**ISSN** 1816-6075 (Print), 1818-0523 (Online)
**Journal of System and Management Sciences**
Vol. 4 (2014) No. 3, pp. 56-80

# Quality Improvement or Perception Enhancement? The Role of Consumer Behavior and Returns Policy

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*(Received Jun 2014, accepted Oct 2014)*

**Abstract.** Consumer valuation for a product can be increased by the improved quality or the enhanced perception. This paper studies the seller's preference between the two forms of effort when (a) consumers enjoy a returns policy and (b) consumers may be naive or sophisticated in their return probability. It is found that, when customers are sophisticated, the seller profits more from perception enhancement by setting low price and low refund. When customers are naive, quality improvement may be more profitable, especially when consumers are less susceptible to the seller's effort. It is suggested that, from the perspective of the seller, perception enhancement activities not be too devoted to, and from the perspective of customers, being naive might be not so bad for them to receive high quality products they expected for. Moreover, it is demonstrated that consumer behavior exerts impacts on the seller's strategy choice between partial returns and full returns.

**Keywords:** Quality Improvement, Perception Enhancement, Consumer Behavior, Consumer Returns

## 1. Introduction

Consumers often face uncertainty about the quality of the products provided by a seller. They tend to form ex ante valuations by the product packaging, the ornament, or even the store environment. For instance, in a deluxe retail store, consumers often take it for granted that the goods sold there should be of higher quality than those in an ordinary store. This phenomenon is more prevalent in online sales. Since consumers are unable to touch or try the real goods, their perceptions of the product quality are more easily to be influenced by the pictures, the descriptions and the website design. Take a manufacturer who sells furniture online for example. Gorgeous pictures generously make his products seemingly more attractive and transcendent, even if they are not so excellent. Due to the uncertainty of consumer valuation, the seller often makes an effort to convey high quality signals to buyers. He can make it by truly improving product quality or by inducing affect on consumer perceptions, including the activities listed above. We call the former quality improvement (QI) effort and the latter perception enhancement (PE) effort. Both types of effort require expenditures, and sometimes, the costs are very high. The seller has to make a choice between them. Moreover, because of the uncertainty of consumer valuation, the seller may find that providing consumers a money-back guarantee is profitable under which any buyer can return the product for a refund once her realized valuation is low. This paper aims to investigate the seller's decision on the choice between QI and PE under consumer returns policy.

We motivate this research mainly for three considerations. First, why is the seller enthusiastic about PE by dressing up the retail store, exquisitely packaging the goods, and costly designing a luxurious store decoration? If these expenditures are used to improve product quality, will it bring the seller a higher profit?

Second, it is well known that money-back guarantee can signal high quality (Moorthy and Srinivasan, 1995). When it comes to the seller's strategy choice between QI and PE, what role will it play? Note that although QI and PE both increase buyers' ex ante valuations at the time of purchase decision making, there exists a significant difference between them. QI truly improves product quality and hence increases customers' ex post utilities. Yet PE always induces customers to buy without increasing their realized valuations. Apparently, the seller should have no incentive to make a perception enhancement effort because it would cause large quantities of returned products. We will explain this phenomenon by investigating the profit mechanisms of QI and PE.

Third, from the perspective of consumers, will their behaviors influence the seller's preference between QI and PE? We define two types of consumers, namely, sophisticated consumers and naive consumers. The former type considers the possibility that they may finally not return the products even when their realized valuations are lower than the refund. In contrast, the latter type does not consider this probability at the time of purchasing. The existence of a return probability may be a result of return deadline missing or simply forgetting (Su, 2009; Janakiraman and Ordóñez, 2012). Faces different types of consumers, will the seller embrace the same effort strategy? If he adopts different strategies for different consumer behaviors, should the buyers behave naive or sophisticated, especially for those who are eager to obtain high quality items?

Our main findings are as follows. First, the reason why a seller shows great enthusiasm for PE rather than QI lies in the different profit mechanisms of the two forms of effort. QI truly improves product quality so that customers are willing to pay a high price for high quality products. While PE dose not truly improve product quality. Instead, it deliberately misguides consumers to overvalue the products ex ante. However, by doing so the seller may put himself into a danger that he might acquire a bad reputation and be excluded out of the market (Noll, 2004). The seller deals with this problem by setting a lower price than if under QI. Accordingly, he also sets a lower refund, considering that PE may cause a large amount of returned products. The seller makes a trade-off between the low price and the low refund. For a customer who makes a purchase decision, low price is more attractive than high refund because she benefits from the former but does not necessarily benefit from the latter. As a result, PE dominates QI in promoting sales.

Second, when consumers are naive, the seller's preference may be reversed. In particular, when QI or PE cannot increase consumer valuation too much, or saying, when consumers are less likely to be influenced by the seller's effort, the seller would rather truly improve product quality than resort to perception enhancement. This is because, under this circumstance, the seller's optimal refund amount is higher than the salvage value of per unit returned product, implying that the advantage of low refund disappears. Compared with QI, PE causes a larger amount of consumer returns, and therefore, is less profitable than QI.

Third, we demonstrate that consumer behaviors exert an important influence on the seller's strategy choice between partial refund and full refund. When consumers are sophisticated, partial returns is the seller's optimal strategy. When consumers are naive, it is possible that full returns policy is optimal. The impact of consumer behaviors on the seller's returns policy making is not considered by previous works.

Last but not least, from the perspective of consumers, being naive may be not a bad thing. No doubt, naive consumers pay a high price for the same product, but in turn they obtain the high quality product they expected for. Therefore, naivety is a double-edged sword. On one hand, naive consumers are unavoidably extracted a higher surplus by the seller. On the other hand, they may avoid being misguided to overvalue the product quality and buying the unwanted products.

We also note that consumer returns policy plays an important role in the seller's strategy choice. Without money-back guarantees, PE plays the same function as QI except for the potential risk of losing long term gains. However, if consumer returns policy is adopted, PE may mitigate this risk because of its low pricing strategy. Therefore, the widespread phenomenon that firms invest substantial funds to increase consumer feelings is not definitely due to their focusing on short term benefits but be a consequence of their sales promoting strategy. However, it could never be said that PE is more profitable than QI, especially when naive consumers are immune from the seller's marketing effort.

The rest of this paper is organized as follows. Section 2 surveys the relevant literature; Section 3 proposes assumptions; Section 4 discusses the seller's decisions when he faces sophisticated consumers; Section 5 extends the model to the case of naive consumers; and Section 6 presents the conclusions.

## 2. Literature Review

There are three major extensions closely related to our paper: the economics literature on quality signals, the operations literature on quality improvement as well as the marketing literature on consumer returns policy.

We first give an overview on various kinds of quality signals. Since it is difficult to observe quality before purchase, consumers have to infer the unobservable quality from observable signals. Kirmani and Rao (2000) classify quality signals into four forms, including price, brand, warranty and advertisement. Price signal is the most common form, and generally speaking, high price means high quality (Bagwell and Riordan, 1991). However, price is shown to be a poor quality indicator as it is often coupled with other forms of signals (Noll, 2004). Milgrom and Roberts (1986) show that customers may not truly infer the product quality when firms find it beneficial to jointly use price and advertising signals. Warranty, as a post-sale support, is also an important way to transmit high quality signals to customers. Since a seller who provides a longer warranty period assures that any faulty product can be repaired or replaced, customers often infer that the seller is more reliable (Murthy and Djamaludin, 2002). However, again, a high warranty does not definitely signify high quality and consumers may also be misled to make a wrong choice (Lutz, 1989). Similar results are also found when it comes to brand signals (Price and

Dawar, 2002). Except for the four types of quality signals above, influencing consumer feelings is also one method to induce customers to buy. The most relevant paper to ours in this extension is Iyer and Kuksov (2010) who mainly discuss how a firm optimally invests in product quality and consumer feelings affect inducement. This paper differs from theirs in that they focus on the optimal investment configuration between product quality and activities in inducing consumer feelings, whereas we discuss the role of consumer returns policy and consumer behavior in the firm's decisions on QI and PE. We incorporate QI, PE, consumer returns policy and consumer behaviors into a general model.

The second relevant area of research is the issue of consumer returns policy. Generally speaking, full returns policy is an ideal signal for customers to infer the unobservable product quality (Moorthy and Srinivasan, 1995). Nevertheless, the 100% money-back guarantee has significant drawbacks. On one hand, it over-protects customers whose surplus cannot be fully extracted. On the other hand, it potentially motivates customers to buy unwanted items to use during the trial period and finally return them for full refunds (Chu et al., 1998). As a result, partial refund policy is prevalently adopted in realities (Hess et al., 1996). How firms optimally implements consumer returns policy under different circumstances are provided by Ruiz-Benitez and Muriel (2014) who assume that the retailer allows returns from end customers and the supplier then buys back the returned items, Huang et al. (2014) who consider the possibility that consumers have access to the secondary market where their returned products are salvaged at a low price, and Ruiz-Benítez et al. (2014) who focus on the case when returns are picked up from a collection point and then processed at a centralized location. In our model, when customers are sophisticated, the seller finds it is optimal to adopt partial returns policy. However, it may not be the case when the seller faces naive consumers. Full returns policy can also be optimal under special conditions. Therefore, our paper confirms that consumer behaviors have a crucial impact on the seller's returns policy making. Contrary to the well-known idea that consumer opportunism urges the seller to offer partial refund, we demonstrate that consumer naivety inspires the seller to provide a full returns policy.

This paper is also related with previous works on quality improvement. Two different assumptions exist in this area of research. One is the works that consider quality as an endogenous variable, such as Balachandran and Radhakrishnan (2005) who study the optimal warranty contract between a seller and the supplier, Zhu et al. (2007) who investigate the different impacts of quality improvement conducted by different firms in a supply chain, Chao et al. (2009) who propose two types of product recall cost sharing contracts between the manufacturer and the retailer in a supply chain in order to motivate their quality improvement efforts, and Veldman and Gaalman (2014) who study how firm owners financially reward managers for product quality and process improvement. The other is the works that use consumer utility to denote product quality, such as Chambers et al. (2006), Kim and Swinney (2009) and Iyer and Kuksov (2010). The most relevant paper is Kim and Swinney (2009) who provide conditions under which quality improvement is more profitable than cost reduction, and vice versa. The main difference between their work and ours is that they assume consumer utility is increased by a certain degree by the seller's quality improvement effort, whereas we assume that consumer valuation is enhanced by a random variable. We believe that to assume a stochastic valuation increase is more reasonable.

This paper contributes to the literature in that we establish a model that reflects the relationship among customer behavior, consumer returns policy and the seller's effort in influencing consumer valuation, as shown in Fig.1. We show that customer behavior exerts an influence on the seller's returns policy which eventually results in the seller's preference change between QI and PE.

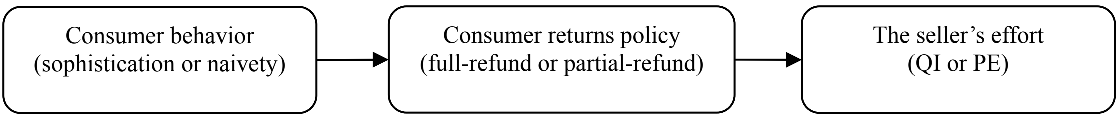


**Fig. 1.** Relationship of consumer behavior, consumer returns policy and the seller's effort

## 3. Model Setup

Consider a seller who faces uncertain market demand $D$ with cumulative distribution function (cdf) $F(\cdot)$ and probability distribution function (pdf) $f(\cdot)$. The customers face uncertainty about their own valuations for the seller's product before they purchase it. Assume that customer valuations $V$ are identically and independently distributed in the interval $[L,H]$ ($0<L\leq H$), with cdf $G(\cdot)$ and pdf $g(\cdot)$. We assume $F(\cdot)$ and $G(\cdot)$ are continuous, increasing and differentiable. Denote $E(V)$ by $\mu$, where $E(\cdot)$ is the expectation operator. The seller has an option to apply consumer returns policy (partial- or full- refund) or not.

Before the selling season, the seller decides the selling price $p$, inventory level $q$ and refund amount $r$ to maximize his expected profit. It should be satisfied that $r \in [0,p]$, where $r=p$ means 100% money-back guarantee, $0< r < p$ means partial refund and $r= 0$ means no refund. During the selling season, customers make purchase decisions to maximize their expected utilities. We assume their reserved utilities are zero and those who are indifferent about purchasing and not purchasing will buy the products. After purchasing an item, a customer may return it when her realized valuation is lower than the refund. Note that in the realistic world, not all the customers whose realized valuations are low will return the products for some reasons which has been discussed in the introduction. We assume a customer with low ex post valuation will eventually choose to return the product with probability $\eta$ ($0< \eta \le 1$).

We define two types of consumers. At the time when consumers make purchase decisions, we call those who consider the possibility that they may finally not return the low value products as sophisticated customers and those who believe they will return the low value products for sure as naive customers. It is noteworthy that their ex ante beliefs do not alter the reality that they may eventually not carry out the return plans.

After the selling season, the seller salvages the surplus inventory, including the unsold products and the sold but finally returned products. Suppose that the salvage value of per unit unsold product is $s$ and per returned unit has the salvage value $s_r$, where $s_r \le s$. Note that returned products may incur the seller a managing cost and incur customers a hassle cost, which are normalized to zero. Denote the seller's per unit production cost by $c$. We assume that $c>s$ to ensure that it is not beneficial for the seller to always increase his inventory and that $c<\mu$ to avoid the trivial case that the seller cannot profit from selling. We assume that the seller and the customers are risk neutral.

Now suppose that the seller can make a fixed investment $I$ for an effort to increase consumer ex ante valuation by $\delta$ through QI or PE. The seller's decision on QI or PE is made before the decisions of $p$, $q$ and $r$ because the efforts of QI and PE are more strategic and unchangeable. Here we use the term "perceived" because consumer valuation is not truly increased if the seller makes a PE effort. As have been discussed, it is reasonable to assume that by a fixed investment, consumer ex ante valuation is enhanced by a random variable. Therefore, we assume $\delta$ is a random variable with support on the interval $[\underline{\delta},\overline{\delta}]$, where $0 \le \underline{\delta} < \overline{\delta}$. Assume that the cdf of $\delta$ is continuous, increasing and differentiable. Denote customer perceived valuation by $\hat{V}$, i.e., $\hat{V} = V + \delta$, with cdf $\hat{G}(\cdot)$ and pdf $\hat{g}(\cdot)$, where $\hat{V} \in [\hat{L},\hat{H}]$. Clearly, we have $\hat{L} > L$ and $\hat{H} > H$.

Denote $E(\hat{V})$ by $\hat{\mu}$. We should exhibit the difference between QI and PE in the presence of consumer returns policy. If the seller makes an effort to improve product quality, then consumers' realized valuations will be drawn from the distribution $\hat{G}(\cdot)$. While if the seller invests in perception enhancement effort, consumers' realized valuations will be drawn from $G(\cdot)$.

We summarize the sequence of events as follows:

1. The seller makes a decision on whether to make an effort (QI or PE);
2. The seller sets the price $p$, the inventory level $q$ and the refund $r$ to maximize his expected profit;
3. Selling season begins. Customers purchase the products if their expected utilities are nonnegative;
4. Consumer valuation is realized. Those with a valuation lower than $r$ return the goods with probability $\eta$;
5. Selling season ends. The seller salvages all the unsold and returned products.

Before proceeding the main analysis, we first propose the following lemma.

*Lemma 1* (i) $\hat{G}(v) < G(v)$ given any $v \in [L, \hat{H}]$; Otherwise, $\hat{G}(v) = G(v)$;

(ii) $\hat{\mu} > \mu$.

*Proof.* (i) If $L < v < H$, we have $\hat{G}(v) = \Pr(\hat{V} \le v) = \Pr(V + \delta \le v) = \Pr(V \le v - \delta) = G(v - \delta) = G(v)$. If $H \le v < \hat{H}$, we have $\hat{G}(v) < 1$ and $G(v) = 1$. Therefore, $\hat{G}(v) < G(v)$ given any $v \in (L, \hat{H})$. Beyond the interval, it is easily seen that $\hat{G}(L) = G(L) = 0$ and $\hat{G}(H) = G(H) = 1$.

(ii) From (i) we have

$$\hat{\mu} - \mu = \int_{\hat{L}}^{\hat{H}} v\hat{g}(v)dv - \int_{L}^{H} vg(v)dv = \left[ v\hat{G}(v) \Big|_{\hat{L}}^{\hat{H}} - \int_{\hat{L}}^{\hat{H}} \hat{G}(v)dv \right] - \left[ vG(v) \Big|_{L}^{H} - \int_{L}^{H} G(v)dv \right]$$

$$= \hat{H} - H - \int_{\hat{L}}^{\hat{H}} \hat{G}(v)dv + \int_{L}^{H} G(v)dv \ge \hat{H} - H + \int_{L}^{H} G(v)dv - \int_{\hat{L}}^{\hat{H}} G(v)dv$$

$$= \hat{H} - H + \int_{L}^{H} G(v)dv - \int_{\hat{L}}^{H} G(v)dv = \hat{H} - H + \int_{L}^{\hat{L}} G(v)dv > 0$$

This completes the proof.

## 4. Sophisticated Consumers

In this section we assume consumers are sophisticated. We first consider the case when the seller makes no effort. We use the backward induction method. For a customer who purchases an item, her ex ante expected utility is

$\int_r^H vg(v)dv+\int_L^r[\eta r+(1-\eta)v]g(v)dv-p$ which equals $\mu+\eta\int_L^r(r-v)g(v)dv-p$ by simple algebra. The seller's profit function is given by

$$\Pi_N = p\bar{G}(r)E[\min(D,q)]+pG(r)(1-\eta)E[\min(D,q)] \\ +(p-r+s_r)\eta G(r)E[\min(D,q)]+s\{q-E[\min(D,q)]\}-cq$$

where the subscript "N" of LHS refers to no effort, the first term of RHS is the revenue from the sold and not returned products due to consumers' high realized valuations, the second term is the revenue from the sold and not returned products due to consumers' return plan missing, the third term is the revenue from the initial sold but finally returned products, the fourth term is the revenue from salvaging the unsold inventory, and the last term is the production costs. By simple algebra, we obtain the seller's decision problem as follows:

$$\begin{aligned} &\max\ \Pi_N(p,q,r)=[p-s+\eta(s_r-r)G(r)]E[\min(D,q)]-(c-s)q \\ &s.t.\quad p\le\mu+\eta\int_L^r(r-v)g(v)dv \end{aligned} \tag{1}$$

The decision variables $p$, $q$ and $r$ can be solved separately. Solving the above problem we obtain the firm's optimal decisions and profit as shown in Proposition 1.

*Proposition 1* Without any effort, the seller's optimal decisions are $r_N^*=s_r$, $p_N^*=\mu+\eta\int_L^{s_r}(s_r-v)g(v)dv$ and $q_N^*=F^{-1}\left[1-\frac{c-s}{\Delta_N(s_r)}\right]$, where $\Delta_N(r)=\mu+\eta\int_L^r(r-v)g(v)dv-s+\eta(s_r-r)G(r)$. The seller's optimal expected profit is given by $\Pi_N^*=\frac{c-s}{\bar{F}(q_N^*)}\int_0^{q_N^*}xf(x)dx$.

*Proof.* Eq.(1) implies that $p=\mu+\eta\int_L^r(r-v)g(v)dv$. Denote $\Delta_N(r)=\mu+\eta\int_L^r(r-v)g(v)dv-s+\eta(s_r-r)G(r)$, which can be rewritten as $\Delta_N(r)=\int_r^H vg(v)dv+(1-\eta)\int_L^r vg(v)dv-s+\eta s_rG(r)$, then we obtain $r^*=\arg_r\max\Delta_N(r)$. Differentiate $\Delta_N(r)$ w.r.t. $r$ yields $\Delta_N(r)'=-rg(r)+(1-\eta)rg(r)+\eta s_rg(r)=\eta(s_r-r)g(r)$, from which we obtain $r_N^*=s_r$. Thus, we have $p_N^*=\mu+\eta\int_L^{s_r}(s_r-v)g(v)dv$. Then, $q_N^*$ can be solved from the newsvendor model, i.e., $q_N^* = F^{-1}\left[1-\frac{c-s}{\Delta_N(s_r)}\right]$. Plugging $r_N^*$, $p_N^*$ and $q_N^*$ into Eq.(1) yields $\Pi_N^* = \Delta_N(s_r)E(\min(D,q_N^*)) - (c-s)q_N^*$, where $E\left[\min(D,q_N^*)\right] = \int_0^{q_N^*} xf(x)dx + \int_{q_N^*}^{\infty} q_N^* f(x)dx = \int_0^{q_N^*} xf(x)dx + q_N^* \bar{F}(q_N^*)$. Since $\bar{F}(q_N^*) = \frac{c-s}{\Delta_N(s_r)}$, we easily have $E\left[\min(D,q_N^*)\right] = \int_0^{q_N^*} xf(x)dx + q_N^* \frac{c-s}{\Delta_N(s_r)}$, substituting which into the seller's profit function we can obtain $\Pi_N^* = \Delta_N(s_r)\int_0^{q_N^*} xf(x)dx = \frac{c-s}{\bar{F}(q_N^*)}\int_0^{q_N^*} xf(x)dx$. This completes the proof.

Proposition 1 shows that $p_N^* \geq \mu > s_r = r_N^*$, implying that partial returns policy is favored over full returns. This conclusion has be drawn by previous works under different considerations, e.g., Hess et al (1996), Chu (1998), Su (2009) and Gurnani et al (2010). The proposition also implies that the seller, to extract maximum consumer surplus, sets the return price equal to the salvage value of per returned unit. This finding is similar to that in Su (2009). However, as will be shown later, it does not always hold under other scenarios.

## 4.1. Quality Improvement Effort

When the seller invests in QI, similar to Eq.(1), we obtain the seller's decision problem as follows:

$$\begin{aligned} &\max \ \Pi_Q(p,q,r) = \left[p - s + \eta(s_r - r)\hat{G}(r)\right]E\left[\min(D,q)\right] - (c-s)q - I \\ &s.t. \quad p \leq \hat{\mu} + \eta\int_{\hat{L}}^{r}(r-v)\hat{g}(v)dv \end{aligned} \tag{2}$$

where the subscript "Q" refers to quality improvement. Next proposition is analogue to Proposition 1.

*Proposition 2* When the seller invests in quality improvement effort, the optimal decisions are $r_Q^* = s_r$, $p_Q^* = \hat{\mu} + \eta\int_{\hat{L}}^{s_r}(s_r - v)\hat{g}(v)dv$ and $q_Q^* = F^{-1}\left[1-\frac{c-s}{\Delta_Q(s_r)}\right]$, where $\Delta_Q(r) = \hat{\mu} + \eta\int_{\hat{L}}^{r}(r-v)\hat{g}(v)dv - s + \eta(s_r - r)\hat{G}(r)$. The seller's optimal expected profit is given by $\Pi_Q^* = \frac{c-s}{\bar{F}(q_Q^*)}\int_0^{q_Q^*} xf(x)dx - I$.

Based on Lemma 1, Proposition 1 and Proposition 2, we obtain the next proposition.

*Proposition 3* (i) When the seller invests in quality improvement effort, he will also raise the price and the inventory level while keep the refund unchanged;

(ii) For sufficiently small *I*, quality improvement enhances the seller's profit.

*Proof.* (i) It is clear that $r_Q^* = r_N^* = s_r$. Furthermore,

$$\begin{aligned}
p_N^* &= \int_{s_r}^{H} vg(v)dv + \int_{L}^{s_r} [\eta s_r + (1-\eta)v] g(v)dv \\
&= \int_{s_r}^{H} vg(v)dv + \eta s_r G(s_r) + (1-\eta)\int_{L}^{s_r} vg(v)dv \\
&= \left[ H - s_r G(s_r) - \int_{s_r}^{H} G(v)dv \right] + \eta s_r G(s_r) + (1-\eta)\left[ s_r G(s_r) + \int_{L}^{s_r} G(v)dv \right] \\
&= H - \int_{s_r}^{H} G(v)dv - (1-\eta)\int_{L}^{s_r} G(v)dv
\end{aligned}$$

Similarly, $p_Q^* = \hat{H} - \int_{s_r}^{\hat{H}} \hat{G}(v)dv - (1-\eta)\int_{\hat{L}}^{s_r} \hat{G}(v)dv$. Following Lemma 1, we have

$$\begin{aligned}
p_Q^* &\geq \hat{H} - \int_{s_r}^{\hat{H}} G(v)dv - (1-\eta)\int_{\hat{L}}^{s_r} G(v)dv \\
&= \hat{H} - \int_{s_r}^{H} G(v)dv - (1-\eta)\left[ \int_{L}^{s_r} G(v)dv - \int_{L}^{\hat{L}} G(v)dv \right] \\
&= \hat{H} - H + p_N^* + (1-\eta)\int_{L}^{\hat{L}} G(v)dv \\
&> p_N^*
\end{aligned}$$

By definition we have $\Delta_N(s_r) = p_N^* - s$ and $\Delta_Q(s_r) = p_Q^* - s$. Therefore, $\Delta_Q(s_r) > \Delta_N(s_r)$ and $q_Q^* > q_N^*$.

(ii) Define $J(q) = \frac{c-s}{\bar{F}(q)} \int_{0}^{q} xf(x)dx$ is an increasing function w.r.t. *q*. Thus, $J(q_Q^*) > J(q_N^*)$. If *I*=0, we easily have $\Pi_Q^* > \Pi_N^*$. By continuity, we get that $\Pi_Q^* > \Pi_N^*$ for sufficiently small *I*. This completes the proof.

Proposition 3 coincides with one's intuition. If QI requires a small cost, the seller then profits more by improving product quality. Our attention is paid to the profit mechanism. First, it can be seen that the enhanced profit directly stems from the increased inventory level, or saying, QI promotes sales. Second, the reason why QI can promote sales is owing to the higher price and the unchanged refund. By setting refund equal to the salvage value of the returned product, the seller receives the same revenue from each unit of returned product as from initial sold product, i.e., $p_Q^* = p_Q^* - r_Q^* + s_r$. At the same time, the seller is able to charge a higher price because of the increased consumer valuation. Also, the seller increases the inventory level for the facts that the refund is unchanged, the price is higher, and the returned product keeps its initial profitability. Therefore, the profit mechanism of QI is that, in a nutshell, the seller profits more from promoted sales by setting higher price and appropriate refund amount.

## 4.2. Perception Enhancement Effort

Different from QI, when the seller adopts PE to increase consumer valuation, consumers' ex post utilities do not increase. Whether buyers decide to return the products depends on their ex post valuations. Thus, the seller's profit function is the same as that in Eq.(1). However, the maximum price the seller can charge is bounded by the restriction that in Eq.(2) because a consumer's decision on buying or not buying depends on her ax ante perceived valuation. Therefore, we obtain the seller's profit function as follows:

$$\begin{aligned} &\max \quad \Pi_P(p,q,r) = \left[p - s + \eta(s_r - r)G(r)\right]E\left[\min(D,q)\right] - (c-s)q - I \\ &s.t. \quad p \le \hat{\mu} + \eta\int_{\hat{L}}^{r}(r-v)\hat{g}(v)dv \end{aligned} \tag{3}$$

where the subscript "P" refers to perception enhancement. Next proposition is analogue to Proposition 2.

*Proposition 4* When the seller invests in perception enhancement effort, we have $r_p^* = \arg_r \max \Delta_P(r)$, $p_P^* = \hat{\mu} + \eta\int_{\hat{L}}^{r_P^*}(r_P^* - v)\hat{g}(v)dv$ and $q_P^* = F^{-1}\left[1 - \frac{c-s}{\Delta_P(r_P^*)}\right]$, where $\Delta_P(r) = \hat{\mu} + \eta\int_{\hat{L}}^{r}(r-v)\hat{g}(v)dv - s + \eta(s_r - r)G(r)$. The seller's optimal expected profit is given by $\Pi_P^* = \frac{c-s}{\bar{F}(q_P^*)}\int_0^{q_P^*} xf(x)dx - I$.

Comparing Proposition 4 to Proposition 2, we find that $\Delta_Q(r)$ and $\Delta_P(r)$ are different, implying that the seller's optimal decisions and expected profit under QI and PE are different. This difference is attributed to the customers' different return decisions. When their purchased items have better quality, their ex post valuations will increase and thus the total returned units equals $\eta\hat{G}(r)E\left[\min(D,q)\right]$. Nevertheless, when they find that they have overvalued the product quality, their true valuations are materialized from the distribution G(·). The total returned units equals $\eta G(r)E\left[\min(D,q)\right]$. One might argue that since

$\hat{G}(r) \le G(r)$, the seller would suffer a loss from a larger amount of returned products and hence profit less under PE than QI. However, we demonstrate that the conclusion is just the reverse, as shown in the next proposition.

*Proposition 5* When the seller invests in perception enhancement effort, compared with the case when he invests in quality improvement effort,

(i) if $s_r > L$, the price and the refund are lower, the inventory level is higher, and perception enhancement is more profitable than quality improvement;

(ii) if $s_r \le L$, the seller's optimal decisions and expected profit hold the same under the two cases.

*Proof.* (i) We first show that $r_P^* < s_r = r_Q^*$ when $s_r > L$. Differentiate $\Delta_P(r)$ w.r.t. $r$ yields

$$\begin{aligned}\Delta_P(r)' &= \eta\hat{G}(r) + \eta r\hat{g}(r) - \eta r\hat{g}(r) - \eta G(r) + \eta(s_r - r)g(r) \\ &= \eta\left[\hat{G}(r) - G(r) + (s_r - r)g(r)\right]\end{aligned}$$

where $\hat{G}(r) < G(r)$ if $r > L$. Clearly, $\Delta_P(r)' < 0$ for all $r \ge s_r$. $\Delta_P(r)$ can be maximized only if $r < s_r$, i.e., $r_P^* < s_r$.

Next, we show that $p_P^* < p_Q^*$ when $s_r > L$. Define $K(r) = \int_{\hat{L}}^{r} (r - v)\hat{g}(v)dv$ which is an increasing function w.r.t. $r$. Thus, $K(s_r) > K(r_p^*)$. From the expressions of $p_P^*$ and $p_Q^*$, we have $p_P^* < p_Q^*$.

To prove that $q_P^* > q_Q^*$, by expression, we need to show that $\Delta_Q(s_r) < \Delta_P(r_P^*)$, which can be easily obtained since $\Delta_P(r_P^*) > \Delta_P(s_r) = \hat{\mu} + \eta\int_{\hat{L}}^{s_r}(s_r - v)\hat{g}(v)dv - s = \Delta_Q(s_r)$.

Recall that $J(q) = \frac{c - s}{\bar{F}(q)}\int_0^q xf(x)dx$ is an increasing function w.r.t. $q$. Thus, $J(q_P^*) > J(q_Q^*)$. From the expressions of $\Pi_P^*$ and $\Pi_Q^*$, we have $\Pi_P^* > \Pi_Q^*$.

(ii) When $s_r \le L$, $\Delta_P(s_r)' = 0$ since $\hat{G}(s_r) = G(s_r) = 0$. Thus, $\Delta_P(r)' > 0$ for any $r < s_r$. Consequently, $\Delta_P(r)$ is maximized at $r = s_r$, i.e., $r_P^* = s_r$. Clearly, when $r_P^* = r_Q^* = s_r$, we have $p_P^* = p_Q^*$, $q_P^* = q_Q^*$ and $\Pi_P^* = \Pi_Q^*$. This completes the proof.

Proposition 5 has important implications. First, PE is never less profitable than QI if they require the same cost. This explains that why firms are enthusiastic about perception enhancement effort by using soft lighting, playing pleasant music, employing attractive salespeople and dressing up their retail stores by flowers and paintings (Iyer and Kuksov, 2010).

Second, the profit mechanisms of PE and QI are different. Recall that QI increases the seller's profit by raising price and hence promoting sales due to the enhancement of consumer valuation, and also by setting an appropriate refund such that he does not surfer any loss from consumer returns. While PE increases the seller's profit mainly by intentionally misguiding the customers to overvalue the products coupled with setting a low price. When it comes to a large amount of returned products, the seller sets the refund amount to be lower than the salvage value of per returned unit such that he can even receive more revenue from customer returns. A question may be raised: Will lowering the refund discourage consumer enthusiasms for purchasing? Of course not. The seller copes with this problem by lowering the price at the same time. Comparing with the higher refund, a lower price is more attractive to consumers because a buyer who purchases an item will definitely benefits from the low price while does not necessarily benefit from a high refund unless she eventually returns the product. This consideration can also explain that why the seller would not set a lower refund under the case of low salvage value of the returned product (i.e., $s_r \le L$).

Third, even under the extreme case where the salvage value of the returned product is no higher than the lower bound of consumer valuation (i.e., $s_r \le L$), the seller can be convinced that PE brings the same profit as QI. He can easily set the refund equal to the salvage value of per returned unit in order that his profit would not be influenced by the large amount of returned products. Since consumers make purchase decisions based on their ex ante perceived valuations and returned products will not incur any loss—these situations are the same as the case of QI, the seller definitely makes the same decisions and earns the same profit under PE and QI.

Finally, if we define social welfare ($SW$) as the sum of the seller's profit and the customers' utilities, then

$$\begin{aligned} SW_N(r) &= \left[\int_r^H vg(v)dv + (1-\eta)\int_L^r vg(v)dv\right] E\left[\min(D,q)\right] + s_r \eta G(r) E\left[\min(D,q)\right] + s\left\{q - E\left[\min(D,q)\right]\right\} - cq \\ &= \Delta_N(r) E\left[\min(D,q)\right] - (c-s)q \end{aligned}$$

By the same token,

$$SW_Q(r) = \Delta_Q(r) E\left[\min(D,q)\right] - (c-s)q - I$$

$$SW_P(r) = \Delta_N(r) E\left[\min(D,q)\right] - (c-s)q - I$$

where $SW_P(r)$ holds because the seller's investment in PE cannot increase consumer ex post utility.

It is clearly seen that $SW_N(r)$ and $SW_Q(r)$ are both maximized, while $SW_P(r)$ is not maximized since $r_P^* \le r_N^*$ and $q_P^* \ne q_N^*$. Based on Proposition 3 and Proposition 5, the next corollary follows.

*Corollary 1* For sufficiently small *I*, quality improvement benefits the seller and social welfare and has no impact on consumer surplus, whereas perception enhancement benefits the seller at the expense of consumer surplus and social welfare.

**Tab. 1.** Effects of QI and PE

| | Seller's profit | Consumer surplus | Social welfare |
|---|---|---|---|
| Quality improvement | ↑ | — | ↑ |
| Perception enhancement | ↑ | ↓ | ↓ |

Corollary 1 can be shown by Table 1. When the seller invests in QI, although customers pay a higher price, they in turn get the high quality products. Thus, consumer surplus remains the same and social welfare increases as the seller's profit increases. However, if the seller invests in PE, customers cannot get the products they expected for and their ex post utilities are less than zero. Besides, PE cannot increase social welfare due to the following two reasons. First, investment I cannot increase consumer ex post valuation. It only reallocates the benefits between the seller and the customers. Second, the seller's decisions on price, refund and inventory level deviate from the socially effective level. Table 1 indicates that PE increases the seller's profit by sacrificing social welfare while QI brings a win-win outcome. It is suggested that social organizers take actions to encourage the seller to adopt quality improvement effort instead of perception enhancement effort.

## 4.3. Section Summary

Within affordable effort cost, the seller may enhance his profit by QI or PE. The former truly improves product quality so that more consumers are willing to pay a higher price for a higher quality product. Accordingly, the seller sets the refund equal to the salvage value of the returned product such that the revenue earned from per unit sold equals that from per unit returned. By this way, the seller improves his profit. The latter dose not truly improve product quality. Instead, it deliberately misguides consumers to overvalue the products at the time they make purchase decisions. No doubt this will cause great quantities of returned products. The seller deals with this problem by setting lower refund such that the revenue earned from per unit returned is even higher than that from per unit sold. This makes consumer returns even more profitable.  In order not to hurt consumer enthusiasms, as an incentive mechanism, the seller provides a lower selling price. The seller balances between the lost sales caused by low refund and the increased sales due to low price and finally improves the expected profit. What surprises us most is that even for equal effort cost, PE dominates QI in increasing profit. This result stems from the seller's low price and low refund strategy under PE. For a customer who is making a purchase decision, low price is more attractive than high refund. Just as the saying goes, a bird in the hand is worth two in the bush. Compared with QI, PE not only has the low price advantage but also receives more revenue from per unit returned product, which gives rise to its higher profitability than QI.

# 5. Naive Consumers

In this section, we assume that consumers are naive. In particular, consumers believe at the time of purchasing that any low-quality product will be returned. However, this belief cannot change the fact that they may finally not return the unwanted product. Under this scenario, if the seller makes no effort, consumers' ex ante expected utilities are no longer $\int_r^H vg(v)dv+\int_L^r[\eta r+(1-\eta)v]g(v)dv-p$ but $\int_r^H vg(v)dv+\int_L^r rg(v)dv-p$, considering that their ex ante expected utilities depend on their beliefs that $\eta$= 1. However, $\eta$ may be actually less than one. Thus, the seller's profit remains unchanged while the price constraint changes into $p\le\int_r^H vg(v)dv+\int_L^r rg(v)dv$, i.e., $p\le\mu+\int_L^r(r-v)g(v)dv$. The seller's decision problem for the no effort case is as follows:

$$\begin{aligned}&\max\ \tilde{\Pi}_N(p,q,r)=\left[p-s+\eta(s_r-r)G(r)\right]E\left[\min(D,q)\right]-(c-s)q\\&s.t.\quad p\le\mu+\int_L^r(r-v)g(v)dv\end{aligned}\tag{4}$$

where we use the mark "~" to denote naive consumers. Define $\tilde{\Delta}_N(r)=\mu+\int_L^r(r-v)g(v)dv-s+\eta(s_r-r)G(r)$, then analogue to Proposition 1 we obtain $\tilde{r}_N^*=\arg_r\max\tilde{\Delta}_N(r)$, $\tilde{p}_N^*=\mu+\int_L^{\tilde{r}_N^*}(\tilde{r}_N^*-v)g(v)dv$, $\tilde{q}_N^*=F^{-1}\left[1-\frac{c-s}{\tilde{\Delta}_N(\tilde{r}_N^*)}\right]$ and $\tilde{\Pi}_N^*=\frac{c-s}{\bar{F}(\tilde{q}_N^*)}\int_0^{\tilde{q}_N^*}xf(x)dx$. Comparing the scenarios of sophisticated consumers and naive consumers yields the following proposition.

*Proposition 6* $\tilde{r}_N^*\ge r_N^*$, $\tilde{p}_N^*\ge p_N^*$, $\tilde{q}_N^*\ge q_N^*$, $\tilde{\Pi}_N^*\ge\Pi_N^*$.

*Proof.* Differentiating $\tilde{\Delta}_N(r)$ w.r.t. $r$ yields $\tilde{\Delta}_N(r)' = (1-\eta)G(r) + \eta(s_r - r)g(r)$, from which it is clearly seen that $\tilde{\Delta}_N(r)' > 0$ for any $r<s_r$. Therefore, $\tilde{r}_N^* \geq s_r = r_N^*$. Since $\int_L^r (r-v)g(v)dv$ is an increasing function w.r.t. $r$, from the expressions of $\tilde{p}_N^*$ and $p_N^*$ we know that $\tilde{p}_N^* \geq p_N^*$. From the expressions of $\tilde{\Delta}_N(r)$ and $\Delta_N(r)$ we have $\tilde{\Delta}_N(s_r) \geq \Delta_N(s_r)$, and therefore, $\tilde{\Delta}_N(\tilde{r}_N^*) \geq \tilde{\Delta}_N(s_r) \geq \Delta_N(s_r)$. Then, from the expressions of $\tilde{q}_N^*$ and $q_N^*$ we get $\tilde{q}_N^* \geq q_N^*$. Finally, from the expressions of $\tilde{\Pi}_N^*$ and $\Pi_N^*$ we get $\tilde{\Pi}_N^* \geq \Pi_N^*$. This completes the proof.

Proposition 6 indicates that if the seller does not invest to increase consumer valuation, he prefers naive customers over sophisticated customers. Facing naive customers, the seller may profit more by increasing the refund, the price as well as the inventory level. Although higher refund makes the seller receive less revenue from per unit returned product than from per unit initial sold (i.e., $\tilde{p}_N^* - \tilde{r}_N^* + s_r \leq \tilde{p}_N^*$), the higher price and larger amount of sales are sufficient to compensate for it. This conclusion is consistent with our intuition. Moreover, $\tilde{r}_N^* \geq s_r$, which implies that under special conditions $\tilde{r}_N^*$ may equal $\tilde{p}_N^*$. That is to say, full refund policy may outperform partial returns. Therefore, unlike the scenario of sophisticated consumers, the naivety behaved by consumers may inspire the seller to provide full returns policy.

## 5.1. Quality Improvement Effort

When the seller resorts to QI to increase naive consumers' perceived valuations, his decision problem is

$$\begin{aligned} &\max \ \tilde{\Pi}_Q(p,q,r) = \left[p - s + \eta(s_r - r)\hat{G}(r)\right] E\left[\min(D,q)\right] - (c-s)q - I \\ &s.t. \quad p \leq \hat{\mu} + \int_{\hat{L}}^r (r-v)\hat{g}(v)dv \end{aligned} \tag{5}$$

Define $\tilde{\Delta}_Q(r) = \hat{\mu} + \int_{\hat{L}}^r (r-v)\hat{g}(v)dv - s + \eta(s_r - r)\hat{G}(r)$. We have $\tilde{r}_Q^* = \arg_r \max \tilde{\Delta}_Q(r)$, $\tilde{p}_Q^* = \hat{\mu} + \int_{\hat{L}}^{\tilde{r}_Q^*} (\tilde{r}_Q^* - v)\hat{g}(v)dv$, $\tilde{q}_Q^* = F^{-1}\left[1 - \dfrac{c-s}{\tilde{\Delta}_Q(\tilde{r}_Q^*)}\right]$ and $\tilde{\Pi}_Q^* = \dfrac{c-s}{\bar{F}(\tilde{q}_Q^*)} \int_0^{\tilde{q}_Q^*} xf(x)dx - I$. The following proposition is then obtained by comparing the scenarios of sophisticated consumers and naive consumers.

*Proposition 7* When consumers are naive, quality improvement improves the seller's profit for sufficiently small $I$.

*Proof.* Analogue to Proposition 6, we easily have $\tilde{r}_Q^* \geq s_r$. Next, we show that $\tilde{\Delta}_Q(r) > \tilde{\Delta}_N(r)$ for any $r \geq s_r$.

Note that $\tilde{\Delta}_N(r)$ can be rewritten as $\tilde{\Delta}_N(r) = \int_r^H vg(v)dv + \int_L^r rg(v)dv - s + \eta(s_r - r)G(r)$ and $\tilde{\Delta}_Q(r)$ is equal to $\tilde{\Delta}_Q(r) = \int_r^{\hat{H}} v\hat{g}(v)dv + \int_{\hat{L}}^r r\hat{g}(v)dv - s + \eta(s_r - r)\hat{G}(r)$, where $\eta(s_r - r)\hat{G}(r) \geq \eta(s_r - r)G(r)$ for any $r \geq s_r$. To prove $\tilde{\Delta}_Q(r) > \tilde{\Delta}_N(r)$ we only need to prove that $\int_r^{\hat{H}} v\hat{g}(v)dv + \int_{\hat{L}}^r r\hat{g}(v)dv > \int_r^H vg(v)dv + \int_L^r rg(v)dv$. Note that $\int_r^{\hat{H}} v\hat{g}(v)dv + \int_{\hat{L}}^r r\hat{g}(v)dv = v\hat{G}(v)\Big|_r^{\hat{H}} - \int_r^{\hat{H}} \hat{G}(v)dv + r\hat{G}(r) = \hat{H} - \int_r^{\hat{H}} \hat{G}(v)dv$ and $\int_r^H vg(v)dv + \int_L^r rg(v)dv = H - \int_r^H G(v)dv$, where $\hat{H} - \int_r^{\hat{H}} \hat{G}(v)dv \geq \hat{H} - \int_r^{\hat{H}} G(v)dv = \hat{H} - \int_r^H G(v)dv > H - \int_r^H G(v)dv$. Thus, $\tilde{\Delta}_Q(r) > \tilde{\Delta}_N(r)$ for any $r \geq s_r$.

Consequently, $\tilde{\Delta}_Q(r_Q^*) \geq \tilde{\Delta}_Q(r_N^*) > \tilde{\Delta}_N(r_N^*)$. From the expressions of $\tilde{q}_Q^*$ and $\tilde{q}_N^*$ we get $\tilde{q}_Q^* > \tilde{q}_N^*$. From the expressions of $\tilde{\Pi}_Q^*$ and $\tilde{\Pi}_N^*$ we know that $\tilde{\Pi}_Q^* > \tilde{\Pi}_N^*$ when $I$=0. By continuity, we conclude that $\tilde{\Pi}_Q^* > \tilde{\Pi}_N^*$ for sufficiently small $I$. This completes the proof.

Proposition 7 shows that when consumers are naive, the seller can still increase profit by QI when the effort cost is affordable. It is noteworthy that the profit mechanism of QI under the naive case is a bit different from that under the sophisticated case. When consumers are naive, although the inventory level also increases, it is hard to say that the price and the refund increases or decreases. This slight change has no impact on the profitability of QI, while as will be shown, it exerts a significant influence on the profitability of PE.

## 5.2. Perception Enhancement Effort

When the seller resorts to PE to increase naive consumers' perceived valuations, his decision problem is

$$\begin{aligned} \max\ & \tilde{\Pi}_P(p,q,r) = \left[p - s + \eta(s_r - r)G(r)\right]E\left[\min(D,q)\right] - (c-s)q - I \\ s.t.\ & p \le \hat{\mu} + \int_{\hat{L}}^{r} (r-v)\hat{g}(v)dv \end{aligned} \tag{6}$$

Define $\tilde{\Delta}_P(r) = \hat{\mu} + \int_{\hat{L}}^{r}(r-v)\hat{g}(v)dv - s + \eta(s_r - r)G(r)$. We have $\tilde{r}_P^* = \arg_r \max \tilde{\Delta}_P(r)$, $\tilde{p}_P^* = \hat{\mu} + \int_{\hat{L}}^{\tilde{r}_P^*}(\tilde{r}_P^* - v)\hat{g}(v)dv$, $\tilde{q}_P^* = F^{-1}\left[1 - \frac{c-s}{\tilde{\Delta}_P(\tilde{r}_P^*)}\right]$ and $\tilde{\Pi}_P^* = \frac{c-s}{\bar{F}(\tilde{q}_P^*)}\int_0^{\tilde{q}_P^*} xf(x)dx - I$ ·

Before comparing $\tilde{\Pi}_P^*$ and $\tilde{\Pi}_Q^*$, we first present the following lemma.

*Lemma 2* $\tilde{r}_P^* \ge s_r$ when consumer perceived valuation experiences a stochastic but sufficiently small increment under investment *I*.

*Proof.* Recall that the seller can make a fixed investment *I* to increase consumer perceived valuation by *δ*. When $\delta \to 0$, we get $G(\cdot) - \hat{G}(\cdot) \to 0$. Differentiating $\tilde{\Delta}_P(r)$ w.r.t. *r* yields $\tilde{\Delta}_P(r)' = \hat{G}(r) - \eta G(r) + \eta(s_r - r)g(r)$, from which we have $\lim_{\delta\to 0}\tilde{\Delta}_P(r)' = (1-\eta)G(r) + \eta(s_r - r)g(r)$. From the proof of Proposition 6 we know $\tilde{r}_P^* \ge s_r$ when *δ*→0. By continuity, we get that $\tilde{r}_P^* \ge s_r$ when *δ* is stochastic but sufficiently small. This completes the proof.

Different from the case of sophisticated consumer, the seller may set the refund higher than the salvage value of the returned product when consumers are naive, especially when the fixed investment can only induce slight increase of consumer valuation. Note that Lemma 2 is a sufficient but not necessary condition. From the proof of lemma 2 we know that even when this condition is not satisfied, $\tilde{r}_P^*$ may also be higher than $s_r$.

Next proposition is obtained based on Lemma 2.

*Proposition 8* $\tilde{\Pi}_P^* \le \tilde{\Pi}_Q^*$ when consumer perceived valuation experiences a stochastic but sufficiently small increment under investment *I*.

*Proof.* Note that $\tilde{\Pi}_P^* \le \tilde{\Pi}_Q^* \Leftrightarrow \tilde{q}_P^* \le \tilde{q}_Q^* \Leftrightarrow \tilde{\Delta}_p(\tilde{r}_P^*) \le \tilde{\Delta}_Q(\tilde{r}_Q^*)$. We only need to prove that $\tilde{\Delta}_p(\tilde{r}_P^*) \le \tilde{\Delta}_Q(\tilde{r}_Q^*)$ when *δ*→0. From Lemma 2 and the proof of Proposition 7 we get that $\tilde{r}_P^* \ge s_r$ and $\tilde{r}_Q^* \ge s_r$ when *δ*→0. By definition we have $\tilde{\Delta}_p(r) \le \tilde{\Delta}_Q(r)$ for any $r \ge s_r$. Therefore, $\tilde{\Delta}_Q(\tilde{r}_Q^*) \ge \tilde{\Delta}_Q(\tilde{r}_P^*) \ge \tilde{\Delta}_P(\tilde{r}_P^*)$ for stochastically but sufficiently small *δ*. This completes the proof.

Proposition 8 is insightful in three folds. First, from the perspective of the seller, as shown in Proposition 5, he never prefer QI over PE when consumers are sophisticated. However, if consumers are not so sophisticated, he may change his strategy, especially when consumer valuation cannot be increased by a considerable degree. This is somewhat surprising. Why the seller dose not definitely favor PE over QI when consumers are naive, considering that even faces sophisticated customers the seller dose have an incentive to misguide customers to overvalue the product instead of to truly improve product quality? This is attributed to the changed refund strategy. When customers are sophisticated, the seller must set the refund lower than the salvage value of per returned unit to cope with large amount of consumer returns. Nevertheless, naive customers overestimate their ex ante expected utilities and consequently have a higher willingness to pay. Under some circumstances (such as the sufficient condition shown in Proposition 8), raising price and refund is more efficient than reducing them (as shown in Proposition 5) to promote sales. Once the refund exceeds the salvage value of the returned product, the seller can not longer benefit from consumer returns, which leads to the lower profitability of PE than QI. However, this does not mean that the seller is injured by naive consumers. Just like Proposition 6, it is easy to prove that $\tilde{\Pi}_P^* > \Pi_P^*$. The seller still prefers naive consumers.

Second, from the perspective of consumers, being naive may be better for them to ultimately get the true increased quality products. Actually, this somewhat counterfactual conclusion can also be found in Iyer and Kuksov (2010). Whereas there exits a big difference between their work and ours. They define rational consumers as those who have the ability to solve back for the true product quality. While we interpret sophisticated consumers as those who consider the probability they may not return the unwanted products when they make purchase decisions.

Third, we should notice the reason why QI definitely dominates PE under the condition that the fixed investment *I* can only cause slight increase of naive consumer ex ante valuation. This is because under this condition, by setting appropriate price only cannot effectively promote sales. It must be coupled with high refund strategy such that more naive consumers are willing to buy. While high refund means QI would be more favorable.

Considering that PE may be dominated by QI when consumers are naive, one may wonder that whether there exist conditions under which PE even decreases the seller's profit for sufficiently small effort cost. Next corollary gives a negative answer to this question.

*Corollary 2* For sufficiently small *I*, perception enhancement increases the seller's profit when consumers are naive.

*Proof.* During the proof of Proposition 7, it is shown that $\int_r^{\hat{H}} v\hat{g}(v)dv + \int_{\hat{L}}^r r\hat{g}(v)dv > \int_r^H vg(v)dv + \int_L^r rg(v)dv$, i.e., $\int_L^r (r-v)g(v)dv > \int_{\hat{L}}^r (r-v)\hat{g}(v)dv$. From the expressions of $\tilde{\Delta}_p(r)$ and $\tilde{\Delta}_N(r)$, we get that $\tilde{\Delta}_p(r) > \tilde{\Delta}_N(r)$. Thus, $\tilde{\Delta}_P(\tilde{r}_P^*) \geq \tilde{\Delta}_P(\tilde{r}_N^*) \geq \tilde{\Delta}_N(\tilde{r}_N^*)$ when *I*=0. Therefore, $\tilde{\Pi}_P(\tilde{r}_P^*) > \tilde{\Pi}_N(\tilde{r}_N^*)$ for sufficiently small *I*. This completes the proof.

### 5.3. Section Summary

When consumers are naive, i.e., when consumers hold beliefs that they will return any low-valued product, the seller can still increase his profit through QI or PE effort. However, unlike the case of sophisticated consumers, PE no longer always outperform QI, especially when the effort has a limited power to affect consumers. The reason lies in the fact that naive consumers overestimate their ex ante expected utilities, which means they are willing to pay more for the products. In order to maximize his profit, under some circumstances, the seller finds it is optimal to set the refund higher than the salvage value of the returned product. Under this high refund strategy, PE is not more profitable than QI any longer because the revenue earned from per unit returned product is less than that from per unit sold. In other words, with high refund policy, the seller will incur potential losses by a larger amount of consumer returns caused by PE.

The insights are obvious. On one hand, when the seller makes a choice between QI and PE to improve profit, he should not only consider the effort cost but also pay enough attention to the type of consumers. It can be never said that low-price-and-low-refund strategy under PE is always the best policy. When the seller faces naive consumers, especially when consumers' ex ante valuations for the products are relatively immune from his QI or PE effort, he might just as well truly improve product quality to avoid massive consumer returns. On the other hand, when consumers make purchase decisions, sophisticated behaviors may pose them into a danger, under which they cannot obtain the high quality products they expected for. Although naive consumers are charged for a higher price, in return they get high quality goods which are consistent with their ex ante valuations. Therefore, again, we cannot jump to a conclusion that which type of consumers owns a relatively advantageous position in the seller-buyer tradeoff.

## 6. Conclusions and Future Research

Consumers hardly observe product quality. The seller often has an incentive to influence consumer feelings at the time of purchase decision making. This paper investigates the role of consumer behavior and consumer returns policy in the seller's decisions on quality improvement and perception enhancement, both of which can increase consumer ex ante valuation. The former truly improve product quality, so the seller can promote sales by charging a higher price. The latter does not truly improve product quality. Instead, it intentionally misguides customers to overvalue the products at the time of decision making. The latter can also promote sales because of its low-price-and-low-refund strategy. Generally speaking, perception enhancement is more attractive to the seller. However, the seller should not be too devoted to this irresponsible action. First, consumer behaviors have an important impact on the profitability of quality improvement and perception enhancement. When consumers are naive, it is hard to say which effort mode is more profitable. Second, our model only considers one-shot deal. Over the long run, the seller should be more cautious about the perception enhancement effort. Consumers may feel that they were deceived and the seller may incur a goodwill lost.

Consumer returns policy plays an important role in the seller's preference between quality improvement and perception enhancement. To extract maximum consumer surplus, the seller sets different refunds, which give rise to the different profitability of QI and PE under different scenarios. Different from previous works, we find that full returns may be an optimal strategy when consumers are naive. It indicates that consumer behavior exerts a significant influence on the seller's returns policy making. The seller may be obliged to adopt partial refund policy by consumers' opportunistic behavior (Hess et al., 1996; Chu et al., 1998), while he may also be encouraged to implement full refund policy by consumers' naive behavior. Therefore, being naive is not such a bad thing for customers. Although they pay a high price, they may in turn obtain the truly high quality product they perceived as.

The above insights are gained through a single-period model. Future works should establish multi-period models to study the seller's decision making problem. We believe that consumer behaviors still have an impact on the seller's strategy choice. Moreover, competitive environment may also change the seller's strategy. Third, if manufactures do not directly sell their products and there are retailers or distributors in the supply chain, the situation is further complicated. Generally speaking, manufactures have the ability to improve product quality and retailers are able to influence consumer feelings by perception enhancement activities. How the two efforts interact with each other requires future research. Fourth, whether and how consumer can rationally adjust their behaviors to induce the seller to implement strategies that are beneficial to them is also an interesting question.

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