Experience Goods Monopolist: Freeware as an Advertisement

Le Duc Niem

This study examines the situation in which a monopolist offers freeware as an advertisement for the increase of demand to maximize profit even though the existence of such freeware will reduce the power of the monopolist in the market. This study proves that the successful application of freeware is dependent on the number of potential consumers and the optimal quality design for freeware in this situation uniquely exists.

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JEL Classification: L86, D83, D42

I. Introduction

"Freeware" is frequently observed in software markets. For example, "LogMeIn,"[1] a web-based computer-remote-control service, provides some services for free but offers other services for paying customers. "Avast"[2] provides free antivirus and commercial antivirus versions simultaneously. However, the reason why companies offer such freeware is being questioned.

Although freeware is copyrighted, it is distributed and redistributed freely without any payment from end users. Haruvy, and Prasad (2005)

[1] Available at https://secure.logmein.com/US/home.aspx

[2] Available at http://www.avast.com/

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proposed that a firm offering freeware may do so as an advertisement to catch the attention of consumers. They also suggested that the existence of freeware may help the firm achieve a competitive advantage. That is, one company can offer for free what another competitor may offer as a commercial product, thereby achieving a monopolist position. However, another convincing reason for the use of freeware is that firms may want to inform potential customers of the quality of their products (Shapiro, and Varian 1998). Gaudeul (2004) examined whether a firm may offer a lower-quality version ("shareware") of the software it wants to sell at a later stage to demonstrate certain aspects of product quality to potential customers. However, shareware is typically offered as a time-limited product. She found that firms providing information about their software via shareware make higher profits than competing firms that do not offer shareware.

This study considers a monopolist setting in which time-limited shareware is inapplicable. Such situation may apply, for example, when users are willing to reinstall their free sample repeatedly (thus avoiding the time limitation) or when the costs associated with the "trial" sample are considerably high.[3] This study proves that freeware of unlimited duration can be used as a persuasive and informative advertisement to attract potential consumers. Moreover, it shows that the optimal quality level of the freeware is uniquely determined and increases along with the number of potential consumers in the market.

In Section II, the basic model is provided. In Section III, the optimal quality level of the freeware over two periods is derived. Section IV presents the conclusions.

II. Model

This study assumes that a monopolist produces one type of commercial software that is non-time limited. This product is an *experience good*. The quality level of the software is normalized to 1. The quality and production costs of the good are so small as to be negligible. The good is sold to a population of consumers with a range of preferences for quality, with each consumer buying one unit of the good at most. However, two types of consumers, namely, *interested*

[3]See Ilan (2001).

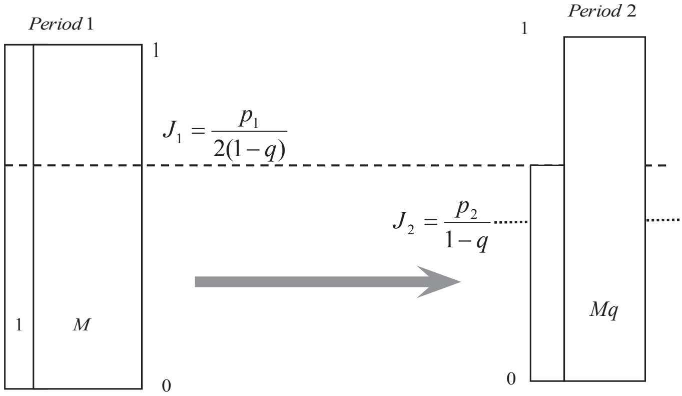

FIGURE 1
THE MONOPOLIST'S DECISIONS WITH FREEWARE

consumers and *potential consumers* exist. Interested consumers are those who are eager to buy the product and have full prior information regarding the quality of the good. Potential consumers are those who are not yet ready to buy the good. These potential consumers need to *experience* the good for a certain period of time before some of them will become interested consumers. When potential consumers become interested ones, they have become fully informed of the quality of the good being offered. The number of interested consumers is normalized to 1, whereas the number of potential consumers is *M*. Each type of consumer is uniformly distributed in the [0, 1] range according to their preference for quality, as assumed in Wauthy (1996) and Lee (1996).

The following game is constructed (See Figure 1). In the first period, the monopolist decides upon the quality level q of the freeware. Then, the monopolist sets a price p_1 to its good (commercial version). In the second period, the monopolist will set another price p_2 to its good. Notably, the freeware is freely distributed and copyable over two periods. In addition, the monopolist who provides freeware with zero-quality level carries the implication that it is not providing any freeware.

The rate of *potential consumers* becoming *interested consumers* after the first period can be reasonably assumed to be positively related to the quality level of the freeware provided. For simplification, the number of *potential-to-interested* consumers is denoted as qM ($0 \leq q \leq 1$). qM implies that, as the quality level of the freeware increases, more potential consumers will enter the market as interested ones after the first period. When the quality level of the freeware is 1, all potential consumers will become interested consumers. As conceptualized by Gabszewics, and Thisse (1979), the preference for quality is dependent on the income of the consumers. Thus, in this setting, all consumers are actually identical, except for their income. When consumers have more income, they are more willing to pay for a given quality level. Moreover, all potential consumers can use the freeware in the first period regardless of their income levels. Therefore, qM is also assumed to be uniformly distributed in the [0, 1] range according to their preference for quality.

The utility function of the consumers is described as follows:

$$U(J_i) = nJ_iQ - p \,. \tag{1}$$

This utility function is commonly used in models of vertical differentiation, such as that used by Wauthy (1996) and Lee (1996). In Equation (1), Q is the quality level built into the software, and p is its price. If the software is expected to be used in one period, then $n = 1$. If the software is expected to be used in two periods, then $n = 2$. This function is an indirect utility function of consumer i, identified by the parameter J_i, which measures the heterogeneity of consumer preference for quality ($J_i \in [0, 1]$, as mentioned previously). Consumers decide to buy the commercial version of the software only when they obtain higher utility than the utility provided by the freeware. Backward induction is applied to solve this game.

III. Freeware Quality Design

Based on the models presented by Wauthy (1996) and Lee (1996), the freeware is regarded as a low-quality product with zero price. In the first period, the marginal consumer who is indifferent to buying the good or using the freeware is defined by $2J_1 - p_1 = 2J_1q$.[4] That is,

$$J_1 = \frac{p_1}{2(1-q)} \,. \tag{2}$$

[4]The commercial and freeware versions are non-time limited and are expected to be used for two periods.

In the second period, the marginal consumer who is indifferent to having the commercial version or the freeware is defined by $J_2 - p_2 = J_2 q$.[5] That is,

$$J_2 = \frac{p_2}{1-q}. \tag{3}$$

***Lemma* 1:** *In the second period, the monopolist will not set the price of its software higher than half of the price set for the good in the first period.*

Proof: If the monopolist sets a pair of prices (p_1, p_2) such that $2p_2 > p_1$. This implies that $J_2 > J_1$. As illustrated in Figure 1, the profits in the first and second periods are independent because only the newly converted *potential-to-interested consumers* buy the good in the second period. In other words, the monopolist sells the good to the interested consumers in the first period and sells the good only to the converted *potential-to-interested consumers* in the second period. In this case, the best response of the firm to price in the first period is $(1 - q)$ and that in the second period is $(1 - q)/2$. Thus, $\Pi_1(p_1) + \Pi_2(p_2) < \Pi_1(1 - q) + \Pi_2((1 - q)/2)$ can be proven. Therefore, such a pair of prices (p_1, p_2) is not the optimal choice because it is dominated by another pair of prices $\{(1 - q), (1 - q)/2\}$. Hence, Lemma 1 is proven.

Let

$$x = \frac{p_1}{2(1-q)},$$

and

$$y = \frac{p_2}{1-q} \text{ (or } 2x(1 - q) = p_1,\ y(1 - q) = p_2).$$

For the sake of mathematical derivation, the optimal values of x, y for profit maximization problems can be derived.

Second Period

In reference to Figure 1, the profit function of the monopolist in the

[5]The commercial and freeware versions are expected to be used only in the second period.

second period is expressed as follows:[6]

$$\Pi_2(a,\ p_2) = (1-q)[x-y]y + qM(1-q)[1-y]y\,. \tag{4}$$

The best response to y is defined by $\partial\Pi_2 / \partial y = 0$. That is,

$$y^* = \frac{(x+qM)}{2(1+qM)}\,. \tag{5}$$

Substituting Equation (5) into Equation (4) yields the profit in the second period, as shown as follows:

$$\Pi_2(x) = \frac{(1-q)(x+qM)^2}{4(1+qM)}\,. \tag{6}$$

First Period

The total profit function of the monopolist is $\Pi(x) = \Pi_1(x) + \Pi_2(x,\ y)$ or

$$\Pi(x) = 2(1-q)(1-x)x + \frac{(1-q)(x+qM)^2}{4(1+qM)}\,. \tag{7}$$

The best response to x is defined by $\partial\Pi / \partial x = 0$. That is,

$$x^* = \frac{4+5qM}{7+8qM}\,. \tag{8}$$

From Equations (7) and (8), the profit function can be derived as follows:

$$\Pi(q) = \frac{2(1-q)(1+qM)(2+qM)}{(7+8qM)}\,. \tag{9}$$

The best response to the quality level of the freeware is derived by $\partial\Pi / \partial q = 0$. That is,

[6]Notably, $(x - y)$ is the number of goods (commercial software) sold to "first period" *interested consumers* in the second period, and $qM(1 - y)$ is the number of goods sold to *potential-to-interested consumers* in the second period.

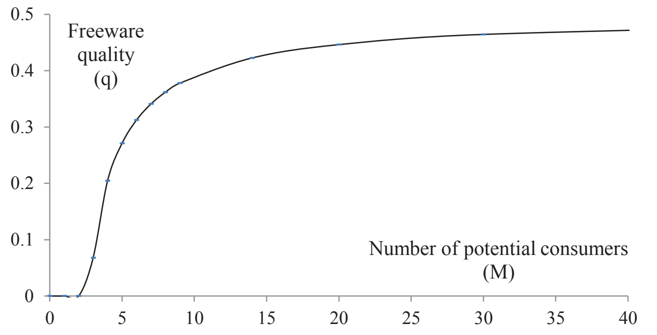

FIGURE 2
OPTIMAL QUALITY LEVEL OF THE FREEWARE

$$(5M - 14) + 14(M - 3)Mq + (8M - 45)M^2q^2 - 16M^3q^3 = 0. \tag{10}$$

For simplicity, q in the cubic expression in Equation (10) is solved using a computer software. The optimal quality level of the freeware is shown in Figure 2.

***Lemma* 2:** *The optimal quality level of the freeware increases in M but it is less than 0.5.*

Figure 2 shows that the optimal quality level of the freeware increases with M.[7] However, this quality level cannot exceed 0.5. Equation (10) can be rewritten as follows:

$$-14 + (5 - 42q)M + q(14 - 45q)M^2 + 8q^2(1 - 2q)M^3 = 0. \tag{11}$$

Thus, if $q \geq 0.5$, then all terms in Equation (11) are negative (the last term can be zero when $q = 0.5$). Thus, any M that might satisfy Equation (11) is not found. Therefore, Lemma 2 is proven.

***Proposition* 1:** *The monopolist will only offer freeware as an advertisement when the number of potential consumers is sufficiently large (M >*

[7]The optimal quality level of the freeware is calculated using the spreadsheet program "Solver" in Excel for all M_i changing from 0 to 40, with $\Delta M = M_i - M_{i-1} = 0.2$. The result is presented in Figure 2.

2.8). In addition, the optimal quality level of the freeware is defined, is unique, and increases with the number of potential consumers in the first period.

Proof: $f(q) = (5M - 14) + 14(M - 3)Mq + (8M - 45)M^2q^2 - 16M^3q^3$ (12)

i) For $0 \leq M \leq 2.8$:

$f(q) < 0$, because all terms in $f(q)$ are negative. The monopolist will maximize the profit by limiting the quality level of the freeware as much as possible. Thus, the monopolist will choose $q = 0$. Recall that zero quality means that the monopolist does not offer the freeware.

ii) For $2.8 < M < 3$:

The function $f(q)$ is cubic with the cubic coefficient $a = -16M^3 < 0$. Differentiating $f(q)$ with respect to q yields the following expression:

$$f'(q) = 14(M - 3)M + 2(8M - 45)M^2q - 48M^3q^2. \quad (13)$$

The function in Equation (13) has two negative roots when $2.8 < M < 3$. Thus, the local maximum and minimum abscissa coordinates of $f(q)$ are both negative. In addition, $f(0) > 0$ and $f(1) < 0$. Thus, $f(q)$ has only one root in the [0, 1] range. In other words, the optimal quality is defined and is unique.

iii) For $M = 3$:

$f(q)$ has only one root in the [0, 1] range. Thus, the optimal quality is defined and is unique.

iv) For $M > 3$:

The function $f(q)$ is also cubic with the cubic coefficient $a = -16M^3 < 0$. The first derivative $f'(q)$ has one negative root and one positive root. In addition, $f(0) > 0$ and $f(1) < 0$. Thus, $f(q)$ has only one root in the [0, 1] range. In other words, the optimal quality is defined and is unique.

On the basis of (i), (ii), (iii), and (iv), Proposition 1 is proven.

IV. Concluding Remarks

This study investigates a simple model where a monopolist uses freeware as an advertising strategy to attract potential consumers. First, the monopolist will offer freeware as an advertisement only when the number of potential consumers is sufficiently large. When the number of potential consumers is small, the existence of freeware may reduce the willingness to buy of current interested consumers.

As a consequence, the firm will make lower profit if it offers freeware. However, when the number of potential consumers is large, the firm will offer freeware because it expects that more consumers will buy the good in the future as they arrive in the market as interested consumers. Second, the optimal quality level of the freeware is defined, is unique, and increases with the number of potential consumers in the first period. This finding implies that a monopolist can design freeware that best responds to a specific market setting.

Although this model provides a theoretical reason for the existence of freeware, it still has a limitation. In reality, software applications are often found in other market structures rather than the monopolistic one. However, it is expected that the findings will be similar when the market setting is modified.

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