Economics of Shareware: How Uncertainty and Piracy Affect Shareware Quality and Brand Premium

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ECONOMICS OF SHAREWARE:
HOW UNCERTAINTY AND PIRACY AFFECT SHAREWARE QUALITY AND BRAND PREMIUM

Economics and Information Systems

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Abstract

In the past, shareware has been mainly used to market small and simple software, the developers of which could not afford to distribute their products through a physical retail channel. Shareware was often distributed through complimentary floppy or CD disks attached to PC or games magazines. However, with increased network speed, it has become viable for digital files, even large ones, to be distributed over the Internet. The Internet channel has opened up new opportunities for developers, small or large, to distribute their products as shareware to reach consumers directly. Indeed, in recent years, we begin to see big firms, including Microsoft, Adobe, and Google, distributing their products as shareware. We find that shareware is an increasingly widespread marketing strategy for selling software products via the Web.

Because the emergence of shareware has not been driven by economic concerns, there is limited analytical research on shareware. However, as shareware gains in popularity as a strategy to reduce consumers’ uncertainty about new software products, there is a need for deeper understanding of the economic implications of its use. This paper analyzes the interrelationships among key issues that are central to the software industry, including uncertainty, piracy, shareware quality, and full version price. We show that customers’ aversion to the uncertainty of software quality tends to increase shareware quality while piracy tends to decrease it. Counter intuitively, the perceived quality of the full version software or the trust toward the software developer does not affect the full version price and the profit of the firm when piracy is prevalent.

Keywords: Shareware, liteware, price discrimination, piracy

Introduction

The existence of freeware has been a puzzling phenomenon to economists, as freeware developers devote their time and effort developing software to be shared by the general public and do not receive any monetary rewards. Shareware is a closely related concept, motivated by “sharing” good software with friends. The first piece of shareware was initially distributed free. However, as maintenance and administrative costs increased, the author of the shareware requested users to donate a small amount of money on a voluntary basis (Knopf 1995), and thus, the shareware distribution model was born. Although monetary compensation is expected in shareware, payment based on the honor system is still not a phenomenon well-explained by classical economics because a classical rational
consumer would never pay for the shareware. As it turned out, however, the owner of this very first piece of shareware actually earned a fortune based on the honor system (Knopf 1995).

The shareware model has one obvious advantage: it allows software developers to bypass intermediaries and keep most of their revenue as their profit. This advantage especially appeals to individual programmers and small developers who normally do not have the financial resources to adopt the traditional on-the-shelf strategy. It is no wonder that in the early days, shareware products were usually small and simple utilities or games written by individual programmers who started off developing these programs as a hobby. As of mid-1990s, shareware was only a $300 million industry, a very humble figure compared to that of commercial software (Foley 1995).

However, the shareware industry has over the recent years changed significantly with broadband penetration. Increased network speed facilitates the transfer of large data files over the Internet. Nowadays it is common to find either shareware or full version software delivered over the Internet. In October 2004, the market was surprised to find that even Microsoft began to adopt the shareware marketing model through the Internet (Geekswithblogs 2004). Shareware is now generally considered different from freeware, with the understanding that the user may pay for it later if he finds it useful and decides to continue using it. The honor system is still in use, but most developers now add various use restrictions in shareware to make sure that their efforts are rewarded. This paper focuses only on liteware (i.e., the disabling of certain features of the software).

In recent years, many users have lamented the “death of shareware” and complained about developers’ excessive disabling of software functionalities in shareware (Ambrosia Software 2005). As the sharing spirit of shareware continues to evaporate, more and more often marketing strategists regard it as a variation of the try-before-use distribution model (Hadley 2003), which aims to reduce the uncertainty faced by consumers when they make their purchase decisions about new products. According to Nelson (1970), some attributes of products can only be collected from experience (using the product). In particular, the quality of software can only be observed by experience, and shareware provides a way for consumers to acquire this experience.

Because the emergence of shareware has not been driven by economic concerns, there are limited analytical studies on it. Yet as shareware gains popularity in the software and gaming industry as a marketing strategy, it is of interest to both researchers and practitioners to better understand the economic implications of its use. Since piracy is common in the software industry, it is also important to understand how it affects shareware decisions. In this study, we analyze the interrelationship between consumers’ uncertainty about quality, piracy, shareware (liteware) quality, and the full version price.

Background

As mentioned earlier, some shareware programs are distributed based on the honor system. However, it is more common nowadays to find shareware that are programmed with a built-in expiration date. Some simply add annoyance in the program once the trial period is passed. One example is NJStar Communicator, a program that writes and views Chinese, Korean, and Japanese characters. If the user continues to use the shareware after expiry, there will be a one second delay per day after the expiry date before the software launches successfully, as shown in Figure 1.

![Figure 1. Built-in Annoyance by NJStar Communicator](image)

Some software developers distribute demonstration versions that would work for only a certain period of time. Afterward that, the user is required to pay a registration fee. An example is MathType, an equation editor that works
in Microsoft Office. When a user installs the shareware, he would receive the dialog box as shown in Figure 2. To obtain the right to use the full version, the user has to input a registration code that he receives upon successful registration. However, the user can easily pirate the software with the use of software key generators (or “keygens”), which are small executable files that generate registration numbers.

![Figure 2. MathType Installation Dialog Box](image)

Other developers offer software with limited functionalities as shareware (also called *liteware*). It serves to lure users to buy the full version of the software. Many PC and Mac games are offered this way. Examples are the Escape Velocity series (http://www.ambrosiasw.com), Airburst (http://www.strangeflavor.com), and Noiz2sa (http://victoly.com/~adam/noiz.html). Users may become satisfied with the liteware and decide to continue to use it instead of buying the full version (Teemas 2004). However, users may also use “crack” programs to modify the code in the shareware and unlock the full version capability. This paper focuses only on *liteware* even though our results can be applied to other shareware restrictions, such as annoyance, with minor modifications to the model.

The business motivation of shareware is to market software to consumers directly. It allows consumers to try a program before they buy it. Many software products are considered experience goods because users would have no idea whether they satisfy their needs or tastes without having tried them (Shapiro and Varian 1999). Allowing consumers to evaluate whether the software fulfills their needs and suits their tastes is important, because it reduces uncertainty on the consumer side. For example, video and online games are typical experience information goods and frequently employ this marketing strategy through trial versions uploaded on the Web or free trials at games counters in department stores and shopping malls.

When deciding whether or not to adopt the shareware strategy, the firm faces a dilemma: If it disables functionalities too much, the user may find that the product is not interesting or that there is too much uncertainty in making the purchase decision; however, if the shareware quality is too good, the user may find the shareware adequate and never buy the full version. Shareware is also particularly vulnerable to piracy because developers rely on the honor system, or the code can be cracked easily. In this study, we seek to answer three research questions: 1) how far should the firm disable full version functionalities in the shareware? 2) how does aversion to uncertainty affect the optimal shareware quality, and 3) how would the shareware and pricing decisions be affected by piracy?

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1 In this paper, we do not worry about how the user pirates software. i.e., we do not differentiate between shareware piracy (e.g. use of crackers to unlock full version capacity) and full version piracy (e.g.e.g. duplication of a legal copy).
Literature Review

Shareware Economics

There has been limited effort in academic research on shareware. Haruvy and Prasad (1998) study shareware as a product strategy in the presence of network externalities. Heiman and Muller (2000) look at the effect of competition on the length of the trial period and usage restrictions and show that competition tends to increase the duration and quality of the trial version. Gaudeul (2003) looks at the economics of shareware in both monopolistic and competitive markets. On a closely related subject, Lerner and Tirole (2000) make a preliminary exploration of the economics of open source software and investigate the motivation of programmers and commercial software companies’ open source strategies. Schmidt and Schnitzer (2002) analyze the differences between proprietary software and open source software with respect to economies of scale, network effects, and switching costs, and they discuss the economic merits of direct or indirect governmental support for open source projects. Although a lot of shareware developers are not very concerned with monetary rewards and are motivated by the very same reasons that motivate freeware and open source software developers (Holzgrafe 2005), in this study, we shall only focus on the role of shareware as a marketing strategy to increase the firm’s future profit.

The most relevant piece of work to the current study is Chellappa and Shivendu’s (2005), which investigates the possibility of using shareware to mitigate piracy in the context of versioning and identifies the conditions under which the offering of shareware is optimal. The managerial insights sought in the current paper are fundamentally different, and our model setup is also notably different from theirs: instead of using shareware to mitigate piracy, we investigate the optimal shareware strategy in the presence of piracy, which is assumed to be a given market condition, i.e., out of the control of the firm. While we do not assume that the firm offers different versions of the legal software, we study other important issues including brand premium, piracy costs, and pirated software quality, and their implications for the marketing practices of software developers.

Aversion to Uncertainty

People are generally averse to risks and uncertainty. Grossman (1981) shows that consumers with rational expectations will assume that the monopolist offers the worst possible quality consistent with his disclosure when he makes less than full disclosure. Thus, it is sometimes of interest to the firm to disclose information about their products to the consumers prior to their purchase decisions. Firms employ various marketing activities to eliminate uncertainty faced by consumers, e.g. brokerage houses provide seminars and reports to potential buyers, free samples of food items can be found at promotional counters in supermarkets, and new releases of video games can be tried at department stores. Firms invest in these strategies in the hope that they can help generate longer term profits.

There are quite a number of analytical studies on marketing strategies for reducing uncertainty. When disclosure of information is used to facilitate price discrimination, Lewis and Sappington (1994) show that in a variety of settings, it is best that either buyers are supplied with the best available knowledge or that no information is supplied at all. Cremer’s study (1994) on discounts on repeated buying shows that the practice of this marketing strategy can be explained by a model in which a monopolist sells a good, and the buyers are uncertain of their taste for the product but not of the quality of the product per se. Che (1996) studies the rationale for customer return policies by focusing on the uncertainty faced by consumers and shows that the firm adopts the return policy when consumers are highly risk averse. In this study, we look at how the quality of shareware can be used to control the consumer’s uncertainty level to maximize the firm’s profit.

Piracy

Although software is a relatively new form of intellectual property compared to literature, it is protected under the same copyright laws. However, due to the ease of duplicating a piece of software, software piracy is particularly prevalent. On average, the software industry loses about US$11 to US$12 billion in revenue to piracy annually. A little less than half comes from Asia, where China, Vietnam, and Indonesia are the biggest offenders. Piracy losses in Western Europe range from US$2.5 to US$3 billion, while losses in North America are around US$2 billion annually (SIIA 2005).
There has been substantial research on piracy in information systems, business ethics and organizational management. A number of potential predictors of piracy have been found, including perceptions of authority figures' approval or disapproval (Christensen and Eining (1991), software prices (Cheng et al. 1997, Harrington 1989), and presence of profit motive (Leventhal et al. 1992, Wong 1995). Hinduja (2003) shows that pirates rationalize their illegal behavior by blaming the relatively high prices of software or faulting the greedy profiteering motives of software corporations. Perceiving the situation and circumstances this way unbridles the individual from any ethical harnesses, freeing him or her to participate in the activity. Other proponents of piracy argue that software creators who fail to implement copy protection schemes actually deserve to have those vulnerabilities exploited or cracked. Finally, culture also plays a role in piracy behaviors (Gopal and Sanders 1998).

Analytical research on piracy can also be found in the literature. From the social planner’s perspective, Banerjee (2003) shows that welfare maximization may or may not result in monitoring as the socially optimal outcome. Chen and Png (2003) show that increases in detection affect welfare more negatively than price cuts and that tax is welfare superior to fines in copyright enforcement. Gopal and Sanders (1998) show that the government’s incentives to enact and enforce copyright laws are closely related to the size of the domestic software industry. From the firm’s perspective, Takeyama (1994), Slive and Bernhardt (1998), and Shy and Thisse (1999) suggest that it might be profitable for the firm to allow limited piracy to exist in the market. The general argument is that piracy increases the network size, which has a positive effect on the value of the software. Chaves and Deroian (2004) explain the benefits of piracy to the firm by learning costs. Gopal and Sanders (1998) analyze the use of strategic alliances between local and foreign software publishers to combat piracy. Bae and Choi (2003) consider two different types of piracy costs: the reproduction cost and the degradation cost, and show that the effects of piracy depend crucially on the nature of the piracy costs.

More recently, Sundararajan (2004) analyzes the optimal pricing scheme and digital rights protection in the presence of piracy. He shows that vertical price discrimination can lead to a lower level of digital rights protection, which in turn increases the total surplus. Jaisingh (2004) studies the effect of digital rights protection on the profitability of recording companies when consumers have the choice of pirating from file-sharing networks. According to him, the disutility associated with digital rights protection on legal copies would decrease revenue in the absence of network effects. Interestingly, in the presence of network effects, none-zero protection become optimal. His results are opposite to what was found in previous research and highlight the importance of considering consumer disutility that results from digital rights protection.

Although the existing literature has provided us with understanding and intuition about the relationship between piracy and full version software, little is known about its effect on shareware. This study analyzes this relationship and provides important business implications to marketing strategists in the software and computer games industry.

**Model and Analysis**

In this study, consumers have different tastes located on the Hotelling model as shown in Figure 3. The firm’s product is fixed and is assumed to be located at 0, but the consumers do not know about this before they have experienced the product.

![Figure 3. Consumer Taste on a Hotelling Model](image)

Consumers also have different demand for quality. Typically the marginal unity of quality is assumed to be decreasing. However, for simplicity, we assume that the utility from quality is piecewise linear, as shown in Figure 4. A consumer has a demand for the quality of the product $q_c$. Below this desired level of quality, every unit of
improvement in quality is valued equally. When the need is met, further improvement in quality is not valued. Therefore, mathematically, we assume that utility is given by

\[
v(q, q_c) = \begin{cases} 
q & q \leq q_c \\
q_c & q > q_c 
\end{cases}
\]

**Figure 4. Utility from Quality**

The Base Model

A consumer’s willingness to pay for the product is given by

\[
v(q, q_c) = |y - x|
\]

where \( q \) denotes the quality of the product, \( y \) the location of the firm’s product, and \( x \) the consumer’s taste. In the base model, we assume that information on the quality and style of the product can be obtained from newsgroups and PC or games magazines. We also assume that the consumer trusts these sources completely, i.e., zero aversion to uncertainty.

There are two stages in the model. In the first stage, the firm decides the level of information revealed to the consumers. A shareware version closer to the full version reveals a higher level of information. Denote the quality of the shareware to be \( q_s \), where \( q_s \leq Q \) and \( Q \) is the quality of the full version. Without loss of generality, we normalize the total number of consumers in the market to 1. We assume that consumer heterogeneity in taste is uniformly distributed over 0 and \( X \), where \( X \) is the highest possible distance in consumer taste. We also assume that consumer heterogeneity in demand for quality (\( q_c \)) is uniformly distributed over 0 and \( Q \), so, \( v(Q, q_c) = q_c \) for consumers. In other words, we analyze the case in which the firm’s full version is of high quality such that, ignoring the distance in taste and the price, all consumers would buy it. We do not look at the possibility that the full version may not be satisfactory to some of the consumers because we wish to focus on the relationships between shareware quality, uncertainty, and piracy.

In the first stage, all consumers would try the shareware. The firm would earn no money. In the second stage, the indifference curves for different types of consumers defined by \( q_c \) and \( x \) are as shown in the Table 1; details of the
derivations for these indifference curves are explained in detail in the Appendix. Figure 5 shows the indifference curves graphically. Without loss of generalizability, we assume that \( Q = 1 \) and \( X = 1 \).²

<table>
<thead>
<tr>
<th>( q_c &gt; q_s )</th>
<th>( q_c &lt; q_s )</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR: ( q_c \geq x + a )</td>
<td>IR: ( x \leq q_s )</td>
</tr>
<tr>
<td>IC: ( q_c \geq q_s + a_2 )</td>
<td>IC: ( q_c \leq q_s + a_2 )</td>
</tr>
<tr>
<td>Full Version User</td>
<td>Liteware User</td>
</tr>
<tr>
<td>Liteware User</td>
<td>Non-user</td>
</tr>
</tbody>
</table>

Table 1. Indifference Curves for the Base Model

\[ \Pi_2 = a_2 \times \text{Area (Subscriber)} \]
\[ = \frac{a_2}{2} (q_s + 1 - a_2) (1 - q_s - a_2) \]
\[ = \frac{a_2}{2} \left[ (1 - a_2)^2 - q_s^2 \right] \]

Equation (1) suggests that, when there is no aversion to uncertainty, it is best to set \( q_s = 0 \).

**Proposition 1.** Without aversion to uncertainty, it is optimal NOT to offer a liteware version.

² Different ratios of \( X/Q \) will change the equilibrium slightly. However, the general qualitative argument should not be affected.
The optimal full version price and the profit can be easily found to be

\[ a_2^* = \frac{1}{3} \]

\[ \Pi_2^* = \frac{2}{27} \]

The solution shows the optimal proportion of consumers the firm includes as its customer base. Even for those who find that the software product fits their tastes perfectly, one-third of them are not willing to pay for it at the optimal price. For those who find the fit less satisfactory, an even higher proportion of them are not willing to pay for the full version. In total, approximately 22% of all the consumers in the market become full version buyers.

**Aversion to Uncertainty**

In Gaudeul’s (2003) model, it is assumed that people value the product less favorably when they do not know much about the product. To incorporate this into our model, we assume that, in Stage 1, the shareware allows consumers to find out the fit of the software in taste, but since some capabilities have been disabled in the shareware, the consumers can only guess the full version quality. This assumption is consistent with Cremer (1994). We further assume that consumers discount the full version quality according to the level of uncertainty they face. This assumption is applicable to liteware for which limited functions do not prevent the consumer from accurately evaluating the fitness of taste (thus, no discounting along the taste dimension). For example, the trial version of a DVD ripper may only allow the user to rip 50% of a DVD. By using the trial version, the user can have perfect understanding of the style of interaction with the software (the taste dimension), but the user may be not be certain about the speed of ripping the entire DVD, the ease of conversion to different video formats, the level of the technical support provided by the firm (including notification of software updates), documentation, and other factors that determine the quality of a software product (Kan, Basili and Shapiro 1994).

We model uncertainty to be \( u = k(1 - q_s) \), as shown in Figure 6. We interpret \( k \) as the negative of trust or distrust toward the software developer. A small \( k \) indicates that the market generally trusts the quality of the products produced by the software developer, while a large \( k \) indicates a general distrust. For the sake of convenience, we define trust \( t = 1 - k \).

![Figure 6. Uncertainty versus Shareware Quality](image_url)
Define the estimated quality of the full version by the consumers as $\tilde{Q}$ which is the actual quality discounted by uncertainty level after experiencing the shareware, and it is given by\(^3\)
\[ \tilde{Q} = Q - uQ = 1 - k(1 - q_s) \]

Note that our treatment of uncertainty-related risk aversion in this paper is different from the notion of risk aversion in classical economics. Risk aversion refers to a consumer's preference for less risky alternatives. Here, uncertainty-related risk aversion refers to the pessimistic evaluation of a product by the consumer due to uncertainty.

Now, in Stage 2, the indifference curves become as shown in Table 2 (Please refer to the Appendix for the derivations). They are graphically presented in Figure 7.

### Table 2. Indifference Curves for the Uncertainty Aversion Model

<table>
<thead>
<tr>
<th>$Q &gt; q_c &gt; \tilde{Q}$</th>
<th>$r\tilde{Q} &gt; q_c &gt; q_s$</th>
<th>$q_c &lt; q_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x \leq \tilde{Q} - a_2$</td>
<td>IR: $q_c \geq x + a_2$</td>
<td>IR: $x \leq q_c$</td>
</tr>
<tr>
<td>IC: $q_c \geq q_c + a_2$</td>
<td>IC: $q_c \leq q_c + a_2$</td>
<td>Non-user</td>
</tr>
</tbody>
</table>

**Figure 7. Indifference Curves for Uncertainty Aversion Model**

\(^3\) To be consistent with Grossman (1981) that consumers tend to be pessimistic about the expected quality of a new product, our model assumes that $\tilde{Q}$ is a function of $Q$ so that it can never exceed $Q$. One could argue that overestimation of the full version quality should also be allowed, and a possible model for this is $\tilde{Q} = (1 + t)q_c$, where the consumer expect the full version quality to be better than the shareware quality by a factor of $1 + t$. We have actually analyzed this possibility and found that only the quantities in the solution are affected, while the propositions (based on comparative statics) are unaffected. (This is not surprising, because the directions of the relations between $\tilde{Q}$ and $t$ and $\tilde{Q}$ and $q_s$ in both models are the same.) To be consistent with Grossman (1981), we decide to model expected full version quality to be $\tilde{Q} = Q - uQ$ in this paper.
The firm’s profit function is

\[ \Pi_2 = a_2 \times \text{Area (Full Version Users)} \]

\[ = a_2 \left[ \frac{1}{2} (q_s + 1 - a_2)(1 - q_s - a_2) - \frac{1}{2} (1 - Q)(1 - a_2 - Q + a_2) \right] \]

\[ = \frac{a_2}{2} \left[ (1 - a_2)^2 - q_s^2 - k^2 (1 - q_s)^2 \right] \] (2)

Now, the optimal value for \( q_s \) is not obvious. We maximize profit with respect to \( q_s \) and \( a_2 \) to find

\[ q_s^* = k^2 \frac{1}{1 + k^2} = \frac{(1 - t)^2}{1 + (1 - t)^2} \]

We can see that \( q_s^* \) increases in \( k \). In terms of trust, \( t \), we have

**Proposition 2.** The optimal quality of the shareware decreases with consumer’s trust toward the software developer, and it decreases in an increasing rate.

The optimal full version price and profit are found to be

\[ a_2^* = \frac{2 + 2k^2 - \sqrt{1 + 5k^2 + 4k^4}}{3(1 + k^2)} \]

and

\[ \Pi_2^* = \frac{\left( 2 + 2k^2 - \sqrt{1 + 5k^2 + 4k^4} \right) \left( 1 - 2k^2 + \sqrt{1 + 5k^2 + 4k^4} \right)}{27(1 + k^2)^2} \]

In terms of trust \( t \), it is easy to prove that

**Proposition 3.** When there is no piracy, the optimal full version price, \( a_2^* \), and profit, \( \Pi_2^* \), both increase with the trustworthiness of the software developer or publisher.

Proposition 3 is intuitive. It is well-known that branded goods are more expensive and profitable than no frills goods. Figure 8 graphically shows the equilibrium quantities with respect to trust \( t \).
Piracy

Piracy is common in the software industry, and shareware is particularly vulnerable to piracy because it is possible for the user to unlock full version capabilities using crackers. In this section, we look at how piracy affects shareware decisions.

Jaisingh (2004) describes in detail why pirated software is of lower quality than the official software. Pirates may not be able to receive technical support from the software developer. They are also deprived of the right to receive patches and upgrades for the software. We assume here that the expected pirated software quality is discounted by a factor of $r$ compared to the expected full version quality, i.e., its quality is expected to be $r\hat{Q}$. Jaisingh (2004) also describes the cost of pirating, which may include the cost of searching for crackers and key generators in the context of shareware piracy. It is denoted as $g$ and it is a one time cost. We also assume that $g < a_2$. In this piracy model, all consumers are allowed to pirate. Although individuals have to pay an ethical cost when they pirate, for simplicity, we ignore this effect. We take a pessimistic view that all consumers are “unethical” software users if pirating provides them the highest positive surplus. The surplus an individual receives from pirating is

$$v(r\hat{Q}, q_c) - x - g$$

In Stage 2, the indifference curves are as shown in Table 3 (Please refer to the Appendix for the derivations). They are graphically presented in Figure 9.

<table>
<thead>
<tr>
<th>$Q &gt; q_c &gt; \hat{Q}$</th>
<th>$\hat{Q} &gt; q_c &gt; r\hat{Q}$</th>
<th>$\hat{Q} &gt; q_c &gt; q_s$</th>
<th>$q_c &lt; q_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x \leq \hat{Q} - a_2$</td>
<td>$x &lt; r\hat{Q} - g$</td>
<td>$x \leq q_c$</td>
<td>$x \leq q_c$</td>
</tr>
<tr>
<td>IR: $q_c \geq x + a_2$</td>
<td>IR: $q_c \geq x + g$</td>
<td>IC: $q_c \geq q_s + g$</td>
<td>IC: $q_c \geq q_s + g$</td>
</tr>
<tr>
<td>IC: $q_c \geq r\hat{Q} + a_2 - g$</td>
<td>IR: $x \leq q_c$</td>
<td>IC: $q_c \geq q_s + g$</td>
<td>IC: $q_c \geq q_s + g$</td>
</tr>
</tbody>
</table>

Table 3. Indifference Curves for the Piracy Model

(Assumed: $a_2 \geq g$)
The firm’s profit function is given by

\[
\Pi_s = a_s \times \text{Area (Full Version Users)}
= a_s \left[ \frac{1}{2} (\tilde{Q} - a_2 + r\tilde{Q} - g) (\tilde{Q} - r\tilde{Q} - a_2 + g) - (1 - \tilde{Q}) (\tilde{Q} - a_2) \right]
= \frac{a_s}{2} \left[ (\tilde{Q} - a_2)^2 - (r\tilde{Q} - g)^2 - 2(1 - \tilde{Q}) (\tilde{Q} - a_2) \right]
\]

Maximizing with respect to \( \tilde{Q} \) and \( a_s \), the optimal expected quality of the full version is found to be

\[
\tilde{Q}^* = \frac{1 + gr}{1 + r^2}
\]

\[
\therefore \ q_c^* = 1 - \frac{1}{k} \left( \frac{1 + gr}{1 + r^2} \right)
\]

We can see that the relation in Proposition 2 still holds. In addition, the optimal quality of the shareware, \( q_s^* \), increases with the cost of pirating, \( g \). From Figure 9, we can see that \( r > g \), and so, \( \tilde{Q}^* \) decreases with \( r \). This implies that the optimal quality of the shareware, \( q_s^* \), decreases when the expected quality of the pirated software, \( r\tilde{Q}^* \), increases.

The result above suggests that if the firm makes it difficult for the consumers to pirate, then it can increase the optimal quality of the shareware. If we look at Figure 9, again, an increase in \( g \) reduces Area(Pirates), because fewer people find the pirated software more attractive than the official full version. With fewer people pirating, the firm finds more room to increase the shareware quality to raise the expected full version quality \( \tilde{Q} \). The result also suggests that if the pirated copy is of high quality compared to the official full version, then it has to decrease the
shareware quality. Figure 9 shows that increase in pirated software quality increases Area(Pirates), so the firm lowers \( q_s^* \) to try to reduce Area(Pirates).

The optimal full version price is

\[
a^* = \frac{2}{3} \left( \frac{4r^2 - 6gr + 1 + 3g^2}{1 + r^2} \right)
\]

Substituting \( a^* \) and \( Q^* \) back into Equation (3), we can see that

**Proposition 4.** Both the optimal full version price, \( a^* \), and profit, \( \Pi^* \), are NOT dependent on consumers’ trust toward the software developer.

Proposition 4 might seem counterintuitive. Mathematically, if we look at the objective functions for the cases with and without piracy, i.e., Equation (2) and Equation (3), we find that Equation (3) can be expressed entirely in terms of \( Q^* \) alone, while Equation (2) cannot. Therefore, the solution to the maximization of Equation (3) gives \( Q^* \) and \( a^* \) expressed in terms of \( r \) and \( g \) only. Intuitively this result is driven by the fact that the official full version is now competing with the pirated version, which is in generally only slightly inferior but much cheaper. The firm now cannot charge consumers based on the expected quality of the full version alone; instead, it has to charge relative to the utility provided by the pirated software.

Given that \( r > g \), it is not hard to show that both the full version price, \( a^* \), and profit, \( \Pi^* \), increase with the cost of pirating, \( g \), and decrease with the expected quality of the pirated software \( rQ^* \). This result is intuitive: if the firm makes it difficult for the consumers to pirate, the firm can raise the full version price and earn more profit because the pirated software is now less competitive. By similar argument, if the expected quality of the pirated software is high, it becomes more competitive, and the firm has to lower the full version price and at the same time loses some business to the pirated software.

**Business Implications**

**Do not offer shareware if the consumers are certain about the quality of the software product**

Proposition 1 shows that when there is no uncertainty, the firm is always better off not to offer shareware. The result implies that if the consumers are already familiar with the product, the firm should not offer shareware. Therefore, the liteware of the latest version of the software should be directed toward non-users of the software instead of existing users.

**Established firms can afford to offer lower quality shareware**

In a world without piracy, when a firm offers a completely new software or game, the optimal shareware quality is negatively related to trustworthiness of the software developer. A software developer that consumers find trustworthy can afford to produce lower quality shareware. For example, the value of massively multiplayer online games (MMOG) comes mainly from interaction with other gamers online, instead of the software itself. In order to play on one of the game servers, the user has to pay the software developer or publisher a subscription fee regularly. The issue of piracy is less relevant. (In fact, a lot of online game developers distribute the game software freely.) In the MMOG market, we can find that popular games such as Disney’s Toontown Online and Linden Lab’s Second Life provide only limited functions for their trial versions, whereas less popular games provide full capabilities in their trial versions.
Invest in digital rights management in shareware

Jaisingh (2004) has shown that it is not optimal to add digital protection in the official full version software in the absence of network externalities because such protection introduces disutility to the ethical users. However, adding protection to the shareware will not introduce such disutility to ethical users who actually use the full version. Our results suggest that firms should invest in digital rights management for shareware to increase the cost of pirating. This way, the firm not only earns more profit but can also increase the quality of the shareware and allow consumers to evaluate the product more completely.

Increase relative quality of the official full version compared to the pirated software

We found that profit increases with the relative quality of the official full version compared to pirated software. One way to achieve this is provide additional value-added services to the official full version users. Perhaps Microsoft does not regularly supply updates and patches of Windows to official users with this motivation; however, it is achieving the same purpose. With so many Microsoft conspiracy theories circulating on the Internet⁴, the business benefit of offering free Windows updates is obvious.

Piracy eliminates brand premium

We also found that without piracy, more trustworthy developers can charge a higher price and earn more profit. This result is intuitive. On the other hand, in a world where every potential user is unethical, trustworthy developers can still afford to offer lower shareware quality, but they can no longer charge a brand premium, nor can they be more profitable than less known developers. While the real world probably lies between our no-piracy model and our piracy model, the fact that piracy undermines brand premium should still hold true. It is not surprising to see that established firms are the ones who are the most keen to fight piracy.

Conclusion

Software is an experience good, and consumers generally have very diverse preferences. Those who are not familiar to a new software product often exhibit uncertainty aversion in their adoption decisions. As broadband services penetrate the market, there is a growing interest in using shareware strategically. Because software piracy is common and because the design of a shareware version is often vulnerable to piracy through the use of crackers, it is important to understand how piracy affects shareware decisions. This study looks at the interrelationships among uncertainty, piracy, shareware quality, and pricing.

We find that when piracy is not severe, a developer’s trustworthiness decreases the optimal quality and increases the full version price and profit. However, when piracy is prevalent, even though trustworthiness continues allows the firm to lower shareware quality, it no longer provides any advantage in pricing or profitability. Our results make good contribution in theorizing shareware economics, an area that has not been much examined. These results are also very relevant to the software industry and provide useful guidelines in devising shareware-related strategies.

We identify here a number of future research directions. First, closely related to liteware quality is the length of the trial period. Future studies should look at how length of the trial period is affected by uncertainty and piracy. A combined strategy of liteware, trial period, and other shareware restrictions, should also be analyzed. Second, our study ignores competitive effects in the industry. Competition is especially more intense in games and entertainment software, where software standards are not as important as in application software. Third, there are a lot of future research opportunities to empirically test the propositions developed in this paper or otherwise, because shareware is a new area of research and has not been well understood by academia and practitioners. Finally, we should in the future investigate the effect of network externalities on the optimal shareware strategy given its close relationship with piracy.

⁴ Just type “windows update conspiracy” in Google.
References

Hadley, B. “You need to get into the shareware business; here are 20 must-have, pre-entry tips,” 2003, http://www.davetalks.com


Appendix

Indifference Curves for the Base Model

In Stage 2, a consumer with \( q_c > q_s \) (i.e., \( v(Q,q_c) = q_c \) and \( v(q_s,q_c) = q_s \)) would buy the product if

\[
IR: v(Q,q_c) - x - a_2 \geq 0
\]

\[
q_c \geq x + a_2
\]

\[
IC: v(Q,q_c) - x - a_2 \geq v(q_s,q_c) - x
\]

\[
q_c \geq q_s + a_2
\]

where \( a_2 \) is the full version price; otherwise, she would continue using the shareware if
IR: \( v(q_s, q^*_s) - x \geq 0 \)
\[ x \leq q_s \]

IC: \( v(Q, q^*_s) - x - a_2 \leq v(q_s, q^*_s) - x \)
\[ q^*_s \leq q_s + a_2 \]

A consumer with \( q^*_c < q_s \) (i.e., \( v(q_s, q^*_c) = q^*_c \)) would be satisfied with the shareware quality and continue to use it if

IR: \( v(q_s, q^*_s) - x \geq 0 \)
\[ x \leq q_c \]

while the rest of the consumers would not buy the full version or continue to use the shareware.

**Indifference Curves for the Uncertainty Aversion Model**

A consumer with \( Q > q^*_s > q_s \) (i.e., \( v(Q, q^*_s) = q^*_s \) and \( v(q_s, q^*_s) = q^*_s \)) would buy the product if

IR: \( v(Q, q^*_s) - x - a_2 \geq 0 \)
\[ q^*_s \geq x + a_2 \]

IC: \( v(Q, q^*_s) - x - a_2 \geq v(q_s, q^*_s) - x \)
\[ q^*_s \geq q_s + a_2 \]

Otherwise, she would continue using the shareware if

IR: \( v(q_s, q^*_s) - x \geq 0 \)
\[ x \leq q_s \]

IC: \( v(Q, q^*_s) - x - a_2 \leq v(q_s, q^*_s) - x \)
\[ q^*_s \leq q_s + a_2 \]

A consumer with \( q^*_c < q_s \) (i.e., \( v(q_s, q^*_c) = q^*_c \)) would be satisfied with the shareware quality and continue to use it (Teemas 2004) if

IR: \( v(q_s, q^*_s) \geq 0 \)
\[ x \leq q_c \]

Since the consumers expects the full version to be lower than \( Q \), consumers with \( Q > q^*_s > \tilde{Q} \) (i.e., \( v(\tilde{Q}, q^*_c) = \tilde{Q} \)) believe that the full version will NOT be up to a standard they demand. Nonetheless, if the taste difference is not that great, there might still be surplus purchasing the full version. They will buy the full version if

IR: \( v(\tilde{Q}, q^*_s) - x - a_2 \geq 0 \)
\[ x \leq \tilde{Q} - a_2 \]

**Indifference Curves for the Piracy Model**

A consumer with \( q^*_c < q_s \) (i.e., \( v(q_s, q^*_c) = q^*_c \)) would be satisfied with the shareware quality and continue to use it if
IR: \( v(q_s, q_e) - x \geq 0 \)
\[ x \leq q_e \]

A consumer with \( rQ > q_e > q_s \) (i.e., \( v(q_s, q_e) = q_e \) and \( v(rQ, q_e) = q_e \)) would pirate the product if

\[
\text{IR : } v(rQ, q_e) - x - g \geq 0 \\
q_e \geq x + g \\
\text{IC 1: } v(rQ, q_e) - x - g \geq v(q_s, q_e) - x \\
q_e \geq q_s + g \\
\text{IC 2: } v(rQ, q_e) - x - g \geq v(q_s, q_e) - x - a_z \\
a_z \geq g
\]

Otherwise, the consumer would continue using the shareware if

\[
\text{IR : } v(q_s, q_e) - x \geq 0 \\
x \leq q_s
\]

We assume that IC 2 in the above is always satisfied, which is a realistic assumption because full version price is normally greater than the cost of pirating.

A consumer with \( Q > q_e > rQ \) (i.e., \( v(rQ, q_e) = rQ \) and \( v(Q, q_e) = q_e \)) would buy the full version if

\[
\text{IR : } v(Q, q_e) - x - a_z \geq 0 \\
q_e \geq x + a_z \\
\text{IC: } v(Q, q_e) - x - a_z \geq v(rQ, q_e) - x - g \\
q_e \geq rQ + a_z - g
\]

Otherwise, the consumer will pirate the software if

\[
\text{IR: } v(rQ, q_e) - g - x > 0 \\
x < rQ - g
\]

Note that we don’t need to worry about the IC between the full version and the shareware because the pirated version is always a better option than the shareware to the unethical user. In order to make sure that positive number of customers buy the official full version, the IC suggests that

\[
Q \geq rQ + a_z - g \\
Q - a_z \geq rQ - g
\]

Otherwise, in our pessimistic model where all consumers are unethical, no one would find the full version more attractive.

A consumer with \( Q > q_e > Q \) (i.e., \( v(Q, q_e) = Q \)) will buy the full version if

\[
v(Q, q_e) - x - a_z \geq 0 \\
x \leq Q - a_z
\]