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Freeware as an Advertisement

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

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1. Introduction

"Freeware" is very 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 at the same time. Why would any company offer a component of its software at no charge?

While it is copyrighted, freeware is distributed and re-distributed freely without any payment from end users.[3] Haruvy and Prasad (2005) proposed that a firm offering freeware may do so as an advertisement to catch the attention of consumers. Also, they suggested that the existence of freeware may help 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, in order to demonstrate to potential customers aspects of product quality. However, shareware is typically offered as a time-limited product.

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

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

[3] http://en.wikipedia.org/wiki/Freeware#cite_note-0

She found that firms providing information about their software via shareware make higher profits than competing firms that do not offer shareware.

In this paper, we consider a monopolist setting in which time-limited shareware is not applicable. Such a situation may apply, for example, when users are willing to repeatedly re-install their free sample (thus avoiding the time limitation), or when the costs associated with the 'trial' sample are considerably high[4]. We prove that freeware of unlimited duration can be used as a persuasive and informative advertisement to attract potential consumers, and show that the optimal quality level of the freeware is uniquely determined, and it increases as the number of potential consumers in the market increases.

In section 2 of this paper we provide the basic model, and in section 3 we derive the optimal freeware quality level over two periods. Section 4 presents our conclusions.

2. The model

We assume that there is a monopolist who 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. We assume that quality and production costs of these goods are so small as to be negligible. The goods are sold to a population of consumers with a range of preference for quality, and we assume each consumer can buy, at most, one unit of the product. However, we imagine there are two types of consumers: '*interested consumers*' and '*potential consumers*'. Interested consumers are those who are eager to buy the product and have full prior information regarding quality of the goods. Potential consumers are those who are not yet ready to buy the goods. These potential consumers need to *experience* the product for a period before some of them will become interested consumers. When a potential consumer becomes an interested consumer, he has become fully informed of the quality being offered. The number of interested consumers is normalized to 1 while the number of potential consumers is M. Each type of consumer is uniformly distributed in [0, 1] according to their taste for quality as in Wauthy (1996).

We construct a game as follows (see figure 1): In the first period, the monopolist decides upon a quality level q for the freeware. Then, it sets a price p_1 to its goods (pay-version). In the second period, the monopolist will set another price p_2 to its goods. It is worth noting that the freeware is freely distributed and copy-able over two periods. Additionally, the monopolist who

[4] See Ilan (2001)

provides freeware with zero quality level carries the implication that it is not providing any freeware.

It is reasonable to suppose that the rate of *potential consumers* becoming *interested consumers* after the first period is positively related to the quality level of the freeware provided. For simplification, we suppose that the number of *potential-to-interested* consumers is qM ($0 \le q \le 1$). This implies that as quality is added to the freeware, more potential consumers will enter the market as interested consumers after the first period. When the quality of the freeware is 1, all potential consumers will turn into interested consumers.

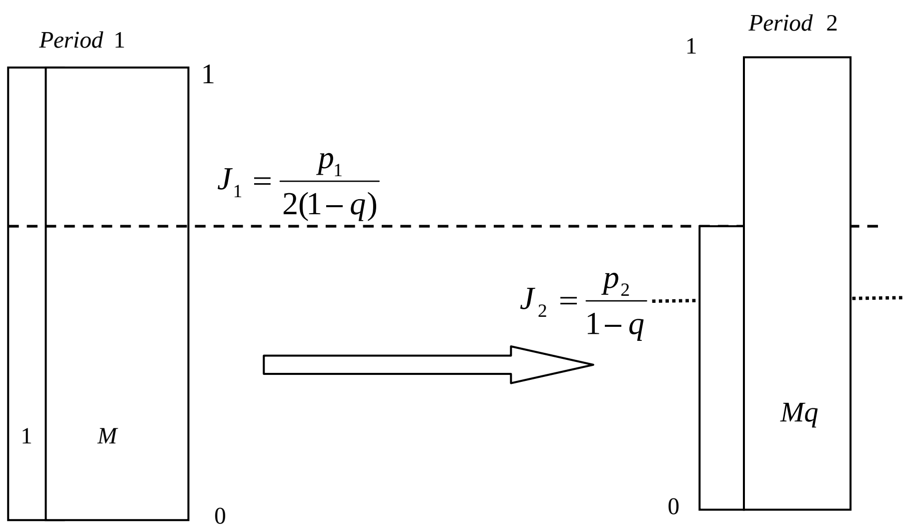

Figure 1: A *monopolist's decisions with freeware*

The consumer's utility function is described as follows:

$$U(J_i) = nJ_iQ - p \qquad (1)$$

Q is quality level built into the good and p is its price. If the good is expected to be used in one period, n =1, and if it is expected to be used in two periods, n =2. This function is an indirect utility function of consumer i, identified by the parameter J_i which measures the heterogeneity in consumer taste for quality[5]. Consumers decide to buy the commercial version of the good only when they get higher utility compared with the utility obtained by the freeware. To solve this game, backward induction is applied.

[5] See utility function in the paper of Wauthy (1996).

3. Freeware quality design

We regard the freeware as a low-quality product with zero-price as in Wauthy (1996). In the first period, the marginal consumer who is indifferent between buying the good or using the freeware is derived from $2J_1 - p_1 = 2J_1 q$.[6] That is

$$J_1 = \frac{p_1}{2(1-q)} \qquad (2)$$

The marginal consumer who is indifferent between having the commercial version or the freeware in the second period is defined by $J_2 - p_2 = J_2 q$ or: [7]

$$J_2 = \frac{p_2}{1-q} \qquad (3)$$

Lemma 1: *In the second period, the monopolist will not set a price for its goods higher than a half the price it sets to the goods in the first period.*

<u>*Proof:*</u>

Suppose 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 newly converting *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 converting *potential-to-interested* consumers in the second period. In this case, it is easy to find that the best response of the firm to price in the first period is $(1-q)$, and in the second period is $(1-q)/2$. Thus, we can prove that $\Pi_1(p_1) + \Pi_2(p_2) < \Pi_1(1-q) + \Pi_2(\frac{(1-q)}{2})$. For this reason, such a pair of (p_1, p_2) is not the optimal choice because it is dominated by another pair of prices $\{(1-q), (1-q)/2\}$. Lemma 1 is proved.

[6] The commercial and freeware versions are both not time-limited, and they are expected to be used for two periods.
[7] The commercial and freeware versions are expected to be used in only the second period.

We let $x = \frac{p_1}{2(1-q)}$ and $y = \frac{p_1}{1-q}$ (or $2x(1-q) = p_1$, $y(1-q) = p_2$). For the sake of mathematical derivation, we can simply find the optimal value of x, y for profit maximization problems.

- *Second period*

Referring to figure 1, the profit function of the monopolist in the second period is:[8]

$$\Pi_2(a, p_2) = (1-q)[x-y]y + qM(1-q)[1-y]y \qquad (4)$$

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

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

Substituting (5) into (4), the profit in the second period is

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

- *First period*

Total profit function[9] of the monopolist is $\Pi(x) = \Pi_1(x) + \Pi_2(x, y)$ or

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

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

$$x^* = \frac{4+5qM}{7+8qM} \qquad (8)$$

From (7) and (8), we can derive the profit function as follows:

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[8] It is worth noting that $(x-y)$ is number of goods sold to "first period" *interested consumers* in the second period and $(1-y)$ is numbers of goods sold to *potential-to-interested* consumers in the second period.

[9] It is noteworthy that $(1-x)$ is number of goods sold to *interested consumers* in the first period.

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

The best response to quality of freeware is derived by $\partial\Pi / \partial q = 0$

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

For simplicity, we solve for q in the cubic expression (10) using computer software. The optimal quality of freeware is as in figure 2.

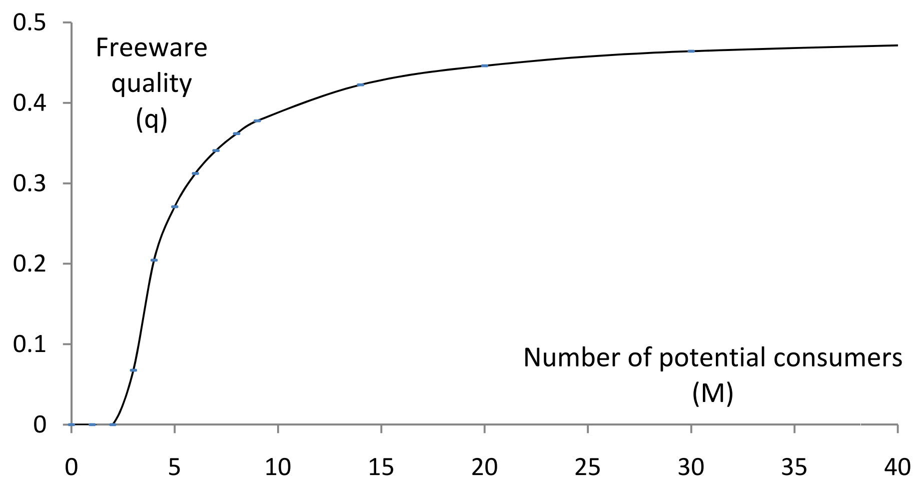

Figure 2: Optimal quality of freeware

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

In figure 2, we can see that the optimal quality level of the freeware increases as M increases.[10] Now, we prove that this quality level cannot exceed 0.5. We rewrite (10) as follows:

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

Thus, if $q \geq 0.5$, all terms in (11) are negative (actually, the last term can be zero when $q = 0.5$). Thus, we cannot find any M that satisfies (11). Lemma 2 is proven.

[10] We calculated the optimal quality level of freeware by 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.

Proposition 1: *The monopolist will only offer freeware as an advertisement when the number of potential consumers is large enough* $(M > 2.8)$ *. In addition, the optimal quality level of the freeware is defined, unique, and increases with the number of potential consumers in the first period.*

<u>Proof:</u>

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

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

We have $f(q) < 0$ because all terms in $f(q)$ are negative. The monopolist will maximize the profit by limiting the quality level of freeware as much as possible. Thus, it chooses $q = 0$. 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, we obtain:

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

The function in (13) has two negative roots when $2.8 < M < 3$. Thus, the local maximum and minimum abscissa co-ordinates of $f(q)$ are less than zero. In addition, we have $f(0) > 0$ and $f(1) < 0$. Thus, $f(q)$ has only one root in $[0, 1]$. In other words, the optimal quality is defined and unique.

iii) For $M = 3$, it is easy to prove that $f(q)$ has only one root in [0, 1]: The optimal quality is defined and 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. We also have $f(0) > 0$ and $f(1) < 0$. Thus, $f(q)$ has only one root in [0, 1], and the optimal quality is defined and unique.

From (i), (ii), (iii), and (iv), proposition 1 is proven.

4. Concluding Remarks

This paper investigates a simple model where a monopolist uses freeware as an advertising strategy to attract potential consumers. First, we find that the monopolist will offer freeware as an advertisement only when the number of potential consumers is large enough. The reason is that 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 more consumers will buy the goods in the future as they arrive in the market as interested consumers. Second, we prove that the optimal quality level of the freeware is defined, unique, and increases as the number of potential consumers in the first period increases. This implies that it is possible for a monopolist to design freeware that best responses to a specific market setting.

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