IOSR Journal of Business and Management (IOSR-JBM)
e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 22, Issue 9. Ser. IV (September 2020), PP 27-36
www.iosrjournals.org

Optimal joint policy of sample try before you buypolicyand returnfor product value uncertainty in online retailing

Yifan Liu, Yiming Sun*
(School of Management, Shanghai University, China)

Abstract: *Product value uncertainty is a critical challenge for retailers and consumers in online retailing.Return is a common policy that retailers have to adopt to solve this problem;however, it may cause retailers' profit loss. Online sample try before you buy is a burgeoning policy for online retailers to mitigate the problem of product value uncertainty.In this paper, we explorewhether this policy could remedy the disadvantage of the return policyto better solve the problem of product value uncertainty. We develop amathematical modelfor the joint policy of sample try before you buy policy and return, and study the optimal product pricing decision for the online retailer and the optimal purchase decisions for consumers. Furthermore, the implementation conditions and value of the joint policyare explored. The results indicate that the online retailer should use the joint policy when the hassle cost of the consumers to use sample try before you buy is sufficiently lowand the matching probability between product value and consumer preference is sufficiently high.In this situation, the sample try before you buy policy can effectively remedythe disadvantage of the return policy. In addition, we find that the online retailer couldadopt the joint policy in a wider parameter range if the marginal revenue level under the high matching is high, the marginal revenue level under the low matching is at an intermediate level, or the matching probability under the normal online retailing is low.*

Keywords: *product value uncertainty; sample try before you buy; return policy; online retailing*

Date of Submission: 04-09-2020 Date of Acceptance: 19-09-2020

I. Introduction

The rapid development of the Internet economy and mobile payment in recent years has made it easy for consumers to shop without leaving home.It greatly promotes the development of online retailing. From 2013 to 2018, the global online retailing market maintained a growth rate of around 20% (EMarketer,2018; Andrew,2019), and the online retailing market in China continued to expand. According to the data from"China e-commerce report 2018",the online retailing sales in China reached 9,006.5 billion RMB in 2018, which is 23.9% increase over the previous year2019. According to the"Global top online retailer report 2019" from the Ministry of Commerce of the People's Republic of China Department of Electronic Commerce and Informatization（2019）, the online retail share in China accounted for more than 18% of the total retailing sales in 2018, with a higher penetration rate than any other country. However, in another sense,online retailing accounts for less than 20% of the industry's total, which indicates that offline retailing remains the dominant retail sector.

Being able to touch, feel and try is an important reason for consumers to choose offline retailing over online(He,2017). Because consumers could only try after purchase in the online, they are often unsure whether the purchasedproduct will meet their expectations and preferences. Therefore, the uncertainty about the value of products to consumers is a huge pain point for online retailing(Honget al.,2010;Hong et al.,2014). Facing the problem of product value uncertainty, on one hand, consumers will worry about whether the product is suitable for them because they cannot see and touch the real products, and can only get the product information through pictures and words.Therefore, they do not want to make the purchase decision easily. On the other hand,without try and experience, consumers will return the product when they realize the product value after the purchase. According to the 2018e-commerce user experience and complaint monitoring report in China,18.46% of the top 20 hot complaints in 2018 were about refund and return (100EC- E-commerce Research Center, 2019).Therefore, whether or not to provide a return guarantee is an important condition for consumers to choose and purchase products. The return guarantee can be used as an ex post policy to make up for the loss of utility caused by consumers'earlier purchase decision and reducethe effect of product value uncertainty.

At present, most of firms offer return service, but for some products with a lot of colors and patterns, such as curtains and floors, it is more difficult for consumers to choose the fabric shading and touch feel ofcurtains or the pattern and quality of floors online. For this kind of product, the matching probability between

*Corresponding author:Yiming Sun, E-mail: sunym777@shu.edu.cn

consumer preference and product value is much higher, and the online retailer will have a higher return risk. Therefore, to solve this problem,the online retailers often recommend consumers to try the samples before purchase these products. For example, consumers can choose their favorite fabric samples online, wait for the samples to arrive at home, and then choose the most suitable one to purchase online.This sample try before you buy policy could reduce the product value uncertainty for the online retailing and ease the loss of profits caused by return. In addition, some game products also belong to this kind of products. They can be tried and also can be returned after purchase. At present, the world's largest comprehensive digital game software distribution platform Steam platform offers a trial version of games. Consumers can have a very short period of time to try the game and could determine whether to purchase the complete game after the short-period experience. The Steam platform also provides a return service for games or software purchased from the Steam store within two weeks and used for no more than two hours. The policy of online sample try before you buy couldimprove the product matching probability forconsumers.The return policycould make consumers believe that the product quality is guaranteed and attract more consumers to buy.Then, whether it is valuable to jointly use these two policies and how to use them are two important questions that are studied in our paper.

"Sample try before you buy" policy has become a trend in the platform based e-commerce and marketing. Based on the above background, this paper aims at solve the problem of the product value uncertainty in the online retailing.We propose and analyze a mathematical modelfor the joint policy of sample try before you buy andreturn, and compare it to the normalonline retailing policy. The research results present when the online retailer should use the joint policy and reveal the implementation value of the sample try before you buy policy.

II. Literature Review

The impact of product value uncertainty on online retailing has been a hot topic in recent years. How to choose an effective marketingmeasure to reduce the uncertainty ofproduct value under the online environment and further attract more consumers is an important concern for online retailers. Hong(2014) divides product uncertainty into descriptive uncertainty, performance uncertainty and product matching uncertainty, where product matching uncertainty is the matching between product characteristics and the buyer's demand. Product matching uncertainty has a greater impact on product revenue, and he stressed that the Internet can be used to address the increasingly common product fit uncertainty. We mainly solve the problem of product value uncertainty by two policies. One is about the influence of returnservice on retailers and consumers'decision-making. The other one is about the study of sample try before you buy policy.

Refund or return service is an ex-post policy to make up for the loss of utility caused by consumers'productpurchase and it allows consumers to return the unfit products to the online retailers.Shen et al.(2011) study the effects of three return strategies on supply chain performance in the context of e-commerce, namely, complete return strategy (full return), no return strategy (zero return), and partial return strategy (partial return), and the optimal decision is obtained by mathematical modeling. Chen et al.(2016) combine the advantages of complete return policy and partial return policy, put forward return guarantee option (such as return freight insurance), and construct a return and pricing model based on option in network sales.Zhang et al.(2019) believe that the uncertainty of product value caused by the lag of online product experience is becoming the main reason for consumers'strategic return behavior, and they study the pricing decision-making for online retailers when consumers have strategic return behavior. Aiming at the problem of high return rate in network channel, they study how retailers choose the channel to sell products and make the return policy. Su et al. (2009) set up a consumer return policy model to study the effects of full return policy and partial return policy on supply chain performance.

The ex post strategy of return or refund aims to convince consumers that the quality of the product is guaranteed and to reduce the uncertainty of consumers about the value of the product in order to attract more consumers to buy. However, refund or return is often a laborious operation. For some retailers, the return risk is high, and the increase in consumer purchases cannot make up for the loss of profit caused by the higher return cost. Therefore, retailers begin to consider the wayof exante trying to improve the consumer and product fit probability to solve the problem caused by too many returns.

Trybefore you buy is a way to reduce the uncertainty of the value of experience products, consumers can experience before buying. Zhang et al. (2016) argue that a pre purchase experience reduces consumer uncertainty about the product, increases the marginal utility of the information obtained, and facilitates consumer purchase decisions. The try before buying online can be divided into offline trial and online trial. One kind of offline trial happens when a consumer voluntarily turns an offline store into a showroom and the consumer chooses to try the product in a physical store to determine the best fit for him. However, after that, the consumer may buy it at a lower price from an online retailer. This behavior is called "Free-riding Behavior." Considering the influence of free-riding behavior of consumers on supply chain operation(Mehra et al., 2018), Pu et al. (2016) design a cost-sharing mechanism to stimulate the promotion efforts and improve the efficiency

of supply chain operation. The other kind of offline trial is that retailers set up offline stores or showrooms to make up for the lack of good shopping experience in online shopping.Based on the case of fashion glasses brand MarbyParker,Bell et al.(2013) study the strategic advantages of showroom model for online retailers. Liu et al. (2013) construct a pricing decision model for a retailer by considering the product quality, in which the showroom model is regarded as a kind of quality free rider.

Due to the limitation of time and place, some consumers will not go to the offline showroom to experience, they prefer to get the product experience through the online way.Li et al.(2019)focus on the try before you buy service for Amazon, namely, Prime Wardrobe.Taking into account customers' self-repair behavior, they analyze that it is feasible for online retailers to adopt try before you buy policy. Liu(2016) models non-sample try before you buyand direct purchase with unconditional return and analyzes the product information to reach a certain value.It is found that try before you buy is better than direct purchase. With the development of science and technology, there are also new breakthroughs in online trial.Sminket al. (2019) study how augmented reality (AR) enables consumers to make a virtual trial online (commonly used in cosmetics and furniture). Then, consumers can get a "try before you buy" experience when they shop online. Liu (2016) compares the free trial service offered by Taobao trial center with the group purchase model, and analyzes when the incentive mechanism of free trial is the most effective. Shao et al. (2016) study the impact of consumer networks on the collaborative mechanism of "merchant- platform" in the free trial model. In this paper, we study the optimal try before you buy policyfor online retailers based on sample products, such as curtains, floors and online games. These sample products can be easier for consumers to try and do not affect the selling of the normal products.

To sum up, the main measures to mitigate the problem of product value uncertainty are the ex ante policy (e.g. try before you buy) and the ex post policy (e.g. return policy). We consider consumers' uncertainty for product value in online retailing and study how to adopt the joint policy of sample try before you buy and return to solve this problem. In addition, we explore the value of the adoption of sample try before you buy policy in the normal online retailing policy.

III. Problem description

In this paper, we consider that an online retailer sells a product to a group of heterogeneous consumers through an online channel at a unit price$p$, and the consumers'willingnessto pay$v$for the product is subject to a uniform distribution$[0, a]$. Followingthe literature, the number of consumers under each willingness to pay is assumed to be 1. Product value uncertainty exists in the online retailing. Similar to the research of Letizia et al.(2018), we characterize this uncertainty by using a binomial distribution. More specifically, with probability$\beta_L(0 < \beta_L \leq 1)$, the consumer's preference has a perfect match with the product value and the consumer with a willingness to pay $v$thus gains a revenue $v\theta_H$from purchasing the product; however, with probability$1 - \beta_L$, the consumer's preference is not matched to the product value and the consumer thus gains a discounted revenue $v\theta_L$ from purchasing the product, where$\theta_H$and $\theta_L$are the marginal value of the productand $\theta_H > \theta_L$ holds.

In order to deal with the problem of product value uncertainty for consumers, the online retailer has to adopt the return and refund policy. According to this policy, after purchasing a product, each consumer could choose whether to return the product based on the actual value of the product. In addition to this *ex post* policy, the online retailer could also provide an*ex ante* policy, i.e., sample try before you buy service. Under this policy, before making apurchase decision, each consumer could apply for a sample product to try and experience. However, due to various online operations,such as filling in forms,waiting for sample delivery and using samples, each consumer shouldpay ahasslecost$h$ for the sample try before you buy service. After the sample try service, the matching probability between the consumer preference and the product value can be increased toβ_H $(0 < \beta_L < \beta_H \leq 1)$ holds.

The sequence of events studied in this paper is: Firstly, the retailer decides whether to adopt the joint policy of sample try before you buy and return; Secondly, the retailer sets the retailing price of the product$p$; Thirdly, according to the retailer's sellingpolicy, each consumer decides whether to apply for the sample try service orbuy the product directly; Finally, the consumer decides whether to apply for a return and refund service or not based on the value of the product.

IV. Benchmark model analysis

In this section, we first study the normal online retailing policy without the sample try before you buy service. Wewill explore the impact of the implementation of the return policy on the profitability of the online retailer.The result can be viewed as abenchmarkfor the further study of the implementation value ofthe sample try before you buypolicy.

4.1Normal online retailing policyanalysis

Under the normal retailing policy, each consumer makes thepurchasing decision according to the retailing price$p$of the product. If a consumer with the willingness to pay v buysthe product, the expected utility function $U_m$can be expressed as:

$$U_m = \beta_L v\theta_H + (1-\beta_L)v\theta_L - p \quad (1)$$

If the consumer does not buy the product, the expected utility is$U_m = 0$. Each consumer's optimal purchasing decision can be easily obtained by comparing thesetwo expected utility functions.That is, consumers with$v \in [\frac{p}{\beta_L\theta_H+(1-\beta_L)\theta_L}, a]$ will buy the product, and consumers with$v \in [0, \frac{p}{\beta_L\theta_H+(1-\beta_L)\theta_L}]$will not buy the product. Then, the online retailer's profit function can be expressed as$\Pi_m(p) = p(a - \frac{p}{\beta_L\theta_H+(1-\beta_L)\theta_L})$.Proposition 1 describes the optimal pricing decision for the retailer under the normal online retailing policy.

Proposition 1. When theonline retailer adopts the normal online retailingpolicy, the optimal pricing decision is$p^* = \frac{a[\beta_L\theta_H+(1-\beta_L)\theta_L]}{2}$.

Proof of proposition 1. The profit function of a retailer under the online retailing policy is expressed as $\Pi_m(p) = (a - \frac{p}{\beta_L\theta_H+(1-\beta_L)\theta_L})p$. It can be examined that this function is a concave function with respect to p. According to the first-order condition, we can obtain the optimal pricing decision.□

Proposition 1 describes the optimal pricing decision under the normal online retailing policy. It indicates that with the decrease of the matching probability between the consumer preference and the product valueβ_L, the marginal revenues $\theta_H$andθ_L, and the maximum willingness-to-pay a, the online retailer should reduce the retailing price to maintain a stable market demand.

4.2 The influence of return policy on the normal online retailing policy

In this section, we will discuss the effect of return policy on the normal online retailing policy.Then, each consumer faces a two-stage decision-making problem: product purchase decision in the first stage and the product return decision in the second stage. We first consider the decision in the second stage. In the second stage,a consumer with a willingness-to-pay $v$could clearly realize the product value and decide whether to apply for the return policy.If the consumer keeps the product, the utility value will be$v\theta_I - p$,where $I = \{H, L\}$,and if the consumer returns the product, the utility value will be 0. Then, the consumer will compare these two utility values to choose the optimal decision. In the first stage, the consumer will decide whether to purchase the product. If the consumer purchases the product, the utility function$U_d$can be expressed as

$$U_d = \beta_L \max\{v\theta_H - p, 0\} + (1-\beta_L)\max\{v\theta_L - p, 0\}. \quad (2)$$

If the consumer does notpurchase, the utility function is$U_d = 0$. Lemma 1 characterizes the consumer's optimal purchase decision when the retailer adopts the return policygiven the product retailing price$p$.

Lemma 1. When the productreturn is allowed for the normal online retailing policyand the retailing price of the product is set as$p$, consumers with$v \in [\frac{p}{\theta_L}, a]$ will purchase the product and not return it, consumers with$v \in [\frac{p}{\theta_H}, \frac{p}{\theta_L}]$will purchase the productbut will return it if the realized product value does not match, andconsumerswith $v \in [0, \frac{p}{\theta_H}]$ will not purchase the product.

Proof of Lemma 1. We consider the following four cases to prove.

(1) When$v\theta_H - p > 0$and$v\theta_L - p > 0$, U_d can be rewritten as$U_d = \beta_L(v\theta_H - p) + (1-\beta_L)(v\theta_L - p)$.It can be examined that$U_d > 0$ holds if$v > \frac{p}{\beta_L\theta_H+(1-\beta_L)\theta_L}$. Because $v > \frac{p}{\theta_H}$, $v > \frac{p}{\theta_L}$, and$\frac{p}{\theta_L} - \frac{p}{\beta_L\theta_H+(1-\beta_L)\theta_L} = p\beta_L\theta_H - p\beta_L\theta_L > 0$, consumers with $v > \frac{p}{\theta_L}$ will buy the productand not return.

(2) When$v\theta_H - p > 0$and$v\theta_L - p < 0$, U_d can be rewritten as$U_d = \beta_L(v\theta_H - p)$.Thus,$U_d > 0$holds if$v > \frac{p}{\theta_H}$. Then, $\frac{p}{\theta_H} < v < \frac{p}{\theta_L}$ holds.Thus,consumers with $\frac{p}{\theta_H} < v < \frac{p}{\theta_L}$ will buy the product.Furthermore, these consumers will not return the productwhen the product value matches the preference and will return the product when the product value does not match the preference.

(3) When$v\theta_H - p < 0$and $v\theta_L - p > 0$,$\frac{p}{\theta_L} < v < \frac{p}{\theta_H}$must hold. Because $\frac{p}{\theta_H} < \frac{p}{\theta_L}$ holds, thiscase does not exist.

(4) When$v\theta_H - p < 0$and $v\theta_L - p < 0$, U_d can be rewritten as$U_d = 0$.Then,consumers with $v < \frac{p}{\theta_H} < \frac{p}{\theta_L}$ will not buy the product.

Lemma 1 can be obtained based on the results of the above four cases. □

Lemma 1 shows that when the retailer adopts the return policy, there are three kinds of decisions based on consumers' willingness to pay: (i) For the consumers with sufficiently high willingness to pay, they will buy the product and will not consider to apply for return; (ii)For the consumers with intermediate willingness to pay,they will buy the product and then return it if the realized valuedoes not match the preference; (iii) For consumers

with sufficiently lowwillingness to pay, they will not to buy the product. Based on Lemma 1, we obtain the retailer's profit function when the retailer adopts the return policy: $\Pi_d(p) = p(a - \frac{p}{\theta_L}) + \beta_L p(\frac{p}{\theta_L} - \frac{p}{\theta_H})$, where $a - \frac{p}{\theta_L}$ represents the demand for the productwith sufficiently high willingness to pay, and $\frac{p}{\theta_L} - \frac{p}{\theta_H}$ represents the demand for the product with intermediate willingness to pay. Proposition 2 characterizes the optimal pricing decision for the online retailer under the return policy.

Proposition 2. When the retailer adopts the joint policy of normalonline retailing and return policies, the optimal pricing decision is $p^* = \frac{a\theta_L\theta_H}{2\theta_H(1-\beta_L)+2\beta_L\theta_L}$.

Proof of proposition 2. The profit function of the online retailer under the joint policy can be expressed as $\Pi_d(p) = p(a - \frac{p}{\theta_L}) + \beta_L p(\frac{p}{\theta_L} - \frac{p}{\theta_H})$.Clearly, this function is a concave function with respect to p. According to the first-order condition, the optimal pricing decision p^* is $\frac{a\theta_L\theta_H}{2\theta_H(1-\beta_L)+2\beta_L\theta_L}$.

Proposition 2 describes the optimal pricing decision of the online retailer under the return policy. Similar to the normal online retailingpolicy, Proposition 2 shows that the online retailer should reduce the retailing price of the product with the decrease of the matching probability between the consumer preference and the product value β_L, the marginal revenues θ_H and θ_L, and the maximum willingness-to-pay a. Furthermore, the effect of the return policy on the retailer's profitability is analyzed. The result is as follows.

Proposition 3. The online retailer's profit is strictly reduced when the return policy is adopted.

Proof of proposition 3. From Proposition 1, we know that the optimal profit of the online retailer under the normal online retailing policy is $\Pi_m^* = \frac{a^2[\beta_L\theta_H+(1-\beta_L)\theta_L]}{4}$. From Proposition 2, we know that the optimal profit of the online retailer under the joint policy of the normalonline retailing and return is $\Pi_m^* = \frac{a^2[\beta_L\theta_H+(1-\beta_L)\theta_L]}{4}$. Comparing the two profits, we have $\Pi_m^* - \Pi_d^* = 4a^2\beta_L(\theta_H - \theta_L)^2(1-\beta_L) > 0$. Therefore, the profit under the normal online retailing policy is strictly larger than the profit with the return policy. □

Proposition 3 indicates that when the online retailer introduces the return policy, although itprovides an effective incentivefor consumers topurchase online, it will cause the decline of the online retailer's profit.Under the increasingly competitive market environment for the online retailing, the online retailer have to implement the refund or refund policy. To a certain extent, the return policy couldindeed makes up for the uncertainty of product value caused by the online retailing for consumers to buy products. However, how to use the return policy more reasonably and economically is a valuable question that is needed a further study.Based on the preliminary exploration of sample try before you buypolicy in practice, this paper will further explore whether this policy can reduce the negative effect of the return policy and improve the profitability of online retailers from the perspective of theoretical research.

V. Sample try before you buypolicy analysis

This section will first analyze the joint decision-making optimization of sample try before you buy and return policies, and then, through the comparison to the normal online retailing policy, we further analyze the implementation value of sample try before you buy policy.

5.1 The joint policy ofsample try before you buy and return

Under the joint policy of sample try before you buy and return,if a consumer with willingness to pay $v$chooses the sample try before you buy service, the utility function U_b can be expressed as:

$$U_b = \max\{\beta_H \max\{v\theta_H - p, 0\} + (1-\beta_H)\max\{v\theta_L - p, 0\}, 0\} - h. \quad (3)$$

Note that if $\beta_H \max\{v\theta_H - p, 0\} + (1-\beta_H)\max\{v\theta_L - p, 0\} < 0$, $U_b = -h < 0$. It means that for consumers who do not buy the product without the sample try before you buy service, the adoption of the sample try before you buy service still cannot attract them to buy the product. Therefore, the consumers that choosethe sample try before you buy service should satisfy $U_b = \beta_H \max\{v\theta_H - p, 0\} + (1-\beta_H)\max\{v\theta_L - p, 0\} - h > 0$.Then, the utility function can be rewritten as follows:

$$U_b = \beta_H \max\{v\theta_H - p, 0\} + (1-\beta_H)\max\{v\theta_L - p, 0\} - h. \quad (4)$$

If the consumer does not buythe product, the utility function is $U_b = 0$. Lemma 2 characterizes the consumer's purchase decisionwhenthe retailer adopts the joint policy of sample try before you buy and return.

Lemma 2. Given the product's retailing price p,when the retailer adopts the joint policy of sample try before you buy and return, there exists a threshold $\hat{p} = \frac{h\theta_L}{\beta_H\theta_H - \beta_H\theta_L}$,such that

(1) when $p > \hat{p}$, consumers with $v \in [\frac{p}{\theta_L}, a]$will purchase the product after trying the sample and will not apply for return after realizing the product value,consumers with $v \in [\frac{h+\beta_H p}{\beta_H\theta_H}, \frac{p}{\theta_L}]$will purchase the product after trying the sample and will apply for return after realizing that the product value does not match the preference,

andconsumers with $v \in [0, \frac{h+\beta_H p}{\beta_H \theta_H}]$will not buy the product.

(2) when$p \le \hat{p}$, consumers with $v \in [\frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}, a]$will purchase the product after trying the sample and will not apply for return after realizing the product value, andconsumers with $v \in [0, \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}]$ will not buy the product.

Proof of Lemma2. We consider the following four cases to prove.

(1) When$v\theta_H - p > 0$and $v\theta_L - p > 0$, U_b can be rewritten as$U_b = \beta_H(v\theta_H - p) + (1-\beta_H)(v\theta_L - p) - h$.It can be examined that$U_b > 0$ holds if$v > \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}$. Because $v > \frac{p}{\theta_L} > \frac{p}{\theta_H}$,we then have$\frac{p}{\theta_L} - \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L} = p\beta_H\theta_H - (p\beta_H + h)\theta_L$. Therefore, when $p > \frac{h\theta_L}{\beta_H(\theta_H-\theta_L)}$, $\frac{p}{\theta_L} > \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}$ holds.Then,$U_b > 0$ holds for consumers with $v > \frac{p}{\theta_L}$and they will not apply for return after realizing the product value.When $p < \frac{h\theta_L}{\beta_H(\theta_H-\theta_L)}$, then $\frac{p}{\theta_L} < \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}$ .Then, $U_b > 0$ holds for consumers with $v > \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}$. $U_b < 0$ holds forconsumers with $\frac{p}{\theta_L} < v < \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L}$and they thus will not buy the product.

(2) When$v\theta_H - p > 0$and$v\theta_L - p < 0$, U_b can be rewritten as$U_b = \beta_H(v\theta_H - p) - h$.It can be examined that$U_b > 0$ holds for $v > \frac{h+\beta_H p}{\beta_H \theta_H}$. Because $\frac{p}{\theta_H} < v < \frac{p}{\theta_L}$,then we have$\frac{h+\beta_H p}{\beta_H \theta_H} - \frac{p}{\theta_H} = h\theta_H > 0$. Furthermore, we have $\frac{p}{\theta_L} - \frac{h+\beta_H p}{\beta_H \theta_H} = \beta_H(\theta_H - \theta_L)p - h\theta_L$. Thus, $\frac{h+\beta_H p}{\beta_H \theta_H} > \frac{p}{\theta_L}$ holds if$p < \frac{h\theta_L}{\beta_H(\theta_H-\theta_L)}$ .Then, $U_b < 0$ holds for consumers with $\frac{p}{\theta_H} < v < \frac{p}{\theta_L}$and they thus will not buy the product. When $p > \frac{h\theta_L}{\beta_H(\theta_H-\theta_L)}$, $\frac{h+\beta_H p}{\beta_H \theta_H} < \frac{p}{\theta_L}$ holds.Then, $U_b < 0$ holds for consumers with $\frac{h+\beta_H p}{\beta_H \theta_H} > v > \frac{p}{\theta_H}$and they will not buy the product. $U_b > 0$holds forconsumers with $\frac{p}{\theta_L} > v > \frac{h+\beta_H p}{\beta_H \theta_H}$and they will buy the product. For the return decision, they will only return the product when it does not match.

(3)When $v\theta_H - p < 0$and $v\theta_L - p > 0$,$\frac{p}{\theta_L} < v < \frac{p}{\theta_H}$must hold. Because $\frac{p}{\theta_H} < \frac{p}{\theta_L}$ holds, thiscase does not exist.

(4) When$v\theta_H - p < 0$and$v\theta_L - p < 0$, U_b can be rewritten as$U_b = -h$.Therefore,consumers with $v < \frac{p}{\theta_H}$will not buy the product.

Lemma2 can be obtained based on the results of the above four cases. □

Lemma 2 shows that when the retailer uses the joint policy of sample try before you buy and return, the consumer will make different purchase decisions according to the online retailer's two pricing policies, i.e., high price policy and low price policy. When the retailer adopts the high price policy, there are three kinds of purchase decisions for consumers: (i) Purchase after trying and not return the product;(ii) Purchase after tryingandreturn the product when the value does not match; (iii) Not purchase. When the retailer adopts the low price policy, there are two kinds of purchase decisionsfor consumers:(i) Purchase after tryingand not return the product;(ii) Not purchase. It can be seen that when the retailer adopts the high price policy afterimplementing the sample try before you buypolicy, some consumers will still apply for return, whereas when the low price policy is adopted, the implementation of the sample try before you buypolicy could eliminate the return.

Based on Lemma 2, the profit function can be obtained when the retailer adopts the joint policy of sample try before you buy and return. When $p > \hat{p}$, the retailer's profit function can be expressed as: $\Pi_b(p) = p(a - \frac{p}{\theta_L}) + \beta_H p(\frac{p}{\theta_L} - \frac{h+\beta_H p}{\beta_H \theta_H})$. When $p \le \hat{p}$, the retailer's profit function can be expressed as: $\Pi_b(p) = p(a - \frac{h+p}{\beta_H \theta_H+(1-\beta_H)\theta_L})$. Proposition 4 characterizes the optimal pricing decision for the online retailer under the joint policy of sample try before you buy and return.

Proposition 4. When the retailer adopts the joint policy of sample try before you buy and return, the retailer's optimal pricing decision is as follows.

(1) When $h < \frac{a\theta_H(\theta_H-\theta_L)}{\theta_H+\theta_L}$ and $\frac{2\theta_H h}{(\theta_H-\theta_L)(a\theta_H+h)} < \beta_H \le 1$, the retailer's optimal pricing decision is$p^* = \frac{h\theta_L - a\theta_H\theta_L}{2\beta_H(\theta_H-\theta_L)-2\theta_H}$.

(2) When $h < \frac{a\theta_H(\theta_H-\theta_L)}{(\theta_H+\theta_L)}$ and $\frac{-(a\theta_L-h)+\sqrt{(a\theta_L-h)^2+8ah\theta_L}}{2a(\theta_H-\theta_L)} < \beta_H \le \frac{2\theta_H h}{(\theta_H-\theta_L)(a\theta_H+h)}$, or when $h \ge \frac{a\theta_H(\theta_H-\theta_L)}{\theta_H+\theta_L}and\beta_H < 1 < \frac{2\theta_H h}{(\theta_H-\theta_L)(a\theta_H+h)}$, the retailer's optimal pricing decision is$p^* = \hat{p} = \frac{h\theta_L}{\beta_H\theta_H - \beta_H\theta_L}$.

(3) When $h < \frac{a\theta_H(\theta_H-\theta_L)}{(\theta_H+\theta_L)}$ and $0 < \beta_H \le \frac{-(a\theta_L-h)+\sqrt{(a\theta_L-h)^2+8ah\theta_L}}{2a(\theta_H-\theta_L)}$, the retailer'soptimal pricing decision

is$p^* = \frac{a[\beta_H\theta_H+(1-\beta_H)\theta_L]-h}{2}$.

Proof of Proposition 4. When $p > \hat{p}$, $\Pi_b(p) = p(a - \frac{p}{\theta_L}) + \beta_H p(\frac{p}{\theta_L} - \frac{h+\beta_H p}{\beta_H\theta_H})$,and it is a concave function with respect to p. According to the first-order condition, the optimal pricing decision is$p^* = \min\left\{\frac{h\theta_L - a\theta_H\theta_L}{2\beta_H(\theta_H-\theta_L)-2\theta_H}, \frac{h\theta_L}{\beta_H\theta_H-\beta_H\theta_L}\right\}$. When $p \le \hat{p}$, $\Pi_b(p) = p(a - \frac{h+p}{\beta_H\theta_H+(1-\beta_H)\theta_L})$,and it is a concave function with respect to p. According to the first-order condition, the optimal pricing decision is$p^* = \max\left\{\frac{a[\beta_H\theta_H+(1-\beta_H)\theta_L]-h}{2}, \frac{h\theta_L}{\beta_H\theta_H-\beta_H\theta_L}\right\}$.The results of Proposition 4 can be obtained by simplifying the two optimal pricing decisions.□

Proposition 4 shows that the retailer's optimal pricing decision is determined by the matching probability between product value and consumer preferenceβ_H and the hassle cost$h$. When the hassle cost$h$is low and the matching probability between product value and consumer preference $\beta_H$is high, the retailer should adopt the high price policy to obtain the optimal profit. When the hassle cost$h$is low and the matching probability between product value and consumer preferenceβ_H is at an intermediate level, or when the hassle cost$h$ is high and no matter the matching probability between product value and consumer preference$\beta_H$is high or low, the retailer should choose the intermediate price threshold$\hat{p}$ as the optimal pricing decision. When thehassle cost h is low and the matching probability between product value and consumer preference$\beta_H$is low, the retailer should adopt the low price policy to obtain the optimal profit.

5.2 The value of the joint policy of sample try before you buy and return

In this section, we compare the joint policy of sample try before you buy and return to the normal online retailing policy, analyze the retailer's optimal strategy choice, and discuss the value of the sampletry before you buy policy. The results are shown in Proposition 5.

Proposition 5. If and only if$h < \frac{a\theta_H(\theta_H-\theta_L)}{\theta_H+\theta_L}$and $\frac{\theta_H}{(\theta_H-\theta_L)} - \frac{\theta_L(h-a\theta_H)^2}{\theta_H a^2[(\beta_L\theta_H+(1-\beta_L)\theta_L](\theta_H-\theta_L)} < \beta_H \le 1$,the joint policy of sample try before you buy and return can improve the profitability.

Proof of proposition 5. According toPropositions 1 and 4, we can obtain the optimal profits under the normal online retailing policy and the joint policy of sample try before you buy and return. Then, we consider the following four cases.

(1) When $h < \frac{a\theta_H(\theta_H-\theta_L)}{\theta_H+\theta_L}$ and $\frac{2\theta_H h}{(\theta_H-\theta_L)(a\theta_H+h)} < \beta_H < 1$, we have $\Pi_b^* - \Pi_m^*$=$4(h\theta_L - a\theta_H\theta_L)^2 - 4\theta_H\theta_L a^2[(\beta_L\theta_H + (1-\beta_L)\theta_L][(1-\beta_H)\theta_H + \beta_H\theta_L]$ .If $\beta_H > \frac{\theta_H}{(\theta_H-\theta_L)} - \frac{\theta_L(h-a\theta_H)^2}{\theta_H a^2[(\beta_L\theta_H+(1-\beta_L)\theta_L](\theta_H-\theta_L)}$, $\Pi_b^* - \Pi_m^* > 0$ holds. Therefore, the joint policy of sample try before you buy and return could achieve a larger profitthan the normal online retailing policy.Considering the condition $\frac{2\theta_H h}{(\theta_H-\theta_L)(a\theta_H+h)} < \frac{\theta_H}{(\theta_H-\theta_L)} - \frac{\theta_L(h-a\theta_H)^2}{\theta_H a^2[(\beta_L\theta_H+(1-\beta_L)\theta_L](\theta_H-\theta_L)} < 1$,we then havewhen $0 < h < \frac{a\theta_H\theta_L - a\beta_L{\theta_H}^2 + a\beta_L\theta_H\theta_L}{2\theta_L}$ and $\frac{h+a\theta_H}{2a(\theta_H-\theta_L)} < \beta_H < 1$ or when $\frac{a\theta_H\theta_L - a\beta_L{\theta_H}^2 + a\beta_L\theta_H\theta_L}{2\theta_L} < h < a\theta_H - a\sqrt{\beta_L{\theta_H}^2 + \theta_H\theta_L - \beta_L\theta_L\theta_H}$ and $\frac{\theta_H}{(\theta_H-\theta_L)} - \frac{\theta_L(h-a\theta_H)^2}{\theta_H a^2[\beta_L\theta_H+(1-\beta_L)\theta_L](\theta_H-\theta_L)} < \beta_H < 1$,the joint policy of sample try before you buy and return could achieve a larger profitthan the normal online retailing policy.

(2)When $h < \frac{a\theta_H(\theta_H-\theta_L)}{\theta_H+\theta_L}$ and $\frac{-(a\theta_L-h)+\sqrt{(a\theta_L-h)^2+8ah\theta_L}}{2a(\theta_H-\theta_L)} < \beta_H < \frac{2\theta_H h}{(\theta_H-\theta_L)(a\theta_H+h)}$, $\Pi_m^* - \Pi_b^* = -4\theta_L h^2 + 4a\theta_L(\beta_H\theta_H - \beta_H\theta_L)h - a^2(\beta_L\theta_H - \beta_L\theta_L + \theta_L)(\beta_H\theta_H - \beta_H\theta_L)^2$ .Because $\Pi_b^* - \Pi_m^* < 0$,the normal online retailing policy is better thanthe joint policy of sample try before you buy and return.

(3)When $h < \frac{a\theta_H(\theta_H-\theta_L)}{\theta_H+\theta_L}$ and $0 < \beta_H < \frac{-(a\theta_L-h)+\sqrt{(a\theta_L-h)^2+8ah\theta_L}}{2a(\theta_H-\theta_L)}$, $\Pi_b^* - \Pi_m^* = 4h^2 - 8a[\beta_H\theta_H + (1-\beta_H)\theta_L]h + 4a^2[\beta_H\theta_H + (1-\beta_H)\theta_L][\beta_H\theta_H + (1-\beta_H)\theta_L - \beta_L\theta_H - (1-\beta_L)\theta_L]$ .It can be examined that$\Pi_b^* - \Pi_m^* < 0$holds.Therefore, the normal online retailing policy is better thanthe joint policy of sample try before you buy and return.

(4)When$h > \frac{a\theta_H(\theta_H-\theta_L)}{(\theta_H+\theta_L)}$, the same as case (2) , we can prove thatthe normal online retailing policy is better thanthe joint policy of sample try before you buy and return. □

Figure 1 illustrates a numerical example for Proposition 5. It showshow the online retailer should choose between the normal online retailing policy and the joint policy under different hassle costs and matching probabilities. The basic parameters are: $\beta_L = 0.1, a = 1, \theta_H = 1, \theta_L = 0.5$. Proposition 5 shows that when the hassle cost is low and the matching probability β_H is high, the joint policy of sample try before you buy and return could achieve a larger profitthan the normal online retailing policy. A lower hassle cost will make

consumers more inclined to choose the sample try before you buy service.This service could reduce the uncertainty of product value for consumers, improve the matching probability, avoid the cost of refund and return, and thus increase the online retailer's profit. It means that the online retailer should consider to adoptthe sample try before you buy policyto remedy the defect of the return policy. Proposition 5 suggests that when the hassle cost is low and the matching probability is high, the implementation of the sample try before you buy policy can improve the return policy, as shown in Figure 1.

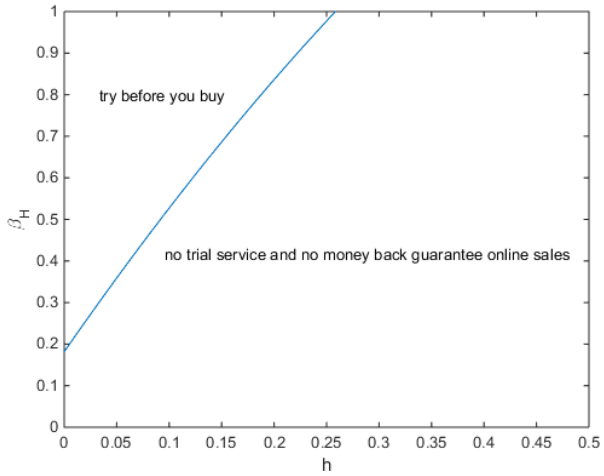

Figure 1 The illustration of the optimality conditions for the online retailer to choose between the joint policy and the normal online retailing policy.

Proposition 5 indicates that only when the matching probability $\beta_H$is largerthan a threshold value, it is valuable for the online retailer to use the sampletry before you buy policy.Next, we rely on the numerical experiments to explore how the relevant parameters affect this threshold value.Figure 2 illustrates the effect of the marginal revenueunder matching$\theta_H$on the threshold valueto adopt the sample try before you buy policy. The basic parameters are: $a = 1,\ h = 0.1,\ \theta_L = 0.1$.$\beta_L$varies among 0.1, 0.2 and 0.3.

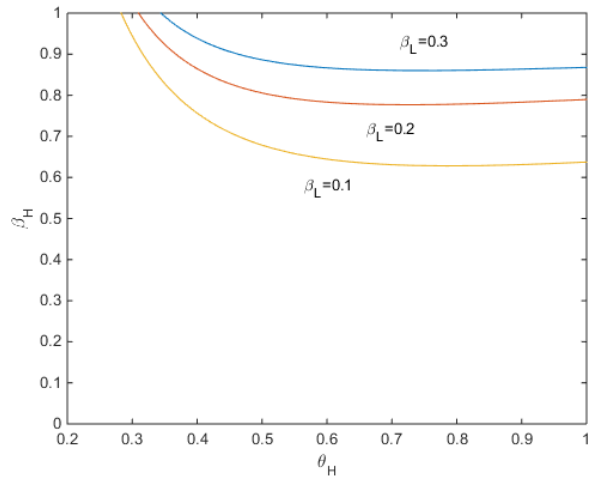

Figure 2 The illustration ofthe effect of the marginal revenue under matching on the matching probability threshold value to adopt the try before you buy policy.

Figure 2 shows that as the marginal revenue under matching $\theta_H$increases, the threshold value significantly decreases at first and then tends to level off gradually. It means that the retailer can take advantage of the sample try before you buypolicy more widely with the increase of θ_H. On the other hand, it can be seen that with the decrease of the matching probabilityβ_L under the normal online retailing policy, the online retailer could use the sampletry before you buy policy in a larger parameter region.

Figure 3 shows the effect of the marginal revenue under mismatching$\theta_L$on the threshold value to adopt the sample try before you buy policy.The basic parameters are: $a = 1,\ h = 0.1,\ \theta_H = 0.8$. The same as Figure 2, $\beta_L$varies among 0.1, 0.2 and 0.3.

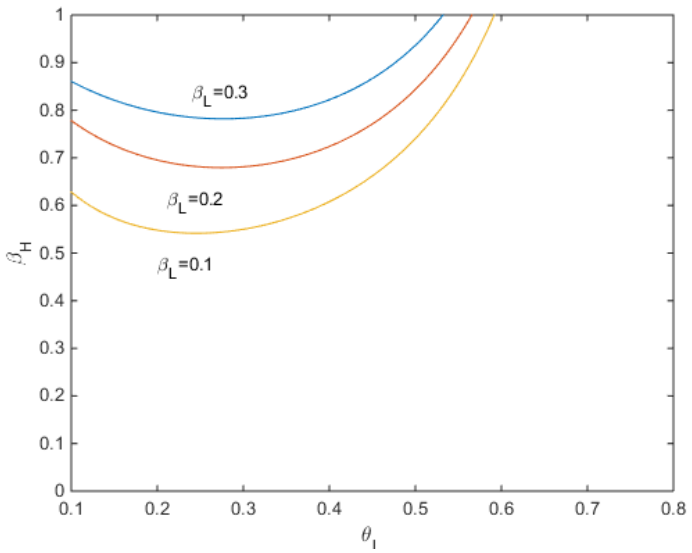

Figure 3 The illustration of the effect of the marginal revenue undermismatching on the matching probability threshold value to adopt the try before you buy strategy.

Figure 3 shows that thematching probability threshold value to adopt the try before you buy policy decreases first and then increases with the increase of the marginal revenue under mismatching θ_L. It means that when the marginal revenue under mismatchingθ_L is at an intermediate level, the online retailer could use the sampletry before you buy policy more widely to improve the profit. Figure 3 also shows that with decrease of the matching probability $\beta_L$under the normal online retailing policy, the online retailer has a larger incentive to use the sample try before you buy policy. It indicates that when the sample try before you buyservice is introduced to improve the matching probability between product value and consumer preference, the online retailer could use the joint policy of sample try before you buy and return in a larger parameter region.

VI. Conclusion

Sample try before you buy is a new marketing policy under the rapid development of e-commerce. Based on the uncertainty of product value in consumer online shopping, this paper studies how the online retailer shouldadoptthe joint policy of sample try before you buy and return to maximize the profit, and analyzes the value of sample try before you buy policy. The results show that: (i) The retailer's profit is reduced when the return policy is introduced in the normal online retailing policy. However, the joint policy of sample try before you buy and return could effectively remedy this phenomenon if the consumer's hassle cost is low and the matching probability between product value and consumer preference is high. (2) When the marginal revenue under matching is sufficiently high and the marginal revenue under mismatching is at an intermediate level, the online retailer could adopt the sample try before you buy policy in a larger parameter region. (3) With the increase of the matching probability between the product value and consumer preference under the normal online retailing policy, the online retailer could adoptthe try before you buy policyin a wider parameter range.

References

[1]. Emarketer. (2018).Worldwide Retail and Ecommerce Sales: eMarketer's Updated Forecast and New McommerceEstimates for 2016—2021. https://www.emarketer.com/Report/Worldwide-Retail-Ecommerce-Sales-eMarketers-Updated-Forecast-New-Mcommerce-Estimates-20162021/2002182.

[2]. Andrew, L. (2019).Global Ecommerce 2019-Ecommerce Continues Strong Gains Amid Global EconomicUncertainty.https://www.emarketer.com/content/global-ecommerce-2019.

[3]. Ministry of Commerce of the People's Republic of China Department of Electronic Commerce and Informatization. (2019).China e-commerce report (2018). http://dzsws.mofcom.gov.cn/article/ztxx/ndbg/201905/20190502868244.shtml.

[4]. Jessica, Y.(2019).Top 10 online retailers: How the largest online retailers in the world fared in 2018. https://www.digitalcommerce360.com/2019/03/14/top-10-online-retailers/.

[5]. He, Y.Y. (2017).A study on O2O decision making considering consumer quality cognitive behavior. University of Science and Technology of China.

[6]. Hong, Y., Pavlou, P. A. (2010). Fit Does Matter! An Empirical Study on Product Fit Uncertainty in Online Marketplaces. https://ssrn.com/abstract=1600523 or http://dx.doi.org/10.2139/ssrn.1600523.

[7]. Hong,K. Y., Pavlou,P.A. (2014). Product Fit Uncertainty in Online Markets: Nature, Effects, and Antecedents. Information Systems Research, 25(2), 328-344.

[8]. 100EC- E-commerce Research Center.(2019). China E-commerce user experience and Complaint Monitoring Report

2018.http://www.100ec.cn/zt/2018yhts/.
[9]. Shen, C. L., Zhang, X. X.(2011). On Customer False Failure Return Policies in E-Business Environment. Industrial Engineering Journal,14(3),55-59.
[10]. Chen, C. P., Chen, Z. X.(2016). Return guarantee and pricing decision-making in online sales. China Management Science, 24(06), 52-60.
[11]. Zhang, L. G., Guo, X. L., Han, D. Y., Yu, Y. G.(2019). Study on product pricing considering the lag of consumers'online shopping experience. China Management Science, 27(03), 77-84.
[12]. Chen, B. T., Chen, J. (2017). When to introduce an online channel, and offer money back guarantees and personalized pricing? European Journal of Operational Research,257(2), 614-624.
[13]. Su, X. M.(2009). Consumer returns policies and supply chain performance. Manuf. Serv. Oper. Manage,11(4), 595–612.
[14]. Zhang, F., Zou, P., Yu, B.(2016). The influence of product experience based on psychological distance on purchasing behavior. Business Research, 09, 107-116.
[15]. Mehra, A., Kumar, S., & Raju, J. S.(2018). Competitive strategies for brick-and-mortar stores to counter "showrooming". Management Science, 64(7), 3076-3090.
[16]. Pu, X. J., Gong, L.(2016). Research on pricing and promotion strategy of dual-channel supply chain under the influence of free-rider behavior. China Management Science, 24(10), 86-94.
[17]. Bell, D. R., Gallino, S., Moreno, A.(2013). Inventory showrooms and customer migration in omni-channel retail: The effect of product information. SSRN Electronic Journal.
[18]. Liu, Q.(2013). 'Showrooming' and price-matching guarantee. SSRN Electronic Journal.
[19]. Li, Y., Li, G., Tayi, G. K.(2019). Try-Before-You-Buy: online retailing strategy with customer self-mending. Electronic Commerce Research and Applications,100866.
[20]. Liu, L. Y.(2016). Operational Mechanism and inventory strategy of Network Trial Marketing Model. Fuzhou University.
[21]. Smink, A. R., Frowijn S., Van Reijmersdal E. A., et al.(2019).Try Online Before you Buy: How does Shopping with Augmented Reality affect Brand Responses and Personal Data Disclosure. Electronic Commerce Research and Applications, 35, 100854.
[22]. Shao, P.(2016). The impact of consumer networks on the business-to-business platform of trial products. China Management Science, 24(02), 76-83.
[23]. Letizia, P., Pourakbar, M., Harrison, T.(2018). The Impact of Consumer Returns on the Multichannel Sales Strategies of Manufacturers. Production and Operations Management, 27(2), 323-349.

Yifan Liu, Yiming Sun. "Optimal joint policy of sample try before you buypolicyand returnfor product value uncertainty in online retailing." *IOSR Journal of Business and Management (IOSR-JBM)*, 22(9), 2020, pp. 27-36.