Competition from Search Goods

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Abstract

We consider an experience goods seller who serves a market consisting of both high-end and low-end consumers. Exclusively serving the high-end consumers helps the building of a reputation of high quality, and this consideration causes the equilibrium price of the experience goods to be non-monotone in the seller’s discount factor. Versioning further facilitates reputation building because it allows the seller to serve all consumers yet limits its incentive to shirk on quality only in the production of high-quality product sold exclusively to high-end consumers. When versioning is permitted, product variety is also non-monotone in discount factor. We also consider competition from search goods sellers. The impact of competition from search goods sellers on the experience goods’ quality critically depends on the quality of the search goods. Competition from low-quality search goods sellers promotes the quality of the experience goods but competition from high-quality search goods sellers leads to an opposite effect on the experience goods’ quality. However, when versioning is allowed, competition may hinder the reputation building regardless of the quality of search goods.

1 Introduction

A growing literature has examined "experience goods" since Nelson [13], who first proposed the concept of "search" as well as "experience". Following Nelson [13], we define "search goods" as the product whose quality can be searched or precisely evaluated before purchase. In contrast, quality of "experience goods" can only be ascertained after consumption takes place. Competition between search goods and

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experience goods seems realistic in many contexts: new products, such as cell-phones and computers with upgraded software and hardware, medicine and health-food with the newly invented formulation and function, competes with the old ones. Consumers have more information about the goods they have bought in previous periods than the goods they have not bought before (Villas-Boas [17]). Therefore, new products are more like experience goods and old products are closer to the search ones according to our definition.

At the beginning of this paper, we consider an experience goods seller who serves both high-end and low-end consumers. Compared with the low-end consumer, the high-end consumer sets a higher valuation on the high-quality product while a lower valuation on the low-quality product. As typically assumed in standard theoretical research (Bar-Isaac [3], Dana and Fong [6]), experience goods seller is able to produce both types of products. Although actual quality is unobservable, consumers are aware of all possible qualities that can be produced by the seller. A seller maintains a high reputation by producing at high quality and failing once leads to the low reputation for sure.

Our model shows that the equilibrium price of the experience goods exhibits a non-monotone relationship with the discount factor of the seller. Serving all consumers means that the price has to be set lower, which limits the profit from each unit of production of high-quality goods and increases the incentive for an experience goods seller to save current production cost instead of earning future equilibrium profit. Therefore, it requires the seller to be more forward-looking. On the other hand, the option to serve the high-end consumers exclusively helps to establish a high-quality equilibrium when the discount factor is not sufficiently high. In this case, the experience goods seller can charge a higher price. When the discount factor is small, the static Nash results becomes the only equilibrium.

Exclusively serving the high-end consumers facilitates the reputation building. Versioning can further help. When versioning is allowed, the experience goods seller can conduct price discrimination, selling the high-quality product to the high-end consumer and the low-quality goods to the low-end consumer. The incentive to shirk on quality is efficiently limited. At the same time, the profit is largely improved by serving additional segment of consumers.

This paper mainly studies the impact of competition from search goods on repeated price and quality determination of an experience goods seller. To our knowledge, we are the first to examine such effect. In our paper, search goods sellers are verified to produce at some specific level of quality. Classical studies of experience goods discuss the equilibrium conditions under which experience goods
sellers will sell a high-quality product. This paper elaborates further on reputation building with the influence of search goods. The impact of competition highly depends on the quality of the search goods. When search goods sellers just provide the low-quality product, competition promotes the quality of experience goods. In other words, the reputation of high quality is much easier to maintain with the existence of competition. This can be justified by some observation in reality. One example comes from Microsoft company. Office Binary File Format Specifications are available to the public after Office Open XML is adopted in office 2007. Firms will advanced technology may disclose old technology so that other competitors can use them. However, when competition is intensified in a way that the quality of search goods becomes closer to the high-quality product, this result probably breaks down. High-quality product may not be supported in the equilibrium even when search goods’ quality is strictly lower than the high-quality goods.

Competition plays a different role when versioning is permitted. Our model shows that competition from search goods sellers may result in low-quality equilibrium although the high-quality product appears in monopoly case. The advantage of price discrimination can be canceled out by competition. We also show that it is more likely for a monopolist to conduct price discrimination than a seller in the competitive environment.

The rest of paper is organized as follows. At first, we discuss related studies in Section 2. Then we introduce basic ingredients of our basic model. Section 4 dicusses the situation that an experience goods seller monopolizes the whole market and selling either one type or two types of products. In section 5, competition from search goods is involved in the model. A special case in which search goods are of minimum quality is discussed. Then we also consider the case where versioning is allowed. A comparison between results in section 4 and 5 shows the impact of competition.

2 Related Literature

Since seminal work by Nelson [13], experience goods have been the focus of theoretical as well as empirical research. A stream of theoretical works considers quality signaling through different channels such as advertising (Schmalensee [15], Milgrom and Roberts [12] and branding (Wernerfelt [18], Cabral [5], Hakenes and Peitz [7]). Another approach studies experience goods from the aspect of moral hazard and reputation. In order to maintain a good reputation and obtain a high long-term profit, sellers are forced to either conduct production (Bar-Isaac [3], Dana and Fong [6]) or exert effort (Hörner [8]) with
extra cost. High reputation leads to a premium above marginal cost, which creates a positive profit flow to compensate their investment in reputation (Shapiro [16], Klein and Leffler [9]). Our work is along with this approach.

Previous research provides several candidates for the definition of reputation. It can be either consumer’s belief of seller’s type (Hörner [8], Mailath and Samuelson [11]) or consumer’s belief of product’s quality (Board and Meyer-ter Vehn [4]). In this paper, reputation is determined in a simpler way by the quality of product last period, as in Shapiro [16], Bar-Isaac [3], Dana and Fong [6]. The reputation of a seller is assumed to break down forever whenever he charges a high price for low-quality goods.

Along with Shapiro [16], Allen [2] consider a more sophisticated consumer who is aware of not only the cost of production but also the quantity of production. In this case, there can exist equilibria where price is equal to average cost but higher than marginal cost. Firms will not cut their price since this would make it more profitable to produce low- rather than high-quality goods. Consumers are aware of this and would not buy its products. In our model, the sophistication consideration does not matter. In competitive environment, deviation in quantity is not profitable because it must trigger a price change which can be detected by consumer immediately. Then we only need to consider consumers who are aware of production cost.

Our work involves the discussion about the impact of market structure on reputation. Both theoretical and empirical research (Bar-Isaac [3], Dana and Fong [6], Aghion et al. [1]) have presented some non-monotonic relationship between the level of competition and the sustainability of high reputation. However, the exact pattern hasn’t been agreed\(^1\). Our analysis follows the framework of Dana and Fong [6], considering two effects of competition on the sustainability of high reputation. On one hand, competition makes punishment from deviation more severe, which facilitates the sustaining of high-quality equilibrium. On the other hand, competition drives price down and deflates the equilibrium profit, therefore motivates experience goods seller to give up the high reputation. Beyond their model, we consider consumers with differentiated taste. Consumer segmentation allows the seller to use strategies targeting at specific group of consumers and therefore lessen the difficulty of reputation building.

Our research is also related to those papers studying the competition between different types of sellers: entry firms and incumbent firms (Krähmer [10]), "inept" firms and "competent" firms (Mailath

\(^1\)The results of Bar-Isaac [3] is somehow opposite to Dana and Fong [6], Aghion et al. [1]
and Samuelson [11]), "brand names" and "no names" (Orosel and Zauner [14]), good firm and bad firm (Hörner [8]). Consumers may differ in availability to information of different firms. For example, in Villas-Boas [17], consumers have more information about the good they have bought in previous periods and have less information about the goods they have not bought before. Follow this idea, we assume that consumer have accurate information about a part of firms (search goods sellers) while having limited information about others (experience goods seller).

Orosel and Zauner [14] perhaps is the paper closest to our work regarding a similar market structure of competition among experience goods sellers and search goods sellers. However, our paper is quite different from Orosel and Zauner [14] in a bunch of ways. Orosel and Zauner [14] consider an experience goods market with vertical differential quality. Goods with minimum quality are supplied by a competitive fringe of firms. Consumers have different tastes for quality. They assume Bertrand competition between experience goods sellers. Although technology is available for firms to produce goods with a continuum of quality level, only maximum and minimum quality level will be chosen by firms, which is called "quality polarization" by the authors. In contrast, our model includes a unique experience goods seller who can either produce high quality or low-quality product. Search goods seller can produce some certain level of product which is not limited to the minimum quality level. Considering such a large range of search goods enables us to compare the impact of different intensity of competition on the behavior of experience goods seller. Price discrimination is a significant extension of our basic model which shows the impact of competition may not always be beneficial for reputation building, which is not considered in Orosel and Zauner [14]. To our knowledge, we are the first one make a comparison between the scenarios of an experience good seller with and without search goods competitors, which make it possible to analyze the influence of introducing competition into the market.

3 The Model

The model characterizes a repeated game in which infinitely lived firms sell to two units mass of heterogeneous consumers. All players share the common discount factor $\delta \in [0, 1]$.

There are two types of consumers: high-end (type-\(h\)) and low-end (type-\(l\)). We consider a continuum of consumers with equal measure of each type\(^2\). Each consumer’s type is private information of consumer

\(^2\)It would become clear that assuming equal measures of the two types of consumers is innocuous as we allow arbitrary
himself while the distribution of consumer’s type is common knowledge. Consumers have a perfect memory about what happens in past periods.

Two types of products, high-quality (type-$H$) and low-quality (type-$L$), with intrinsic values $v_H$ and $v_L$ respectively, may be produced by the experience goods seller. The two products are imperfect substitutes for the two types of consumers with heterogeneous tastes described as follows:

High-end consumers evaluate the high-quality and low-quality products, respectively, at $v_H$ and $\alpha v_L$, where $\alpha \in (0, 1)$. Low-end consumers evaluate the high-quality and low-quality products, respectively, at $\beta v_H$ and $v_L$, where $\beta \in (0, 1)$. $\alpha$ and $\beta$ represent the private discount of evaluation by different types of consumers. It’s natural to further assume that $\beta > \frac{v_H}{v_L}$ so that all consumers set a higher valuation on the high- than the low-quality product.

The production costs of each unit of the high- and low-quality goods are $c_H$ and $c_L$, with $c_L < c_H$, $c_H < v_H$ and $c_L < v_L$. As is standardly assumed in the literature,

$$v_H - c_H > v_L - c_L \quad (1)$$

Social surplus from providing high-quality goods to high-end consumer is larger than providing low-quality product to low-end consumers. It immediately follows that $v_H - c_H > \alpha v_L - c_L$, for any $\alpha \in (0, 1)$, which indicates that it is socially more efficient to serve high-end consumers with high-quality goods rather than low-quality goods. However, (1) can not give us similar implication about low-end consumers.

Information asymmetry exists before consumption. Product quality and production cost are privately known to the seller before purchase. Consumer ascertains the quality only after he experienced it. We call such kind of product as the experience goods in the following analysis. It is possible for an experience goods seller to charge a high price while selling a low-quality product. Throughout this paper, we focus on the perfect Bayesian equilibrium in which consumers’ consumption decision depends on current price of product and their belief about current quality. Consumers’ belief about quality is consistent with Bayes’ rule and seller’s equilibrium strategy. The experience goods seller adopts a grim trigger strategy in which single defection of the seller triggers defection forever.

We characterize the time-line of the stage game as follows:

In each period, the experience goods seller chooses the quality and price for the product simultaneously. After observing price, consumers form a belief of the quality and decide whether to buy the variations in consumers’ valuations.
product. Then consumption takes place and really quality of the experience goods is revealed to all consumers. Payoff of each player is realized.

4 Monopoly of Experience Goods

4.1 Unique Product

We begin with the situation that the experience goods seller monopolizes the whole market and produces only one type of product in each period.

Consumer forms a belief about quality of the product in each period before purchase. The worst possible belief of consumers is that the seller produces at low quality. We define low-quality equilibrium as that in which experience goods seller produces at low quality. Heterogeneity of consumers’ taste divides the consumers into two segments. The experience goods seller can choose to trade with either one or both ones. So the highest profit an experience goods seller can obtain in the low-quality equilibrium is given by

\[ \max \{ v_L - c_L, 2(\alpha v_L - c_L) \} \]

Before we come to discussion of the equilibrium in which high-quality product can be supported, we denote two types of equilibria as below:

**H0(M)-equilibrium**: on the equilibrium path, the experience goods seller produces at high quality and only sells to high-end consumers;

**HH(M)-equilibrium**: on the equilibrium path, the experience goods seller produces at high quality and sells to both high-end and low-end consumers.

It immediately follows our assumption of consumers’ taste that there are only two cases of high-quality equilibrium as listed above. It is impossible that in an equilibrium, the low-end consumers buy the high-quality product while the high-end consumers buy the low-quality ones.

Since this is a game of perfect monitoring, it is without loss of generality to assume that any deviation by the seller leads to reversion to the worst possible belief that the seller forever produces at low quality as soon as the deviation is detected. In other words, if the seller produces at the low quality this period, which will be detected at the end of the period, starting from the next period, buyers believe that the seller will forever produce at low quality. If the seller charges a price different from the equilibrium level, which will be detected before consumers buy the product, buyers believe that the seller will forever
produce at low quality starting from the current period.

At first, we consider the H0(M)-equilibrium. Let equilibrium price of experience goods be denoted by $p_H$. The seller must set $p_H \leq v_H$ to attract some high-end consumers. The incentive compatible condition for the seller not to shirk on quality is

$$\frac{p_H - c_H}{1 - \delta} \geq p_H - c_L + \frac{\delta}{1 - \delta} \max \{v_L - c_L, 2(\alpha v_L - c_L)\}$$

$$\frac{\delta}{1 - \delta} [(p_H - c_H) - \max \{v_L - c_L, 2(\alpha v_L - c_L)\}] \geq c_H - c_L$$

(2)

According to (2), the benefit of shirking is to save the cost of production on one unit of high-quality goods rather than low-quality goods and the loss is profit gap between high- and low-quality equilibrium. Raising $p_H$ increases the high-quality equilibrium profit at the same time makes it easier to maintain a reputation for high quality.

If the seller deviates in price, then consumers immediately believe that the seller forever produces at low quality. Given this belief, the maximum deviation profit is $\max\{v_L - c_L, 2(\alpha v_L - c_L)\}$. Therefore, the condition for the seller not to deviate in price is

$$\frac{p_H - c_H}{1 - \delta} \geq \max \{v_L - c_L, 2(\alpha v_L - c_L)\}$$

(3)

It is clear that (3) is a necessary condition for (2) to hold, so it is redundant to consider price deviation. Then whenever the price of experience goods satisfies (2), the consumer can trust the seller in providing the high-quality product.

In HH(M)-equilibrium, let the equilibrium price be denoted by $p'_H$. The seller should set $p'_H \leq \beta v_H$ to attract low-end consumers. For the seller not to shirk on quality, it requires that

$$\frac{2(p'_H - c_H)}{1 - \delta} \geq 2(p'_H - c_L) + \frac{\delta}{1 - \delta} \max \{v_L - c_L, 2(\alpha v_L - c_L)\}$$

$$\frac{\delta}{1 - \delta} [2(p'_H - c_H) - \max \{v_L - c_L, 2(\alpha v_L - c_L)\}] \geq 2(c_H - c_L)$$

(4)

Similarly to previous case, raising $p'_H$ increases the high-quality equilibrium profit at the same time makes it easier to maintain the reputation of high quality. It is redundant to consider the incentive to deviate in price for the same reason as in the previous type of equilibrium.

If high quality cannot be sustained by selling to only the high-end consumers at $p_H = v_H$ as well as by selling to both types of consumers at $p'_H = \beta v_H$, then there is no equilibrium in which the monopolist produces at high quality. Multiple equilibria may exist. We define the optimal equilibrium in this paper
as the most profitable equilibrium for experience goods seller. For the experience-good monopolist to achieve lower profits, a public randomization device can be introduced in the first period of the game to allow mixing between the optimal equilibrium and the equilibrium which gives the seller the lowest possible profit. So from now on, we restrict attention to \( p_H = v_H \) and \( p'_H = \beta v_H \).

The necessary condition for (2) to hold for some \( \delta > 0 \) is:

\[
v_H - c_H > \max \{v_L - c_L, 2(\alpha v_L - c_L)\}.
\]

(5)

Moreover, for (4) to be held for some \( \delta > 0, \beta \) should satisfy

\[
\beta \geq \max \left\{ \frac{v_L - c_L + 2c_H}{2v_H}, \frac{\alpha v_L - c_L + c_H}{v_H} \right\} \equiv \beta_0
\]

(6)

(6) implies that only when the low-end consumers obtain a high valuation on the high-quality goods, the experience goods seller begins to sell the high-quality product to them. However, under the assumption (5), it is always more profitable to sell the high-quality product rather than the low-quality product to the high-end consumers.

Setting \( p_H = v_H \) and rewriting (2), it follows that a profit of \( (v_H - c_H) / (1 - \delta) \) is sustainable if and only if

\[
\delta \geq \frac{c_H - c_L}{v_H - c_L - \max \{v_L - c_L, 2(\alpha v_L - c_L)\}} \equiv \delta^{H0}.
\]

(7)

Setting \( p'_H = \beta v_H \) and rewriting (4), it follows that a profit of \( 2(\beta v_H - c_H) / (1 - \delta) \) is sustainable if and only if

\[
\delta \geq \frac{2(c_H - c_L)}{2(\beta v_H - c_L) - \max \{v_L - c_L, 2(\alpha v_L - c_L)\}} \equiv \delta^{HH}.
\]

(8)

If (7) and (8) are violated, there will be no high quality products sold in equilibrium regardless the price.

** Proposition 1 ** Under the assumption that \( v_H - c_H > \max \{v_L - c_L, 2(\alpha v_L - c_L)\} \), the optimal equilibrium in a market where there is only an experience goods seller is characterized as follows:

1. If \( \beta \in (\frac{\alpha v_L}{c_H}, \beta_1) \), then \( v_H - c_H \geq 2(\beta v_H - c_H) \) and \( \delta^{H0} < \delta^{HH} \).

For \( \delta \geq \delta^{H0} \), the seller produces at high quality and sets price at \( p_H = v_H \), only selling the product to high-end consumers; for \( \delta < \delta^{H0} \), the seller produces at low quality.

3Here, we assume \( \frac{\alpha v_L}{c_H} < \beta_1 \) so that "type 1" high-quality equilibrium can be a part of the optimal equilibrium.
2. If $\beta \in (\beta_1, \beta_2]$, then $v_H - c_H < 2(\beta v_H - c_H)$ and $\delta^{H0} \leq \delta^{HH}$.

For $\delta \geq \delta^{HH}$, the seller produces at high quality and sets price at $p'_H = \beta v_H$, selling to both type of consumers; for $\delta^{HH} > \delta \geq \delta^{H0}$, the seller produces at high quality and sets price at $p_H = v_H$, only selling to high-end consumers; for $\delta < \delta^{H0}$, the seller produces at low quality.

3. If $\beta \in (\beta_2, 1)$, then $v_H - c_H < 2(\beta v_H - c_H)$ and $\delta^{H0} > \delta^{HH}$.

For $\delta \geq \delta^{HH}$, the seller produces at high quality and sets price at $p'_H = \beta v_H$, selling to both types of consumers; for $\delta < \delta^{HH}$, the seller produces at low quality.

Where $\beta_1 = \frac{v_H + c_H}{2v_H}$ and $\beta_2 = 1 - \frac{\max\{v_L - c_L, 2(\alpha v_L - c_L)\}}{2v_H}$.

Proof. See appendix.

When $\beta$ is extremely low (even it is lower than $\beta_0$), high quality product can still be supported in the optimal equilibrium by serving high-end consumers exclusively. In this case, no matter how patient of a seller is, he will never sell to the low-end consumer. This is commonly observed in the luxury industry.

As in Figure 1, price is non-monotone in discount factor when $\beta \in [\beta_1, \beta_2)$. A more patient seller may not charge a higher price. With low discount factors, the experience good seller sets the price at $v_L$ or $\alpha v_L$, With medium discount factors, the seller sets the price at $v_H$; and with high discount factors, the seller sets the price at $\beta v_H$. Monopolist should be very patient so that they will not give up future profit in order to resist the temptation of cost cutting in current period. When $\delta$ is not that large, the
low-end consumer cannot believe monopolist in producing a high-quality product. The seller can raise
the price to increase profit he earns from high-end consumers so that high-end consumer can still trust
the seller. In this case, the price can be set to a higher level without concerning low-end consumers.
When \( \delta \) is even lower, the seller cares very little about long-run profit. Then no consumer will believe
monopolist in producing a high-quality product.

4.2 Versioning

In this section, we allow the experience goods seller to produce both high- and low-quality products
at the same time. Assume that if a consumer is indifferent between two products, he prefers the high-
quality one. This assumption makes sure that a type of consumer will only buy from one type of product
and can simplify our analysis.

Consider an equilibrium strategy, in which monopolist sells high-quality goods at \( p_H \) to high-end
and low-quality goods at \( p_L \) to low-end consumers, profit of monopolist is given by:

\[
\pi = p_H + p_L - c_H - c_L
\]  

(9)

Prices should satisfy:

\[
v_H - p_H \geq \alpha v_L - p_L
\]  

(10)

\[
v_L - p_L > \beta v_H - p_H
\]  

(11)

\[
v_H \geq p_H
\]  

(12)

\[
v_L \geq p_L
\]  

(13)

The most profitable prices satisfy above four constraints are given by \( p_H = v_H \) and \( p_L = v_L \). As
before, we assume that consumer’s belief reverses to the worst one when any deviation is detected.
Although the quality of all products sold by the experience goods is uncertain for consumers before
consumption, the experience goods seller can only deviate in the production of high-quality goods.

The experience goods seller has no incentive to deviate in quality if he sets prices for high-quality
product and low-quality product to satisfy:

\[
\frac{p_H + p_L - c_H - c_L}{1 - \delta} \geq p_H + p_L - 2c_L + \frac{\delta}{1 - \delta} \max\{v_L - c_L, 2(\alpha v_L - c_L)\}
\]  

(14)

\[
\frac{\delta}{1 - \delta} [(p_H + p_L - c_H - c_L) - \max\{v_L - c_L, 2(\alpha v_L - c_L)\}] \geq c_H - c_L
\]
\[
\delta \geq \frac{c_H - c_L}{p_H + p_L - 2c_L - \max\{v_L - c_L, 2(\alpha v_L - c_L)\}}
\]

The seller may also deviate in price, which will be detected immediately. The most profitable price deviation is decreasing price and selling low-quality product. For the monopolist not shirk on price:

\[
\frac{p_H + p_L - c_H - c_L}{1 - \delta} \geq \frac{\max\{v_L - c_L, 2(\alpha v_L - c_L)\}}{1 - \delta}
\]

(15) is the necessary condition for (14). It is redundant to consider price deviation.

From now on, we focus on the highest price an experience goods seller can charge. With \(p_H = v_H\) and \(p_L = v_L\):

\[
\delta \geq \frac{c_H - c_L}{v_H + v_L - 2c_L - \max\{v_L - c_L, 2(\alpha v_L - c_L)\}} \equiv \delta^V
\]

Compared with the case of H0(M)-equilibrium,

\[\delta^V < \delta^{H0}\]

When a monopolist can produce multiple products and set different prices, he can earn a higher equilibrium profit without influence the off-equilibrium profit. Cheating consumers becomes less attractive. Hence it makes the equilibrium involving high-quality product easier to be sustained.

Compared with the case of HH(M)-equilibrium:

\[\delta^V < \delta^{HH}\]

Although price discrimination facilitates the reputation building, it does not guarantee a higher profit.

When \(\beta \geq \frac{v_H - c_H + v_L - c_L}{2v_H - c_H}\), it is easy to check:

\[2(\beta v_H - c_H) \geq v_H + v_L - c_H - c_L\]

A large \(\beta\) implies that the low-end consumers obtain a high valuation about high-quality products.

**Proposition 2** Suppose an experience goods seller is able to conduct price discrimination and produce both high- and low-quality products at the same time, and assume that \(v_H - c_H > \max\{v_L - c_L, 2(\alpha v_L - c_L)\}\),

the optimal equilibrium is characterized as below:

\[d_{hl} - d_d = \beta v_H - c_L - \frac{1}{2}\max\{v_L - c_L, 2(\alpha v_L - c_L)\} - (v_H + v_L - 2c_L - \max\{v_L - c_L, 2(\alpha v_L - c_L)\})
= (\beta - 1)v_H - v_L + c_L + \frac{1}{2}\max\{v_L - c_L, 2(\alpha v_L - c_L)\} < 0\]

where \(d_{hl}\) and \(d_d\) are denominators of \(\delta^{HH}\) and \(\delta_d\) respectively.
1. If $\beta < \frac{v_H c_H + v_L c_L}{2 v_H}$, when $\delta \geq \delta^V$, the seller sells high-quality product at $p_H = v_H$, and sell low quality product at $p_L = v_L$, otherwise, the experience goods seller sells only low-quality product.

2. If $\beta \geq \frac{v_H c_H + v_L c_L}{2 v_H}$, when $\delta \geq \delta^{HH}$, the seller only high-quality product at $p_H = \beta v_H$, when $\delta^V \leq \delta < \delta^{HH}$, the seller sells high-quality product at $p_H = v_H$, and sells low-quality product at $p_L = v_L$, otherwise, the seller sells only low-quality product.

Proof. See appendix.

Versioning may not guarantee a profit improvement when $\beta$ is large. A large $\beta$ implies that it is more profitable to sell low-end consumer high- rather than low-quality product. However, price discrimination facilitates reputation building and makes it easier to sustain an equilibrium with the high-quality product being sold. Versioning wakens the temptation of deviation by reducing the benefit
of defection from two units of cost saving to one unit while still allows the seller to serve two units of buyers. When $\beta \geq \frac{v_H - v_L}{2v_H - v_L}$, we can see a non-monotone relationship between products version number and the discount factor $\delta$ in optimal equilibrium as shown in figure 2.

5 Impact of Competition from Search Goods

5.1 Search Goods with Medium Quality

From this section, we introduce competitors who are producing goods with certain qualities (search goods). We assume that there is a competitive market with infinite sellers selling search goods. Consumers can observe the price of all products while only quality of search goods.

Intrinsic value of search goods is given by $v \in [v_L, v_H]$. The quality of search goods is between high and low. We define consumer’s valuation for this medium-quality product in a linear form. High-end consumers’ valuation $u^h(v)$ for the product with $v$ is

$$u^h(v) = \alpha v_L + \frac{v - v_L}{v_H - v_L} (v_H - \alpha v_L)$$

Low-end consumers’ valuation $u^l(v)$ for the product with quality $v$ is

$$u^l(v) = \frac{v - v_L}{v_H - v_L} (\beta v_H - v_L)$$

Similarly, the production cost $c(v)$ can be generalized by

$$c(v) = c_L + \frac{v - v_L}{v_H - v_L} (c_H - c_L)$$

Consumers’ valuation and production cost are all increasing with $v$. For simplicity reason, let $\gamma = \frac{v - v_L}{v_H - v_L}$, then we can rewrite

$$u^h(\gamma) = (1 - \gamma)\alpha v_L + \gamma v_H$$
$$u^l(\gamma) = (1 - \gamma)v_L + \gamma \beta v_H$$
$$c(\gamma) = (1 - \gamma)c_L + \gamma c_H$$
When $\gamma = 1$, the search goods are with the same quality of high-quality goods. Then the situation becomes trivial. When $\gamma = 0$, the quality of search goods is the same as the low-quality goods. We will discussion this special case later. In this section, we focus on the situation that $\gamma \in (0, 1)$, in which the quality of search goods is between high and low.

Bertrand competition among search goods sellers results in zero profit for each search goods seller. Search goods have to sold at a price equal to marginal production cost $c(\gamma)$.

As shown in Figure 4, high-end consumer’s valuation of medium goods $v$ can be either higher or lower than that of the low-end consumer. Compared with the discussion in the previous section, when competitive fringe of sellers produces at medium quality, a positive profit may be still possible if the experience goods seller produces at low quality. To see this, we first consider a low-quality equilibrium in which the experience goods seller produce at low quality and other sellers produce at medium quality.

It is impossible for the experience goods seller to sell low-quality goods to the high-end consumer with the existence of competitive sellers selling medium quality goods. This is because

$$\alpha v_L - p_L < u^b(\gamma) - c(\gamma) = (1 - \gamma)(\alpha v_L - c_L) + \gamma(v_H - c_H)$$

for any $p_L \geq c_L$, under the assumption $v_H - c_H > v_L - c_L$.

Then in any low-quality equilibrium, an experience goods seller should only target at the low-end
consumer, he set the price at \( p_L \) such that

\[
v_L - p_L \geq u^L(\gamma) - c(\gamma) = (1 - \gamma)(v_L - c_L) + \gamma(\beta v_H - c_H)
\]

It can be easily verified that producing low-quality goods is profitable if and only if

\[
v_L - c_L \geq \beta v_H - c_H
\]

This implies that it is more efficient for the society to provide low-quality goods instead of high-quality goods to the low-end consumer. Otherwise, producing at low quality will not be profitable.

As in the monopoly case, there are also two types of high-quality equilibria with the presence of search good sellers. We denote them as follows:

- **HM(S)-equilibrium**: on the equilibrium path, the experience goods seller sells high-quality product to high-end consumers and the search goods seller sells medium-quality goods to low-end consumers;

- **HH(S)-equilibrium**: on the equilibrium path, the experience goods seller sells high-quality product to all consumers.

**Case 1**: \( v_L - c_L < \beta v_H - c_H \). Any seller who sells low-quality goods in equilibrium earns no positive profit.

Following the terminology in the previous section, we define the equilibria in which experience goods seller produces low-quality products as low-quality equilibrium. Both high-end and low-end consumers will prefer to buy the medium-quality goods from search goods sellers rather than buy low-quality goods from the experience goods seller, since

\[
\alpha v_L - p_L < u^h(\gamma) - c(\gamma) = (1 - \gamma)(\alpha v_L - c_L) + \gamma(v_H - c_H)
\]

\[
v_L - p_L < u^l(\gamma) - c(\gamma) = (1 - \gamma)(v_L - c_L) + \gamma(\beta v_H - c_H)
\]

for all \( p_L \geq c_L \) and \( \gamma \in (0, 1) \). Then whenever an experience goods seller deviates from high-quality equilibrium, he is believed to produce low-quality goods forever and earn a non-positive profit from the time deviation is detected. As before, any price change can be detected immediately. In the case of \( v_L - c_L < \beta v_H - c_H \), no consumer will come to low-quality goods seller. Hence deviation in price can never be profitable. We only need to focus on the quality deviation.

In **HM(S)-equilibrium**, the price he can charge is limited by

\[
v_H - p_H \geq u^h(\gamma) - c(\gamma)
\]
High-end consumers get a higher surplus from consuming high-quality goods rather the medium-quality goods.

\[ p_H \leq v_H - u^h(\gamma) + c(\gamma) = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L) \] (16)

The experience goods seller has no incentive to shirk on quality if

\[ \frac{p_H - c_H}{1 - \delta} \geq p_H - c_L \]

\[ \delta \geq \frac{c_H - c_L}{p_H - c_L} \]

Raising price increases profit and makes it easier to sustain high-quality equilibrium. From now on, set

\[ p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L) \]

Then no deviation condition becomes

\[ \delta \geq \frac{c_H - c_L}{\gamma(c_H - c_L) + (1 - \gamma)(v_H - \alpha v_L)} \equiv \delta^H_{s_0} \]

The cutoff value of discount factor \( \delta^H_{s_0} \) increases with \( \gamma \). When competition becomes more intense, selling the high-quality product to high-end consumer becomes difficult since the room for profit is narrowed down.

In **HH(S)-equilibrium**, the price he can charge is limited by

\[ \beta v_H - p_H' \geq u^l(\gamma) - c(\gamma) \]

\[ v_H - p_H' \geq u^h(\gamma) - c(\gamma) \]

that is

\[ p_H' \leq \min\{\beta v_H - u^l(\gamma) + c(\gamma), v_H - u^h(\gamma) + c(\gamma)\} \]

Under the assumption \( \beta v_H - c_H \geq v_L - c_L \), there exist some \( p_H' \geq c_H \) satisfies the restriction. The experience goods seller has no incentive to shirk on quality if

\[ 2\frac{p_H' - c_H}{1 - \delta} \geq 2(p_H' - c_L) \]

\[ \delta \geq \frac{c_H - c_L}{p_H' - c_L} \]
We focus on \( p_H = c_H + (1 - \gamma)(\beta v_H - c_H - v_L + c_L) \), which is the highest price that an experience goods seller can charge for a high-quality product.

\[
\delta \geq \frac{c_H - c_L}{\gamma(c_H - c_L) + (1 - \gamma)(\beta v_H - v_L)} \equiv \delta_{s_0}^{HH}
\]

\( \delta_{s_0}^{HH} \) also increases with \( \gamma \). When competition becomes more intense, selling the high-quality product to all consumers also becomes harder. It is easy to check:

\[
\delta_{s_0}^{HH} \geq \delta_{s_0}^{HM}
\]

Same as before, competition makes it easier to sustain a high-quality equilibrium in which experience good seller sells only to the high-end rather than all consumers.

**Case 2**: \( v_L - c_L \geq \beta v_H - c_H \). In this case, providing the low-quality goods to the low-end consumers is socially better than selling the high-quality goods to them.

If experience goods seller produces low-quality goods in equilibrium, he can only sell it to the low-end consumer at a price \( p_L \) such that

\[
v_L - p_L \geq u'(\gamma) - c(\gamma) = (1 - \gamma)(v_L - c_L) + \gamma(\beta v_H - c_H)
\]

The highest price he can charge for one unit of low-quality product is given by:

\[
p_L = c_L + \gamma(v_L - c_L - \beta v_H + c_H)
\]

Then the highest profit he can get from producing low-quality product is

\[
\pi_L = \gamma(v_L - c_L - \beta v_H + c_H) > 0
\]

The experience goods seller can make positive profit by selling low-quality goods only. The profit is increasing with \( \gamma \). When quality from search goods becomes closer to high-quality goods, the off-equilibrium profit increases, increasing the incentive to deviate from high-quality equilibrium.

Now consider high-quality equilibrium in which experience goods seller produces the high-quality product, and other sellers produce the search goods with medium-quality.

In **HM(S)-equilibrium**, the price he can charge is limited by \( v_H - p_H \geq u'(\gamma) - c(\gamma) \), that is

\[
p_H \leq v_H - u'(\gamma) + c(\gamma) = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)
\]

For the experience goods seller to not shirk in price:

\[
p_H - c_H \geq \pi_L
\]

\[
(1 - \gamma)(v_H - c_H - \alpha v_L + c_L) \geq \gamma(v_L - c_L - \beta v_H + c_H)
\]
that is,

\[ \gamma \leq \frac{v_H - \alpha v_L - c_H + c_L}{v_H - \alpha v_L - \beta v_H + v_L} \]

Then for any \( \beta \) such that \( v_L - c_L \geq \beta v_H - c_H \), when medium quality \( \gamma > \frac{v_H - \alpha v_L - c_H + c_L}{v_H - \alpha v_L - \beta v_H + v_L} \), price deviation is always profitable. In this case, no high-quality equilibrium can be sustained in the market.

Experience goods seller sells low-quality product while search goods sellers sell medium-quality product.

When \( \gamma \leq \frac{v_H - \alpha v_L - c_H + c_L}{v_H - \alpha v_L - \beta v_H + v_L} \), some high-quality equilibrium may exist if discount factor is large enough. The experience good seller has no incentive to shirk on quality if

\[ \frac{p_H - c_H}{1 - \delta} \geq p_H - c_L + \frac{\delta}{1 - \delta} \pi_L \]

Raising price increases profit and makes it easier to sustain high-quality equilibrium, set

\[ p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L) \]

\[ \delta \geq \frac{c_H - c_L}{p_H - c_L - \pi_L} \]

Again, \( \delta_{s1}^{H} \) increases with \( \gamma \). When competition becomes more intense, selling the high-quality product to high-end consumer becomes difficult since the room for profit is narrowed down.

It is also easy to check that

\[ \delta_{s1}^{H} \geq \delta_{s0}^{H} \]

As \( \beta \) increases, it becomes easier to sustain a high-quality equilibrium in which experience goods seller only targets at high-end consumers. The profit from selling low-quality goods decreases, and finally becomes zero. This limits the incentive for an experience goods seller to deviate from high-quality equilibrium.

However, when \( v_L - c_L \geq \beta v_H - c_H \), it is impossible for experience goods seller to target at both types of consumers in high-quality equilibrium. HH(S)-equilibrium does not exist. Since

\[ \beta v_H - p_H < w'(\gamma) - c(\gamma) = (1 - \gamma)(v_L - c_L) + \gamma(\beta v_H - c_H) \]

for any \( p_H \geq c_H \). Therefore, as long as \( \beta \leq \frac{v_L - c_L + c_H}{v_H} \), the low-end consumer will not be provided the high-quality product.
We summarize the analysis above and characterize the optimal equilibrium for the experience goods seller in the following proposition.

**Proposition 3** Optimal equilibrium with competition from search goods with quality level $\gamma$ is characterized as below:

1. if $\beta \in (\frac{v_L}{v_H}, \frac{v_L-c_L+c_H}{v_H}]$, for $\gamma \leq \frac{v_H-\alpha v_L-c_H+c_L}{v_H-\alpha v_L-\beta v_H + v_L}$ and $\delta \geq \delta_{s1}^H$, the experience-goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1-\gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\gamma \leq \frac{v_H-\alpha v_L-c_H+c_L}{v_H-\alpha v_L-\beta v_H + v_L}$ and $\delta < \delta_{s1}^H$, or $\gamma > \frac{v_H-\alpha v_L-c_H+c_L}{v_H-\alpha v_L-\beta v_H + v_L}$ the experience-goods seller sells low quality goods at $p_L = c_L + \gamma(v_L - c_L - \beta v_H + c_H)$.

2. if $\beta \in (\frac{v_L-c_L+c_H}{v_H}, \beta_3]$, for $\delta \geq \delta_{s0}^H$, the experience-goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1-\gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\delta < \delta_{s0}^H$, the experience-goods seller produces low quality goods and earns zero profit.

3. if $\beta \in (\beta_3, 1)$, for $\delta \geq \delta_{s0}^H$, the experience-goods seller produces at high quality and sells product to both types of customers and set $p'_H = c_H + (1-\gamma)(\beta v_H - c_H - v_L + c_L)$; for $\delta_{s0}^H \leq \delta < \delta_{s0}^H$, the experience-goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1-\gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\delta < \delta_{s0}^H$, the experience-goods seller produces low quality goods and earns zero profit.

Search goods sellers always sell product with quality $\gamma$ at price equal to $c(\gamma)$

**Proof.** See appendix.

When $\beta \leq \frac{v_L-c_L+c_H}{v_H}$, low-end consumers obtaining such a low valuation about the quality improvement that even when the product of search goods seller is with strictly lower quality than high-quality goods, the experience goods seller still not produce any high-quality goods. The profit from selling high-quality goods to the high-end consumer is much lower than selling low-quality goods to the low-end consumer.

Since $\delta_{s1}^H \geq \delta_{s0}^H$, the critical value of discount factor is decreasing as $\beta$ increases. Larger $\beta$ leads to lower profit in low-quality equilibrium which reduces the experience goods seller’s incentive to produce
low-quality good. It is also easy to check that when $\gamma$ is large enough, $\delta_{s_1}^{HM} \geq \delta^{H0}$ and $\delta_{s_0}^{HM} \geq \delta^{H0}$.

Competition can impede the experience goods seller building a high-quality reputation.

5.2 Search Goods with Minimum Quality

In this section, we consider a case that search goods sellers are known to produce goods with minimum quality $v_L$. Although this is just the special case when $\gamma = 0$, it deserves to be discussed alone since we often see it in reality. Consider the situation that there is a seller obtaining an exclusive technology to produce high-quality goods so that it has no technology concerns in the production of either high quality or low-quality product. Other sellers in the market are search goods sellers who only have access to the technology of producing the low-quality product.

Collusion between sellers is excluded. Hence low-quality goods must be sold at a competitive price. Bertrand competition leads to zero profit for sellers who are producing at the low quality in equilibrium.

As before, in the high-quality equilibria, we assume that any deviation by experience good seller leads to reversion to the worst possible belief that the seller forever produces at low quality as soon as the deviation is detected. If a seller deviates in price, consumers detect deviation immediately and believe that the seller produces at low quality. Any price higher than $c_L$ cannot be sustained in low-quality equilibrium. Deviation in price is never profitable.

We also consider two types of equilibria. In the first one, the experience goods seller only sells to the high-end consumers, then the highest price he can charge for the high-quality good is pinned down by

$$v_H - p_H \geq \alpha v_L - c_L$$

For any $\alpha \in (0, 1)$, there must be some $p_H > c_H$ satisfies (18). Any price $p_H \in (c_H, v_H - \alpha v_L + c_L]$ can be the possible price of the high-quality product in equilibrium so that there is at least some consumer want to buy at the same time some seller want to sell. For the experience goods seller not to shirk on quality, it requires that

$$\frac{p_H - c_H}{1 - \delta} \geq (p_H - c_L)$$

$$\delta \frac{p_H - c_H}{1 - \delta} \geq c_H - c_L$$

(19) shows that the benefit of shirking is to save the one unit of production cost. The loss comes from the lower future profit after deviation. The only difference with previous monopoly case is that now
profit after deviation is zero. Raising $p_H$ increases the equilibrium profit at the same time facilitates the maintaining of a reputation for high quality.

If experience goods seller sells high-quality good to all consumers, then the highest price one can charge is pinned down by

$$\beta v_H - p'_H \geq v_L - c_L \tag{20}$$

$$v_H - p'_H \geq \alpha v_L - c_L \tag{21}$$

Both types of consumers prefer the high-quality product rather than the low quality one. It can be easily verified that (21) is necessary condition for (20). Whenever a low-end consumer decides to buy a high-quality product, the price for it should be acceptable to a high-end consumer. Combine (20) and (21), we obtain:

$$p'_H \leq \beta v_H - v_L + c_L \tag{22}$$

(22) implies that $\beta \geq \frac{c_H + v_L - c_L}{v_H}$, which is the necessary condition for the existence of some $p'_H \geq c_H$ satisfies (22). It can be easily verified that $\beta_c \geq \beta_0$. Competition drives the price down. Negative profit prevents seller from selling the high-quality product to the low-end consumer with $\beta \in [\beta_0, \beta_c)$ when there are search goods competitors. However, it may still profitable to sell to them if experience goods seller is a monopoly.

For the experience goods seller not to shirk on quality, it requires that

$$\frac{2(p'_H - c_H)}{1 - \delta} \geq 2(p'_H - c_L)$$

$$\delta \left[ \frac{2(p'_H - c_H)}{1 - \delta} \right] \geq 2(c_H - c_L) \tag{23}$$

Similar to previous analysis, the only difference between (23) and (4) results from zero profit in the off-equilibrium path in competition case. Again, raising $p'_H$ both raises the equilibrium profit and makes it easier to maintain the reputation of high quality.

Again, we restrict our attention to $p_H = v_H - \alpha v_L + c_L$ and $p'_H = \beta v_H - v_L + c_L$. Then we can rewrite (19) and (23) as:

$$\delta \geq \frac{c_H - c_L}{v_H - \alpha v_L} \equiv \delta_e^{HL} \tag{24}$$

$$\delta \geq \frac{c_H - c_L}{\beta v_H - v_L} \equiv \delta_e^{HH} \tag{25}$$

Since $v_H - \alpha v_L \geq \beta v_H - v_L$, $\delta_e^{HL} \geq \delta_c^{HL}$ for any $\alpha \in (0, 1)$, $\beta \in [\beta_c, 1)$. It implies that targeting at only high-end consumer is always easier than targeting at both types of consumers under the competitive
environment. Price is more limited when a seller tries to trade with low-end consumers rather than high-end consumers. Current profit from each unit of consumer decreases due to the lower price. Then only when a seller cares future profit so much that he can convince all consumers of providing the high-quality product.

**Proposition 4** Optimal equilibrium with existence of competitive market for low quality goods is characterized as below:

(i) if $\beta \in (\frac{c_L}{v_H}, \beta_3]$ for $\delta \geq \delta_c^{HL}$, the experience-goods seller produces at high quality and sells product to high-end customer and set $p_H = v_H - \alpha v_L + c_L$; for $\delta < \delta_c^{HL}$, the experience-goods seller produce low quality goods.

(ii)if $\beta \in (\beta_3, 1)$ for $\delta \geq \delta_c^{HH}$, the experience-goods seller produces at high quality and sells product to both types of customers and set $p_H = \beta v_H - v_L + c_L$; for $\delta_c^{HL} \leq \delta < \delta_c^{HH}$, the experience-goods seller produces at high quality and sells product to high-end customer and set $p_H = v_H - \alpha v_L + c_L$; for $\delta < \delta_c^{HL}$, the experience-goods seller produce low quality goods.

**Proof.** Proof of this proposition follows immediately the proof of in proposition 3 by setting $\gamma = 0$.

We have shown that in monopoly case, when $\beta > \beta_2$, $\delta^{HO} \geq \delta^{HH}$, and when $\beta \leq \beta_2$, $\delta^{HO} < \delta^{HH}$. Sustainability of two types of high-quality equilibrium depends on the value of $\beta$. Larger $\beta$ facilitates building reputation among all consumers. While in the competitive environment we defined in this section, targeting at the high-end consumer alone is always easier than targeting at both types of consumers. Experience goods seller always faces a trade-off between loss of high-quality equilibrium profit in future periods and cost saving from cheating consumers in the current period. When the experience goods seller produces two unit of products, it becomes more attractive for him to deviate since now he can save two unit of production cost. However, in monopoly case, when the low-end consumers evaluate the high-quality product at a higher level, the seller can charge a higher price so that he can earn more profit. The influence of higher profit counteracts the effect created by the larger amount of production. In competitive environment, even when the low-end consumers obtain a high valuation about high-quality, the price of high-quality goods is still largely limited by competition. Although selling more high-quality products brings the experience goods seller higher profit, more cost saving still tempts the seller to cheat consumers. Maintaining reputation of high quality among all
consumers is difficult in this case. Extremely constrained pricing ruins the reputation and offsets the advantage that larger amount of consumer brings.

We summarize the ranking of threshold value of discount factor in the following lemma:

**Lemma 1** The ranking of threshold values of discount factor is as below:

1. When \( \beta \in [\beta_0, \beta_2) \), \( \delta^{HL}_c \leq \delta^{H0} \leq \delta^{HH} \leq \delta^{HH}_c \);

2. When \( \beta \in [\beta_2, \beta_4) \), \( \delta^{HL}_c \leq \delta^{HH} \leq \delta^{H0} \leq \delta^{HH}_c \);

3. When \( \beta \in [\beta_4, 1) \), \( \delta^{HL}_c \leq \delta^{HH} \leq \delta^{HH}_c \leq \delta^{H0} \).

**Proof.** See appendix.

According to Lemma 1, regardless of the preference of consumers, high-quality equilibrium is always easier to be sustained in the competitive environment since \( \delta^{HL}_c \leq \delta^{H0} \). In detail, competition makes it easier to sustain high-quality equilibrium in the sense that the high-quality equilibrium in which experience goods seller only serves the high-end consumers becomes easier to be sustained compared with all high-quality equilibria in monopoly case. In practice, when a seller faces a low discount factor which disables him to win trust from consumers, Lemma 1 suggests that he can disclose the technology for low-quality product and introduce some competition into the market. Giving up the position of monopoly may gain trust from consumers.

Competition mainly has two effects: on one hand, competition makes punishment severer. The experience-goods seller earns zero profit forever if he deviates from high-quality equilibrium. However, positive profit is still available for the experience-goods seller if he is a monopolist in the market. Losing a high reputation is more costly in the case of competition, which makes it more attractive for the experience-goods seller to convince consumers of high quality.

On the other hand, competition limits the price an experience-goods seller can charge. Price of the high-quality product should be low enough so that at least some consumer prefers to buy from him. This leads to a lower profit in the future. Consumer concerns more about deviation problem in this case. It is difficult for high-quality equilibrium to be sustained.

When experience-goods seller targets at only the high-end consumer, the first effect dominates the second one. The situation is reversed when experience goods seller targets at the whole market. Since \( \beta_3 \geq \beta_1 \) and \( \delta^{HH} \leq \delta^{HH}_c \), it is less probable for experience goods seller to selling high quality good to both types of consumers under the competitive environment.
When discount factor is large enough, high-quality equilibrium is sustainable in both monopoly case and competitive case. However, the competition may lead to a smaller scale of production. When $\beta \in (\beta_1, \beta_3)$, in competitive case, even when the discount factor is large enough, the experience goods seller is trying to set a high price and only target at the high-end consumer.

Although in many cases the equilibrium quantity of high-quality goods is not changed by competition, the price is driven down for sure. This results in a reallocation of surplus between consumers and sellers.

5.3 Versioning and Competition

When there is a competitive fringe of sellers selling low-quality goods, the price of low-quality goods must be $c_L$, then, price discrimination will not affect the equilibrium price. However, when competitors produce at medium quality, versioning may help. In order to make the discussion simple, we assume that when a consumer is indifferent between two products sold by different sellers, he will buy from experience goods seller. If a consumer is indifferent between products sold by the same seller, he will buy the high-quality one.

In an equilibrium, in which the experience goods seller produces multiple products and conducts price discrimination, the seller will set price for the high-quality product and the low-quality product to satisfy following constraints.

$$v_H - p_H \geq u^H(\gamma) - c(\gamma) = (1 - \gamma)(\alpha v_L - c_L) + \gamma (v_H - c_H)$$  \hspace{1cm} (26)

$$v_L - p_L \geq u^L(\gamma) - c(\gamma) = (1 - \gamma)(v_L - c_L) + \gamma (v_H - c_H)$$  \hspace{1cm} (27)

$$v_H - p_H \geq \alpha v_L - p_L$$  \hspace{1cm} (28)

$$v_H - p_L \geq \beta v_H - p_H$$  \hspace{1cm} (29)

$$p_H \leq v_H$$  \hspace{1cm} (30)

$$p_L \leq v_L$$  \hspace{1cm} (31)

The second constraint implies that

$$v_L - c_L \geq \beta v_H - c_H$$  \hspace{1cm} (32)

Otherwise, we can not find any $p_L \geq c_L$ satisfying above conditions\(^5\). Price discrimination is profitable

\(^5\)Setting price below $c_L$ will not be optimal although the total profit can be positive
if

\[ p_L - c_L + p_H - c_H \geq 0 \]  

(33)

Compared to the case that experience goods seller can not produce multiple products, under the assumption (32), the experience goods seller can not set any price to attract low-end consumer buy high-quality goods from him, which means there is no \( p_H \geq c_H \) such that:

\[ \beta v_H - p_H \geq u^d(\gamma) - c(\gamma) = (1 - \gamma)(v_L - c_L) + \gamma(\beta v_H - c_H) \]

Hence for any \( \beta \) with which an experience goods seller can adopt price discrimination, there does not exist equilibrium in which experience goods seller sells high-quality goods to all consumers. More specifically, when \( \beta \leq \frac{v_L - c_L + c_H}{v_H} \), lower quality is more attractive to low-end consumers. All constraints for price discrimination equilibrium above can be rewritten as below

\[
\begin{align*}
p_H & \leq c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L) \\
p_L & \leq c_L + \gamma(v_L + c_L - \beta v_H + c_H) \\
\beta v_H - v_L & \leq p_H - p_L \leq v_H - \alpha v_L
\end{align*}
\]

(34)

(35)

(36)

For the experience goods seller not shirk on quality:

\[
\frac{p_H + p_L - c_H - c_L}{1 - \delta} \geq p_H + p_L - 2c_L + \frac{\delta}{1 - \delta}(p_L - c_L)
\]

(37)

After the experience goods seller shirks in quality, he can still earn a positive profit by selling low-quality goods. As before, we focus on the highest price the experience goods seller can charge. Let

\[
\begin{align*}
p_H & = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L) \\
p_L & = c_L + \gamma(v_L + c_L - \beta v_H + c_H)
\end{align*}
\]

Then discount factor should follow:

\[
\delta \geq \frac{c_H - c_L}{(1 - \gamma)(v_H - \alpha v_L) + \gamma(c_H - c_L)} \equiv \delta_s^V = \delta_{s0}^{HM} \leq \delta_{s1}^{HM}
\]

(38)

It is obvious that price shirking can not be profitable. In this case, price discrimination helps the sustainability of high-quality production.

**Proposition 5** In a market with a seller obtaining technology to produce both high- and low-quality products at the same time and a fringe of search goods sellers producing some medium-quality product, the optimal equilibrium can be characterized as below:
1. If $\beta \in (\frac{v_H}{v_H}, \frac{v_L - c_L + c_H}{v_H})$,

when $\delta \geq \delta^V$, the experience goods seller sells high-quality product at $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$ and low-quality product at $p_L = c_L + \gamma(v_L + c_L - \beta v_H + c_H)$ at the same time, otherwise, the experience goods seller sells only low-quality product.

2. if $\beta \in (\frac{v_L - c_L + c_H}{v_H}, \beta_3)$,

for $\delta \geq \delta^H_{s0}$, the experience goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\delta < \delta^H_{s0}$, the experience goods seller produces low quality goods and earn zero profit.

3. if $\beta \in (\beta_3, 1)$,

for $\delta \geq \delta^H_{s0}$, the experience goods seller produces at high quality and sells product to both types of customers and set $p'_H = c_H + (1 - \gamma)(\beta v_H - c_H - v_L + c_L)$; for $\delta^H_{s0} \leq \delta < \delta^H_{s0}$, the experience goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\delta < \delta^H_{s0}$, the experience-goods seller produces low quality goods and earn zero profit.

Search goods sellers always sell product with quality $\gamma$ at price equal to $c(\gamma)$

**Proof.** See appendix.

Conducting price discrimination may improve equilibrium profit of the experience goods seller by extra production of low-quality products which can be observed when $\beta$ is small. Price discrimination facilitates reputation building at the same time. When quality of search goods is close to high level, as long as the discount factor is sufficiently high, high-quality product can still be supported along with low-quality product. Allowing production of multiple products compensates the low profit from selling high-quality product and makes it more attractive to produce multiple products rather than only low-quality product.

Compared with the two propositions in previous sections, it is obvious to see the impact of competition from search goods sellers. Different from monopoly case, price discrimination in competition environment is optimal only in the case when $\beta$ is small. As low-end consumer’s valuation of high-quality goods raises, it is increasingly difficult to attract the low-end consumer to buy the low-quality product. Then the price of low-quality goods must low enough and no profit can be earned at last.
When $\beta \leq \frac{v_L - c_L + c_H}{v_H}$, with large enough discount factor, the experience goods seller will produce two versions of products. However, when the competitors enter the market, winning trust from consumer becomes more difficult implied by $\delta^V_s > \delta^V$. Competition facilitates reputation building when an experience goods seller cannot conduct price discrimination. However, competition may frustrate reputation building when the experience goods seller can set different prices for different products.

Next we consider $\beta \in \left( \frac{v_L - c_L + c_H}{v_H}, \frac{v_H + c_H + v_L - c_L}{2v_H} \right)$. As a monopolist, when discount factor is sufficiently high, the seller will produce multiple variants of product. However, the existence of search goods sellers (sell medium-quality goods) limits the experience goods seller to only produce the high-quality product. Production line shrinks. When $\beta$ is larger, competition eliminates the possibility for the experience goods seller to sell multiple versions.

6 Conclusion

This paper examines the impact of competition from search goods on the behavior of experience goods seller. With heterogeneous consumers who have different tastes on quality, we revisit some typical discussion in experience goods research. We characterize the optimal equilibrium in monopoly as well as the competitive environment. In both situations, we observe a non-monotonic relationship between price and discount factor. By comparing the pricing and quality decision of the experience goods seller in the market with and without search goods competitors, we find that exclusively offering the high-quality product to those with a high valuation of quality is always easier when search goods competitors sell minimum quality products. Even some impatient sellers can be trusted to produce the high-quality product in the equilibrium. However, when search goods competitors produce at a higher quality, competition can damage all high-quality equilibrium. The results are quite different when we allow experience good seller to produce multiple products and conduct price discrimination. Competition may hinder the reputation building of experience goods seller when versioning is permitted.
Appendix

As we have shown the conditions for the experience goods seller not to deviate from high-quality equilibrium, the proof of proposition 1-5 only needs to check the conditions for most profitable equilibrium under different parameters.

Proof of proposition 1. As we have shown, there are two types of high-quality equilibria. The necessary condition for the experience goods seller to not shirk on quality in \textbf{H0(M)-equilibrium} (\textbf{HH(M)-equilibrium}) is $\delta \geq \delta_{H0}$ ($\delta \geq \delta_{HH}$). Raising price improves profit and makes high-quality equilibrium easier to sustain in each case. Therefore, we only need to focus on the highest price that the experience goods seller can charge in each case. That is, the experience goods seller sets $p_{H} = v_{H}$ when he targets only at the high-end consumer and sets $p_{H}' = \beta v_{H}$ when he targets at all consumers.

When $\beta \leq \beta_{1} = \frac{v_{H} + c_{H}}{2v_{H}}$, targeting only the high-end consumers is more profitable since

$$v_{H} - c_{H} \geq 2 (\beta v_{H} - c_{H})$$

It is also easy to check, the profit is lower from \textbf{low-quality equilibrium} than \textbf{H0(M)-equilibrium} according to (5).

$$v_{H} - c_{H} > \max \{v_{L} - c_{L}, 2 \alpha (v_{L} - c_{L})\}$$

Then, If $\beta \in (\frac{v_{L}}{v_{H}}, \beta_{1}]$, when $\delta \geq \delta_{H0}$, the experience goods seller produces at high quality, sets price at $p_{H} = v_{H}$, and only sells the product to high-end consumers; when $\delta < \delta_{H0}$, the experience goods seller produces at low quality.

When $\beta_{1} < \beta \leq \beta_{2} = 1 - \frac{\max \{v_{L} - c_{L}, 2 (\alpha v_{L} - c_{L})\}}{2v_{H}}$, targeting at all consumers is more profitable since

$$v_{H} - c_{H} < 2 (\beta v_{H} - c_{H})$$

$\beta \leq \beta_{2}$ implies that $\delta_{H0} \leq \delta_{HH}$. It is easy to check $\beta_{1} \geq \beta_{0}$ under the assumption (5). Then when $\beta_{1} < \beta \leq \beta_{2}$, for $\delta \geq \delta_{HH}$, the seller produces at high quality and sets $p_{H}' = \beta v_{H}$, selling to all consumers; for $\delta_{HH} > \delta \geq \delta_{H0}$, the experience goods seller produces at high quality and sets $p_{H} = v_{H}$, only selling to high-end consumers; for $\delta < \delta_{H0}$, the seller produces at low quality.

When $\beta > \beta_{2}$, targeting at all consumers is more profitable since $v_{H} - c_{H} < 2 (\beta v_{H} - c_{H})$

Meanwhile, $\beta > \beta_{2}$ implies that $\delta_{H0} > \delta_{HH}$. When $\delta \geq \delta_{HH}$, the seller produces at high quality and sets $p_{H}' = \beta v_{H}$, selling to both types of consumers. When $\delta < \delta_{HH}$, the experience goods seller produces at low quality.
Proof of Proposition 2. It’s obvious that the profit from versioning equilibrium is always higher than profit from $H_0(M)$-equilibrium\(^6\). Since $\delta^V < \delta^b$, $H_0(M)$-equilibrium should not be the optimal equilibrium when versioning is allowed. Hence, we can restrict our attention to the situation of versioning equilibrium and $HH(M)$-equilibrium.

When $\beta \geq \frac{v_H - c_H + v_L - c_L}{2v_H}$, it is easy to check:

$$2(\beta v_H - c_H) \geq v_H + v_L - c_H - c_L$$

Selling high-quality products to all consumer is more profitable rather than versioning. $\delta^V < \delta^{HH}$ regardless of $\beta$. Then when $\delta \geq \delta^{HH}$, the seller sells only high-quality product at $p_H = \beta v_H$, when $\delta^V \leq \delta < \delta^{HH}$, the seller sells high-quality product at $p_H = v_H$, and sells the low-quality product at $p_L = v_L$, otherwise, the seller sells only low-quality product.

When $\beta \geq \frac{v_H - c_H + v_L - c_L}{2v_H}$, $2(\beta v_H - c_H) < v_H + v_L - c_H - c_L$. Versioning is more profitable and easier to sustain at this time. Hence, when $\delta \geq \delta^V$, the seller sells high-quality product at $p_H = v_H$, and sell low quality product at $p_L = v_L$, otherwise, the experience goods seller sells only low-quality product.

Proof of proposition 3. When $\beta \in \left(\frac{v_L - c_L + c_H}{v_H}, \frac{v_L - c_L + c_H}{v_H}\right]$, the experience goods seller earns positive profit if he sells low-quality product. As we have discussed, for $\gamma \leq \frac{v_H - \alpha v_L - c_H + c_L}{v_H - \alpha v_L - \beta v_H + v_L}$ and $\delta \geq \delta^{HM}_{s1}$, the experience goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\gamma \leq \frac{v_H - \alpha v_L - c_H + c_L}{v_H - \alpha v_L - \beta v_H + v_L}$ and $\delta < \delta^{HM}_{s1}$, or $\gamma > \frac{v_H - \alpha v_L - c_H + c_L}{v_H - \alpha v_L - \beta v_H + v_L}$ the experience goods seller sells low quality goods at $p_L = c_L + \gamma(v_L - c_L - \beta v_H + c_H)$.

When $\beta > \frac{v_L - c_L + c_H}{v_H}$, the experience goods seller earns zero profit if he sells low-quality product. The experience goods seller gets more profit in $HM(S)$-equilibrium than $HH(S)$-equilibrium if and only if

$$(1 - \gamma)[(v_H - c_H) - (\alpha v_L - c_L)] > 2(1 - \gamma)[(\beta v_H - c_H) - (v_L - c_L)]$$

$$(v_H - c_H) - (\alpha v_L - c_L) > 2[(\beta v_H - c_H) - (v_L - c_L)]$$

$\iff \beta \leq \frac{v_H + (2 - \alpha)v_L + c_H - c_L}{2v_H} \equiv \beta_3$

$$\Rightarrow \beta_3 \geq \frac{v_L - c_L + c_H}{v_H}$$

\(^6\)In the whole proposition and proof, we focus on the highest price that the experience goods seller can charge in each case.
Similar to the proof in proposition 1, we have

If $\beta \in (\frac{2c_L}{v_H} - \frac{c_L}{v_H}, \beta_3]$, for $\delta \geq \delta_0^{HM}$, the experience goods seller produces at high quality and sells product to high-end customer with $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\delta < \delta_0^{HM}$, the experience-goods seller produce low quality goods and earn zero profit.

If $\beta \in (\beta_3, 1)$, for $\delta \geq \delta_0^{HH}$, the experience goods seller produces at high quality and sells product to both types of customers and set $p'_H = c_H + (1 - \gamma)(\beta v_H - c_H - v_L + c_L)$; for $\delta_0^{HM} \leq \delta < \delta_0^{HH}$, the experience-goods seller produces at high quality and sells product to high-end customer and set $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$; for $\delta < \delta_0^{HM}$, the experience-goods seller produce low quality goods and earn zero profit.

**Proof of Lemma 1.** It can be easily verified that $\delta^{H0} \geq \delta^{HL}$, $\delta^{HH} \leq \delta^{HL}$ and $\delta^{HL} \leq \delta^{HH}$ for any $\alpha \in [0, 1], \beta \in [0, 1]$.

We already compare $\delta^{H0}$ and $\delta^{HH}$:

- If $\beta \leq \beta_2$, $\delta^{H0} \leq \delta^{HH}$.
- If $\beta > \beta_2$, $\delta^{H0} > \delta^{HH}$.

What left is to compare $\delta^{H0}$ and $\delta^{HH}$, $\delta^{HL}$ and $\delta^{HH}$. Since they share the same numerator: $c_H - c_L$, we only need to compare their denominators. We use $d^{H0}, d^{HL}, d^{HH}, d^{cH}$ to denote the denominators of $\delta^{H0}, \delta^{HL}, \delta^{HH}, \delta^{HH}$ respectively.

$\delta^{H0} \leq \delta^{HH}$ if and only if $d^{H0} \geq d^{cH}$

$$d^{H0} - d^{cH} = v_H - c_L - \max\{v_L - c_L, 2(\alpha v_L - c_L)\} - (\beta v_H - v_L)$$

$$d^{H0} \geq d^{cH} \iff \beta \leq 1 - \frac{\max\{v_L - c_L, 2(\alpha v_L - c_L)\} - (v_L - c_L)}{v_H} \equiv \beta_4$$

$$\beta_4 - \beta_2 = \frac{2(v_L - c_L) - \max\{v_L - c_L, 2(\alpha v_L - c_L)\}}{2v_H} \geq 0$$

$\delta^{HH} \geq \delta^{cH}$ since

$$d^{HH} - d^{cH} = \beta v_H - c_L - \frac{1}{2} \max\{v_L - c_L, 2(\alpha v_L - c_L)\} - (v_H - \alpha v_L)$$

$$= (\beta - 1)v_H + (\alpha v_L - c_L) - \frac{1}{2} \max\{v_L - c_L, 2(\alpha v_L - c_L)\}$$

$$\leq (\beta - 1)v_H + (\alpha v_L - c_L) - (\alpha v_L - c_L)$$

$$\leq (\beta - 1)v_H \leq 0$$

This completes the proof.
Proof of proposition 5. As discussed in the paper, versioning can only happen when $\beta \leq \frac{v_L - c_L + c_H}{v_H}$. Profit is higher in the versioning equilibrium than HM(S)-equilibrium. And compared with HM(S)-equilibrium, versioning equilibrium is easier to maintain since $\delta^V_s = \delta^{HM}_s \leq \delta^{HM}_a$.

When $\delta \geq \delta^V_s$, the experience goods seller sells high- and low-quality products at the same time, at $p_H = c_H + (1 - \gamma)(v_H - c_H - \alpha v_L + c_L)$ and $p_L = c_L + \gamma(v_L + c_L - \beta v_H + c_H)$ respectively. otherwise, the seller sells only low-quality product. When $\delta < \delta^V_s$, no high-quality equilibrium can be sustained. The optimal equilibrium becomes the low-quality one.

When $\beta > \frac{v_L - c_L + c_H}{v_H}$, versioning cannot happen, the optimal equilibrium is exactly same with the case that experience goods seller can only produce one type of product.
References


