Shortage and Introductory Offer Signal Product Quality*

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February, 2015

Abstract

When word-of-mouth communication serves as an important channel of quality-information diffusion, a monopoly firm combines a shortage with an introductory offer to signal a high-quality product. Furthermore, shortage is more pronounced and price is lower when word-of-mouth communication is more effective. Our model’s predictions are consistent with the marketing behavior of many household items and the so-called "hunger marketing" strategy that prevails in China’s smartphone industry. (JEL 022, 026)

Keywords: Introductory offers, quality signal, shortage, word-of-mouth communication

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*We benefit comments from Yongmin Chen, Tianle Zhang and other participants at the 8th Biennial Conference of Hong Kong Economic Association Conference held in Shandong University, Jinan, China.

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I Introduction

Consumers are more willing to trust “earned” media—such as word of mouth or recommendations from people they know—than any form of paid media when purchasing a new product. According to a 2012 Nielsen study, 92 percent of consumers believe the recommendations of family and friends over all other forms of advertising. Online consumer reviews are the second-most-trusted source of brand information; 70 percent of global consumers surveyed reported that they trust online reviews. The research firm PQ Media estimates that despite the worst recession in decades in the U.S., corporate spending on word-of-mouth marketing in 2008 rose 14.2 percent from last year, reaching $1.54 billion, and was expected to hit $3 billion by 2013.

Marketing researchers have long recognized the power of word-of-mouth recommendations as a driver of sales. Katz and Lazarsfeld (1955) demonstrated more than half a century ago that it is the single most importance source of information for certain household items. More recently, the rise of social networking sites has attracted researchers’ attention, and many studies have documented the effectiveness of online word-of-mouth marketing on various products, such as books and movies (c.f., Chevalier and Mayzlin, 2006; Liu, 2006; Trusov, et al., 2009).

We study a two-period signaling model in which word-of-mouth communication serves as an important channel of product quality-information diffusion. We show that in any separating equilibrium, a monopoly firm combines a shortage with an introductory offer to signal high quality. The essential argument is as follows. Compared to a low-quality product, the high-quality product enjoys a word-of-mouth premium for future sales. To screen out the low-quality firm, the high-quality firm sacrifices some first-period profits by charging an introductory price that is lower than the marginal cost of a low-quality firm in the first period. However, to limit the loss from introductory sales, the high-quality firm supplies just a fraction of the demand for the first-period price, thereby creating a shortage. In a Pareto-dominant equilibrium, the more effective the word-of-mouth communication, the lower the introductory price and the more severe the shortage created in the first period.

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3 A classic case is Tupperware, which shunned formal ads for word-of-mouth campaigns in the form of Tupperware parties. By recruiting women to host informal “Tupperware parties” for friends, family and colleagues, Tupperware grew into a household name.
4 Alternatively, we can define a separating equilibrium as a high-quality firm’s plan to sell the product through multiple periods instead of adopting a "fly-by-night" strategy that might be preferred by a low-quality firm.
Our model's predictions are consistent with the hunger marketing strategy that prevails in China's smartphone industry, as with the casual observation that many household items are occasionally sold at a discount and that these items are often offered in limited amounts.\textsuperscript{5}

Many assume that over time, word of mouth will screen out low-quality products. This idea can be captured by a pooling equilibrium, in which both types of firms charge the same price and have positive sales in the first period. In the second period, uninformed customers do not buy, and only the high-quality firm sells to informed customers. Whether a pooling equilibrium exists depends on the prior distribution of types. When the prior probability of high-quality type is sufficiently small, there only exists a separating equilibrium for the high-quality firm. However, when both pooling and separating equilibria exist, a high-quality firm prefers pooling to separation.

Our study contributes to the literature on introductory offers. For example, Farrell (1986) studies the role of introductory offers in assuring buyers of the entrant's quality choice. He concludes that introductory offers cannot act as a commitment and any explanation of introductory offers must depend on an incomplete-information argument. Bagwell (1987) argues that when price information is costly to obtain, a low-cost producer may use introductory offers to signal to consumers that its costs are low and, therefore, that its future price will also be low. In this way, the low-cost firm gains in overall profits from repeat business. In our model, introductory offers are driven instead by a high-quality firm's incentive to screen out a low-quality firm, and the introductory offers are combined with shortages to generate efficient signals.

Our study is also related to an extensive literature on price as a signal of quality.\textsuperscript{6} For example, Bagwell and Riordan (1991) consider a model in which some consumers are exogenously informed about product quality by reading published quality reviews such as \textit{Consumer Reports}. They find that if a high-quality product is more costly to produce, the high-quality good will be introduced at a high price that is lowered over time toward the full-information monopoly price as more consumers become informed. In contrast, our results do not depend on the cost-differential assumption; we conclude that high-quality products may actually adopt an upward-sloping price profile. Our study complements Bagwell and Riordan's by endogenizing word of mouth, which is an important channel of product information for many products.

In a similar framework, Milgrom and Roberts (1986) show that both introductory price and advertising (or other means of dissipative marketing expenditures) can be used as signals for a high-

\textsuperscript{5}For example, featured products for sale on supermarket flyers often include a "supplies limited" message.
\textsuperscript{6}See Jean Tirole (1988, Ch. 2) for an excellent discussion of the literature in this area.
quality nondurable good. Although a shortage in our model can be recast as a kind of dissipative expenditure in Milgrom and Roberts’ model, our results differ from theirs in at least two respects. First, we explicitly model word-of-mouth communication and point out that a shortage can be combined with an introductory offer to signal product quality, and second, because we focus on pricing for durable goods, repeat purchase is not necessary for our analysis.\textsuperscript{7}

The rest of the article is as follows. The model is laid out in section II. The analysis is contained in section III, in which we begin with pooling equilibria and then consider separating equilibria. Section IV concludes.

\section{Model}

A monopoly firm has just developed a unique durable product and decides to sell it in two periods.\textsuperscript{8} The monopolist knows the quality of his product, while potential customers know only that the product is of one of two possible quality levels, \(l\) or \(h\). Each possibility is initially assigned by consumers with a strictly positive prior probability, \(1 - \theta\) and \(\theta\), respectively. For simplicity, we assume that the product is produced with a technology of constant marginal cost of production. Let \(c_l\) (\(c_h\)) denote the unit cost of producing a low-quality (high-quality) item and we assume that \(c_h \geq c_l\).\textsuperscript{9}

Each consumer demands, at most, one unit of the product. The total size of consumers is normalized to be unity without loss of generality. Consumers have homogeneous valuation for the product and obtain utility \((v)\) if a high-quality product is bought and 0 otherwise. Thus, the consumers’ utility function is given by:

\begin{equation}
\begin{aligned}
    u &= \begin{cases}
        v - p & \text{if a high-quality product is purchased at price } p, \\
        -p & \text{if a low-quality product is purchased at price } p.
    \end{cases}
\end{aligned}
\end{equation}

The new product is experiential by nature; that is, one needs to consume it to learn its quality. However, some consumers who don’t consume the product in the first period may also learn the quality of the product in the second period through word-of-mouth communication with those who consumed the product in the first period.

\textsuperscript{7}It should be noted that most previous studies are based on a repeat-purchase assumption (e.g., Bagwell (1987); Milgrom and Roberts (1986)). In any case, our model could easily be extended to include the repeat-purchase assumption.

\textsuperscript{8}It is straightforward to extend the model into multiple periods.

\textsuperscript{9}In contrast with Bagwell and Riordan (1991), the assumption that the higher-quality firm has higher costs of production is not crucial to our model. However, we adopt this assumption to accentuate the role of word-of-mouth communication in quality signaling (see Section III(ii)).
More specifically, we consider the following two-period game: At the beginning of the first period, the monopolist announces the price $p_1$ and the quantity supplied $s$ for the first period. Note that if the quantity demanded under $p_1$ exceeds $s$, a shortage is created in the first period. Consumers form their beliefs about the quality of the product after observing $p_1$ and $s$ and make their purchase decisions accordingly. If all of the consumers are served in the first period (i.e., $s = 1$), the game ends; otherwise, it evolves into the second period. In the second period, among the $1 - s$ unserved consumers, $s^\alpha - s$ learn the true quality of the product by word-of-mouth communication, while the rest of them $1 - s^\alpha$ remain uninformed.\(^{10}\) Here $\alpha$ ($0 \leq \alpha \leq 1$) measures the effectiveness of word of mouth. A smaller $\alpha$ indicates more effective word of mouth and $\alpha = 1$ indicates there is no word of mouth. The firm sets the second-period price at $p_2$ and sells the amount demanded by consumers in the second period. We assume that the monopolist cannot commit itself to a second-period price ($p_2$) in the first period (e.g., Coase, 1972).\(^{11}\) Finally, for simplicity, we assume there is no discount over the periods.

These actions and objectives define a two-period signaling game. Our solution concept is a perfect Bayesian equilibrium, which requires that the firm’s and consumers’ strategies be sequential rational, and that uninformed consumers’ beliefs be Bayesian whenever possible. We focus on pure-strategy equilibria and distinguish between pooling and separating equilibria (in which high- and low-quality firms choose different prices and quantities).

## III Equilibrium analysis

**III(i) Pooling Equilibrium**

We first study pooling equilibria. Due to the multiperiod feature of the model, pooling equilibria can be divided into four types. In a pooling equilibrium, consumers cannot distinguish the high-quality firm from the low-quality firm, and therefore their willingness to pay for the product is the expected value of the product, $\theta v$, in both periods. Type I involves zero transactions for both firms in the first period, but positive sales in the second period. Therefore, in a Type I pooling equilibrium the first period price is higher than $\theta v$, but the second period price is lower than $\theta v$. More specifically, any triplet $(s, p_1; p_2)$ satisfying $p_1 > \theta v$ and $p_2 \in [c_h, \theta v]$ defines a Type I pooling equilibrium with

\(^{10}\)Note that although $s^\alpha$ of the consumers are informed of the true quality at the beginning of the second period, only $s^\alpha - s$ are unserved because $s$ of them purchased the durable product in the first period.

\(^{11}\)It should be noted that assuming that the monopolist commits a second-period price in the first period would not affect our main result but can simplify equilibria refinement.
the out-of-equilibrium belief that any deviation from the equilibrium triplet implies low quality. Note that the existence of Type I pooling equilibria requires $\theta \geq \frac{c_h}{v}$.

Type II pooling equilibria entail positive sales for both firms in two periods. The informed consumers who did not purchase in the first period will be willing to purchase in the second period only if the product is of high quality, and therefore it follows that any Type II pooling equilibrium $(s, p_1; p_2)$ must satisfy the following set of constraints:

\begin{align}
(2) & \quad (p_1 - c_l) s + (p_2 - c_l) (1 - s^\alpha) > 0, \\
(3) & \quad (p_1 - c_h) s + (p_2 - c_h) (1 - s) > 0, \\
(4) & \quad (p_2 - c_h) (1 - s) \geq (v - c_h) (s^\alpha - s), \\
(5) & \quad p_1 \leq \theta v, p_2 \leq \theta v,
\end{align}

where (2) is the low-quality firm’s participation constraint, (3) and (4) the high-quality firm’s participation constraint and incentive constraint, respectively, and (5) the consumers’ participation condition. Conversely, any $(s, p_1; p_2)$ satisfying the above four constraints is a Type II pooling equilibrium with the out-of-equilibrium belief that any deviation suggests a low quality. Notice that the condition (5) implies that a Type II pooling equilibrium requires $c_h \leq p_2 \leq \theta v$, or $\theta \geq \frac{c_h}{v}$, i.e., the prior probability of the product’s being high quality must be sufficiently large. Since both Type I and Type II pooling equilibria are relatively trivial, we henceforth rule out these two types of pooling equilibria by focusing on $\theta < \frac{c_h}{v}$.

Type III pooling equilibria are much more interesting. In this type of equilibrium, both types of firms have positive sales in the first period. The second period, however, produces zero sales for the low-quality firm and positive sales for the high-quality firm. To ensure this, the second-period pooling price must be higher than $\theta v$, and therefore positive transactions occur between the high-quality firm and consumers who become aware of its high quality via word-of-mouth communication in the second period. Consequently, the second-period price charged by the high-quality firm must be $v$.\textsuperscript{12} Type III pooling equilibria can thus be characterized by the following necessary and sufficient

\textsuperscript{12}$v$ is a pooling price, because for uninformed consumers not to purchase, the low-quality firm must also charge this price in the second period.
conditions, with the off-equilibrium-belief that any deviation signals a low quality:

\[
(p_1 - c_l) s > 0, \\
(p_1 - c_h) s + (v - c_h) (s^\alpha - s) > 0, \\
p_1 \leq \theta v.
\]

The first two inequalities are participation constraints for the low- and high-quality firms, respectively, and the last inequality is consumers’ participation constraint in the first period. Notice that in a Type III pooling equilibrium \(c_l \leq p_1 \leq \theta v < p_2 = v\), which requires that \(\theta \geq \frac{c_l}{v}\).

To reduce the number of pooling equilibria, given our model’s multiperiod setting, the appropriate refinement is the generalized intuitive criterion proposed by Cho (1987). However, as Cho (1987, p.1385) notes, this refinement is often weak. This is also true in our model, because almost any first-period deviation that benefits the high-quality firm could improve profits for the low-quality firm under certain consumer beliefs, and as a result uninformed consumers will generally be unable to associate a deviation with the high-quality firm. Therefore, the refinement has no power in our model. Nevertheless, following Bagwell and Riordan (1989, p236), we look for the Pareto-dominant equilibrium for the high-quality firm. To find this equilibrium, we solve

\[
\max_{\{s,p_1\}} (p_1 - c_h) s + (v - c_h) (s^\alpha - s) \\
s.t. \quad p_1 \leq \theta v.
\]

First-order conditions yield

\[
p_1 = \theta v, \\
s = \min \left\{ 1, \left[ \frac{\alpha (v - c_h)}{(1 - \theta) v} \right]^{\frac{1}{1-\alpha}} \right\}.
\]

It is straightforward to check that second-order conditions hold. Notice, first, that if \((1 - \theta) v \leq \alpha (v - c_h)\) i.e., \(\theta \geq \frac{(1-\alpha)c + \alpha c_h}{v}\), then \(s = 1\). That is to say, when the prior probability of the firm’s being high quality is sufficiently large, the pooling equilibrium involves all consumers just being served in the first period at the price \(\theta v\). We call this equilibrium a Type IV pooling

\footnote{Differing from the standard Spence-type signaling games in which the sender (employee) pays for its signal (education) directly (Spence, 1974), signaling itself is without cost in our model. Combined with the receiver’s (consumers’) behavior in the first period, however, some cost may accure to the sender (firm), which complicates the equilibrium refinement. Bagwell and Riordan addressed a similar issue in section II.C of their 1991 paper.}
equilibrium, which is trivial; to rule it out, we assume \( \theta < \frac{(1-\alpha)v + c_h}{v} \). It follows that when \( 0 \leq \theta < \frac{(1-\alpha)v + c_h}{v} \), the Pareto-dominant Type III pooling equilibrium for the high-quality firm is \( s = \left[ \frac{\alpha(\theta - c_h)}{(1-\theta)v} \right]^{\frac{1}{\alpha}}, \ P_1 = \theta v; \ P_2 = v \) and the equilibrium profit for the high-quality firm is

\[
\Pi^P = \frac{(1-\alpha)(1-\theta)v}{\alpha} \left[ \frac{\alpha(v - c_h)}{(1-\theta)v} \right]^{\frac{1}{\alpha}} > 0.
\]

We summarize and classify pooling equilibria and Pareto-dominant pooling equilibria in the table below.\(^\dagger\)

<table>
<thead>
<tr>
<th>Pooling Equilibrium</th>
<th>( 0 \leq \theta \leq \frac{c_1}{v} )</th>
<th>( \frac{c_1}{v} \leq \theta \leq \frac{c_h}{v} )</th>
<th>( \frac{c_h}{v} \leq \theta \leq \frac{(1-\alpha)v + c_h}{v} )</th>
<th>( \frac{(1-\alpha)v + c_h}{v} \leq \theta \leq 1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pooling Equilibrium</td>
<td>None</td>
<td>Type III</td>
<td>Type I, II, III and IV</td>
<td>Type I, II, III and IV</td>
</tr>
<tr>
<td>Pareto-dominant Equilibrium</td>
<td>None</td>
<td>Type III</td>
<td>Type III</td>
<td>Type IV</td>
</tr>
</tbody>
</table>

Table 1. The classification of pooling equilibria

### III(ii) Separating equilibrium

In a separating equilibrium, the demands for the low-quality firm are zero in both periods; therefore, equilibrium profits for the low-quality firm are also zero. To simplify notation, we henceforth refer to the triplet \((s, p_1; p_2)\) as the equilibrium strategy adopted by the high-quality firm.

If the low-quality firm mimics the high-quality firm only in the first period, it gets

\[(p_1 - c_l)s.\]

Moreover, if it mimics the high-quality firm in both periods, it gets

\[(p_1 - c_l)s + (p_2 - c_l)(1 - s^\alpha).\]

Therefore, to ensure that the low-quality firm never imitates the high-quality firm in a separating equilibrium, we must have

\[(6) \quad \max\{(p_1 - c_l)s, (p_1 - c_l)s + (p_2 - c_l)(1 - s^\alpha)\} \leq 0.\]

As for the high-quality firm, in any separating equilibrium we must have

\[(7) \quad (p_1 - c_h)s + (p_2 - c_h)(1 - s) > 0\]

\(^\dagger\)Note that both Types I and II equilibria are always dominated by either Type III or IV equilibria.
and

\[(8) \quad (v - c_h)(s^a - s) \leq (p_2 - c_h)(1 - s),\]

where (7) is the participation constraint for the high-quality firm. (8) implies that in the second period, the high-quality firm is at least better off selling to all unserved consumers rather than only exploiting surplus from informed consumers. Therefore, any separating equilibrium can be characterized by conditions (6), (7), and (8); conversely, any triplet \((s, p_1; p_2)\) satisfying (6), (7), and (8) can be supported by a separating equilibrium, with uninformed consumers believing that any deviation from the triplet \((s, p_1; p_2)\) implies a low quality.

Similar to the case for pooling equilibria, the generalized intuitive criterion of Cho (1987) in general does not eliminate any of the separating equilibria.\(^{15}\) The reason is that in any separating equilibrium, if consumers observe any deviation from equilibrium signals \((s\text{ and } p_1)\) in the first period, they will think it is more likely to be a low-quality firm and thus not purchase. However, when new information \((p_2)\) arrives in the second period, consumers may change their beliefs and think that the product is actually of high quality. In this way, the firm will make a positive profit because it avoids the “stick” in the first period and enjoys the “carrot” in the second period. Because the low-quality firm can benefit from such a deviation given the described beliefs, there is no "bad deviation" for the low-quality firm.

Two observations about the separating equilibria are in order, which we state below as lemmas. First, the high-quality firm uses an introductory price to signal product quality in the first period and then charges a higher price in the second period. As a result, the price rises over time as more consumers become informed through word-of-mouth communication. Second, in the first period, the high-quality producer will supply only a fraction of the demand, creating a shortage. Therefore, we conclude that in any separating equilibrium, the high-quality firm uses both low introductory price and limited supply to signal product quality in the first period.

**Lemma 1** In any separating equilibrium, \(p_1 \leq c_l \leq c_h < p_2\).

**Proof.** \(p_1 \leq c_l\) follows directly from inequality (6), and the rest of the inequality follows from the assumption of \(c_h \geq c_l\) and the inequality (7).\(^{\Box}\)

**Lemma 2** In any separating equilibrium, the high-quality producer supplies a fraction of the demand for the first-period price.

\(^{15}\)Except for the case where the high-quality firm might charge a negative price, which will be discussed later.
Proof. To see this, first notice that the demand for the high-quality product in the first period is the whole market, 1, since \( p_1 \leq c_l \leq v \) by Lemma (1). However, the producer won’t supply the whole market, because otherwise condition (7) is violated.

Our results contrast with Bagwell and Riordan’s (1991) model, in which a high-quality good is introduced at a high price that is lowered over time toward the full-information monopoly price. As Bagwell and Riordan explain (p234), the key assumption generating their result is that information diffusion is independent of market activity. Our results confirm their conjecture that when word-of-mouth communication serves as an important channel of product-quality information diffusion, high prices—which discourage sales—become a less attractive tool for quality signaling. Instead, the high-quality firm will prefer to signal with a low introductory price to attract consumers and then raise the price over time, as more consumers become aware of the product’s quality.

Another interesting finding of our model is that when the high-quality firm uses a low introductory price in the first period, a shortage must be combined with the introductory offer so that together they will signal high quality. As mentioned previously, China’s smartphone industry employs a hunger-marketing strategy, in which a firm deliberately uses low prices and limited supply to gain consumers’ attention and, in turn, trigger higher future demand and profit margin. As a successful start-up that employed the strategy, Xiaomi Technology took just three years to emerge as China’s number one smartphone producer. Although the strategy has been controversial for Xiaomi—both in China and in overseas markets—our study suggests that its adoption may be driven by firms’ quality-signaling concerns.

We next identify the Pareto-dominant equilibrium for separating equilibria. From constraint (6), it must be true that

\[
(p_1 - c_l) s + (p_2 - c_l) (1 - s^g) \leq 0.
\]

To find the Pareto-dominant equilibrium, we solve

\[
\max_{s,p1\mid p2} \quad (p_1 - c_h) s + (p_2 - c_h) (1 - s) \\
\quad \text{s.t. (6)}.
\]

Because of Lemma 1, the constraint (6) must be binding, because otherwise the high-quality firm

\[\text{For more about Xiaomi and the controversy over its adoption of the hunger marketing strategy, see http://www.ejinsight.com/20140811-xiaomi-lack-of-charisma-in-gadget-market/}\]
could simply increase its profits by raising $p_1$. Therefore, the maximization problem becomes

$$\max_{s, p_1, p_2} (p_2 - c_l) s^\alpha - (p_2 - c_l) s - (c_h - c_l).$$

First-order conditions yield

$$p_2 = v, s = \alpha^{\frac{1}{1-\alpha}} < 1$$

and the second-order condition is satisfied because $\alpha (\alpha - 1) (v - c_l) s^{\alpha-2} \leq 0$. As expected, the first-period equilibrium price is less than the marginal cost of production of the low-quality firm, since

$$p_1 = c_l - (v - c_l) \left( s^{-1} - s^{\alpha-1} \right)$$
$$= c_l - (v - c_l) \left( \frac{\alpha^{\frac{\alpha}{\alpha-1}} - 1}{\alpha} \right) < c_l.$$

To summarize, in a Pareto-dominant separating equilibrium, the high-quality firm adopts the strategy

$$(s, p_1; p_2) = \left( \alpha^{\frac{1}{1-\alpha}}, c_l - \frac{(v - c_l) \left( \alpha^{\frac{\alpha}{\alpha-1}} - 1 \right)}{\alpha}; v \right).$$

Notice that because $\frac{\alpha^{\frac{\alpha}{\alpha-1}} - 1}{\alpha}$ is decreasing in $\alpha$, the first-period price $p_1$ is decreasing as the word-of-mouth communication becomes more powerful. This may explain why products that rely heavily on word-of-mouth communication often offer free samples.

To understand our model’s signaling mechanism, note that compared to the low-quality firm, the high-quality firm has a fraction of $s^\alpha - s$ informed customers who can be sold at the reservation price $v$, due to word-of-mouth communication in the second period. Because of this, the high-quality firm is able to withstand the loss that comes from charging a price lower than its marginal cost of production in the first period. It is not surprising that the profit $(v - c_h) (s^\alpha - s)$ is maximized at the efficient separating equilibrium, i.e., $s = \alpha^{\frac{1}{1-\alpha}}$. Notice that in equilibrium, $s$ is increasing in $\alpha$, and therefore the more effective the word of mouth (smaller $\alpha$), the more pronounced the shortage (smaller $s$) in the first period. Finally, it should be noted that if the first-period price for the high-quality firm is negative—which is possible under some parameter values—then only the Pareto-dominant separating equilibrium survives the generalized intuitive criterion (Cho, 1987). This is because consumers will always purchase in the first period even if they believe the quality is low.
After characterizing the Pareto-dominant separating equilibrium, we now turn to its existence.

Separation occurs only if the high-quality firm gets positive profits, i.e.,

\[
\hat{\Pi}^S = (p_1 - c_h) s + (v - c_h) (1 - s)
= \left( c_l - \frac{(v - c_l)}{\alpha} \left( \frac{\alpha}{\alpha + \tau} - 1 \right) - c_h \right) \alpha \frac{1}{\tau} + (v - c_h) \left( 1 - \frac{1}{\alpha} \right)
= (1 - \alpha) \alpha \frac{v}{1 - \alpha} (v - c_l) - (c_h - c_l) > 0.
\]

We summarize the above results in the following proposition:

**Proposition 1** When word-of-mouth communication is sufficiently effective (i.e., \((1 - \alpha) \alpha \frac{v}{1 - \alpha} > \frac{c_h - c_l}{v - c_l}\)), there exists a separating equilibrium in which the high-quality firm sells below the marginal cost of the low-quality firm and supplies a fraction of the demand in the first period. In addition, the first-period price is lower and the available quantity is smaller when word-of-mouth communication is more effective.

In light of the above proposition, we point out that in our model, if \(c_h \leq c_l\)—i.e., the high-quality product is more efficient to produce—the high-quality firm can always distinguish itself from the low-quality firm absent word-of-mouth communication. On the other hand, if \(c_h > c_l\), then word-of-mouth communication is necessary for a separating equilibrium, because otherwise the high-quality firm cannot gain more profit in the second period, and therefore would not have enough resources to deter mimicry by the low-quality firm. Furthermore, note that \((1 - \alpha) \alpha \frac{v}{1 - \alpha}\) is decreasing in \(\alpha\); therefore \((1 - \alpha) \alpha \frac{v}{1 - \alpha} = \frac{c_h - c_l}{v - c_l}\) defines a unique \(\alpha^*\) such that there exists a separating equilibrium when \(\alpha < \alpha^*\)—or, in other words, the separating equilibrium exists only if word-of-mouth communication is sufficiently effective when \(c_h > c_l\).

Lastly, it is interesting to point out that when both separating and Type III pooling equilibria are present, the high-quality firm benefits more from the pooling equilibrium than from the separating equilibrium.

**Proposition 2** (i) If \(0 \leq \theta < \frac{c_l}{v}\) and \((1 - \alpha) \alpha \frac{v}{1 - \alpha} > \frac{c_h - c_l}{v - c_l}\), i.e., the prior of high quality is sufficiently low and word of mouth is sufficiently effective, only a separating equilibrium exists.

(ii) If \(\frac{c_l}{v} \leq \theta \leq \frac{c_h}{v}\) and \((1 - \alpha) \alpha \frac{v}{1 - \alpha} > \frac{c_h - c_l}{v - c_l}\), i.e., the prior of high quality is sufficiently large and word of mouth is sufficiently effective, both separating and Type III pooling equilibria exist. Furthermore, the high-quality firm gets more equilibrium payoffs from the Pareto-dominant Type III pooling equilibrium than from the Pareto-dominant separating equilibrium.
Proof. (i) It follows directly from the necessary conditions for all types of pooling equilibria and proposition (1).

(ii) The first part follows from the necessary conditions for the existence of separating equilibrium and Type II and Type III pooling equilibria. To prove the second part, recall that

\[ \Pi^S = \max_s (v - c_l) s^\alpha - (v - c_l) s - (c_h - c_l) \]
\[ = \max_s (v - c_h) (s^\alpha - s) - (c_h - c_l) (1 - s^\alpha + s), \]
and

\[ \Pi^P = \max_s (v - c_h) (s^\alpha - s) - (c_h - \theta v) s. \]

Because \( \theta v > c_l \) and \( 1 - s^\alpha > 0 \), it follows that \( \Pi^S < \Pi^P \). Notice that the proof depends on the assumption that \( c_h \geq c_l \).

To see why the high-quality firm gains more from pooling, notice that for a given level of supply \( s \), the high-quality firm in a separating equilibrium charges a lower first-period price (lower than \( c_l \) vs. higher than \( c_l \)), but sells a higher volume in the second period (\( 1 - s \) vs. \( s^\alpha - s \)) than in a Type III pooling equilibrium. In other words, the high-quality firm loses in the first period—but gains in the second period—in a separating equilibrium, in contrast to a pooling equilibrium. The above proposition thus establishes that by adopting a separating equilibrium, the first-period loss for the high-quality firm exceeds the second-period gain. As a result, the pooling equilibrium always dominates the separating equilibrium when both of them exist.

IV Conclusion

When word-of-mouth communication serves as an important source of product information, a high-quality good is introduced at a lower price and in a limited supply. Over time, the price rises up and the shortage decreases. Introductory prices are used because, compared with a low-quality firm, a high-quality firm enjoys more profits from future sales. However, to limit the loss from introductory offers, the high-quality firm must combine them with limited supplies to signal its quality. Our model’s predictions are consistent with the casual observation that supermarket products on sale are typically offered in limited amounts, as with the hunger-marketing strategy adopted by many IT start-ups, such as Xiaomi Technology in China. Our study complements the existing literature by studying word of mouth, which, with rise of social media, has become an increasingly popular way to communicate quality information. To
highlight its role, we adopt a simplified model; however, many of its special features can be relaxed. For example, consumers’ homogeneous demands can be replaced by more general downward-demand functions. The two-period framework can also expand to a multi-period setting.
References


