Decision Support Systems 48 (2009) 14–22

Contents lists available at ScienceDirect

Decision Support Systems

journal homepage: www.elsevier.com/locate/dss

Sampling of information goods ☆

Chong (Alex) Wang *, Xiaoquan (Michael) Zhang

Hong Kong University of Science and Technology, Hong Kong SAR, China

ARTICLE INFO

Available online 19 May 2009

Keywords:
Advertising
Digital information goods
Free sample
Information technology

ABSTRACT

As one of the most commonly utilized marketing tools, free sampling also has its online presence, especially for information goods. In this article, we provide an analytical model to study the economic rationale behind free online samples. We argue that with the development of technologies, a "free sample" is less and less under control of the seller. We find that this trend does not always hurt the seller. Under certain circumstances, the monopolist can be better off with the presence of the free samples provided by third parties. Further, we argue that the decreasing search costs for free samples threaten the effectiveness of advertising.

1. Introduction

Consumers face uncertainty about a product's value if they have not used it before. Free samples are the most direct way to reduce consumers' uncertainty about a product by enabling them to have a personal experience with it. Free samples have long been widely used as an effective product promotional tool, especially for new products. As recorded by Bawa and Shoemaker [6], a 1997 poll in the United Kingdom indicated that 84% of the adults had experienced some form of free sampling in the previous 6 months. In 1995, 85% of the manufacturers of packaged goods engaged in product sampling as part of their promotional mix, and sampling accounted for 10% of the manufacturers' consumer promotion budget [44]. Various dimensions of free-sampling effects have been identified and investigated by marketing researchers [7,25,27,42]. In the context of Internet shopping, Cases [14] shows that sampling ranks high among all risk-reduction strategies considered.

Information goods is defined as products that are valued mostly because of the information carried, for example, magazines, software, music, videos, books, etc. Most information goods are also experience goods whose true value cannot be revealed to the consumer until they can be consumed [34]. For information goods, free sampling is even more helpful for consumers to make good choices. Consumers need "real experience" with a product (information good) before they can reasonably evaluate its value. Advertising is less effective in generating this "real experience." And claims about experience are often questionable [52].

Facilitated by advances in information technologies, firms, especially firms providing digital information goods in electronic marketplace, have more flexibility in implementing free sample promotions. For example, the MP3 format of digital music allows individuals to sample music before they purchase. Information goods consumers are experiencing a shift in consumption model from "buy and try" to "try and buy." Various samples are now available on the Internet in order for consumers to get personal experiences. Online music radio stations are readily accessible whenever and wherever an Internet connection is available. Music videos can be played before you click the buy button in online music stores. Movie trailers are no longer exclusively for televisions and theaters. And with a golden membership of Xbox Live, game players can download HALO 3 preview version as long as their consoles are connected to the Internet.

Besides lowering the cost of sampling promotions, the development of the Internet also makes free sampling less controllable. Traditionally, free samples have been provided by product manufacturers or retailers who can then decide when, where, how and to whom the samples are provided. However, for information goods, these controlling rights are eroding in a way that samples can be accessed through diverse ways over the Internet. With digital information goods, broadband penetration and the availability of online communication tools, everyone can become a source of free samples. Once an information product is released, the producer effectively has no control over the samples available to consumers. While RIAA continues its litigation campaign against file-sharing of copyrighted digital contents, companies are trying to gain from the emerging opportunity of consumer sampling.[1] For example, commercial movie trailers and music TVs are always among the top viewed on YouTube.com. With Microsoft's new digital music device, ZUNE, one can share music with friends through a wireless connection. Seattle-

☆ We thank Chris Dellarocas, Jungpil Hahn, Karl Lang, Tom Lee, Eric Walden, Chuck Wood, three anonymous referees and participants of the International Conference on Electronic Commerce (ICEC) 2007 for valuable comments. We are responsible for any errors.

* Corresponding author.
E-mail addresses: alexwch@ust.hk (C. Wang), zhang@ust.hk (X. Zhang).

[1] Consumer sampling in this work means consumer searching for free samples, rather than sampling of consumers.

0167-9236/$ – see front matter © 2009 Elsevier B.V. All rights reserved.
doi:10.1016/j.dss.2009.05.011

based rock band, Harvey Danger, released their newest album *Little by Little* for free as MP3 files. And the online music store, Amiestreet (http://amiestreet.com/), start at a price of zero for downloads.

Despite its importance for both firms and consumers, surprisingly little theoretical work has been done to investigate the economic rationale behind firms' initiating free sample promotions. To our knowledge, there has been no analytical model dealing with the controllability issues of free samples, which as we argue, is one of the major changes that information technology developments bring to the market of information goods.

Our research is different from, although related to, previous research about piracy of digital goods. Research in information goods piracy has identified "trying out" as one of the reasons of consumers' involvement in piracy [15,16,39,40]. This literature points out that some piracy could be prevented by legitimate means of "trying out." In our context, "trying out" is a form of free sampling. In our model, samples, unlike pirated versions of digital goods, cannot be substitutes for the purchased goods, from which consumers obtain utility. In addition, free samples in our context may be provided by the seller as well as by any third-party entity. We recognize that the simplification on substitution effect renders the model not being able to fully represent the market reality where consumers have access to freely available substitutes (the pirated versions). However, we benefit from clarity and tractability. By restraining from discussing pirated information goods, we can focus our attention on the issues of sampling product information and non-controllable free sampling.

Our contribution to the literature is twofold. First, we provide an analytical model for the economics behind free sample promotion considering the controllability of samples, and its impact on firms' pricing strategy. The model helps us better understand the properties of information goods and the differences between physical and digital markets. In light of the various changes in market condition brought by the Internet and information technology, this research contributes to the research stream on economics and electronic commerce [30]. Second, strategic insights are generated to help the information goods provider better respond to the changing technology context in electronic market places.

The rest of the paper is organized as follows. Section 2 gives a brief review of related literature. In Section 3, we set up a model to analyze a firm's sampling strategy. In Section 4, the model is extended to include advertising strategy. Section 5 concludes.

2. Literature review

For the music industry, new technology standards and file-sharing likely have reshaped the equilibrium supply. It is one of the contexts where our theory may apply. Empirical works have been carried out to measure how the development of file-sharing may have an impact on the industry [10,32,36,49]. Peitz and Waelbroeck [38] review traditional distribution of music and discuss the challenges and opportunities brought about by digitization of music. Bockstedt et al. [11] propose a model for digital music value chain, highlighting changes in the market structure from the perspective of the players in the music industry. Gapol et al. [21] find, with a model in which consumers use shared music as a tool to get information, that a consumer's incentive to sample is closely related to the value of the item. They show sampling may threaten the phenomenon of the superstars.

One directly related branch of literature concerns about free sample promotions. However, little economic work has been done to explain sampling on sales and price decisions, as pointed out by Liebowitz [32]. Jain et al. [29] present a theoretical work concerning sample promotion with a modified Bass Model [5] to investigate the relationship between sampling level and adoption pattern. Heiman et al. [26] propose an analytical model to derive the optimal sampling strategy. In their model, sampling effect is decomposed into a long-run effect (goodwill building) and a short-run effect (immediate sale). They conclude that although incentive to sample will decline over the life-cycle of the product, it may continue for mature products. The equilibrium sale and goodwill are positively correlated with the effectiveness of the samples. They also show that the short-term loss of sampling cost can be justified by long-term goodwill building. The model assumes exogenous product price and treats free sample promotion as a kind of advertising with the potential to induce immediate consumption for conventional physical goods. Bawa and Robert [6] propose a model of free sampling and conduct two field experiments on free samples. They divide consumers into three groups, *prior triers* who have purchased the subject brand prior to the free sample promotion; *likely triers* who have never purchased the subject brand but may take a trial use if no free sample is provided; and *non-triers* who would never make a first purchase if they could not try it for free. It is claimed that, for the *likely triers*, the "cannibalization effect" will decrease the paid trial purchase; and for *non-triers*, an "acceleration effect" will occur. In the experiments reported there, a significant long-term effect over demand is identified. Although this model does not give an economic explanation for the effects identified, it is one of the first to show that free samples can be highly effective in increasing sales over a long period of time. Sun [48] discusses the problem of when firms should provide free trials. In her paper, the product is characterized by two features, vertical quality and horizontal suitability. And cases where information is available in different dimensions are discussed.

Our approach is different from these studies in several ways. First, we focus on the information goods for which cost of providing samples is significantly lowered with digitization. More importantly, we discuss how firms should respond to their diminishing control over samples of information goods due to the development of the Internet and other communication technologies. Note that, for physical non-durable goods, revenue comes from repeat purchases. Sampling promotion aims at bringing new customers into the purchasing cycle. However, for information goods, the main purpose of sampling is to reduce uncertainty for consumers. Second, unlike Heiman et al. [26], we focus on the information transferred by samples to consumers rather than from other people's positive feelings or the buyers' immediate impulse. And we discuss the economic rationale behind informative role played by free samples. This informative role of free samples is extremely important for information goods. Consumers are naturally heterogeneous in their tastes for information goods. Most often, the value can only be assessed after trying the product. We shall not discuss the long-term effect on subsequent purchasing, even though such an effect may well exist for information goods. Third, we treat samples as a strategic tool that can influence firms' decision on price, that is, we discuss pricing and sampling strategy endogenously and simultaneously.

With the development of enabling technologies, consumer sampling is getting harder and harder to control. It is often argued that file-sharing enabled piracy is one of the most important threats that the Internet has brought about to the information goods industries. According to RIAA, the music industry has reported a 29% shrink in CD sales since the year 2000, with online file-sharing often quoted as the reason. And industry statistics shows that revenue loss due to piracy in software industry is over 50% of the total revenue in 1999 [45].

Extensive studies of online file-sharing and piracy of information goods have been carried out. Peitz and Waelbroeck [39] provide a critical review for the literature concerning piracy of digital goods. Several interesting effects of piracy on demand are discussed in their review. The most related sub-branch of piracy literature contains those examining the sampling effect. Cheng et al. [16] find that an important reason why consumers pirate is the need to "try out." Peitz and Waelbroeck [39] note that piracy plays two contravening roles in this aspect. The positive role is as information transmitter which reduces the cost for the copyright owner, and the negative role is as a

cheaper substitution which will reduce the revenue. Peitz and Waelbroeck [37] construct a unit circle model to investigate the effect of file-sharing as a tool for consumers to get explicit information about suitability. In their model, searching for shared or pirated music enables the consumer to choose the most suitable product. The firm, which produces the N goods simultaneously, makes the decision whether to advertise in order to eliminate the incentive for consumers to search. They argue that the original copy can provide additional value which is proportional to the consumers' utility of consumption. Chellappa and Shivendu [15] investigate a pricing model for digital experience goods in a vertically segmented market with pirated goods functioning partly for transmitting information about the product. They also consider providing samples and show that sampling is optimal only under very restrictive conditions.

This article benefits a great deal from the insights generated in the literature of information goods piracy. However, we are not investigating piracy *per se* [28]. Free samples in our context can take various forms other than illegal copies, such as online broadcasts, customized online radio, movie clips and so on. In our framework, free samples provide information, and we do not allow them to be substitutes for a good. As noted in the introduction, by restricting our attention, we benefit in the clarity in discussing information transformation and consumer sampling, neither of which has been analytically examined in IS research. A unique feature in out paper is the emphasis on the non-controllability of free samples of digital information goods, which in our view, is a major differentiating factor to separate information goods from physical goods.

Our paper also relates to the discussion about versioning of information goods [43,50]. It is a common practice that information goods manufacturers provide different versions of the products at different prices to take advantage of product differentiation. While controlled free samples in our paper can be treated as free versions of the goods, we investigate the role of free samples as an information source rather than instruments of price discrimination. Further, our main goal is to investigate how non-controllable samples influence the profitability of information goods manufacturers.

While we borrow liberally from the marketing and economics literature for insights to address the issues, the research question is an important IS one. This paper builds on the stream of literature that Kauffman and Walden [30] refer to as the difference between physical and digital markets. As pointed out by [8], some of the problems that restrict the use of new technologies are rooted in the use of conventional market mechanisms to distribute them. In this study, we explicitly distinguish the conventional and digital market mechanisms and investigate the role of free samples (especially non-controllable ones) in electronic marketplaces. Related to this stream of literature, other IS researchers have looked at questions like product variety in electronic markets [12], transparency of online selling mechanism [23], online review systems and their influence on differentiation [17,18], and intellectual property rights allocation in outsourcing relationships [51], etc. Also, closely related to our setting, Bhattacharjee et al. [9] empirically examine the effect of music sharing. And Aron et al. [3] study pricing and customization issues specific in digital markets.

3. A model for free sample promotion

We consider a profit-maximizing monopolist selling a single information good. The marginal cost for additional copies of the good can be neglected in the model. A monopolistic model is suitable for this context, as information goods are mostly experience goods for which product differentiation creates some monopoly power. Any fixed cost associated with product introduction is assumed sunk.

The monopolist is facing a market composed of two types of consumers: optimistic and pessimistic. One interpretation for this categorization is that consumers are different in their set of product information. Bawa and Robert [6] divide consumers into two general categories: those with previous knowledge about the product (*prior trier* and *likely trier* in their paper) and those without (*non-trier*). For information goods, consumers are assumed to have unit demand. This assumption rules out the case of *prior triers*. However, consumers still possess different product information. Superior information can be obtained from past experience or knowledge from other sources like word-of-mouth. As for music, information may be obtained from songs produced by the same musician, or from radio/Internet promotion. Another interpretation is that consumers are always heterogeneous with respect to their attitude towards uncertainty. In our model, we deal with this consumer heterogeneity by dividing them into *optimistic consumers* and *pessimistic consumers*.[2] Another way to interpret our categorization lies in the modern economic theory concerning consumers' choice under uncertainty. Most of the time when making consumption decisions, consumers face not only the risk of uncertain outcomes (which is represented by a distribution of possible outcomes) but also of incomplete knowledge about the characteristics of the risk itself (or ambiguity, which is represented by the uncertainty about the underlying probability space). Facing ambiguous information, pessimistic consumers tend to behave in a safer way by holding low expectations. That is, in addition to the traditional risk aversion, consumers behave in an ambiguity-averse way. In the economics literature, when making decisions under incomplete information or uncertainty, Gilboa and Schmeidler [22] show that when consumers face ambiguity, they will base their choice on the worst scenario outcomes (see also [13]). Inspired by their results, we believe the two interpretations we have made above are consistent with each other. Consumers with more information tend to be more confident in their decision and tend to have more optimistic expectations, while consumers with less information tend to have lower expectations.

Assume that each consumer has unit demand and the true value obtained from purchasing the goods follows uniform distribution on $[0,v]$ which is common knowledge to all market participants. In our model, optimistic consumers hold unbiased expectations about the value obtained from the good. Their reserve value for the product is $\frac{v}{2}$. Although pessimistic consumers have the knowledge about value distribution, they hold a reserve value of zero (they look at the worst case scenario and believe that any unknown music has no value to them). Total population of the consumer is assumed to be one, we use α to denote the proportion of the pessimistic consumer in the market. α could be interpreted as a measure of market level confidence determined not only by information accessibility of the product but also by macro-level factors [19].

Consumers can get precise information through sampling. Free sampling is either provided by the monopolist or can be obtained through a search by the consumer with cost s (for example, listening to online music, or playing the trial version of a game). We assume that once the monopolist decides to provide free samples to the consumers, all the consumers can get the sample at cost $s=0$, and all the consumers will take the trial before making a decision. We also assume that the monopolist incurs some cost $c\geq 0$ to issue the samples.[3] After sampling, the product's true value is fully revealed, which, as assumed, follows uniform distribution on interval 0 to v, $U[0,v]$.

3.1. Baseline model: controlled free sample

We begin the study by considering the case when free sampling is not available through a search if not provided by the monopolist; or

[2] It may be helpful to think of *pessimistic consumers* as infinitely risk averse, while *optimistic consumers* as risk neutral.

[3] In the rest of this paper, for exposition simplicity, we take c as zero, and it does not alter the result.

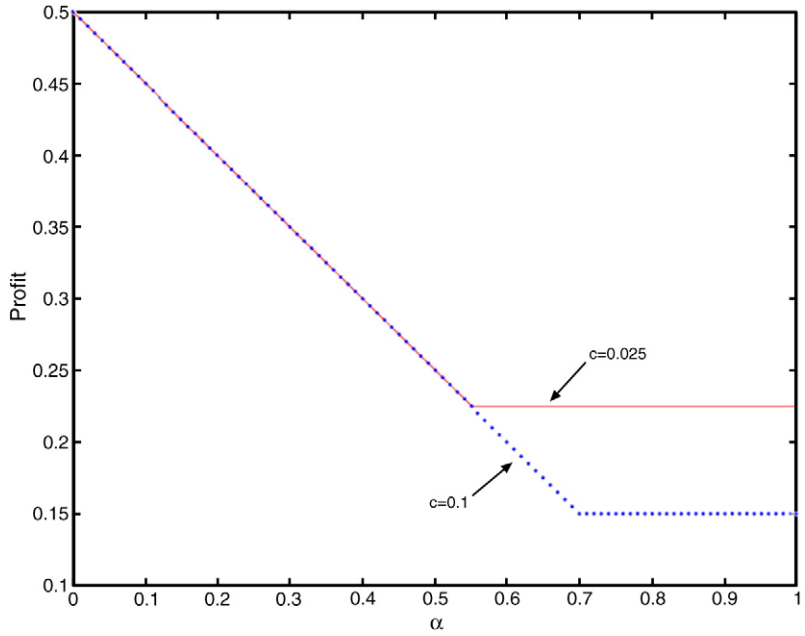

Fig. 1. Monopoly profit under different free sample implementation costs.

equivalently, assume that search cost s is so large that no consumer has the incentive to search for free samples on the Internet.[4] Under this assumption, free sampling is a strategic tool controlled by the monopolist. This setting was more or less the situation before the information era. Before the Internet explosion, information goods had been confined within physical forms, such as compact disks, video tapes, or the paper on which books are printed. Sources of free sampling were limited to friends, libraries and book/music stores. Search costs for specific titles are very high. Since we assume that pessimistic consumers hold a reserve value of zero, if the monopolist decides not to provide free samples to the consumers, she will only cater to the optimistic buyers and set a monopoly price of $p = \frac{v}{2}$ and enjoy a profit of $\frac{v}{2}(1-\alpha)$.

Alternatively, the monopolist can issue a free sample with cost c. In this case, the free sample is available to all consumers at zero search cost, and all consumers will try the product. After the sample is issued, the monopolist faces a demand of $D(p) = 1 - \frac{p}{v}$. Her profit function is $\pi(p,v) = p - \frac{p^3}{v} - c$, which is maximized at $p^* = \frac{v}{2}$, and we have $\pi(p^*|v) = \frac{v}{4} - c$. Fig. 1 illustrates the monopoly profits under different free sample implementation costs. Note that, in Fig. 1, α denotes the proportion of pessimistic consumers in the market. And we set $v=1$ in all figures. In the figure, when the optimistic consumers represent the majority of the market (when α is low), the monopolist will not issue samples and will just enjoy the monopoly profit from the optimistic consumers. As the proportion of pessimistic consumers increase, economic rationale for the monopolist to provide free sample emerges (right hand side of the figure).

Proposition 1. *For the information good, the monopolist will not provide a free sample if the majority of consumers are optimistic. The propensity of providing free samples is further weakened if free sample promotions are costly to implement.*

The intuition for Proposition 1 is straightforward. When a large portion of potential buyers are optimistic about the product performance, there is no incentive for the seller to provide exact information about the product by issuing samples. In reality, if big labels have well established consumer confidence in product performance, then there is little incentive for them to implement free sample promotion to provide precise product information to the consumers. At the same time, niche products target consumers with more obscure expectations and less confidence in product quality. If the cost for providing free samples is sufficiently low, niche producers will provide trial without hesitations.

3.2. When samples cannot be controlled

The consumers in the Internet age are blessed with an explosive increase in the variety of information goods available, and a significant decrease in search costs.[5] At the same time, free samples for information goods are more and more out of the control of the producers due to the fact that the cost of issuing free samples over the Internet is going toward zero.[6] For almost any piece of music, through a quick search in Google, one has a good chance of finding some trial version. Information technology is enabling consumers to search for free online samples more easily in a more diversified product space with or without the producers liking it or not.

Facing the increased choice diversity in information goods and the decreased search costs, consumers have more incentives to search for free online samples than ever before. In this paper, the incentive is given by the expected gain from sampling. Intuitively, sampling can prevent high expectation consumers (optimists) from making a bad choice, and at the same time enable the low expectation consumers (pessimists) to gain from a good choice that would not have been possible without sampling. In this model, the incentive of the consumers to search and experience the free sample is given as follows.

$$E[\text{gain from sampling–buying}] = \int_0^p \frac{1}{v}(p-x)dx = \frac{p^2}{2v}$$
$$E[\text{gain from sampling–not buying}] = \int_0^p \frac{1}{v}(x-p)dx = \frac{p^2}{2v} + \frac{1}{2}(v-2p) \quad (1)$$

Again, for the consumers who are buying without sampling, the benefit is derived from preventing potential loss of buying a good at a

[4] One extreme case is when search cost exceeds the maximum value of the consumers, that is, when $s>v$.

[5] Rhapsody has an inventory of over 1.5 million music tracks. Netflix offers over 55,000 DVD titles. And at Amazon, 3.7 million book titles are ready for you to choose.

[6] In the following parts of the model, we assume that $c=0$. Deviation from this assumption does not influence the results.

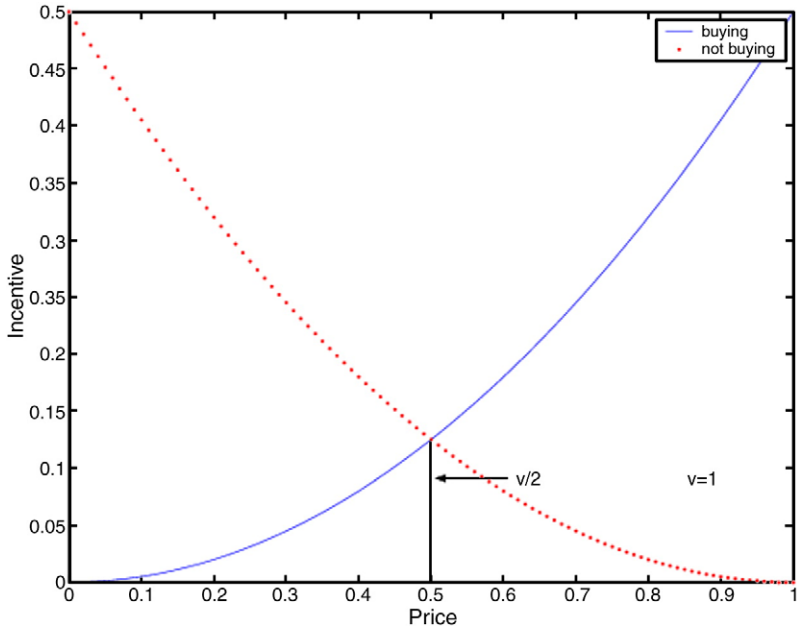

Fig. 2. The incentive of sampling.

price higher than its value; while for the consumers who are not buying without sampling, benefit is derived from not buying at a good price. Fig. 2 depicts the incentives given in Eq. (1). From the figure, we can see that the non-buying consumers have greater incentive for sampling when the price charged by the monopolist is lower than $\frac{v}{2}$. People are more eager to seek information when they feel that they are missing some good bargain or they feel that they are likely to be cheated.

One direct result following the incentive calculation is that the monopolist has no incentive to charge a price higher than $\frac{v}{2}$. When the price is higher than $\frac{v}{2}$, the current buyers (before sampling) have higher incentive to search for free samples. If the consumers who purchase the good do not sample, neither will the consumers who do not purchase the good. At this price there will be no demand since the highest price the monopolist can charge the consumers who are not sampling is $\frac{v}{2}$. If the purchasing consumer samples the good, then the optimal price to charge will be $\frac{v}{2}$. The monopolist will be better off if she provides a free sample given that doing this is at no cost to her. If all consumers sample the good, the optimal price is $\frac{v}{2}$.

In the remainder of this section, we consider two types of strategic responses to the monopolist facing non-controllable free sampling. Specifically, in the *pooling equilibrium*, the monopolist sets the price at $\frac{v}{2}$, while in the *separating equilibrium*, she takes advantage of the free online samples and tries to enlarge her demand by adjusting the price.

3.2.1. Pooling equilibrium

As discussed in Section 3.1, when the portion of optimistic consumers $(1-\alpha)$ is relatively low, the firm will provide free samples to attract pessimistic consumers and charge the optimal price of $p = \frac{v}{2}$. All the consumers will sample, and those with reserve value higher than p will buy the product.

When the optimistic consumers represent a relatively large proportion, the firm has less incentive to provide precise product information. However, when the consumers can search for free online samples, and if the monopolist ignores the existence of the free samples and charges $p = \frac{v}{2}$ expecting the optimistic consumers to buy, we can see from Eq. (1) that the optimistic and the pessimistic consumers will have the same incentive to search. If s is sufficiently low (when $s \leq \frac{v}{8}$), both types of consumer will search for online samples, just as in the case when the monopolist decided to provide the sample herself. In the case when more than 50% of consumers are optimistic, the availability of free online samples would prevent the monopolist from taking advantage of the ambiguous information. The maximum profit she can enjoy is $\frac{v^2}{4}$ no matter how large the proportion of the optimistic consumers $(1-\alpha)$ is.[7]

3.2.2. Separating equilibrium

Aware of the existence of free samples, the monopolist may take advantage of them to attract the pessimistic consumers who are not purchasing without sampling, thereby improving the demand. From Eq. (1) we can see if $p < \frac{v}{2}$ and $\frac{p^2}{2v} \leq s \leq \frac{p^2}{2v} + \frac{1}{2}(v-2p)$, that is, the pessimistic consumers have incentives to sample while the optimistic ones do not.[8] The profit for the monopolist charging p is

$$\pi(p|\alpha, v) = (1-\alpha)p + \alpha p\left(1 - \frac{p}{v}\right) \tag{2}$$

which is maximized at $\frac{v}{2\alpha} > \frac{v}{2}$. Therefore given s, in equilibrium, the monopolist will charge the price

$$p = \begin{cases} \sqrt{2vs} \text{ if } s < \dfrac{1}{8}v \\ v - \sqrt{2vs} \text{ if } s \geq \dfrac{1}{8}v \end{cases}. \tag{3}$$

The profit is then given by

$$\pi^* = \begin{cases} \sqrt{2vs} - 2\alpha s \text{ if } s < \dfrac{1}{8}v \\ (1-\alpha)v - (1-2\alpha)\sqrt{2vs} - 2 \text{ if } s \geq \dfrac{1}{8}v \end{cases} \tag{4}$$

Eq. (4) generates two important insights. First, note that in the pooling equilibrium case, when $s < \frac{1}{8}v$, if the monopolist charges the monopoly price $\frac{v}{2}$, both types of consumer will sample and leave the monopolist with profit $\frac{v}{4}$. We can show that if there is no significant

[7] Even when this is the case, the firm may not pursue a separating equilibrium. The intuition here is that to separate consumers with price screening, the monopolist must lower its price. Sometimes the drop in price is so significant due to high search costs that it no longer makes economic sense (see Fig. 3 Region 1). We thank Eric Walden for advice on making this point clear.

[8] For this to happen, the search cost must be in the triangular region depicted in the left hand side of Fig. 2. If not, the market equilibrium will be such that the monopolist charges $p = \frac{v}{2}$.

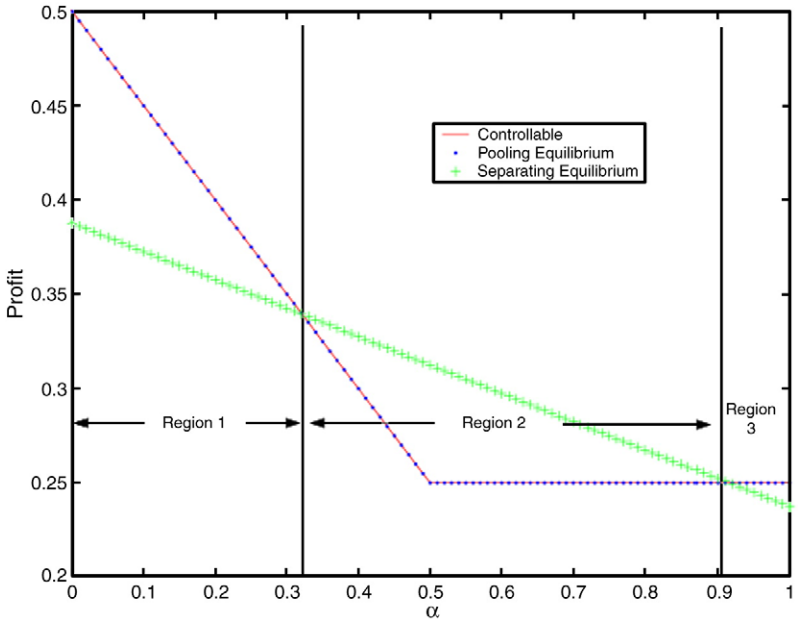

Fig. 3. Comparison of profits I, $s = \frac{3}{16}v$.

proportion of pessimistic consumers, say less than $\frac{1}{4}$, the optimal strategy for the monopolist is to lower the price to persuade the optimistic consumers to buy without sampling, while at the same time give the pessimistic consumers higher incentives for searching for free online samples. Second, if the sampling cost is not very low, then the monopolist may take advantage of the availability of the free samples on the Internet by lowering the price.

Figs. 3 and 4 illustrate the monopoly profit under the three cases: the baseline case (controllable), the pooling equilibrium, and the separating equilibrium.[9] From the figures we can see that

- In Region 1, when search cost is high (Fig. 3), the monopolist will not try to encourage a pessimistic consumer to search. Since the majority of the consumers hold optimistic expectations and they are not trying to sample, enlarging demand by lowering price becomes too costly for the monopolist. When search cost is low (Fig. 4), it is critical to prevent the optimistic consumers from sampling. Therefore, the optimal reaction of the monopolist is to lower its price. In this case, the availability of free samples hurts the monopolist's profit.
- In Region 2, the monopolist will always be better off if the samples are available at a reasonable cost for the consumers to search. However, the intuitions behind these two figures are different. In Fig. 3, the purpose of the lowering price is to give incentives for the pessimistic consumers to sample the product. In contrast, in Fig. 4, the purpose is to prevent optimistic consumers from sampling.
- In Region 3, the market is dominated by the pessimistic consumers. It is of no value to differentiate consumers with lowered price. The optimal strategy for the monopolist is therefore to issue samples and enjoy the revenue from the consumers who highly value the product.

The analysis above gives the following proposition.

Proposition 2. *When free samples are available for consumers through searching, the monopolist should strategically lower the price to accommodate consumer searching. Online sampling is not always beneficial or harmful to the monopolist. When search cost is sufficiently low, the monopolist is forced to lower the price in order to prevent optimistic consumers from searching for free samples. When search cost is not that low, the monopolist may enjoy increased demand resulting from consumers searching for free samples.*

Proposition 2 suggests that the producers of information goods should act strategically when facing the challenge presented by increased availability of free samples brought about by Information Technology development. Industries for information goods hold conflicting attitudes towards free sampling over the Internet. From the analysis given above, we show that increased free sample availability does hurt the producers when the market condition favors ambiguous information, high search cost for free samples and a high proportion of optimistic consumers. Our analysis also points out that when potential consumers are relatively pessimistic, producers can benefit from the availability of free samples. While not good news to the big labels, increased availability of free online samples does present opportunities for information goods providers without that halo to increase sales.

4. Advertising strategy with consumer sampling

Advertising is probably one of the most commonly utilized and heavily invested marketing strategies. The interaction between advertisements and product sales has been intensively discussed in the literature (see [4] for a summary). In the following section of this paper, we extend our model to include advertising as a tool to manipulate consumer expectations. We would like to examine how the advertising strategies should be changed when consumers are more and more able to obtain information from free samples.

In the economics literature, three effects of advertising have been identified. Advertising is either *informative*, *persuasive*, *complementary*, or all the three. Empirically, spending on advertising has been directly linked to sales increases [20,24,41]. However, it is not clear how advertising is doing its job. Is advertising informative in helping consumers make more informed choices, or is it persuasive in nature and increases sales without adding material information? Ackerberg [1,2] proposes two different approaches in order to empirically distinguish between the informative and persuasive effects of advertising. One of his findings is that after consumers try out a product, they are less likely to be influenced by the advertisement. A few experiments have been carried out to investigate the mutual influence between product trial and advertising [31,33,46,47]. In all these studies, advertising consistently becomes less effective after the consumers take the trial. What happened is that after the product

[9] In Fig. 3, the line for baseline case and pooling equilibrium are identical. The reason is that with high sampling cost, consumers have no incentive to search for free samples.

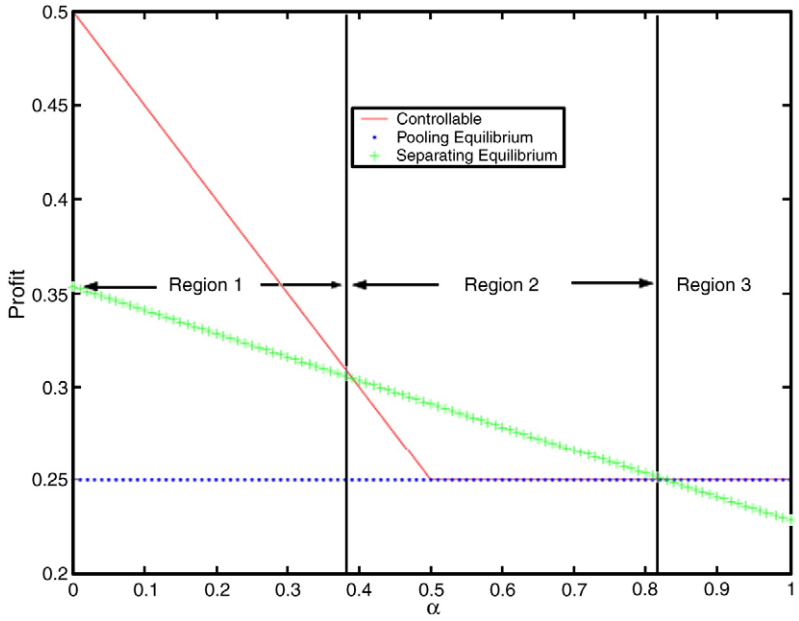

Fig. 4. Comparison of profits II, $s = \frac{1}{16}v$.

trials, consumers are more certain about the value of the product, and advertising is less useful in their decision process.

In this paper we assume that advertising can alter, through creating positive bias in expectation, consumers' expectations before sampling. That is, the optimistic consumers' expectations become $\frac{1}{2}v + B(S_{ad})$, and the pessimistic consumers' expectations become $B(S_{ad})$, where $B(S_{ad})$ is a concave increasing function of advertising spending S_{ad}. After sampling or purchasing, the real value is revealed to the consumers which, still as in the case with no advertisement, follows the uniform distribution, $U[0,v]$. For simplicity, we implicitly assume that advertising has the same effect on both the pessimistic and optimistic consumer. One interpretation for our model is that we are actually modeling pure combative advertising, which adds no material information for consumers. Nelson [35] makes the distinction between search and experience product attributes. For information goods, experience attributes, which are more efficiently communicated by direct experience, are more related to tastes. Advertisements for information goods are more persuasive in the sense that less information can be transferred to help consumers evaluate product value through advertising. Further, although consumers know the distribution of the product value, they are inclined to believe that the product is a closer fit than before after being exposed to advertising. After the sampling, consumers obtain the precise value of the product, and the value is independent of the advertising spending by the monopolist. An implicit assumption here is that advertising does not enter into the consumers' utility function.

For mathematical tractability, we further assume that both optimistic and pessimistic consumers' reserve value is altered by the same amount with a quadratic cost function, $S_{ad} = kB^2$, with k representing average effectiveness of advertising in manipulating the consumers' expectations (how much more a consumer is willing to pay per dollar spent on advertising).[10] Similar to Section 3, we first add advertising to the baseline model and then discuss the case when free sampling is available through consumer search.

4.1. Controllable free sampling and advertising

When consumer expectations (or reserve value) can be manipulated by the monopolist with advertising, the monopolist will choose the optimal advertising spending to maximize profit. Under our assumptions, the reserve value becomes $\frac{1}{2}v + B(S_{ad})$ and $B(S_{ad})$ for the optimistic and pessimistic consumers, respectively. Advertising cost is kB^2. The profit function becomes

$$\pi(B;v) = \begin{cases} (1-\alpha)\left(\frac{1}{2}v + B\right) - kB^2 \text{ if } p = \frac{1}{2}v + B \\ B - kB^2 \text{ if } p = B \end{cases}.$$

Maximizing this profit function with respect to B gives

$$\max_B \pi(B;v) = \begin{cases} \frac{1}{2}(1-\alpha)v - \frac{(1-\alpha)^2}{4k} \text{ if } p = \frac{1}{2}v + B \text{ and } B = \frac{(1-\alpha)}{2k} \\ \frac{1}{4k} \text{ if } p = B \text{ and } B = \frac{1}{2k} \end{cases} \quad (5)$$

By our assumption, the consumers will try the product before purchasing if free sampling is provided by the monopolist. Apparently, advertising is not efficient in the case where the monopolist decides to provide free samples. No matter how much the monopolist invests in advertising, she will end up with the same demand. So again, if the monopolist decides to provide free samples in the market, she will charge the price $p = \frac{v}{2}$ and earn a profit of $\frac{v}{4}$.

Let π_{High}, π_{Both} and π_{Sample} denote the maximum profit under optimal pricing strategy with respect to serving only the optimistic consumers, serving all consumers, and issuing free samples, respectively. The profit for the first two cases is shown in Eq. (5). The profit associated with issuing free samples is $\frac{v}{4}$. Given k and v,

- when $(1-\alpha) \geq \sqrt{(kv)^2 + kv} - kv$, $\pi_{High} \geq \pi_{Sample}$;
- when $(1-\alpha) \geq \sqrt{(kv)^2 + 1} - kv$, $\pi_{High} \geq \pi_{Both}$;
- and when $kv \geq \sqrt{(kv)^2 + kv} - kv$, $\pi_{Sample} \geq \pi_{Both}$.

The value of kv determine the relative value of these critical values. When advertising is efficient in altering consumers' expectations (in our case, $kv \ll 1$), it is optimal for the monopolist to use advertising to manipulate the market and to serve the pessimistic consumers, and the monopolist will not be willing to provide free samples. When advertising is not efficient ($kv > 1$), issuing free samples is the most

[10] Although more general functional forms may work as well, we believe that the intuition generated remains the same.

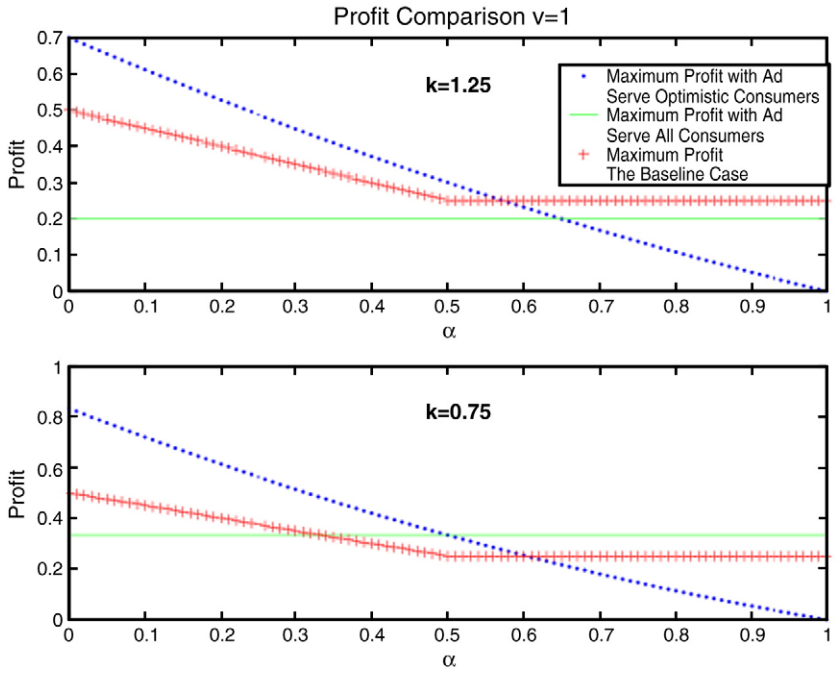

Fig. 5. Profit with advertising and free sample.

direct way to convey product information to pessimistic consumers. This is further strengthened when the cost of issuing free samples gets smaller. In traditional consumer goods markets, where free sample promotion is costly to implement with limited exposure to consumers, a free sample promotion may not be as effective in attracting consumers as in our context. As a result, advertising should always focus on the optimistic consumers. The best way to attract the pessimistic consumers is to issue free samples. The critical value of α for the monopolist to issue sample is less than $\frac{v}{2}$ which is the critical value when advertising is not considered in Section 3.1. This means that the monopolist will have less incentive to provide free samples given that she can alter consumers' expectations with advertising. Fig. 5 illustrates the above discussion, and we summarize the results in the following proposition.

Proposition 3. *Given better capability to manipulate consumers' expectations with advertising, the monopolist is more reluctant to issue free samples. When advertising is efficient in altering consumers' expectations, it may be optimal to alter the expectations of pessimistic consumers and serve them. In this case free samples are never issued by the monopolist. When advertising is not efficient, advertising is focused on optimistic consumers. Free samples are provided by the monopolist more strictly than when advertising is considered.*

4.2. Non-controllable free sampling and advertising

When free samples are accessible through Internet search, the monopolist is less likely to benefit from manipulating consumer expectations. To see this, consider the incentive of sampling given by Eq. (1). If the monopolist tries to sell the product at a price higher than $\frac{v}{2}$, the consumers who are buying the product will have higher incentives to sample. Once the price is larger than $\sqrt{2vs}$, the buying consumers will sample. Combining this fact with the optimal advertising strategy given by Eq. (5), for the case where the monopolist tries to sell to optimistic consumers at a higher price, if the proportion of the optimistic consumers is large (the upper left part of the curve), the monopolist may not be able to charge the optimal price. Further, if the search cost is sufficiently low $s < \frac{v}{8}$, the buying consumers are going to sample even when the price is set to $\frac{v}{2}$, which is the optimal price when advertising is not considered. In this case, it does not make sense for the monopolist to use advertising. When the consumers can seek free samples at relatively low cost, expectation manipulation becomes so costly since it cannot help the monopolist ask for a better price. As the search cost approaches zero, the monopolist is forced to accept the profit of $\frac{v^2}{4}$.

Proposition 4. *With the availability of non-controllable samples, the effectiveness of advertising targeted toward consumer expectation manipulation is significantly limited. If the search cost for free samples is sufficiently low, the monopolist no longer wants to manipulate consumer expectations.*

5. Conclusion and discussion

In this article, we provide an analytical model to study the economic rationale for a monopolist to provide free samples for information goods. We investigate the case when free samples are accessible through Internet search at some cost to the consumers. The optimal strategic response for the monopolist facing Internet sampling is discussed. We find that under some market conditions (market not too optimistic, search cost for free samples not too low, initiating sampling promotion costly), the monopolist can actually benefit from consumer searching for samples. We further extend our discussion to include advertising as a tool for consumer expectation management. We find that the effectiveness of advertising is weakened given the opportunity of consumer searching for free samples.

Several managerial insights are generated from the model discussion. First, in the baseline model, we show that when sampling for information goods can be controlled by the provider, it is optimal for the monopolist facing a pessimistic market condition (we use this term to refer to the market condition where pessimistic consumers are the majority) to consider issuing free samples as a way to draw more consumers' attention, especially when cost for providing free samples is low, which is typically the case for information goods. Second, we show that although the existence of non-controllable sampling with consumer search may reduce profit under some market conditions, if treated strategically (with pricing decision based on the availability of free samples), it can increase the monopoly profit, especially when search cost for free samples is low relative to the price charged. This result suggests that the monopolist would enjoy gains if she could strategically take advantage of the increasing accessibility of free samples over the Internet, a strategy

already adopted by some artists, such as Harvey Danger. Third, we show that with the existence of non-controllable free samples, persuasive advertising is significantly limited in its effectiveness to boost profit. The intuition is simple: with the ease of sampling, consumers are going to sample when the price is high. In addition, sampling will eliminate the fascination created by the marketing campaigns.

Our model is only a first step towards a good understanding of changes happening in the market for information goods. The model focuses on a monopolist producer, who experiences market changes brought about by the development of information technologies. It is interesting to analyze the case where competition exists among several sellers for similar information goods, especially when free samples are accessible under consumer search. Our assumption of homogeneous consumers can be relaxed if we allow consumer values to follow different distributions and if advertising has different effects on different types of consumers. Further, with our model setting, we are not able to provide a welfare analysis for free sampling. Such welfare analysis is of both theoretical and practical significance.

To conclude, this study provides an economic analysis for sampling of information goods. The results shed light on the possible strategies a monopolist may consider when free samples are more accessible. Our discussion on the sampling and interactions between sampling and advertising can lead firms to rethink their marketing strategies when the market condition is changing.

References

[1] D.A. Ackerberg, Empirically distinguishing informative and prestige effects of advertising, Rand Journal of Economics 32 (2) (2001).
[2] D.A. Ackerberg, Advertising, learning, and consumer choice in experience good markets: an empirical examination, International Economic Review 44 (3) (2003).
[3] R. Aron, A. Sundararajan, S. Viswanathan, Intelligent agents in electronic markets for information goods: customization, preference revelation and pricing, Decision Support Systems 41 (4) (2007).
[4] K. Bagwell, The Economics of Advertising, Edward Elgar Pub., 2001
[5] F.M. Bass, A new product growth for model consumer durables, Management Science 15 (5) (1969).
[6] K. Bawa, R. Shoemaker, The effects of free sample promotions on incremental brand sales, Marketing Science 23 (3) (2004).
[7] C.O. Bettinger, Dawson, E. Lyndon, H.G. Wales, The impact of free-sample advertising, Journal of Advertising Research 19 (3) (1979).
[8] H.K. Bhargava, R. Krishnan, R. Müller, Decision support on demand: emerging electronic markets for decision technologies, Decision Support Systems 19 (3) (1997).
[9] S. Bhattacharjee, et al., Whatever happened to Payola? An empirical analysis of online music sharing, Decision Support Systems 42 (1) (2006).
[10] D. Blackburn Does file sharing affects record sales? In International Industrial Organization (Chicago, 2004).
[11] J.C. Bockstedt, R.J. Kauffman, F.J. Riggins, The move to artist-led on-line music distribution: a theory-based assessment and prospects for structural changes in the digital music market, International Journal of Electronic Commerce 10 (3) (2006).
[12] E. Brynjolfsson, Y.J.H.M.D. Smith, Consumer surplus in the digital economy: estimating the value of increased product variety at online booksellers, Management Science 49 (11) (2003).
[13] C. Camerer, M. Weber, Recent developments in modeling preferences: uncertainty and ambiguity, Journal of Risk and Uncertainty 5 (4) (1992).
[14] A.-S. Cases, Perceived risk and risk-reduction strategies in internet shopping, international review of retail, Distribution and Consumer Research 12 (4) (2002).
[15] R.K. Chellappa, S. Shivendu, Managing piracy: pricing and sampling strategies for digital experience goods in vertically segmented markets, Information Systems Research 16 (4) (2005).
[16] H.K. Cheng, R.R. Sims, H. Teegen, To purchase or to pirate software: an empirical study, Journal of Management Information Systems 13 (4) (1997).
[17] E.K. Clemons, G. Gao, L.M. Hitt, When online reviews meet hyperdifferentiation: a study of the craft beer industry, Journal of Management Information Systems 23 (2) (2006).
[18] C. Dellarocas, The digitization of word of mouth: promise and challenges of online feedback mechanisms, Management Science 49 (10) (2003).
[19] J. Dominitz, C.F. Manski, How should we measure consumer confidence? Journal of Economic Perspectives 18 (2) (2004).
[20] T. Erdem, M.P. Keane, Decision-making under uncertainty: capturing dynamic brand choice processes in turbulent consumer goods markets, Marketing Science 15 (1) (1996).
[21] R.D. Gapol, S. Bhattacharjee, G.L. Sanders, Do artists benefit from online music sharing? Journal of Business 79 (2006).
[22] I. Gilboa, D. Schmeidler, Maxmin expected utility with non-unique prior, Journal of Mathematical Economics 18 (2) (1989).
[23] N. Granados, A. Gupta, R.J. Kauffman, Designing online selling mechanisms: transparency levels and prices, Decision Support Systems 45 (4) (2008).
[24] P.M. Guadagni, J.D. C., A logit model of brand choice calibrated on scanner data, Marketing Science 2 (3) (1983).
[25] B.C. Hamm, M. Perry, H.F. Wynn, The effect of a free sample on image and attitude, Journal of Advertising Research 9 (4) (1969).
[26] A. Heiman, et al., Learning and forgetting: modeling optimal product sampling over time, Management Science 47 (4) (2001).
[27] J.H. Holmes, John D. Lett, Product sampling and word of mouth, Journal of Advertising Research 17 (5) (1977).
[28] W. Hui, B. Yoo, K.Y. Tam, Economics of shareware: how do uncertainty and piracy affect shareware quality and brand premium? Decision Support Systems 44 (3) (2008).
[29] D. Jain, V. Mahajan, E. Muller, An approach for determining optimal product sampling for the diffusion of a new product, Journal of Product Innovation Management 12 (2) (1995).
[30] R.J. Kauffman, E.A. Walden, Economics and electronic commerce: survey and directions for research, International Journal of Electronic Commerce 5 (4) (2001).
[31] D.S. Kempf, R.E. Smith, Consumer processing of product trial and the influence of prior advertising: a structural modeling approach, Journal of Marketing Research 35 (3) (1998).
[32] S.J. Liebowitz, Pitfalls in measuring the impact of file-sharing on the sound recording market, CESifo Economic Studies 51 (2–3) (2005).
[33] L.J. Marks, M.A. Kamins, The use of product sampling of sequence of exposure and degree of advertising claim exaggeration on consumers' belief strength, belief confidence, and attitudes, Journal of Marketing Research 25 (3) (1988).
[34] P. Nelson, Information and consumer behavior, Journal of Political Economy 78 (2) (1970).
[35] P. Nelson, Advertising as information, Journal of Political Economy 82 (4) (1974).
[36] F. Oberholtzer-Gee, K. Strumpf, The effect of file sharing on record sales: an empirical analysis, Journal of Political Economy 115 (1) (2007).
[37] M. Peitz, P. Waelbroeck File-Sharing, Sampling, and Music Distribution, International University in Germany Working Paper, vol. 26, 2004.
[38] M. Peitz, P. Waelbroeck, An economist's guide to digital music, CESifo Economic Studies 51 (2–3) (2005).
[39] M. Peitz, P. Waelbroeck, Piracy of digital products: a critical review of the theoretical literature, Information Economics and Policy 18 (4) (2006).
[40] M. Peitz, P. Waelbroeck, Why the music industry may gain from free downloading — the role of sampling, International Journal of Industrial Organization 24 (5) (2006).
[41] M.J. Roberts, L. Samuelson, An empirical analysis of dynamic, nonprice competition in an Oligopolistic industry, Rand Journal of Economics 19 (2) (1988).
[42] T. Roselius, Consumer rankings of risk reduction methods, Journal of Marketing 35 (1) (1971).
[43] C. Shapiro, H.R. Varian, Information Rule: A Strategic Guide to the Network Economy, Harvard Business School Press, Boston, Massachusetts, 1999.
[44] K. Shermach, Coupons, in-store promotions motivate consumer purchasing, Marketing News 29 (21) (1995).
[45] S.K. Shin, et al., Global software piracy revisited, Communications of the ACM 47 (1) (2004).
[46] R.E. Smith, Integrating information from advertising and trial: processes and effects on consumer response to product information, Journal of Marketing Research 30 (2) (1993).
[47] R.E. Smith, W.R. Swinyard, Attitude–behavior consistency: the impact of product trial versus advertising, Journal of Marketing Research 20 (3) (1983).
[48] M.J. Sun, When Should Firms Offer Free Trials? Boston University, 2006.
[49] T. Tanaka, Does File Sharing Reduce Music CD Sales?: A Case of Japan, Institute of Innovation Research, Hitotsubashi University, 2004.
[50] H.R. Varian, Versioning Information Goods, 1997.
[51] E.A. Walden, Intellectual property rights and cannibalization in information technology outsourcing contracts, MIS Quarterly 29 (4) (2005).
[52] A.A. Wright, John G. Lynch, Communication effects of advertising versus direct experience when both search and experience attributes are present, Journal of Consumer Research 21 (4) (1995).

Chong (Alex) Wang (alexwch@ust.hk) is currently a PhD candidate of information systems at the School of Business and Management at the Hong Kong University of Science and Technology. His research interests include e-marketing, IT facilitated mass collaboration, and online social communities.

Xiaoquan (Michael) Zhang (zhang@ust.hk) is an assistant professor of management information systems at the School of Business and Management at the Hong Kong University of Science and Technology. He received his Ph.D. at MIT Sloan School of Management. His research interests include pricing of information goods, online reputation systems, online advertising, and economics of social media.