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# Complimentary Return-Freight Insurance Serves as Quality Signal or Noise?

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## Abstract

In order to decrease the consumer return transaction cost, e-commerce platform Alibaba invited an insurance company to develop a new type of insurance to compensate consumers for returns, which is called return-freight insurance. The new insurance has resulted in online return's explosive growth. However, some online retailers still choose to offer complimentary return-freight insurance to signal their products' quality. Using signaling theory, we build a conceptual economic model to explore what kind of online retailer should adopt this strategy under incomplete information. Based on the fact that each product's return probability, profit, and insurance compensation are different, our main results show the separating equilibria, where only high-quality online retailers will offer complimentary return-freight insurance. Interestingly, return-freight insurance profit and compensation play different roles in the signal effect. The insurance premium plays a deep role while the compensation plays at the surface, because consumers could only observe the compensation when purchasing.

**Keywords** Return-freight insurance, Signaling Quality, Separating Equilibrium

## 1 Introduction

With continuing e-commerce development, the number and types of online products are constantly increasing, giving consumers more choices. Such online environments are the norm for experience goods. But even for so-called search goods, because people are increasingly buying products online, there is significant uncertainty about product quality at the time of purchase. It is not strange that the return rates for online shopping are generally double those of brick-and-mortar purchases (McWilliams 2012). Initially, some online retailers and platforms provided money-back guarantees (MBGs) as a return policy, which can be used as a product-quality signal (Moorthy and Srinivasan 1995). However, since all major online retailers improved their product quality and take the MBG strategy, it is no longer an effective signal (McWilliams 2012). Though online reputation, product descriptions, and online product reviews could serve as product-quality signals (Mavlanova et al. 2012), they can easily be subverted by fake online reviews or opinion spam (Lau et al. 2011), confusing consumers (Dellarocas 2003). This situation requires more shopping skills of online consumers and the aforementioned signals do not work well. Are any other effective signal available to online retailers?

In 2010, an insurance company, which profits by using the probability of product reservation, invented a new type insurance called return-freight insurance (Zhang and Hu 2013). Regardless of whether the purchase is insured by the consumer or by the online retailer, insurance company will pay the return-freight fee if the consumer returns a product after the purchase. With a low premium, easy signup, and convenient claim features, return-freight insurance provides psychological and financial security for online consumers. However, the emergence of return-freight insurance leads to another problem: many more returns than before, which has exhausted online retailers (Shulman et al. 2010; Zhang and Hu 2013). Return quantity increased significantly, partially because some online retailers offer the return-freight insurance for free to consumers. Does this choice provide information to consumers that these retailers' products are high quality? We call the aforementioned strategy complimentary return-freight insurance. High-quality retailers consider absorbing the consumer's return transaction cost to signal that their product quality is high. In contrast, the usual return policy (MBG) allows the consumer to return a product for any reason, but requires the consumer to bear the return-freight fee.

Since most online retailers adopt the MBG strategy (Hsiao and Chen 2012), our objective is to show whether the more lenient return policy, complimentary return-freight insurance, can signal online-product quality. A low-quality online retailer offering a complimentary return-freight will have a higher probability of return than a high-quality retailer. With homogeneous consumers, this effect by itself is sufficient to ensure a low-quality retailer does not mimic the high-quality retailer's complimentary return-freight insurance strategy. We interpret this logic by building a conceptual economic model and analysing the costs and benefits of using complimentary return-freight insurance as a signal.

The high-quality online retailer, who knows that his product is better than his competitors', is eager to signal that quality to consumers. The consumer, a signal receiver who does not know which online retailer's product is better, may see the high-quality retailer's largesse as signaling a high-quality product. However, when the return-freight insurance is purchased directly by the consumer, he or she observes both the insurance premium and the compensation. In contrast, when offered by the online retailer, only the insurance compensation is available to the consumer. Products of different quality levels have different insurance premiums and compensation (Geng et al. 2017), so the retailer must decide whether to offer complimentary return-freight insurance as a product-quality signal, and what level of compensation signals best. On the other hand, the consumer observes two meanings from the return-freight insurance. First, the consumer sees whether the retailer give the insurance as a gift. After that, without knowing the premium, the consumer can only calculate the insurance compensation. Whether a higher or a lower compensation signals more effectively is the focus of our research.

We interpret the important conception of online product quality broadly to mean performance on attributes, which are quickly revealed after purchase and received without consuming the product followed the assumption in Moorthy and Srinivasan's work (Moorthy and Srinivasan 1995), including such attributes as whether the product is suitable to the consumer's needs, fit, and style, etc. These attributes that could have been considered before purchase, but could not be revealed because either the online purchase is a remote transaction or the product delivered is hidden in packaging. The online retailer is trying to signal the correspondence between what is claimed about these attributes in the online description and what will be delivered. The meaning of quality is related the issue that online purchases are returned for many reasons in addition to simple product defects (Dellarocas 2003).

Our article is related to a long-standing literature on return policies and signaling. As the product returns serve as an instrument to protect consumers against product-quality uncertainty. Our article is also related to the large literature on product warranties. In the classic paper, Moorthy and Srinivasan's signaling model represents the comparative analysis of MBG use between high- and low-quality sellers, demonstrating that it is relatively more costly for the retailers whose product quality is low (Moorthy and Srinivasan 1995). This provides an effective tool for high-quality sellers to distinguish themselves from others. However, McWilliams indicates that MBGs are ubiquitous among major retailers, explores a competitive environment between high- and low- quality retailers, and finds low-quality retailer gains relative to when MBGs were not offered (McWilliams 2012), which appears to be aimed at denying Moorthy and Srinivasan's signaling model, and also means a new product-quality signal is needed in practice. Moorthy and Srinivasan also discuss that sellers should absorb the buyer's transaction cost when the cost is small enough (Moorthy and Srinivasan 1995). In contrast, our results reveal that, even when the quality signal (the return-freight insurance premium) is not cheap, it can still be worthwhile for high-quality retailers to occupy the market. There are also papers that demonstrate the insurance effect (Grossman 1981; Gu and Tayi 2015; HEAL 1985). The central idea is that a more lenient return policy boosts consumer demand and increases the retailers' gross revenue. In the real world, the return-freight insurance premium and compensation is not fixed as they imaged, but flexible (Zhang and Hu 2013). A key insight of our study is that, in the online shopping context with real insurance instead of the insurance effect, the high-quality retailer's revenue does not always increase.

A return is actually a good opportunity to please the customer and a recognized tool to create more loyal consumers (Griffis et al. 2012; Mukhopadhyay and Setoputro 2005). This is even truer for the increasingly popular Internet sales in where examining the product physically before purchasing is impossible. The return policy is still essential even in the context of the financial crisis and a loose return policy was more profitable than tight return policy (Petersen and Kumar 2010). The purchase decision is likely to be framed as two separate decisions: consumers' decisions to order and, upon receipt, their decisions to keep or return the item. The endowment effect suggests some surprising benefits of return policy leniency to the retailer (Wood 2001). From the manufacturer's point of view, following a policy of modularization and offering a generous return policy would increase revenue, but also increase the cost due to increased likelihood of return and increased design costs (Mukhopadhyay and Setoputro 2005).

Using signaling theory, Mavlanova et al. found that low-quality retailers were likely to avoid costly and easy-to-verify signals and used fewer signals than did high-quality retailers, who used costly and difficult-to-verify signals and displayed more signals (Mavlanova et al. 2012). Using a signaling model, conditions were obtained when online retailers use price to manage their customers' service expectations. In contrast to extant theory, it is possible for both low- and high-service online retailers to use price to signal their service levels (Mitra and Fay 2010). Lee et al. (2005) investigate three possible signals to distinguish "trustworthy" and "untrustworthy" Web merchants in the case of B2C Internet commerce. A firm may signal the unobservable quality of its products through several marketing-mix variables. Kirmani et al. developed a typology that classifies signals and discussed the available empirical evidence on the signaling properties of several marketing variables (Kirmani and Rao 2000). To our knowledge, using a return policy as a signal has not been studied in e-commerce, only in offline commerce. The e-commerce product return is more complicated. In the real world, the consumer's cost for returning to the store will not bother the retailer much, while the product transaction fee always affects both sides of an e-commerce transaction. We examine whether the new return policy still fits the same separating equilibrium condition as for offline retailers.

## 2 Model

Due to length limitations, we only consider an online retailer selling a product to a homogeneous group of online consumers. Without loss of generality, the size of the group is normalized to 1. We follow Moorthy and Srinivasan's assumption (Moorthy and Srinivasan 1995) with the addition of return-freight insurance. The online retailer could offer a high-quality product or a low-quality product. We call the retailer offering a high-quality product a type  $h$  retailer, while a retailer offering a low-quality product a type  $l$  retailer. The unit costs are  $c_h$  and  $c_l$  for the two type of retailers with  $c_h > c_l = 0$ .

For this paper, we assume that online consumers cannot know the product quality before purchasing.

Consumers have a perceived utility,  $v_h$ , for the high-quality product if it “works”; otherwise the reservation price is 0. The corresponding numbers for the low-quality product are  $v_l$  and 0, respectively. The probability of a high-quality product not working is  $f_h$  and the probability of a low-quality product not working is  $f_l$ . We assume that  $0 < f_h < f_l < 1$  and  $(1 - f_h)v_h > (1 - f_l)v_l$ . Our notion of quality is consistent with that in the total quality management (TQM) literature (Moorthy and Srinivasan 1995). This literature defines quality as comprising both “levels of attributes” and “consistency in delivery of attributes.” In our model, level of attributes is contained in the consumer’s perceived utility for a working product ( $v_h$  and  $v_l$  for high and low qualities, respectively), while consistency in delivery is contained in the probability of working ( $1 - f_h$  and  $1 - f_l$ ).

The pricing strategy of return-freight insurance contains two parts: the premium,  $T$ , and the compensation,  $C$ , (Geng et al. 2017). As with other types of insurance, a different estimation the risk implies a different insurance premium (Barseghyan et al. 2013). Return-freight insurance is focused on the risk of product return. The return-freight insurance premiums for high- and low-quality products are  $T_h$  and  $T_l$ , respectively, which also have two parts: marginal cost and profit. Different from traditional cargo insurance, return-freight insurance does not compensate product damage during delivery, but focuses on the product-return freight fee. The return-freight insurance compensation for high- and low-quality products are  $C_h$  and  $C_l$ , respectively. Let  $T_j = f_j C_j + \pi_j$ ,  $\pi_j > 0$ ,  $j = h, l$ , the difference between the high and low return-freight insurance premium profits is  $e_1 = \pi_h - \pi_l$ , and the difference between high and low return-freight insurance compensation is  $e_2 = C_h - C_l$ . Therefore,  $\pi_j > 0$  means that regardless of whether product quality is high or low, the insurance company makes profit from the expected insurance premium. Return-freight insurance has two endogenous constraints: The insurance premium must be less than the compensation ( $T_j < C_j$ ); otherwise, nobody would insure when purchasing. The second is that the insurance compensation must be less than or equal the return-freight fee ( $C_j \leq t_b$ ), to address the insurance moral hazard.

Our modeling of consumer utility via reservation prices subsumes within it the assumption that consumers are risk-neutral in evaluating gambles and product price is higher than transaction cost ( $p > t_b$ ). This allows us to ensure that, when the product does not work, consumers would return it.

The online retailer has to make two decisions: Choose a price,  $p$ , for the product and decide whether to offer consumers complimentary return-freight insurance. If complimentary return-freight insurance is not offered, product return will work as follows. The consumer may return the product if he or she wishes and get  $p$  back. However, the consumer will have to bear the transaction cost (such as the return-freight fee),  $t_b$ , of sending the product back. In contrast, if complimentary insurance is offered, the consumer may return the product to receive  $p$  and suffer little or even no transaction cost:  $t_b - C$ , due to the compensation from the insurance company. The difference of the two strategies for the online retailer is whether it pays an insurance premium  $T$  when the consumer purchases.

Under both return strategies, online retailers have to deal with the transaction cost and the product salvage value. Therefore, we assume that both the online retailer’s transaction cost of processing a return and the product’s salvage value are 0 for the convenience of calculating.

The entire notation used in the paper is summarized in Table 1 for reference.

Symbol	Description
$v_j$	Consumers’ perceived utility for type $j$ online product when it works, $j = h, l$
$f_j$	Probability of type $j$ online retailer’s product not working, $j = h, l$
$c_j$	Type $j$ retailer’s marginal cost of production, $j = h, l$
$t_b$	Consumer’s transaction cost for regular product return
$p_j^c (p_j^n)$	Optimal complete-information product price for type $j$ online retailer with (without) a complimentary return-freight insurance, $j = h, l$

$\Pi_j^c (\Pi_j^n)$	Type $j$ online retailer's expect profit with (without) a complimentary return-freight insurance when quality is known, $j = h, l$
$r_j^c (r_j^n)$	Reservation price for type $j$ online retailer's product with (without) complimentary return-freight insurance, $j = h, l$
$T_j$	The return-freight insurance premium for type $j$ online retailer, $j = h, l$
$C_j$	The return-freight insurance compensation for type $j$ online retailer, $j = h, l$
$\pi_j$	Insurance company's profit for type $j$ product, $j = h, l$
$e_1 (e_2)$	Difference between high and low return-freight insurance profit and compensation

Table 1. Notation

### 3 Complimentary Return-freight insurance as a signal of product quality: homogeneous consumers

In this section, we assume the consumer does not know the online product quality a priori. Can the high-quality online retailer signal product quality by offering complimentary return-freight insurance?

The standard methodology for addressing this question is to model the online retailer–consumer interaction as a sequential game of incomplete information and look for a perfect Bayesian equilibrium satisfying the intuitive criterion: The online retailer moves first with a complimentary return-freight insurance or MBG without return-freight insurance. The consumer moves second with a decision to purchase or not purchase the product. The consumer's decision will be based on her posterior assessment of the probability of dealing with as high-quality online retailer after observing the online retailer's offer because that determines his or her reservation price for the online product. If and only if the online product's price does not exceed the reservation price, the consumer will buy it. The intuitive criterion is designed to reduce the number of perfect Bayesian equilibria by restricting consumers' beliefs off the equilibrium path. Essentially, it says that if the consumer observes an out-of-equilibrium-price complimentary return-freight insurance offer that is dominated by the equilibrium offer for one type of online retailer and not the other, then the consumer should assume that the latter made the offer.

We define a separating equilibrium as a perfect Bayesian equilibrium satisfying the intuitive criterion in which the two types of online retailer employ different strategies. In such an equilibrium, the online retailer's type is revealed by the chosen strategy. Given our objective of discovering whether a complimentary return-freight insurance could be used to signal quality, we will be looking for a separating equilibrium in which only the high-quality online retailer offers complimentary return-freight insurance. The other possibility is an equilibrium where the two types of online retailer use the same strategy. This is a pooling equilibrium, which offers no signaling opportunity.

To view the role of complimentary return-freight insurance, let us compute the consumer's reservation price for the two types of products when complimentary return-freight insurance is not offered and the product is returned normally upon failure. Figure 1(a) shows the “gamble” faced by the consumer when the online retailer's price is  $p$ . When the product does not work, the consumer has to decide between returning the product and not returning. In the former case, the consumer's surplus is  $-t_b$ : the product provides no utility, the consumer gets  $p$  back, and the transaction cost of redeeming the return is  $t_b$ . In the latter case, the consumer surplus is  $-p$ . The consumer will return the non-functional product if and only if  $t_b < p$ . Given the probability of a non-functional product, if it is returned, the consumer surpluses are  $(1 - f_h)(v_h - p) - f_h t_b$  and  $(1 - f_l)(v_l - p) - f_l t_b$  for the high- and low-quality products, respectively. Therefore, the reservation prices in the cases of product returns are

$$r_h^n = v_h - \frac{f_h}{1 - f_h} t_b \quad (1) \quad r_l^n = v_l - \frac{f_l}{1 - f_l} t_b \quad (2)$$

These reservation prices are meaningful only when they exceed  $t_b$ , which translates to  $t_b < r_h$  and  $t_b < r_l$ .

With a price  $p$ , the expected profit for the two types of online retailer are  $(p - c_h) - f_h p$  and  $p - f_l p$ , respectively. Substituting for  $p$  the corresponding reservation price, we get the online retailer's maximum expected profit under MBG:

$$\Pi_h^n = (1 - f_h)v_h - c_h - f_h t_b \quad (3) \quad \Pi_l^n = (1 - f_l)v_l - f_l t_b \quad (4)$$

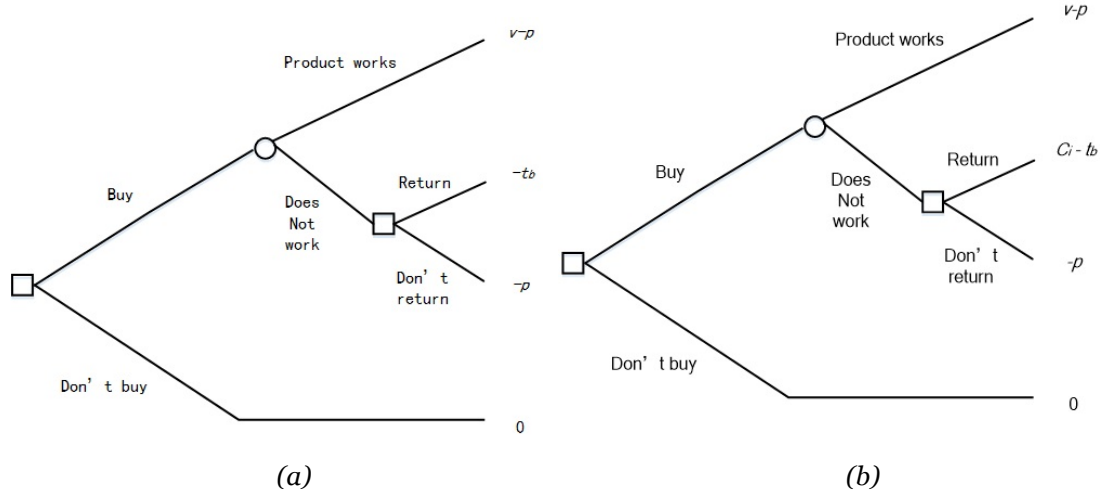


Figure 1(a): MBG without complimentary return-freight insurance

Figure 1(b): Return with complimentary return-freight insurance

If the online retailer offers complimentary return-freight insurance and the product price is  $p$ , then the consumer's decision problem is shown in Figure 1(b). When the product does not work, the consumer's returning condition is changed: The transaction cost is compensated by the insurance company with a compensation  $C$ . The consumer surplus is  $(1 - f_h)(v_h - p) - f_h(t_b - C_h)$  and  $(1 - f_l)(v_l - p) - f_l(t_b - C_l)$ , for the high- and low-quality products, respectively. The reservation prices in the presence of complimentary return-freight insurance are:

$$r_h^C = v_h - \frac{f_h}{1 - f_h}(t_b - C_h) \quad (5) \quad r_l^C = v_l - \frac{f_l}{1 - f_l}(t_b - C_l) \quad (6)$$

Now, comparing Equations (5), (6), (1), and (2), we note that the reservation price with complimentary return-freight insurance is greater than the reservation price under MBG.

With a price  $p$ , the expected profits for the two types of online retailer are  $(p - c_h - T_h) - f_h p$  and  $(p - T_l) - f_l p$ , respectively. Substituting for  $p$  the appropriate reservation price, we get the online retailer's maximum expected profit with complimentary return-freight insurance:

$$\Pi_h^C = (1 - f_h)v_h - c_h - f_h(t_b - C_h) - T_h \quad (7) \quad \Pi_l^C = (1 - f_l)v_l - f_l(t_b - C_l) - T_l \quad (8)$$

### 3.1 Can Complimentary Return-freight Insurance Signal Product Quality?

In particular, can we have a separating equilibrium with the high-quality online retailer offering a complimentary return-freight insurance and the low-quality online retailer not offering it? Suppose such an equilibrium exists, and let  $p_h$  and  $p_l$  be the prices offered by the two types of online retailer in the equilibrium. Observing a complimentary return-freight insurance, the consumer infers high quality. Not observe complimentary return-freight insurance the consumer infers low quality. The retailers could use the signal to adjust the consumer's subjective estimation of high or low quality. However, this does not change the objective probability of the product not working.

What are necessary conditions for such an equilibrium? Clearly,  $p_h \leq r_h^n$  and  $p_l \leq r_l^n$  because any price greater than reservation price yields no sales for that type of online retailer and is therefore dominated

for both types of online retailer by the reservation price. In fact, we can go further and assert that  $p_l = r_l^n$  because any price less than  $r_l^n$  is dominated by  $r_l^n$  for type  $l$  product. The other basic condition is that neither type of online retailer should want to masquerade as the other type. That is, the low-quality online retailer must not gain by charging  $p_h$  and offering complimentary return-freight insurance,

$$(1 - f_l)v_l - c_l - f_l t_b \geq (1 - f_l)p_h - c_l - T_l \quad (9)$$

and the high-quality online retailer must not gain by not offering return-freight insurance,

$$(1 - f_h)p_h - c_h - T_h \geq (1 - f_h)r_l - c_h - f_h t_b \quad (10)$$

Equations (9) can be written as  $p_h \leq v_l + \frac{\pi_l}{1 - f_l} - \frac{f_l}{1 - f_l}(t_b - C_l)$ , define  $p^i = v_l + \frac{\pi_l}{1 - f_l} - \frac{f_l}{1 - f_l}(t_b - C_l)$  (11)

Equations (10) yields  $p_h \geq v_l + \frac{\pi_h}{1 - f_h} - \frac{f_h}{1 - f_h}(t_b - C_h)$ , so  $p^o = v_l + \frac{\pi_h}{1 - f_h} - \frac{f_h}{1 - f_h}(t_b - C_h)$  (12).

Intuitively, the high-type product price  $p_h$  cannot be greater than the consumer's reservation price,  $r_h^C$ . Therefore, to verify the high-type product price upper bound, there are two cases to consider:  $p^i \leq r_h^C$  and  $p^i > r_h^C$ .

### 3.1.1 Case 1 $p^i \leq r_h^C$

Given  $f_l < 1$ ,  $p^i$  is well defined and we confirm that  $p_h$  must then be  $p^i$ . What remains to check is the requirement that  $p^i \geq p^o$ .

This condition, as well as the defining condition  $p^i \leq r_h^C$ , can be written in terms of  $\pi_h$  and  $C_h$  as:

$$(1 - f_h)\pi_h + (f_l - f_h)C_h \leq (1 - f_h)(1 - f_l)(v_h - v_l) + (f_l - f_h)t_b + (1 - f_h)e_1 + f_l(1 - f_h)e_2 \quad (13)$$

$$(f_l - f_h)\pi_h + (f_l - f_h)C_h \geq (f_l - f_h)t_b + (1 - f_h)e_1 + f_l(1 - f_h)e_2 \quad (14)$$

The condition  $p^i \leq r_h^C$  is equivalent to equations (13) and the condition  $p^i \geq p^o$  is equivalent to equations (14). Hence, the foregoing analysis can be summarized as saying that if  $\pi_h$  and  $C_h$  fulfil the inequalities equations (13) and (14), then any separating equilibrium with only the high-quality seller offering complimentary return-freight insurance must have  $p_h = p^i$ ,  $p_l = r_l^n$ .

### 3.1.2 Case 2 $p^i > r_h^C$

Since  $p^i$  satisfies equations (9) as an equality,  $r_h^C$  must satisfy it strictly, which means when the low-type retailer uses  $r_h^C$  as the product price and gives complementary return-freight insurance to consumers. The retailer's profit is lower than only providing MBG. The high-type retailer uses  $r_h^C$  as the price and makes the highest profit. Where  $p^o$  satisfies inequality equations (10),  $r_h^C$  must also. The condition  $p^i > r_h^C$  can be restated as

$$(1 - f_h)\pi_h + (f_l - f_h)C_h > (1 - f_h)(1 - f_l)(v_h - v_l) + (f_l - f_h)t_b + (1 - f_h)e_1 + f_l(1 - f_h)e_2 \quad (15)$$

There is an upper bound on  $\pi_h$ , set by the nonnegative profit requirement,  $\Pi_h^C \geq 0$ :

$$\pi_h \leq (1 - f_h)v_h - f_h t_b - c_h \quad (16)$$

The foregoing analysis tells us that when  $\pi_h$  and  $C_h$  fulfil the inequality equations (15) and (16), any separating equilibrium with only the high-quality seller offering complimentary return-freight insurance must have  $p_h = r_h^C$ ,  $p_l = r_l^n$ .



**Lemma 1.** Under the condition that consumers' perceived utility,  $v_h$ , for high-type online products when it works is be greater than or equal to  $\frac{f_h}{1-f_h}t_b + \frac{1}{1-f_h}c_h + \frac{1}{f_l-f_h}e_1 + \frac{f_l}{f_l-f_h}e_2$ , the separating equilibriums could exists.

Figure 2 combines Cases 1 and 2 that the upper bound equations (16) should be higher than the lower limit equations (14) with  $C_h$  ranging between 0 and  $t_b$ .

### 3.2 The Role of Return-freight Insurance

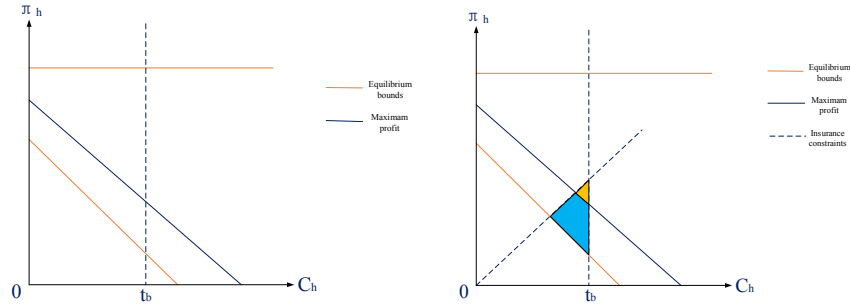


Figure 2: Separating equilibrium without return-freight insurance constraints (left)

Figure 3: Separating equilibrium with return-freight insurance constraints (right)

In our research, return-freight insurance is the signal cost and contains two parts, the premium and the compensation. Based on the fact that different return-freight insurance offerings have different profit and compensation levels, we get different separating equilibria. Therefore, the offer could signal product quality signal or it could just add noise. As we mentioned, return-freight insurance has two endogenous constraints: The insurance premium must be less than the compensation ( $T_j < C_j$ ). Also the insurance compensation must be less than or equal to the return-freight fee ( $C_j \leq t_b$ ) to avoid the insurance moral hazard. Based on  $T_j = f_j C_j + \pi_j$ , the constraint  $T_h < C_h$  can be translated into  $\pi_h < (1-f_h)C_h$  (17).

**Proposition 1.** Under the condition  $v_h \geq \frac{f_h}{1-f_h}t_b + \frac{1}{1-f_h}c_h + \frac{1}{f_l-f_h}e_1 + \frac{f_l}{f_l-f_h}e_2$ , the probability  $f_h$  of the high-type online product not working should be less than or equal to  $f_l - \frac{e_1 + f_l e_2}{t}$ .

Given constraint equation (17) and the lower limit equation (14), the slope of the insurance constraint,  $1-f_h$ , should be greater than  $\frac{(1-f_h)e_1 + f_l(1-f_h)e_2}{t_b}$ . Solving the inequality, we get  $f_h < f_l - \frac{e_1 + f_l e_2}{t}$ .

Once the reservation value is high enough and the possibility of product return is low enough, the online retailer could use the strategy of offering complimentary return-freight insurance.

**Proposition 2.** When complimentary return-freight insurance does signal, the insurance compensation,  $C_h$ , should be greater than or equal to  $\frac{1}{2-f_h}t_b + \frac{1-f_h}{(f_l-f_h)(2-f_h)}e_1 + \frac{f_l(1-f_h)}{(f_l-f_h)(2-f_h)}e_2$ .

Interestingly, in the separating equilibrium when the compensation  $C_h$  increases, the range of the insurance profit,  $\pi_h$ , increases, while the insurance profit  $\pi_h$  increases, but the range of the compensation,  $C_h$ , increases at first and then decreases. This effect is shown in Figure 3. This happens for two reasons. The intuitive reason is that insurance profit cannot drive the cost of insurance too high. Additionally, the compensation should not be high enough to create a moral hazard.

**Proposition 3.** Under the condition  $v_h \geq \frac{f_h}{1-f_h}t_b + \frac{1}{1-f_h}c_h + \frac{1}{f_l-f_h}e_1 + \frac{f_l}{f_l-f_h}e_2$ , the complimentary return-freight insurance strategy only works when  $e_1 + f_l e_2 < (f_l - f_h)t_b$ .

**Corollary 1.** Under the conditions of Prop.3, when  $e_1 + f_l e_2 < (f_l - f_h)(v_h - v_l)$  and  $e_1 + f_l e_2 < (1 - f_h)t_b - (1 - f_l)(v_h - v_l)$ , h-type retailer use complimentary insurance to maximize profit.

## 4 Conclusion and Future Research

We show the conditions when high-quality online retailers can use complimentary return-freight insurance to effectively inform consumers about product quality. Due to page limitations, only homogeneous consumers was considered. However, heterogeneous consumers could be reviewed in future research. In the model we considered, once the quality information is unavailable, complimentary return-freight insurance is a workable signal. Our results show that the efficacy of complimentary return-freight insurance as a signal depends on the insurance company's profit from paying compensation if the consumers request it. These costs reduce the incentives for low-type retailers to mimic the high-type online retailer's strategy.

Moorthy and Srinivasan indicated that the seller should absorb the buyer's transaction costs when they are small. While we show only when compensation is high can return-freight insurance work as signal.

We only consider the separating equilibrium in which high quality online retailers can both convey their private information and maximize their profit. There is another equilibrium high-quality online retailers could use to spread news that they have high-quality products to gain market share without gain profit in the short term. Due to the page limited, we have not discussed this equilibrium.

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