Available online at www.sciencedirect.com
ScienceDirect
Information Economics and Policy 18 (2006) 374–384
INFORMATION ECONOMICS AND POLICY
www.elsevier.com/locate/iep

Publishers, artists, and copyright enforcement

Amit Gayer [a], Oz Shy [a,b,*]

[a] Department of Economics, University of Haifa, Haifa 31905, Israel
[b] WZB – Social Science Research Center Berlin, Reichpietschufer 50, D-10785 Berlin, Germany

Received 27 January 2005; received in revised form 13 March 2006; accepted 16 March 2006
Available online 2 May 2006

Abstract

This paper investigates whether and to what extent there is a conflict of interest between artists and their publishers, regarding to whether and to what degree illegal distributions of their copyrighted recordings should be prevented. This conflict arises because artists also earn their profit from other market activities such as giving live performances, in addition to their share of profits from sales of their copyrighted recordings via the publishers.

JEL classification: L82; K42

Keywords: Piracy; Copyright enforcement; Artists; Publishers; Music industry

1. Introduction

The massive number of highly publicized law suits in the past two years initiated by the Recording Industry Association of America (RIAA) against individuals who downloaded music files via the Internet, and the recent declaration by the Motion Picture Association of America (MPAA) to follow the RIAA massive law suits, raise the question who really benefits and who loses from these litigations. An interesting clue to answer this question, hinting that these law suits may damage artists, comes from a recent survey by the Pew

* Corresponding author.
E-mail addresses: amit_gayer@yahoo.com (A. Gayer), ozshyMail@gmail.com (O. Shy).

0167-6245/$ - see front matter
doi:10.1016/j.infoecopol.2006.03.003

Internet & American Life Project[1] that finds that 43% of paid artists agree that, "file-sharing services are not really bad for artists, since they help to promote and distribute an artist's work to a broad audience". The same survey also found that 37% of all artists and 35% of paid Artists say that file sharing of music and movies should be legal. The purpose of this paper is to investigate whether artists gain or lose from music file sharing and compare it with their publishers' incentives to reduce or eliminate file sharing activities over the Internet.

The economics literature has already characterized situations under which sellers of copyrighted material benefit from some infringement on their intellectual property. In theoretical papers, Conner and Rumelt (1991), Shy and Thisse (1999), and Peitz (2004) demonstrated that strong network externalities imply that a firm's earnings need not be reduced as a result of piracy as long as the demand for legal copies is enhanced with the actual distribution of illegal copies. Other theoretical contributions include Takeyama (1994, 1997), Slive and Bernhardt (1998), Gayer and Shy (2003), and a critical review by Peitz and Waelbroeck (2003). Peitz and Waelbroeck (in press) demonstrate an environment where publishers can enhance their profit by allowing free downloading of digital products, because sampling enhances willingness to pay when it informs the consumers on which product corresponds to their most preferred one. There is also an empirical investigation by Givon et al. (1995) which estimates how the degree in which an increase in illegal usage of software boosts the demand for buying legal copies. Finally, Rob and Waldfogel (2004) and Oberholzer-Gee and Strumpf (2004) empirically demonstrate that a free download does not imply a lost sale.

Caves (2003) analyzes the contractual arrangements in the music industry in terms of the efficient division of risk, incentives, and rewards. Krueger (2005) presents data showing that from 1996 to 2003, concert ticket prices grew much faster than inflation while ticket sales and the number of concerts by star performers have declined. He then provides several theoretical explanations. One explanation attributes this observation to the erosion of complementarities between concerts and album sales because of file sharing and CD copying, and the [somewhat disputed, as he remarks] decline in CD sales due to file sharing.

In all of the above theoretical literature, sellers and copyright owners were *modeled as a single entity*. Whereas this assumption may be appropriate for the software industry, it does not capture the music industry where artists and publishers are different agents. More interestingly, artists and publishers may benefit differently from the network effects generated by the number of those who buy legal copies and those who obtain illegal recordings.

This short paper fills in this gap by explicitly modeling how network effects affect artists and publishers separately. We identify the conditions under which artists and publishers have different incentives regarding to whether to pursue an enforcement of their copyrighted recordings, or whether to allow for piracy. This is captured by assuming that artists earn profit not only from their share in the publishers' profit from sales of recorded media, but also from other market activities such as selling tickets for live performances, getting hired to perform on television and on radio advertising, and even selling ringtones for mobile phones. Now, if the demand for, say, live performances is enhanced by the "popularity" of the artists generated from the number of distributed recordings (legal

[1] See, http://www.pewinternet.org/press_release.asp?r=94, or a New York Times article entitled "Pew File-Sharing Survey Gives a Voice to Artists" by Tom Zeller dated December 6, 2004.

and illegal copies combined), then we obtain the conditions under which publishers of recorded media may lose from piracy, whereas artists may gain from piracy.[2]

Section 2 develops a simple model of an artist and her publisher. Section 3 solves for the equilibrium distribution of legal and illegal recordings and prices when piracy prevails. Section 4 solves for the equilibrium when copyrights are enforced so that piracy is eliminated. Section 5 compares artist's profit and the publisher's profit under piracy to a regime when piracy is prevented. Section 6 discusses our results.

2. A model of musicians and publishers

Consider a market for certain musical recordings marketed on various magnetic and optical media. The products that we have in mind include music performances marketed on compact discs, video cassettes and DVDs showing live performances, all of which consumers can buy and repeatedly play at home. The unit production cost of each unit sold in store, borne by the publisher, is denoted by $c > 0$.

To demonstrate our thesis, we focus on a single musician artist who also sells other services such as live performances in addition to selling her recorded music.

2.1. Consumers: The demand for recorded media

Consumers who wish to obtain these recording have three options: They can buy the recorded medium at a store for the price of p_r. Alternatively, they can make an illegal copy without having to pay for it. Finally, they can choose not to obtain any copy (nonusers in what follows).

Whether or not consumers hold legal or illegal copies, the consumers (users in what follows) benefit from network externalities stemming from the popularity of the artist's recording. More precisely, let N denote the total number of users (legal and illegal combined). Then, each user's utility is enhanced by γN, where $\gamma > 0$ measures the marginal benefit from the network size, N. In other words, consumers gain when more people play the recorded medium due to the common social and other "fashion" popularity effects.

Suppose that all potential users are indexed on the nonnegative real line by $x \in [0, +\infty)$ according to a declining preference for obtaining this recording. The utility function of a consumer indexed by x is given by[3]

$$U_x \stackrel{\text{def}}{=} \begin{cases} \alpha(1-x) + \gamma N - p_r & \text{if buys a legal recording,} \\ \beta(1-x) + \gamma N & \text{if uses a pirated recording,} \\ 0 & \text{does not use this recording.} \end{cases} \tag{1}$$

Observe that for users indexed by $x > 1$, the first part of the utility function (1) is negative reflecting a situation that consumers may be dissatisfied from having to find and to obtain the product, but are still better off obtaining it one way or another to "enjoy" the

[2] We shall be using the example of "live performances" to mean any income generating activity to artists in addition to artists' share in publishers' profits or royalties from the sales of recorded media.

[3] Treating all music records as being subjected to the same bandwagon effect is clearly a limitation of the present model. One possible extension would be to separate the network effects into those generated by pirated copies, $\gamma_{NL} N_{NL}$, and those generated by legal copies, $\gamma_L N_L$, where N_{NL} and N_L are the number of illegal and legal users, respectively.

popularity of this recording. We now make the following assumption regarding the preferences described by (1).

Assumption 1.

(a) Legally- and illegally-obtained recordings are vertically differentiated. Formally, $\alpha > \beta > \gamma > 0$.
(b) The publisher's cost of producing a copy sold to consumers is lower than consumers' additional utility gain associated with buying a legal copy instead of obtaining a pirated copy. Formally, $c < \alpha - \beta$.

Assumption 1(b) is naturally needed as otherwise there cannot be any private or social incentives to justify the production and sale of legal copies. To see why Assumption 1(a) implies vertical differentiation, note that when $p_r = 0$, $\alpha > \beta$ implies that any consumer x would prefer the legal copy over a pirated recording. The intuition behind this assumption is that legal copies are generally both easier to obtain and easier to use. In addition, legal copies could be bundled with some extra features such as lyrics, pictures, and manuals, that cannot be easily copied. The extra benefits from buying a legal copy also include discounts on similar products, and avoiding a punishment and the embarrassment associated with being caught using an illegal copy. Finally, the above restriction on γ to be bounded below the basic utility parameters α and β is always needed in network models to avoid having the number of users approaching $N = \infty$.

2.2. Consumers: The demand for live performances

We assume that consumers' demand for live performances is heavily influenced by the magnitude of distributed recordings, as measured by the combined number of legal and illegal users, N. Denote by p_p the ticket price of a live performance, and by q_p the demand for tickets. We assume that the demand for live performances is linear and takes the form of[4]

$$q_p \stackrel{\text{def}}{=} \max\{\delta N - p_p, 0\}, \tag{2}$$

where the parameter $\delta > 0$ measures the intensity in which the legally- and illegally-distributed recordings affect the popularity of the artist and hence the demand for her live performances. The demand for live performances specification (2) rests on our assumption that live performances and recorded music are complements, due to reputation and advertising effects. Clearly, our argument falls apart if consumers view recorded media as perfect substitutes to live performances. However, the very fact that sales of CDs and DVDs are commonly observed during live performances implies recorded media and live performances are complements for some consumers. In fact, most modern operas and concert halls have stores selling CDs and DVDs of the performing artists and orchestras during the intermissions.

[4] Note that for the sake of simplicity we choose a demand which is linear with respect to the network size. However, one should not rule out some alternative specifications, such as $q_p = \delta N^{\lambda} - p_p$, for $0 < \lambda \leqslant 1$, reflecting diminishing (or constant) network size effects on the part of consumers. This demand specification is analyzed in Appendix A.

Suppose that the artist acts as a monopoly when selling tickets for live performances and bears no production costs. Then, given N, the artist chooses a performance price p_p to maximize $\pi_p = p_p q_p = p_p(\delta N - p_p)$ yielding the price and the profit generated from performances given by

$$p_p = \frac{\delta N}{2} \quad \text{and} \quad \pi_p = (p_p)^2 = \frac{\delta^2 N^2}{4}. \tag{3}$$

Therefore, an increase in the number of distributed recordings, N, increases linearly the ticket price of a live performance, and increases quadratically the artist's profit from performances.

3. Equilibrium sales with piracy

If piracy prevails, the number of users N (the network size) clearly exceeds the number of buyers which we denote by $\hat{x}$. Therefore, these two endogenously-determined variables must be distinguished when used for evaluating utility levels. First note that the second and third rows in (1) imply the utility of a consumer who is indifferent between making an illegal copy and becoming a nonuser is affected only by the total number of users N. Therefore, the number of users is equal to this consumer's indexed variable, so substituting $x = N$ into the second line of (1) implies that the total number of users is uniquely determined by $\beta(1 - N) + \gamma N = 0$. Hence, $N = \beta/(\beta - \gamma)$.

We now turn to buyers. The consumer who is indifferent between buying and making an illegal copy, indexed by $\hat{x}$, is determined by $\alpha(1 - \hat{x}) + \gamma N - p_r = \beta(1 - \hat{x}) + \gamma N$. Substituting for N from the above expression we have it that

$$N = \frac{\beta}{\beta - \gamma} \text{ implies that } \hat{x} = \frac{\alpha - \beta - p_r}{\alpha - \beta}. \tag{4}$$

The top part of Fig. 1 illustrates how consumers are divided among buyers, illegal users, and nonusers, when piracy prevails.

Suppose that the agreement between the publisher and the artist is that the artist is entitled to a share of s $(0 < s < 1)$ of the profit generated from the sales of the recorded medium. Denoting the total profit made from the sales of the recorded medium by π_r, under this agreement $s\pi_r$ is given to the artist, and $(1 - s)\pi_r$ is left for the publisher. Recall that each recorded medium sold in stores costs c to produce. Then, the recording firm (publisher) sets the price of the recorded medium p_r to solve

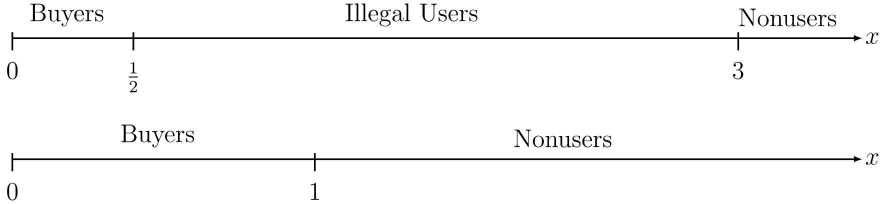

Fig. 1. Top: Consumer allocation in the presence of piracy. Bottom: Consumer allocation in the absence of piracy. *Note*. Exact numbers should be ignored at this stage since they correspond to a numerical example given in Table 1 below.

$$\max_{p_r}(1-s)\pi_r \overset{\text{def}}{=} (1-s)(p_r-c)\hat{x} = (1-s)(p_r-c)\frac{\alpha-\beta-p_r}{\alpha-\beta}, \tag{5}$$

yielding a price, sales of legal copies, and total profit given by

$$p_r = \frac{\alpha-\beta+c}{2}, \quad \hat{x} = \frac{\alpha-\beta-c}{2(\alpha-\beta)}, \quad \text{and} \quad \pi_r = \frac{(\alpha-\beta-c)^2}{4(\alpha-\beta)}. \tag{6}$$

Clearly, in view of the utility function (1), an increase in the difference $\alpha-\beta$ enhances the recording publisher's monopoly power. That is, (6) shows that both the price of a legal recording and the associated profit level rise with an increase in this difference, which is interpreted as the degree of vertical differentiation between legal and illegal copies.

We now turn to the artist whose recordings are sold by the recording publisher. The artist earns profit from two sources: First, from selling tickets for her live performances, as summarized by (3). Second, she earns royalties from the publisher's sales of the recorded medium. Recall that s ($0<s<1$) denotes the artist's share (royalties) from the profit generated from the sales of the recorded medium, given in (6). Substituting the network size N from (4) into (3), the artist's profit is given by

$$\pi_a = \pi_p + s\pi_r = \frac{\beta^2\delta^2}{4(\beta-\gamma)^2} + s\frac{(\alpha-\beta-c)^2}{4(\alpha-\beta)}. \tag{7}$$

The artist's total profit (7) stems from our assumption that the artist's share in profit from sales of recorded media is proportional to π_r, thus assuming away fixed sums of money which are sometimes transferred from publishers to artists. The reason for this omission follows from the observation that often these fixed sums are used as advances against future royalties.[5]

4. Equilibrium when there is no piracy

Suppose that the publisher is able to completely eliminate piracy of the recorded medium. In this case, all users are legal buyers, as illustrated on the bottom part of Fig. 1. That is, when piracy becomes infeasible, the number of users equals the number of buyers, N. In this case, the utility function (1) implies that N is determined by

$$\alpha(1-N) + \gamma N - p_r = 0, \text{ hence } N = \frac{\alpha-p_r}{\alpha-\gamma}. \tag{8}$$

The publisher then chooses a price p_r to solve

$$\max_{p_r}(1-s)\pi_r = (1-s)(p_r-c)N = (1-s)(p_r-c)\frac{\alpha-p_r}{\alpha-\gamma} \tag{9}$$

yielding

$$p_r = \frac{\alpha+c}{2}, \quad N = \frac{\alpha-c}{2(\alpha-\gamma)}, \quad \text{and} \quad \pi_r = \frac{(\alpha-c)^2}{4(\alpha-\gamma)}. \tag{10}$$

[5] Quoting from Caves (2003, p. 79), "The label advances the musician a sum to cover the cost of recording... If one record's royalties fail to cover its advance, the shortfall becomes a charge against records issued subsequently."

Finally, substituting the network size N from (10) into (3), the artist's profit when there is no piracy is given by

$$\pi_a = \pi_p + s\pi_r = \frac{\delta^2(\alpha - c)^2}{16(\alpha - \gamma)^2} + s\frac{(\alpha - c)^2}{4(\alpha - \gamma)}. \tag{11}$$

5. Who gains and who loses from copyright enforcement?

We now turn to our main investigation which is finding the conditions under which the artist and the publisher will have conflicting incentives whether to enforce copyright protection for the purpose of preventing piracy.

5.1. The recording publisher

Comparing the publisher's profit under no-piracy (full copyright enforcement) given in (10), to the profit level when piracy prevails (6), implies that enforcement is profitable to the publisher if and only if

$$(1 - s)\frac{(\alpha - c)^2}{4(\alpha - \gamma)} \geqslant (1 - s)\frac{(\alpha - \beta - c)^2}{4(\alpha - \beta)}. \tag{12}$$

It is important to note that if condition (12) is reversed, piracy enhances the publisher's profit for the same reason as in Conner and Rumelt (1991) and Givon et al. (1995) since piracy enhances the value of the recording via network effects thereby enhancing the demand for legal recordings. Finally, notice that condition (12) must hold when $c = 0$, that is, when recordable media are costless to produce.

5.2. The artist

Turning now to the artist, comparing (11) with (7) implies that piracy enforcement is profitable to the artist if and only if

$$\frac{\delta^2(\alpha - c)^2}{16(\alpha - \gamma)^2} + s\frac{(\alpha - c)^2}{4(\alpha - \gamma)} \geqslant \frac{\beta^2\delta^2}{4(\beta - \gamma)^2} + s\frac{(\alpha - \beta - c)^2}{4(\alpha - \beta)}. \tag{13}$$

We are now ready to state our main result, which is proved in Appendix B.

Result 1. Copyright protection is profitable to the artist as long as the number of distributed recordings does not have a significant impact on the demand for live performances [δ, first used in (2), is small], and/or when the artist's share in profit s is sufficiently large. Formally, this happens if

$$s \geqslant \phi\delta^2, \tag{14}$$

where ϕ satisfies

$$\phi \stackrel{\text{def}}{=} \frac{(\alpha - \beta)[c(c - 2\alpha)(\beta - \gamma)^2 - \alpha^2(3\beta^2 + 2\beta\gamma - \gamma^2) + 8\alpha\beta^2\gamma - 4\beta^2\gamma^2]}{4(\alpha - \gamma)(\beta - \gamma)^2\{c^2(\beta - \gamma) + 2c\gamma(\alpha - \beta) + (\beta - \alpha)[\alpha(\beta + \gamma) - \beta\gamma]\}}.$$

In contrast, if the network spill-over effect from the recorded medium market onto the market for live performances, measured by the parameter δ, is significant, then the artist should "utilize" the legal and illegal distribution of the recorded medium in order to enhance the sales and profits from live performances. In this case, the artist benefits from piracy.

Fig. 2 illustrates condition (14) in the $\langle s, \delta \rangle$ space. Fig. 2 is drawn under the assumption that piracy is not profitable to the publisher, that is condition (12) applies. Therefore, the figure shows that high values of the artist's profit share parameter "s" make the artist better off if piracy is prevented. However, larger values of δ would increase the artist's profit from live performances and this profit is higher when piracy prevails in the market for the recorded medium. Thus, Fig. 2 demonstrates that the artists face a tradeoff between higher spill-over network effects and a higher share in the profit from selling the recorded medium.

The implications of Result 1 are summarized as follows.

Result 2. Suppose that the publisher earns a higher profit when copyrights are enforced and piracy is prevented, that is (12) holds. Then, if $s < \phi\delta^2$ the artist and the publisher have conflicting interests in pursuing enforcement of the recorded copyrighted material.

5.3. Numerical examples

Fig. 1 displays the equilibrium allocation under piracy and when piracy is prevented for parameter values given by $c = 0$, $\alpha = 400$, $\beta = 300$, and $\gamma = 200$. In this case, (12) implies that the publisher will prevent piracy. However, (14) implies that the artist is better off under piracy as long as $s < (2/175)\delta^2$.

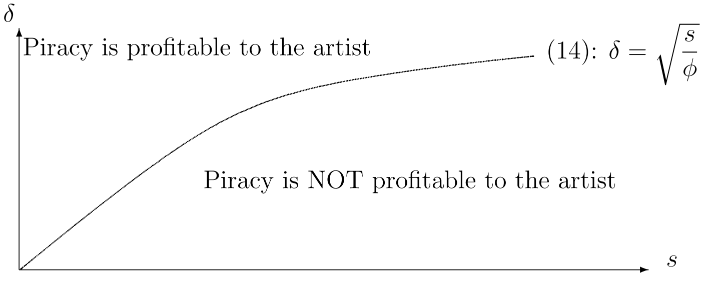

Fig. 2. Artist's profit from copyright enforcement: spill-over network effect versus artist's share in publisher's profit.

Table 1
Profits under piracy and no piracy

	Piracy prevails		Piracy prevented
Publisher's profit	$25(1-s)$	$<$	$200(1-s)$
Artist's profit from performances	$\frac{9\delta^2}{4}$	$>$	$\frac{\delta^2}{4}$
Artist's total profit	$25s + \frac{9\delta^2}{4}$	Depends	$200s + \frac{\delta^2}{4}$
$\hat{x}$ = Buyers (legal copies)	$\frac{1}{2}$	$<$	1
N = Users (legally and illegally)	3	$>$	1

For the sake of completeness, the various profit levels for this numerical example are given in Table 1 which is further discussed in the concluding section below. Some values are also drawn in Fig. 1.

6. Discussions and concluding comments

Table 1 demonstrates that even when the publisher's profit is lower when piracy prevails, the profit generated from live performances is higher when piracy prevails, compared with an equilibrium when piracy is eliminated. The reason for this is that illegal copies directly compete with the monopoly publisher, thereby forcing the publisher to reduce prices. The elimination of piracy enables the publisher to exercise full monopoly power.

As for the artist, the demand for live performances is substantially reduced when piracy is prevented since, as shown in Table 1, the number of users falls from $N = 3$ to $N = 1$. That is, the elimination of piracy increases the number of legal buyers to $\hat{x} = 1$, but also eliminates all illegal users. Thus, the total network size shrinks to one-third of the network size when piracy is eliminated. This reduction makes the artist significantly less popular thereby reducing the demand for the artist's live performances.

The present model is static. However, if we look at some dynamic considerations which are not addressed in the present model, it becomes clear that many artists may want to have as many records as possible listened to, even if pirated, because of prestige, status seeking, and for the sake of enhancing future reputation. To capture this effect, one can define artists' utility as a function of the extra utility generated from having N recordings listened to by N users, in addition to the combined profits earned from artists' share of profits from selling recorded media and the profit from live performances, given by (7) and (11).

We do not explicitly discuss or analyze policy issues in this short paper. We merely want to point out that massive anti-piracy campaigns, and the large number of ongoing and pending law suits that we now observe in many countries, may eventually hurt artists and authors. Clearly, these massive campaigns are heavily pushed by the private legal sector. Thus, this short paper highlights the fact that the recent wave of litigations against individuals who illegally use copyrighted material may not be to the best interest of the artists whose recordings are being pirated. Alternatively, artists should reconsider whether to surrender their copyrights to publishers when signing a recording contract. In view of the present model, artists may be better off by signing an exclusive recording contract with one publisher while not surrendering their copyrights. Under this arrangement, the artists themselves will make the decision whether and to what extend enforcement of their intellectual property should be pursued.

Acknowledgements

We thank three anonymous referees for most valuable comments on an earlier draft.

Appendix A. Demand for performances: An extension

We now show that our results continue to hold for a more general class of demand functions for live performances. Formally, we now replace the demand for live performances (2) with $q_{\mathrm{p}} = \delta N^{\lambda} - p_{\mathrm{p}}$, for $0 < \lambda \leqslant 1$, which exhibits positive and can also capture diminishing marginal benefit from users' network size. Maximizing profit from live performances yields the equivalent of (3) given by

$$p_{\mathrm{p}} = \frac{\delta N^{\lambda}}{2} \quad \text{and} \quad \pi_{\mathrm{p}} = \frac{\delta^2 N^{2\lambda}}{4}, \text{ hence } \pi_{\mathrm{p}} = \frac{\delta^2}{4}\left(\frac{\beta}{\beta-\gamma}\right)^{2\lambda}, \tag{15}$$

where the value of the network size N when piracy prevails is substituted from (4). Hence, the artist's total profit, that is the equivalent of (7), is now given by

$$\pi_{\mathrm{a}} = \pi_{\mathrm{p}} + s\pi_{\mathrm{r}} = \frac{\delta^2}{4}\left(\frac{\beta}{\beta-\gamma}\right)^{2\lambda} + s\frac{(\alpha-\beta-c)^2}{4(\alpha-\beta)}. \tag{16}$$

We now proceed to analyzing the no-piracy case. Substituting N from (10) into the middle term in (15) yields the profit from live performances. Adding this profit to the artist's share in profit from record sales also given in (10) yields the artist's profit when there is not piracy. Thus, the equivalent of (11) is given by

$$\pi_{\mathrm{a}} = \pi_{\mathrm{p}} + s\pi_{\mathrm{r}} = 2^{-2(1+\lambda)}\delta^2\left(\frac{\alpha-c}{\alpha-\gamma}\right)^{2\lambda} + s\frac{(\alpha-c)^2}{4(\alpha-\gamma)}. \tag{17}$$

Comparing the artist's total profit under piracy (16) to the profit when piracy is eliminated (17) yields the equivalent of (14) where

$$\phi = \frac{2^{-2\lambda}\delta^2(\alpha-\beta)(\alpha-\gamma)\left[\left(\frac{\alpha-c}{\alpha-\gamma}\right)^{2\lambda} - \left(\frac{2\beta}{\beta-\gamma}\right)^{2\lambda}\right]}{c^2(\beta-\gamma) + 2c\gamma(\alpha-\beta) + (\beta-\alpha)[\alpha(\beta+\gamma)-\beta\gamma]}. \tag{18}$$

Observe that (18) is identical to (14) for the special case where $\lambda = 1$ (linear demand for live performances).

In order to confirm the validity of the extended condition (18), we utilize the same numerical example as in Section 5.3. The profit of the publisher is unaffected by the change in the demand for live performances and therefore maintains the same level as in the first row of Table 1. However, the total profit made by the artist is affected by this change since artists make profit from live performances. Setting, for example, $\lambda = 0.5$, the artists total profit when piracy prevails, and when eliminated, that is the equivalent of the third row in Table 1, are now given by

$$\pi_{\mathrm{a}}^{\mathrm{piracy}} = 25\text{ s} + \frac{3\delta^2}{4} \text{ and } \pi_{\mathrm{a}}^{\mathrm{no}} = 200\text{ s} + \frac{\delta^2}{4}. \tag{19}$$

Therefore, the artist earns a higher profit under piracy compared with no piracy, that is $\pi_{\mathrm{a}}^{\mathrm{piracy}} > \pi_{\mathrm{a}}^{\mathrm{no}}$, if her share in the profit from record sales is sufficiently small, formally if $s < \delta^2/350$.

Appendix B

Proof of Result 1. The parameter ratio listed in (14) follows directly from (13) as long as the sum of the coefficients of "s" in (13) is positive (meaning that we do not divide by a negative number when solving for s). Straightforward computations reveal that the sum of these coefficients is positive if

$$\frac{(\alpha-\gamma)\{c^2(\beta-\gamma)+2c\gamma(\alpha-\beta)+(\beta-\alpha)[\alpha(\beta+\gamma)-\beta\gamma]\}}{\alpha-\beta}<0. \tag{20}$$

To prove that (20) holds for all values of c satisfying Assumption 1, we first substitute $c = 0$ into the LHS(20) to obtain $(\gamma-\alpha)[\alpha(\beta+\gamma)-\beta\gamma]$ which is negative. Next we substitute $c = \alpha - \beta$ (the largest permissible value under Assumption 1) again into the LHS(20) we obtain $\beta^2(\gamma-\alpha)$ which is also negative. Finally, we differentiate LHS(20) with respect to c to obtain $(\alpha-\beta)\mathrm{dLHS(20)}/\mathrm{d}c = 2(\alpha-\gamma)[c(\beta-\gamma)+\gamma(\alpha-\beta)] > 0$ for $c \geqslant 0$. Hence, LHS(20) does not flip signs when c varies on the interval defined by Assumption 1. □

References

Caves, R., 2003. Contracts between art and commerce. Journal of Economic Perspectives 17, 73–83.

Conner, K., Rumelt, R., 1991. Software piracy: an analysis of protection strategies. Management Science 37, 125–139.

Gayer, A., Shy, O., 2003. Copyright protection and hardware taxation. Information Economics & Policy 15, 467–483.

Givon, M., Mahajan, V., Muller, E., 1995. Software piracy: estimation of lost sales and the impact on software diffusion. Journal of Marketing 59, 29–37.

Krueger, A., 2005. The economics of real superstars: the market for rock concerts in the material world. Journal of Labor Economics 23, 1–30.

Oberholzer-Gee, F., Strumpf, K., 2004. The Effect of File Sharing on Record Sales: An Empirical Analysis. Harvard Business School.

Peitz, M., 2004. A strategic approach to software protection: comment. Journal of Economics & Management Strategy 13, 371–374.

Peitz, M., Waelbroeck, P., 2003. Piracy of Digital Products: A Critical Review of the Economics Literature. CESifo Working Paper #1071. Electronic document available at: <www.ssrn.com>.

Peitz, M., Waelbroeck, P., in press. Why the music industry may gain from free downloading – the role of sampling. International Journal of Industrial Organization.

Rob, R., Waldfogel, J., 2004. Piracy on the High C's: Music Downloading, Sales Displacement, and Social Welfare in a Sample of College Students. NBER Working Paper No. W10874.

Shy, O., Thisse, J., 1999. A strategic approach to software protection. Journal of Economics & Management Strategy 8, 163–190.

Slive, J., Bernhardt, D., 1998. Pirated for profit. Canadian Journal of Economics 31, 886–899.

Takeyama, L., 1994. The welfare implications of unauthorized reproduction of intellectual property in the presence of network externalities. Journal of Industrial Economics 62, 155–166.

Takeyama, L., 1997. The intertemporal consequences of unauthorized reproduction of intellectual property. Journal of Law and Economics 40, 511–522.