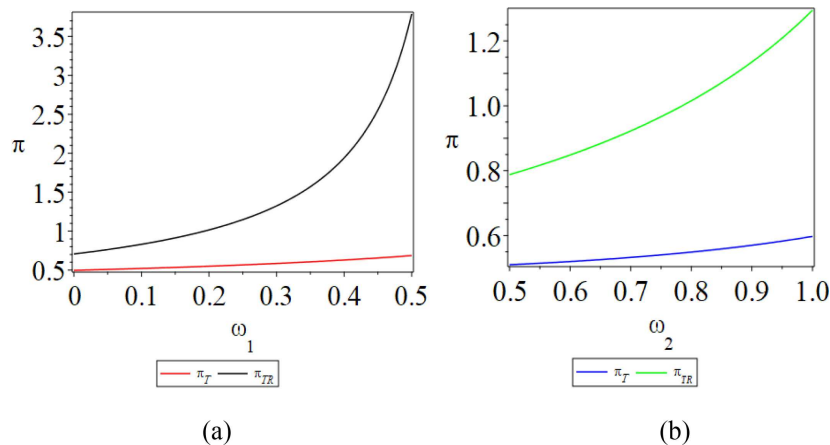


FIGURE 1. The impact of online reviews on the profits of the online retailer.

4. CASE ANALYSIS

In this section, we study the relationship between the profits and online reviews and related parameters of the online retailer under the condition that the online retailer offers return compensation and not. In the following, we take $h = 0.1$.

4.1. The impact of online reviews on the profit of the online retailer

Take $\lambda = g = 0.3$, and assume that in the absence of return compensation, the consumer's perception of product mismatch is consistent with that of return compensation. The total profits of online retailer are related with ω_1, ω_2 . Considering that negative reviews are more perceptual and credible than positive reviews for high-risk adverse consumers ($0 < \omega_1 < \omega_2 < 1, \omega_1 + \omega_2 = 1$), take $\omega_2 = 0.8$, and the impact of positive reviews on the online retailer's total profits can be obtained, which is shown in Figure 1a. In addition, take $\omega_1 = 0.2$, and then the impact of negative reviews on the profits of the online retailer can be determined and shown in Figure 1b. According to Figure 1, if the online retailer provides return compensation, he will acquire more total profits.

From Figures 1a and 1b, it can be observed that the higher the impact coefficient, the higher the total profit for the retailer, regardless of whether the reviews are positive or negative. Figure 1 shows that higher impact coefficients indicate that positive review content increases the perceived value of consumers' evaluations of products, thus increasing consumers' willingness to pay overall, allowing online merchants to set sales prices accordingly and helping them to increase profits. The impact of negative review content is not very significant compared to positive review content. From the perspective of offering and not offering return compensation, when the online retailer does not offer return compensation, the product doesn't meet the expectations of the consumers, and then consumers will choose to return the product and give negative reviews. Then the product sales will decrease and the online retailer will lose more profits. However, when the online retailer offers return compensation to consumers, the return compensation compensates for the loss of utility caused by the product mismatch. Therefore, consumers will hold the product and give positive reviews. As a result, the product sales and the total profits both increases.

4.2. The profits of the online retailer with product mismatch

According to the previously given parameter values ($\omega_1 = 0.2, \omega_2 = 0.8$), by using Maple 2019, we can calculate the online retailer's total profits under the condition of offering or not offering return compensation, and construct the graph of the online retailer's total profits over the product mismatch shown in Figure 2.

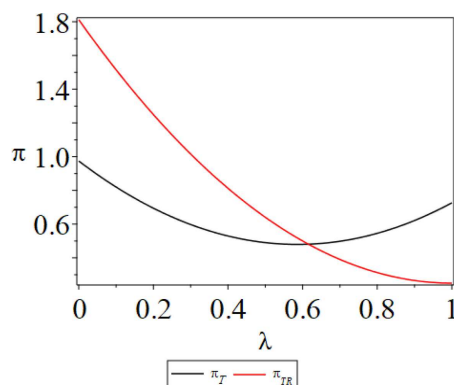


FIGURE 2. The online retailer's total profits under the condition of offering or not offering return compensation.

According to Figure 2, when the product mismatch does not exceed a certain value, the total profits of the online retailer under the condition of offering return compensation are always higher than those under the condition of not offering return compensation. In addition, the lower the product mismatch is, the greater the profits after providing return compensation are.

Under the condition that the retailer does not provide a return compensation policy, if the consumer's perceived product demand mismatch is small, the consumer's utility in the first stage is positive and gives a positive review. This leads to increased product sales in the second stage and thus increased profits for the retailer, the greater the product demand mismatch, the lower the profits for the retailer. However, when the product demand mismatch exceeds a certain threshold, it can be found that as the product demand mismatch increases, the retailer's profit increases, this is because the higher the consumer's expectation, the higher the premium price brings to everyone after receiving the product. As a result, fewer and fewer consumers will purchase the product. To attract consumers, the online retailer will cut prices in the second stage to increase profits. If the retailer provides a return compensation policy, when the product mismatch is small, the online retailer can set a lower selling price to attract more consumers in the first stage. After receiving the products, consumers find that the product mismatches their expectations. In order to compensate consumers, the online retailer offers certain return compensation. At the same time, the offered return compensation enables those consumers who are not satisfied with the product to obtain higher real utility so that they will make positive reviews. In such case, the number of positive reviews increases and positive reviews bring a better reputation to the product. Due to more positive online reviews, the online retailer can set a higher selling price for its product in the second stage. Therefore, the return compensation brings more consumers and higher profits. When the consumer-perceived product demand mismatch increases, the consumer-perceived utility is lower, and more and more consumers choose to return the product. The compensation cost increases the retailer's cost and therefore the retailer's profit will decrease.

4.3. The profits of the online retailer with return compensation and product mismatch

In order to compare the impact of consumers' product mismatch and return compensation on the profits of the online retailer in the case of the online retailer offering return compensation, set $\omega_1 = 0.2$, $\omega_2 = 0.8$, and we can determine the online retailer's profits. Figure 3 shows the relationship between the online retailer's profits and the product mismatch and return compensation. According to Figure 3, when the online retailer offers return compensation, the retailer's profits will decrease with the increase of the product mismatch. In addition, when the product mismatch is large, the total profits are higher than the profits of the second stage.

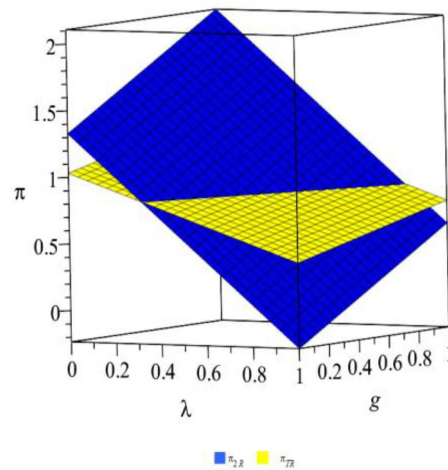


FIGURE 3. The impact of product mismatch and return compensation on the profits of the online retailer.

In other cases, the total profits are lower than the profits of the second stage. Moreover, the retailer's profits will increase as return compensation increases in return compensation.

When the online retailer offers return compensation, the product mismatch is remedied through return compensation. As the product mismatch increases, the consumer's utility decreases, the number of negative reviews increases, and the online retailer's product reputation declines. In severe cases, this will lead to fewer consumers. So, the online retailer needs to set low prices in the first stage to attract more consumers. When the online retailer offers return compensation, the product mismatch decreases and consumers are more likely to give positive reviews. When the number of positive reviews increases, the product reputation increases. As a result, more and more consumers will choose to purchase this product. As seen from Figure 3, in order to make more profits, the online retailer can choose to give relatively high return compensation.

4.4. Managerial insights

In this section, management insights are drawn from the research findings above.

- (1) If an online retailer does not offer a return compensation policy, when the product mismatch is high, the retailer should establish lower product prices in both the first and second stages to increase consumer utility and reduce negative evaluations. At the same time, lower prices will stimulate consumer purchase behavior and make the market expansion effect greater than the price reduction effect. When retailers offer return compensation policies, they can set lower prices in the first stage to attract consumers to purchase. Lower prices and offering return compensation can motivate consumers to provide positive evaluations, and these evaluations can attract more consumers. Then retailers can set higher prices in the second stage to obtain higher profits.
- (2) As consumers' product mismatch increases, retailers' profits show a downward trend. Excessive product mismatch not only affects retailers' profits but also their reputation. Therefore, retailers should further understand consumers' needs to reduce product mismatch and reduce the occurrence of returns, as well as reduce the number of bad reviews. If the high mismatch is due to product quality problems, companies should improve product quality; if it is due to return compensation problems, companies provide personalized services to consumers. Therefore, retailers should strengthen quality management and improve their service level.

- (3) Consumers are paying more and more attention to online reviews before making purchase decisions, so online retailers need to strengthen the management of online reviews and give full play to the role of online reviews. By taking measures to improve the amount of information in online reviews, retailers can help consumers better understand their products and at the same time, they can more accurately target their markets to customers whose needs are better matched to their products, thereby generating higher revenues.

5. CONCLUSIONS

With the rapid development of network technology and the rise of e-commerce, consumers are more and more interested in shopping online. Online reviews have also become an important reference for consumers to make purchase decisions. Considering return compensation offered by the online retailer, we establish a two-stage theoretical model and explore the online retailer's profits and consumers' behavior under different conditions, and then we can obtain the following conclusions.

- (1) When the online retailer offers return compensation, the product price is both affected in the first and the second stage. Since return compensation can improve the consumers' utility, online retailers can compensate for the consumers' loss by providing return compensation. This practice can attract more consumers to some extent. Therefore, the online retailer can set a higher price in the second stage.
- (2) In the case that the online retailer provides return compensation, product mismatches are negatively correlated with the number of positive reviews and positively correlated with the number of negative reviews. In other words, when return compensation fails to compensate the consumers, the higher consumers' perception of a mismatch between product and expectation is, the lower the number of positive reviews is. The higher the online retailer's return compensation is, the lower the number of negative reviews is.
- (3) By comparing the profits of the online retailer in different situations, product mismatch and return compensation play an important role in the profits of the online retailer. When the product mismatch is high, the online retailer can offer a higher return compensation, which can increase the number of positive reviews and may eventually stimulate more consumers to purchase and bring more profits.

In this paper, we study the effect of return compensation policy on online retailers' prices, profits, online reviews, and the product mismatch of the consumer. In our study, we assume that there is only one monopolistic retailer in the market and do not consider the competitive relationship between different retailers or between retailers and upstream manufacturers. In future research, in order to make the research model closer to real life, a dynamic game of multiple retailers with competing relationships can be considered, and a dynamic pricing model can be constructed to analyze the impact of return policies on retailers' pricing, profits, and online reviews. In addition, the studies in the main part of this paper consider single-cycle one-time decisions, and future studies can be conducted on extending them to multi-cycle dynamic decisions.

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DATA AVAILABILITY STATEMENT

The data used to support the findings of this study will be considered by the corresponding author.

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