Price, quality and advertising decisions considering reference quality effects: search versus experience goods

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Abstract. This research is stimulated from two facts. First, most products can be either search goods or experience goods. Consumers can learn the product quality of search goods before purchase, yet they can know that of experience goods until they have bought and used them for a certain period. Second, there is usually a kind of expectation on the quality of products, i.e. reference quality, formulated in a consumer's mind before he makes his purchase decision. Thus, when a consumer faces a search goods, he can compare its quality with his expectation and thus his decision will be influenced by the difference; yet he can make his decision just depending on his expectation when he occurs to an experience one since he cannot observe its quality before purchase. In this paper, we incorporate this fact with a modified Nerlove–Arrow model and then investigate firms' joint decisions on price, quality and advertising. The firms' optimal decisions are derived out under a differential game theory framework. Our results show that when the firms make their decisions mentioned above, they should consider the characteristics of their products seriously.

Keywords: reference quality effect; search goods; experience goods; differential games

Introduction

This research is stimulated from two facts. Firstly, Nelson (1970) proposes a distinction between two types of products, search goods and experience goods. Search goods are defined as products whose attributes can be verified before purchasing, yet consumers

cannot determine the quality of experience goods until they have bought and experienced the product for a certain period.

Secondly, empirical study on marketing illustrates that reference quality will affect the consumer's choice significantly when a consumer decides whether or not to buy a product. The reference quality can be understood as consumer's expectation with respect to product quality. When a consumer decides to purchase a product or not, the comparison of the reference quality and the actual quality of the product takes an effect. For instance, Kopalle and Winer (1996) showed that the demand of search goods is a function of the difference between expected quality and the product quality.

Combing the above two facts, we can conclude that when a consumer faces a search good, he can compare its quality with his expectation and thus his decision will be influenced by the difference; yet the consumer' purchasing decision for experience goods only depends on his expectation since he cannot observe its quality before purchase. Such difference between search goods and experience goods will affect the sales of the product and the firms' decisions significantly. Thus, in this paper we incorporate this fact into firms' decision model on joint price, quality and advertising decisions, to analyze whether the firms should consider the characteristics of their products seriously when they make those decisions.

Literature review

Literatures related to this paper are from two streams, (i) the research on search goods and experience goods, and (ii) literatures on reference quality effect.

In the former stream, Nelson (1970) firstly distinguished between two types of goods: search goods and experience goods. Based on such discrimination, Nelson (1974a,b) also introduced a different view on advertising. While conventional view considered that the effectiveness of advertising is a function of its content (the message), execution (how the ad conveys the message), and frequency (how often a consumer sees the ad), Nelson (1974a,b) argued that how advertising works depends on whether the product is a search or an experience goods and that the marketing view applies only to search goods. For experience goods, the only thing that matters is the advertising spending level because consumers can rationally infer that high-quality products would advertise more than low-quality products. Recently, Moorthy and Hawkins (2005) tested the Nelson's theory against the marketing view and offered evidence in support of the marketing view. Their experiments showed that advertising repetition influence the perceived quality and advertising does not seem to differentiate between search goods and experience goods. Erdem *et al* (2008) proposed that consumers learn about brand quality for experience goods through four distinct channels: price, advertising frequency, use experience and advertising content.

In the latter stream, Hardie *et al* (1993) developed the notion of reference quality and empirically demonstrated that differences between observed quality and reference quality can significantly affect purchase probabilities and that consumers weigh losses from a reference point more than equivalent sized gains (loss aversion). Kopalle and Winer (1996) introduced reference quality into the modeling area of reference effects together

with reference price effects and proposed that the expected quality is the perceived product quality that is formed over time using information from a variety of sources, such as, past product quality level, price, and so on. Fogel *et al* (2004) presented experimental evidence of reference effects for quality and showed the impact of reference quality and supported the existence of loss aversion for quality in a controlled choice setting with real products. Gavious and Lowengart (2012) separated the effects of price and reference quality on demand and assumed that the consumers' expectations about product quality are only based on their previous experience with the product.

Model

The system considered consists of a supplier and a retailer. To improve brand image, the supplier will invest in brand advertising. We denote the advertising effort level as $u(t)$. The supplier and the retailer decide the wholesale price $w(t)$ and the retail price $p(t)$ respectively. Let $q(t)$ denote the product quality determined by the supplier.

To reflect this long-term effect of national advertising on customers demand function, we utilize the concept of goodwill in Nerlove and Arrow in our framework and assume that quality can also influence the goodwill. As with previous literature, we assume that the changing of the goodwill is formulated as:

$$\dot{G}(t) = \alpha(q - r_q) + \beta u - \varphi G, G(0) = G_0 \geq 0, \tag{1}$$

where $G(t)$ is the accumulated goodwill over time t, $G_0 \geq 0$ is the initial goodwill, r_q is the reference quality, and other parameters such as α, β and φ are all positive constants.

In Eq. (1), the term $\alpha(q - r_q)$ implies that the firm's goodwill increases when the product's actual quality is higher than a consumer's reference quality, and will decrease on the contrary; the term βu means that the advertising effort has also a positive effect in improving the firm's goodwill; and the term φG means that the goodwill diminishes at a constant rate. Furthermore, we assume that there is positive relationship between the goodwill and the reference quality, i.e., $r_q = (q_0 + \xi G)$, where q_0 is the consumer's basic requirement on quality. A higher goodwill with the product implies a higher expectation with respect to product quality. Substituting it into Eq. (1) and letting $\delta = \alpha\xi + \varphi$, we have

$$\dot{G}(t) = \alpha(q - q_0) + \beta u - \delta G, G(0) = G_0 \geq 0. \tag{2}$$

For search goods, product quality is observable before purchase. Thus we assume that the sales for search goods is given by

$$S_S(t) = a - bp + d(q - q_0) + k(q - r_q) + \theta G, r_q = q_0 + \xi G, \tag{3}$$

where a, b, d, k and θ are all positive constants. In Eq. (3), the term $k(q - r_q)$ represents the reference quality effects on sales. When a product's current quality q is larger than its reference quality r_q, such effect is positive, whereas when $q < r_q$, the effect will be negative. The terms $d(q - q_0)$ and θG represent the positive impact of quality and goodwill on the sales.

For experience goods, consumers cannot observe the product actual quality before purchasing, thus the consumers' purchasing decisions are only affected by their reference quality. Thus, we assume that the sales for experience good is given by

$$S_E(t) = a - bp + f(r_q - q_0) + \theta G, r_q = q_0 + \xi G. \tag{4}$$

In Eq. (4), the term $f(r_q - q_0)$ represents the positive impact of reference quality on sales.

We assume the unit cost of the supplier is c where $c \geq 0$. The cost of advertising and quality follow a simple quadratic form (i.e., the cost of advertising and quality are $u^2 / 2$ and $(q - q_0)^2$).

Thus, the supplier's profit is

$$\pi_{iS} = (w - c)S_i - \frac{1}{2}u^2 - (q - q_0)^2, \tag{5}$$

and that of the retailer is

$$\pi_{iR} = (p - w)S_i, \tag{6}$$

where $i \in \{S, E\}$, S represents search goods and E represents experience goods.

The channel members have a constant and positive discount rate r and play a Stackelberg differential game over an infinite horizon. We regard the supplier as the Stackelberg leader and the retailer as the follower. Given the supplier's announced policies, the retailer's optimal control problem is given by

$$V^{iR}(G) = \underset{p \geq 0}{Max} \int_0^\infty e^{-rt}(p - w)S_i dt. \tag{7}$$

The supplier's problem can be stated as

$$V^{iS}(G) = \underset{\substack{w,u \geq 0 \\ q \geq q_0}}{Max} \int_0^\infty e^{-rt}[(w - c)S_i - \frac{1}{2}u^2 - (q - q_0)^2]dt. \tag{8}$$

Analysis

In this section, we derive the firm's optimal decision utilizing differential game and optimal control theory. To save space we just introduce our result without explaining them in detail.

Search goods

Proposition 1. The equilibrium goodwill path is given by

$$G_s^*(t) = G_{sss} + (G_0 - G_{sss})e^{-m_s t}, \tag{9}$$

where the exponent m_s and the steady state goodwill G_{sss} are given by

(i) when
$k \le \theta / \xi$

$$m_s = -\frac{1}{2}r + \frac{\sqrt{[r+2\delta - \dfrac{2\alpha(\theta - k\xi)(d+k)}{8b - (d+k)^2}]^2 - 8[\dfrac{4b\alpha^2}{8b - (d+k)^2} + \beta^2]\dfrac{(\theta - k\xi)^2}{8b - (d+k)^2}}}{2},$$

$$G_{sss} = \frac{(a-bc)}{[8b - (d+k)^2]m_s(m_s + r)}[\alpha(d+k)(r+\delta) + (\alpha^2 + 2\beta^2)(\theta - k\xi)];$$

(ii) when $k > \theta / \xi$,

$$m_s = -\frac{1}{2}r + \frac{\sqrt{[r+2\delta - \dfrac{2\alpha(\theta - k\xi)(d+k)}{8b - (d+k)^2}]^2 - \dfrac{32b\alpha^2(\theta - k\xi)^2}{[8b - (d+k)^2]^2}}}{2},$$

$$G_{sss} = \frac{\alpha(a-bc)}{[8b - (d+k)^2]m_s(m_s + r)}[(d+k)(r+\delta) + \alpha(\theta - k\xi)].$$

In Fig.1, we illustrate the pattern of the equilibrium goodwill path when $k \le \theta / \xi$. The equilibrium goodwill follows a pattern of an introductory period with either decreasing or increasing level until it reaches the second stage, where it stabilizes over time.
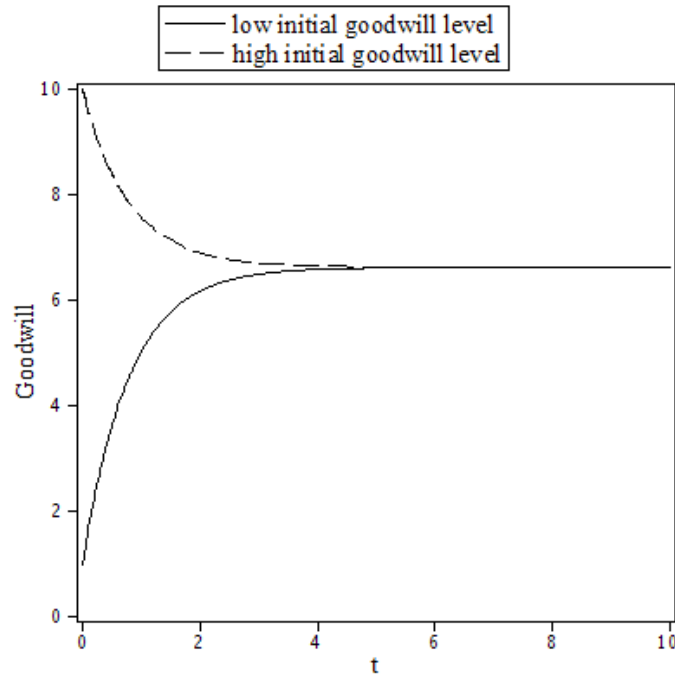

Fig. 1. The equilibrium goodwill path

Proposition 2. The equilibrium advertising path is as following:
(i) when
$$k < \theta / \xi$$
$$u_s(t) = u_{sss} + 2\beta\kappa_s(G_0 - G_{sss})e^{-m_s t}, \qquad (10)$$
where
$$u_{sss} = 2\beta\delta(a - bc)(\theta - k\xi) / \{[8b - (d+k)^2]m_s(m_s + r)\}.$$
(ii) when
$$k \geq \theta / \xi$$
$$u_s(t) = 0$$

Proposition 3. The equilibrium quality path is:
$$q_s(t) = q_{sss} + \frac{(\theta - k\xi)(d+k) + 8b\alpha\kappa_s}{8b - (d+k)^2}(G_0 - G_{sss})e^{-m_s t}, \qquad (11)$$
where
$$q_{sss} = q_0 + \frac{(a - bc)\delta}{[8b - (d+k)^2]m_s(m_s + r)}[(d+k)(r+\delta) + \alpha(\theta - k\xi)].$$

Proposition 4. The equilibrium wholesale price and retail price paths are:
$$w = w_{sss} + 4\frac{(\theta - k\xi) + \alpha\kappa_s(d+k)}{8b - (d+k)^2}(G_0 - G_{sss})e^{-m_s t}, \qquad (12)$$
$$p = p_{sss} + 6\frac{(\theta - k\xi) + \alpha\kappa_s(d+k)}{8b - (d+k)^2}(G_0 - G_{sss})e^{-m_s t}, \qquad (13)$$
where
$$w_{sss} = c + 4\frac{(a - bc)\delta(r+\delta)}{[8b - (d+k)^2]m_s(m_s + r)}, \quad p_{sss} = c + 6\frac{(a - bc)\delta(r+\delta)}{[8b - (d+k)^2]m_s(m_s + r)}.$$

Corollary 1. For search good, the ratio of advertising costs to the quality costs in the steady-state will decrease as the consumers' reference quality effect k becomes stronger.

Experience goods

Proposition 5. The equilibrium goodwill path is given by
$$G_e^*(t) = G_{ess} + (G_0 - G_{ess})e^{-m_e t}, \qquad (14)$$

where the exponent m_e and the steady state goodwill G_{ess} are given by

$$m_e = -\frac{1}{2}r + \frac{\sqrt{(r+2\delta)^2 - (\alpha^2 + 2\beta^2)\dfrac{(\theta + f\xi)^2}{2b}}}{2},$$

$$G_{ess} = \frac{(\alpha^2 + 2\beta^2)(a - bc)(\theta + f\xi)}{8bm_e(m_e + r)}.$$

Proposition 6. The equilibrium advertising, quality and pricing paths are:

$$u_e^*(t) = u_{ess} + 2\beta\kappa_e(G_0 - G_{ess})e^{-m_e t}, \tag{15}$$

$$q_e^*(t) = q_{ess} + \alpha\kappa_e(G_0 - G_{ess})e^{-m_e t}, \tag{16}$$

$$w_e^*(t) = w_{ess} + \frac{\theta + f\xi}{2b}(G_0 - G_{ess})e^{-m_e t}, \tag{17}$$

$$p_e^*(t) = p_{ess} + \frac{3(\theta + f\xi)}{4b}(G_0 - G_{ess})e^{-m_e t}, \tag{18}$$

where

$$u_{ess} = 2\beta\delta\frac{(a - bc)(\theta + f\xi)}{8bm_e(m_e + r)}, \quad q_{ess} = q_0 + \alpha\delta\frac{(a - bc)(\theta + f\xi)}{8bm_e(m_e + r)},$$

$$w_{ess} = c + \frac{4(a - bc)\delta(r + \delta)}{8bm_e(m_e + r)}, \quad p_{ess} = c + \frac{6(a - bc)\delta(r + \delta)}{8bm_e(m_e + r)}.$$

Corollary 2. For experience good, the ratio of advertising costs to the quality costs in the steady-state will decrease as the consumers' long-term reference quality effect α becomes stronger.

Comparing the results of the experience goods with that of search goods, we find that the decisions on advertising, quality and price are different for these two products and have the following results.

Proposition 7. A firm should pay more attention on quality when his products is search goods, and should pay more attention on advertising if his product is experience goods.

The ratio of advertising costs to quality costs is larger for experience goods than that for search goods, which indicates that advertising is more important for experience goods.

Concluding remarks

The main results of this paper include the following: (i) the firm should consider the characteristics of their products seriously when making his advertising, quality and price decisions; (ii) the supplier will pay more attention to the product quality as the consumers' reference quality effect becomes stronger; (ii) advertising is more important for experience goods relative to search goods.

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