J Cult Econ (2007) 31:187–204
DOI 10.1007/s10824-007-9042-y

ORIGINAL ARTICLE

Determinants of music copyright violations on the university campus

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Received: 24 November 2005 / Accepted: 3 May 2007 / Published online: 9 June 2007

Abstract The protection of copyrights in the music industry has been of paramount concern as the popularity of digital music players, personal websites, and file-sharing continues to grow, each of which subsequently contributes to the persistence of Internet music piracy. While the Recording Industry Association of America (RIAA) links file-sharing to copyright piracy, others argue that file-sharing allows maximum exposure of artists' music which in turn increases its value. While this debate continues, little empirical research has specifically addressed the behavioral aspects of the consumer. In this paper, we use survey data on university students to study how attitudes toward copyright law along with economic and demographic factors affect the extent of music copyright violations. We find that while students are responsive to economic incentives and perceptions of risk, the extent of these incentives has not reversed the overall propensity to engage in file-sharing.

Keywords Copyright protection · File-sharing · Music piracy · Risk perceptions

JEL classification O34 · K42 · D12

1 Introduction

The means of purchasing and listening to music has undergone a major transformation in the past decade. Music stores are being displaced by Internet

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download services, and portable compact disc (CD) players are being replaced with digital music players. Apple's popular iPod music player has sold 88 million units as of the end of 2006 (Apple 2007), spurring competitors to develop substitute brands and greatly changing the way music is acquired. As the Internet plays an increasing role in the dissemination of music, Internet music piracy remains a persistent problem facing the music industry, especially as file-sharing services persist and the growth of personal websites and music blogs continues to grow. While legal online music stores have experienced dramatic growth in recent years, a large proportion of music files are still acquired using means that, according to the Recording Industry Association of America (RIAA), violate copyright law and cost the industry an estimated $4 billion in losses in 2006 (IFPI 2006). Illegal music dissemination continues to flourish due to its convenience, low cost, access to unlimited music selections, and, when carried out in moderation, low risk.

This article analyzes the attitudes and behavior of university students with respect to music consumption and piracy. University students represent a market segment that is technologically savvy and exhibits high demand for music (Hoffman et al. 2004). Using survey data, we focus on two general strategies undertaken by the RIAA to combat music piracy: enforcement (e.g., the threats or initiation of lawsuits) and economic incentives (e.g., increasing song selections among legal online music distributors while lowering prices). Our empirical model studies the underlying values placed on these deterrents and incentives to determine their effectiveness in reducing music piracy.

The rest of the article is organized as followed. Sect. 2 presents the background literature on copyright piracy. Sect. 3 discusses the role of technology in music. Sect. 4 describes a snapshot of the data. The empirical model is presented in Sect. 5. Sect. 6 discusses the empirical results. Policy implications are discussed in Sect. 7 and concluding comments appear in Sect. 8.

2 Background literature

While enforcement strategies and economic incentives both aim to reduce music piracy and hence increase revenues via legal purchases, there is a debate as to their relative effectiveness. In recent years, a growing literature on copyright piracy and file-sharing has emerged; yet, little has been done to understand how an individual responds to the many factors influencing his or her behavior. It is in this spirit that we build upon the existing research.

Any study on the economics of law and enforcement would naturally begin with Becker's (1968) seminal study. Since then, numerous studies on the risk and enforcement of illicit activities have developed, which ties the economics literature with that of criminal science. Cameron (1988) provides a comprehensive survey of both theoretical and empirical determinants of crime; Butler (2000) and Hinduja (2006) provide further analysis of the relationship between economics and criminal science by focusing on ''high-tech crime'', to which music piracy is categorized. A comprehensive literature review of copyright piracy is provided by Peitz and Waelbroeck (2003); they introduce several key issues facing both consumers and

copyright holders with respect to how copyrights are to be protected and how violations of copyrights should be enforced. These issues include network effects, the utility of pirated digital products, and the role of deterrents.

The role of network effects is an important argument made by those who oppose harsh penalties for copyright violations or even any enforcement at all. Yet, the importance of network effects, that the value of digital copyright products such as music rises as more consumers acquire the product both legally and illegally, have been subject to debate. On the one hand, Gayer and Shy (2005) argued that enforcement will reduce network externalities in the music industry and subsequently penalize musicians, while Ben-Shahar and Jacob (2004) argued that while network effects are important, the use of selective enforcement of copyright violations could be used as a strategy to increase the market share of legal music sales. These arguments complement a previous article by Boldrin and Levine (2002) that highlighted the social inefficiencies of intellectual property rights in general.

The literature has also examined the relationship between the utility received from copyright piracy and its effect on the music industry. First, it was shown by Marron and Steel (2000) and Silva and Ramello (2000) that low-economic development and low-per capita income both resulted in higher-national piracy rates. Complementing these studies, Zentner (2005) found that countries with greater Internet capacities (which facilitate file-sharing) have seen aggregate music sales fall. In subsequent studies, Stevans and Sessions (2005) and Zentner (2006) found that while people who file-share typically purchase more music in aggregate, the probability of purchasing music (i.e., proportion of music legally purchased) is reduced. Further, Liebowitz (2006) argued that file-sharing was the dominant reason for the decline in music sales. This confirmed an earlier study by Oberholzer and Strumpf (2004), who matched a sample of actual music downloads to US sales data on 500 random albums, and found a negative correlation between downloads and sales. Yet, another study by Rafael and Waldfogel (2006) found that college students generally report a smaller utility value for downloaded music compared to purchased music; thus, while file-sharing reduces the probability of purchasing music, a large proportion of downloaded music would never have been purchased.

Inferring further into the determinants of music piracy, a number of recent papers have studied the role of personal characteristics and environmental factors. For example, Cheng et al. (1997) and Gopal and Sanders (1998) used survey data to determine how age, income, and ethnicity affected the propensity of software piracy by individuals. A subsequent study by Chiang and Assane (2002) found that among college students, class standing and field of study are important determinants of software piracy, with senior students and technical majors exhibiting higher propensities. The former is likely due to peer effects, particularly in a college environment where like-minded individuals with similar values interact, which subsequently affect student behavior. Lastly, cultural factors can influence the likelihood of piracy; for example, individuals are more likely to engage in piracy if exposed to an environment where copyrights are routinely violated. Moores (2003) found that cultural differences in the values placed on copyright law among countries affected national piracy rates.

In the present article, we build upon the existing literature by incorporating determinants of music piracy into a succinct empirical model, using survey data on

university students that reveal their views of file-sharing and copyright law and their subsequent behavior with respect to purchasing and acquiring music. We develop a model that includes four categories of determinants of the propensity and extent of music file-sharing: risk factors (*Risk*), utility factors and budget constraints (*Utility*), university-specific variables (*University*), and personal characteristics (*Innate*). By studying the relative importance of each category of determinants, we aim to assist policymakers in formulating effective policies to address the music piracy problem.

3 The role of technology in music

The continuing advancement of technology has played a key role in facilitating as well as preventing Internet music piracy. Prior to the widespread use of the Internet, consumers would duplicate tapes and CDs as an alternative to purchasing legal versions. Yet, the quality of the duplications and time required limited the widespread use of such methods. With the Internet and its subsequent increase in bandwidth, music was digitalized and began to be disseminated on a much larger scale (Lam and Tam 2001). A major advancement in Internet piracy occurred when Shawn Fanning developed a file-sharing software that became the original Napster, a service that was subsequently followed by Kazaa, Grokster, BitTorrent, and others. Today, the popularity of personal websites and music blogs offer further means by which consumers can share music worldwide.

Such recent advancements in the technology of music piracy have led to various strategies taken by the RIAA to stem its growth. In 2001, the RIAA began pursuing lawsuits against firms that facilitate music piracy, and in 2003, the RIAA began pursuing lawsuits against suspected large-scale individual file-sharers, and continues to this day. While studies have shown some reduction in file-sharing, the extent of file-sharing remains substantial (Bhattacharjee et al. 2006). Yet, despite these actions, the RIAA acknowledges the value of the Internet as a medium for disseminating music and strongly supports fee-based online music services that provide a legal alternative to file-sharing. Such services have grown immensely in recent years due to increased song selection and lower prices. In fact, Apple iTunes sold over 70 million downloads in its first year and surpassed one billion total downloads in 2006 (Apple 2007).

Major music distributors such as EMI Records, Universal Music Group, Virgin Records, Sony BMG, and Warner Music Group, which comprise a dominant majority of the RIAA, have been successful in combining their music offerings so that legal online music services can compete with illegal alternatives. Today, major online music services include iTunes, Napster, Rhapsody, MusicMatch, and eMusic, each offering up to three million songs in their catalog, with typical pay-per-download prices of less than $1 per song or $13 per album (prices are approximate). Despite the growth of music download services, file-sharing services still widely exist. The original Napster, at its peak in 2001, had 60 million users and over three million titles in its database, and spawned many other file-sharing programs that offer basic file-sharing services at no cost. Today, file-sharing remains a popular method despite the various caveats faced, including quality issues, the risk of

lawsuits, and the threat of computer viruses and spyware that accompany shared files. Because file-sharing is highly dependent on network effects (where more users increases the value of file-sharing which encourages more users), the speed at which file-sharing gained popularity could potentially reverse itself at a similar pace. But even if file-sharing is ultimately curtailed, the RIAA is faced with even newer technologies that facilitate illegal music transfer.

4 A snapshot of the data

The data is taken from a survey distributed and collected among students at two large US universities (Florida Atlantic University and University of Nevada Las Vegas) during the 2003–2004 academic year, and was based on a revision from an earlier survey administered to a different sample of students during the 2000–2001 academic year. The survey contains questions relating to a student's listening habits and consumption patterns (e.g., the extent of file-sharing and the willingness-to-pay for music), knowledge and perceptions of copyright law including views on recent enforcement actions, and general demographics and peer effects.[1] The survey was distributed among a wide range of classes including general education and field classes, and also to all levels of students, from first-year to graduate students. Due to the sensitive nature of certain questions, it was important that students understood their responses were confidential and that they would remain anonymous. All completed surveys were assigned a random number to avoid aggregation from a single source. A total of 665 responses were collected, of which 472 were sufficiently complete to be incorporated into the empirical model.

Summary statistics from the survey data are provided in Table 1. The sample contains a distribution of class standings, majors, gender, and ethnicity that closely reflects the demographics of the surveyed universities. The median age is 21, with males constituting 51% of the sample. White/Caucasian and Asian students represent 51% and 14% of the sample, respectively; all other ethnicities combined represent the remaining 35%. Business majors (including all business-related majors), science/engineer majors (including all majors within the science and engineering fields), and computer science majors represent 38%, 19%, and 7% of the sample, respectively; all other majors combined make up the remaining 36%.[2] Students living on campus represented 14% of the sample, and 71% of students work at least part-time.

The key question asked is whether the student downloads music from the Internet using file-sharing services, and the percentage of total music and recently acquired music (obtained in the past six months) consisting of file-shared music.[3] Since

[1] An abridged version of the survey containing all questions relating to this article is found in Appendix 2.

[2] Though we collected information on students' majors, initial regression estimates showed that the type of major did not influence patterns of music consumption or how music is acquired. Thus, we do not include this variable in the regression analysis, though we present summary statistics for the purpose of describing the distribution of students surveyed.

[3] Although we ask questions based on file-sharing, CD duplication (music ripping) is also a very common way of ''sharing'' music. In general, the survey seemed to capture the use of both methods, since the alternative to file-sharing are the legal alternatives. Thus, CD duplication would fall under the same category as file-sharing.

Table 1 Variable names, definitions, and descriptive statistics

Variables	Description	Mean (Standard deviation)
Dependent variables		
Music	1 = student currently engages in file-sharing	.581 (.49)
Total	Percentage of total music collection consisting of file-shared music downloads	.402 (.39)
New	Percentage of new music collection consisting of file-shared music downloads	.399 (.42)
Risk variables		
RIAA-Threat	Perceived chance of being sued by the RIAA for a copyright violation	13.03 (17.35)
Log(Penalty)	Amount of fine to be paid to the RIAA if found guilty of a copyright violation ($)	6.06 (2.01)
Utility variables		
Value	Amount willing to pay per download song ($)	.66 (.96)
Work	1 = Work at least part-time	.71 (.45)
University variables		
Campus	1 = FAU and 0 = UNLV	.55 (.50)
Antipiracy	1 = Familiar with a current anti-piracy awareness campaign	.13 (.34)
Innate variables		
Male	1 = Male and 0 = female	.51 (.50)
Class	1 = First-year to 5 = Graduate Student	2.72 (1.08)
White	1 = White / Caucasian	.51 (.50)
Asian	1 = Asian / Asian-American	.14 (.35)
Fairness variable		.48 (.41)

file-sharing is seen by some as a violation of copyright law and by others as a legitimate activity, the manner in which this question is phrased can influence the results if students choose not to answer truthfully. To downplay the criminal connotation of the activity, we avoid using the terms ''illegal'' or ''piracy'' in its description, using simply the term ''file-sharing'' wherever appropriate. We therefore expect the results to reflect truthful responses to each question. In our survey, 58% of students admitted to file-sharing, and the mean proportion of total music collections consisting of file-shared music was 40.2%. The mean proportion of recently acquired music consisting of file-shared music was 39.9%. While the difference in proportions are small, differences between individual students may be significant. Lastly, only 2.5% of music collections were reported to be purchased from fee-based online music services.[4]

The economic reasoning for file-sharing becomes clear when we ask students why they file-share: 83% say cost is a major factor, 53% say time is a major factor in

[4] The 2.5% finding was during the 2003–2004 year, when fee-based music services were just starting to develop. This figure is likely to be significantly higher today, though based on industry analysts, not likely to exceed the file-sharing percentage.

that it is more convenient to acquire music via file-sharing, and 65% say file-sharing services offer access to songs that stores or online fee-based services do not carry. Clearly, there are reasons beyond cost that explain the popularity of file-sharing. Of students who admit to file-sharing, those who indicated only 'cost' to be important had on average 55.5% of recent music acquired via file-sharing, while those who indicated only 'time' had on average 56.2% of recent music acquired via file-sharing. Those who indicated only access to hard-to-find music had on average 32% of recent music acquired via file-sharing, which suggests that these students typically purchase music legally (since cost and time are not important), but use file-sharing to acquire music that are difficult to purchase using legal channels. Lastly, when students indicated both 'cost' and 'time' to be important, music acquired via file-sharing increased to 70.6%. Due to various reasons why students use file-sharing services, we found that 76% of students do not support shutting them down. When asked whether file-sharing is unfair to music artists, music distributors, and music stores, we find that 58%, 49%, and 40% of students, respectively, agree.

An important factor that fee-based services take advantage of is the ability to sell single songs rather than entire albums. While music stores in the US have largely dropped the sales of CD singles (arguably due to music file-sharing), fee-based services are largely based on such sales. In the survey, students were asked their willingness-to-pay for a downloaded single, and the mean was $0.68. A significant number of students stated a 'zero' willingness-to-pay; for those that gave non-zero responses, the mean was $0.81, which is close to the actual amount charged by the major online services (except those that charge an additional monthly fee).

Finally, it is important to gauge the risk factors involved with file-sharing. In addition to the potential costs resulting from viruses and spyware that spread via shared Internet files, there is the risk of apprehension by the RIAA and other music associations which have actively pursued litigation against file-sharers. In the survey, we ask students to state the probability that an average person using file-sharing will actually face litigation. The mean response was 13.0%. And when asked what the average amount of fines that guilty individuals will pay if the music industry is successful in its litigation against individuals, the mean response was $2,912. Interestingly, this figure closely approximates the average settlement amount agreed between the RIAA and approximately 200 defendants in the year 2003 that agreed to settle to avoid further litigation. However, it is a small percentage of the initial damages sought by the RIAA, which is typically the $150,000 maximum fine per infringed copyright allowed by US law (RIAA 2007). This suggests that students expect the RIAA to offer reasonable settlement offers and that the full amount of the lawsuit is often used as a threat to force defendants into settlement.

5 Empirical model

Table 1 provides the names, definitions, and descriptive statistics of all variables used. The dependent variables, *Music*, *Total*, and *New*, all exhibit a high number of 'zero' values that represent students who do not download music illegally. Due to

the nature of this censored data, applying ordinary least squares (OLS) methods would lead to biased estimates. Tobit (type-1) is the appropriate model to handle censored data. But Tobit (type-1) is restrictive particularly in our analysis because it would assume that the coefficient estimates of the factors that affect file-sharing are similar to those that affect the extent of files shared. To avoid this problem we use a Tobit-2 (or Heckman selection) model to separately account for the two decisions. Accordingly, we consider the following censored system of equations:

$$Y_1^* = X_1\beta_1 + \varepsilon_1 \quad (1)$$

$$Y_2^* = X_2\beta_2 + \varepsilon_2 \quad (2)$$

where X_1 and X_2 are the vectors of regressors, β_1 and β_2 are the vectors of unknown parameter coefficients and ε_1 and ε_2 are the error terms that reflect random variations and unobserved factors that affect Y^*_1 and Y^*_2, respectively. The latent variable Y^*_1 measures whether or not the student engages in file-sharing, whereas Y^*_2 is measured in two different ways as (i) the percentage of a student's entire music collection that consists of file-shared music or as (ii) the percentage of music obtained in the past six months consisting of file-shared music. Equation 1 is the ''selection'' equation, which indicates whether or not a randomly selected student engages in file-sharing, while Eq. 2 is the ''regression'' equation which determines the extent of the activity. Next, we briefly outline the set of explanatory variables.

5.1 The regressors

The sets of regressors X_1 and X_2 include two key vectors of variables, *Risk* and *Utility* and two vectors of control variables, *University* and *Innate*. *Risk* measures the effect that copyright enforcement policies have on the behavior of students. The recent attempts by the RIAA to litigate against users underscore these policies. Do students actually respond to these threats, or do they view them as non-credible? Consistent with the literature on the effects of deterrents on illicit activity (e.g., Cameron 1988), we expect a negative correlation between the *Risk* factors and music file-sharing. Moreover, an issue raised in the risk and uncertainty literature is that risk perceptions by individuals are not exogenous but formed by characteristics inherent to an individual, environmental (peer effects), and information factors (Cameron 1988; Smith and Johnson 1988; Viscusi 1991). Risk perception is measured directly by *RIAA-Threat*, the perceived chance of being sued by RIAA and by *Penalty*, the perceived amount of fine to be paid if found guilty of a copyright violation.

Utility is measured by *Value* and *Work*, which offer a general framework for analyzing student preferences and budget constraints in file-sharing behavior, respectively. *Value* embodies a student's willingness-to-pay per song in response to the many fee-based online services that charge a fee per downloaded song, while *Work* indicates whether or not the student works, which is a loose proxy for income given that many students rely on parental support or financial aid. In general, we expect these two variables to correlate negatively with file-sharing behavior.

University variables measure the effect of the university and its environment on file-sharing. These variables include *Campus* which measures whether or not there

are inherent behavioral differences between the students of the two surveyed institutions, FAU and UNLV; *Antipiracy*, which accounts for whether the student is familiar with any current anti-piracy awareness campaigns. Although there is no *a priori* expectation on the variable *Campus*, the variable *Antipiracy* is expected to have a deterrent effect on file-sharing.

Innate variables measure the effect of inherent characteristics such as gender, ethnicity, and class standing on individual behavior. Male students are expected to exhibit a higher rate of music file-sharing because they are more inclined toward riskier activities, on average. But as students over time achieve higher class standing (a proxy for maturity), they tend to engage less in activities that constitute copyright violations.

5.2 Econometric specification

Given the system of Eqs. 1 and 2, the selection variable depend on the sign of Y^*_1, while Y^*_2, the latent variable of interest, is observed when $Y^*_1 > 0$. The joint distribution (Y^*_1, Y^*_2) assuming a bivariate normal is characterized by ($X_1\beta_1$, $X_2\beta_2$, σ_1^2, σ_2^2, ρ) where σ_1, σ_2 and ρ are the standard deviation of the marginal distribution of Y^*_1 and Y^*_2 and the correlation of Y^*_1 and Y^*_2, respectively. The error terms ε_1 and ε_2 are assumed to be independent of the regressors and they follow a bivariate normal distribution.

$$\begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \end{bmatrix} \sim \mathrm{N}\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad \begin{bmatrix} 1 & \rho\sigma \\ \rho\sigma & \sigma^2 \end{bmatrix} \right) \tag{3}$$

Equations 1 and 2 are estimated following (i) the two-step Heckman (1976, 1979) procedure and (ii) the maximum likelihood method developed by Amemiya (1984).

Given our system of equations, it would be desirable for identification to use a set of different regressors for the selection and the regression equations. But imposing such restrictions on the parameters of the system is seemingly unrealistic. Indeed, regressors that explain the decision to file-share are likely to affect the amount of music downloaded. The lack of valid exclusion restrictions leads to a high collinearity between lambda (λ), the inverse Mill's ratio and the regressors (Vella 1992; Leung and Yu 1996). Accordingly, we introduce the variable *Fairness* to mitigate the possible identification problem. *Fairness* measures whether or not the student believes that file-sharing is unfair to music artists; it is expected to be correlated with the selection process but not with the main equation. Indeed, one can assume that a student who perceives file-sharing as unfair to music artists will likely not engage in the activity nor possess a large share of file-shared music.

6 Empirical results

Table 2 contains the results of the two-step Heckman procedure and the maximum likelihood method. Appendix 1 reports benchmarks results to Table 2 when the two equations are estimated separately using Probit for Eq. 1 and Tobit for Eq. 2 (e.g., Cox and Jappelli 1990; Dudley and Montmarquette 1976). In Table 2, Columns 1 and 3 show estimates of the percentage of all music (*Total*) consisting of file-shared

Table 2 Two-step Heckman and Maximum Likelihood (MLE) Estimates of File-Sharing

	Two-step Heckman		Maximum Likelihood Method	
	1 Total	2 New	3 Total	4 New
Risk variables				
RIAA-Threat	−.208* (.127)	−.145** (.065)	−.198* (.109)	−1.99*** (.020)
Log (Penalty)	−.011 (.010)	−.006 (.010)	−.011 (.010)	−.001 (.009)
Utility variables				
Value	−.053*** (.019)	−.049*** (.010)	−.053*** (.018)	−.049*** (.017)
Work	−.046 (.048)	−.042 (.045)	−.045 (.042)	−.047 (.047)
University variables				
Campus	−.052 (.084)	−.003 (.103)	−.024 (.043)	− .027 (.051)
Antipiracy	.189* (.099)	.027* (.019)	.085 (.057)	.067** (.026)
Innate variables				
Male	.044* (.026)	.093** (.044)	.053** (.028)	.070** (.032)
Class	−.046** (.022)	−.042** (.019)	−.044** (.019)	−.047** (.021)
White	.041* (.022)	.048** (.026)	.043* (.022)	.060** (.033)
Asian	.149** (.074)	.116** (.043)	.163** (.062)	.166*** (.008)
Intercept	.726*** (.140)	.595*** (.158)	.681*** (.096)	.577*** (.141)
Log likelihood			−272.11	−273.74
Lambda (λ)	−.448 (.397)	−.178 (.312)		
N	472	472	472	472

Note: Numbers in parentheses are asymptotic standard deviations. The asterisks *, **, *** indicate statistical significance at .1, .05, and .01, respectively

music while those in Columns 2 and 4 show estimates of the percentage of recently acquired music (*New*) consisting of file-shared music. Overall, the coefficient estimates and particularly those of the key variables, risk perception (*RIAA-Threat, Penalty*) and utility (*Value, Work*), exhibit the expected signs. Moreover, the coefficient on the variable *Value* is negative and significant. Hence, students with a higher willingness-to-pay are more likely to use fee-based services, whereas those with little to no willingness-to-pay are likely to use file-sharing, *ceteris paribus*. Finally, the signs of the coefficients for our control variables are, for the most part, consistent with expectations. There is a strong positive *Gender* effect on file-sharing behavior. The unexpected positive coefficients on *Antipiracy* could signal ''defiant'' attitudes that characterize youth with respect to law. And the negative coefficient on *Class* suggests that as students over time achieve higher-class standing (i.e., as they mature), they tend to use file-sharing methods less.[5]

Comparing results from Columns 1 and 3 (*Total*) with those from Columns 2 and 4 (*New*), the latter estimates are found to be relatively stronger, illustrating that the

[5] The *Fairness* variable does not appear in Table 2, because *Fairness* is used in the selection equation for identification purposes. But the effect of *Fairness* on file-sharing can be observed in the results in Appendix 1. Indeed the coefficient has a negative sign as expected, and is statistically significant at conventional levels for the Probit and Tobit specifications.

Table 3 Collinearity measure based on the Two-step Heckman estimates in Table 2

Criteria	Total collections		New collections	
	3.1	3.2	3.3	3.4
$R^2 = [r(\lambda, X)]^2$ (VIF)	.634 (2.73)	.713 (3.48)	.742 (3.87)	.757 (4.11)
Condition number	21.42	22.18	20.98	21.35

extent of file-sharing tends to change with the popularity of music. In other words, individuals tend to replace old music downloads with new downloads; therefore, aggregate music collections might not reflect the actual level of file-sharing. Thus, if various factors play an influential role in the behavior of university students, it will likely be more evident in more recent behavior compared with all past behavior.

The coefficient estimate of λ is negative but insignificant suggesting that the unobservable factors that affect file-sharing are not significantly correlated with the unobservable factors that affect the extent of files shared. As noted above, a potential criticism of our generalized Tobit results is the lack of exclusion restrictions, which could lead to high collinearity between λ and the rest of the regressors. Although checking for collinearity could be a vexing econometric issue, we follow Vella (1992) and Leung and Yu (1996) by using two approaches to detect this problem. These concern (i) the sample correlation R_i^2 between λ and the other regressors or the variance inflation factor (VIF $= [(1-R_i^2)]^{-1}$) and (ii) the BKW condition number as discussed in Besley et al. (1980), which is the square root of the maximum to the minimum eigenvalue of the matrix (λ'X).

Table 3 summarizes the findings of the VIF and condition number criteria. Since there is an one-to-one correspondence between $R_i^2 = [r(\lambda,X)]^2$ of the auxiliary regression and the VIF, the estimates of the VIF are reported in parentheses. The R_i^2 values range from .63 to .76 and the corresponding VIF measures are between 2.73 and 4.11, which are below the conventional threshold (e.g., a VIF of 5) for collinearity to be an alarming issue. Moreover, the estimates of the BKW condition number range between 20.98 and 22.18, which again are below the conventional threshold (e.g., 30) and hence, indicates that collinearity cannot be a major concern. Hence, whether one uses the VIF or the BKW criteria when checking for collinearity, the conclusion remains the same; that is, λ and the other regressors share information but the strengths of these relationships are not strong enough to cast doubt on the results.

7 Discussion

The results from the previous section consistently indicate that students are sensitive to risk and are influenced by the availability of fee-based online music services. To gain insights into policy implications of these results, we report in Table 4 and Table 5 responses to changes in the two key regressors, *RIAA-Threat* and *Value*.The findings reinforce the negative correlations between file-sharing and these two key variables.

Results in Table 4 measure the effects of incremental variations of *RIAA-Threat* and *Value* on the percentage of music collection file-shared. In Panel A, when the

Table 4 Predicted percent of music collections consisting of file-shared music (A) per incremental change in perceived RIAA-threat and (B) per incremental change in willingness-to-pay (Value) (Standard Deviation in parentheses).

	Two-step Heckman		MLE	
	Total	New	Total	New
(A) Variations in perceived RIAA-threat (%)				
Threat				
Threat <.25	.467 (.110)	.498 (.136)	.487 (.111)	.499 (.127)
.25 ≤ Threat <.50	.405 (.112)	.418 (.121)	.409 (.114)	.419 (.132)
.50 ≤ Threat <.75	.398 (.140)	.401 (.142)	.376 (.143)	.402 (.123)
.75 ≤ Threat ≤1	.220 (.114)	.232 (.173)	.207 (.112)	.243 (.141)
(B) Variations in willingness-to-pay (Value)				
Value				
Value <$.25	.501 (.124)	.511 (.123)	.502 (.167)	.511 (.152)
$.25 ≤ Value <$.50	.478 (.108)	.497 (.122)	.479 (.104)	.498 (.095)
$.50 ≤ Value <$.75	.448 (.101)	.436 (.121)	.434 (.107)	.438 (.122)
$.75 ≤ Value ≤$1.00	.238 (.102)	.251 (.109)	.273 (.111)	.276 (.103)
$1.00 ≤ Value ≤$1.50	.167 (.095)	.123 (.087)	.146 (.022)	.123 (.088)
Value >$ 1.50	.100 (.001)	.102 (.001)	.101 (.002)	.103 (.001)

Table 5 Elasticities of key variables

	Two-step Heckman		MLE	
Variable	Total	New	Total	New
RIAA-Threat	−.049* (.127)	−.040** (.065)	−.051** (.109)	−.039*** (.020)
Value	−.080*** (.019)	−.068*** (.010)	−.082*** (.018)	−.073*** (.017)

Note: Numbers in parenthesis are asymptotic standard deviations. The asterisks *, ** and *** inidicate statistical significance at .1, .05, and .01, respectively

perceived risk of being apprehended is below 25%, nearly 47–50% of music collections consist of file-shared music, whereas this percentage is reduced by about half when the perceived risk increases to the range of 75–100%. Likewise, the results in Panel B suggest that university students are also sensitive to music prices. A low willingness-to-pay for music results in a high proportion of file-shared music, and vice versa. Indeed, when students exhibit a *value* (willingness-to-pay) that is less than $0.25, about 50% of individual music collections are acquired from file-sharing; this percentage drops to roughly 10% when *value* is above $1.50.

In the same vein, using the ''regression'' equation, we have computed the various elasticities ($\partial \log y / \partial \log x$) of the percent of total and recent collections consisting of file-shared music with respect to the two key variables *RIAA-Threat* and *Value*.[6] The elasticity findings in Table 5 are consistent with those in Table 4 in that students

[6] The elasticities are readily computed in STATA with the Heckman and MFX procedures.

do respond negatively to changes in *RIAA-Threat* and *Value*. The *RIAA-Threat* and *Value* elasticity estimates based on the two-step Heckman and the MLE estimates are negative but small in absolute value, indicating that the size of the collections of file-shared music is inelastic with respect to these two variables. For example, a 10% increase in the perceived risk of apprehension results in between 0.4% and 0.5% decrease in file-shared music, while a 10% increase in willingness-to pay leads to between 0.7% and 0.8% decrease in file-shared music. The relatively low-elasticity estimates are consistent with expectations and could be explained by a number of factors: (i) the low cost of music singles (e.g., less than $1) which constitute a negligible share of most students' budget, (ii) the hedonic nature of a particular song which clearly lacks good substitutes, (iii) the addictive nature of music and particularly that of a new song, and finally (iv) the short-run scope of our study.

In sum, university students are somewhat sensitive to risk factors. While certain characteristics regarding risk are more innate in nature, others can be influenced to an extent by one's environment and peers. Hence, steps by the music industry or the university can influence student behavior regarding an activity that may violate copyright law. In our results, we find that recent decisions of pursuing litigation against individual users of file-sharing services have had some impact in shaping the risk perceptions of students. On the other hand, our results highly suggest that university students can somewhat be sensitive to music prices, and therefore the success of fee-based online music services may hinge on whether the difference in price can be offset by higher quality of music, reduced risk accompanied by legal downloads, and greater music selections that reduce the time and song selection factors.[7] Clearly, students who place higher value on the option of fee-based downloads are much less likely to use file-sharing services. This suggests that if the music industry can offer enough incentives to increase the willingness-to-pay for legal downloads, the results can be profound.

8 Conclusion

Technological innovations largely influence the way individuals perform their daily activities. In the music industry, innovations such as the tape recorder, CD burners, and Internet file-sharing all share a similar dilemma in that while the innovation itself is of great value and popularity among both consumers and producers, it is also the major culprit of copyright piracy. For the consumer, the ability to obtain music quickly and of all types carries substantial value. For the producer, such innovations maximize the dissemination of music to consumers and thus increase market potential. The dilemma occurs as technology changes so rapidly that market efficiency takes precedent over the ability to protect intellectual property rights.

[7] Since the questions measuring the importance of cost, time, and song selection were only asked of students that admit to file-sharing, we are unable to include these variables in the full regression model estimating the determinants of file-sharing. However, we ran the full model again using the sub-sample of students that answered the question and including the cost, time, and song selection variables. The coefficients for *New* (percentage of recent music acquired via file-sharing) as follows: Cost: 17.39*** (T-statistic: 3.77); Time: 14.18*** (T-statistic: 3.59); Song Selection: 1.03 (T-statistic: 0.26).

In the music industry, consumers naturally strive to attain the highest value of music for the lowest price. Online music sharing accomplished this feat with efficiency, but without compensation to the artists and copyright holders. This article studies the attitudes of university students with respect to music piracy, and in particular, how the use of enforcement and economic incentives, two general strategies used to reduce piracy, affect subsequent behavior.

This article finds that university students, based on survey responses to the risk and value of music piracy, are responding to the changes in the music industry. We find that enforcement actions can be effective in reducing the incentive to engage in music piracy, especially when there are attractive legal alternatives, such as new fee-based services, which offer large selections at low prices. As these fee-based services continue to expand their offerings, they will continue to be embraced by the music consumer.

Acknowledgments We wish to thank the Editor and two anonymous referees for their valuable comments on an earlier draft of this article. In addition, we thank the following individuals for their input in the development of this article: Xuemei Jiang, Bill Robinson, Brad Wimmer, Lara Gardner, Patrick Cooper, Mark Bymaster, and seminar participants at Florida Atlantic University, California State University Long Beach, New Mexico State University, University of North Florida, and the 2004 Western Economic Association International Meetings. All remaining errors are ours.

Appendices

Appendix 1 Probit and Tobit estimates of the determinants of music file-sharing

	Probit	Tobit	
		Total	New
Risk variables			
RIAA-Threat	−.087 (.359)	−.257* (.142)	−.232*** (.168)
Log(Penalty)	−.031 (.031)	−.012 (.011)	−.012 (.014)
Utility variables			
Value	−.162*** (.063)	−.099*** (.026)	−.096*** (.030)
Work	−.057 (.148)	−.043 (.053)	−.058 (.063)
University variables			
Campus	−.099 (.128)	.009 (.056)	.011 (.061)
Antipiracy	.420** (.192)	.118* (.071)	.057 (.178)
Innate variables			
Male	.201* (.126)	.078* (.048)	.165*** (.058)
Class	−.109* (.070)	−.059** (.024)	−.067** (.028)
White	.248* (.134)	.102** (.053)	.094** (.037)
Asian	−.016 (.202)	.219*** (.080)	.176** (.072)
Fairness variable	−.229** (.014)	-.053* (.032)	-.039***(.010)
Intercept	.752** (.313)	.632*** (.121)	.529***(.145)
Log-likelihood	−295.63***	−322.72***	−364.68
N	470	441	437

Note: Numbers in parentheses are asymptotic standard deviations. The asterisks *, **, *** indicate statistical significance at .1, .05, and .01, respectively

Appendix 2 Abridged version of the survey on music consumption

Note: The full-length survey included questions relating to both software and music consumption. This abridged version only shows questions relating to music consumption.

1. How frequently do you listen to music on a typical day?

___ virtually all day long
___ consistently throughout the day
___ sporadically throughout the day
___ only when played in the background
___ rarely to never

2. How frequently do you purchase or acquire music from the following sources?

	Daily	2-3/week	Once/week	Occasionally	Never
Physical Music Store	☐	☐	☐	☐	☐
Online Music Store	☐	☐	☐	☐	☐
File-Sharing Services	☐	☐	☐	☐	☐
Other Sources	☐	☐	☐	☐	☐

3. Do you currently download music from the Internet? Yes___ No___

3a. What percentage of your **total** music collection consists of music downloads that you obtained **at no cost via file-sharing**?

Specify an approximate percentage (from 0 – 100%): _____

3b. What percentage of your **new** music (music you obtained in the last six months) consists of downloads obtained **at no cost via file-sharing**?

Specify an approximate percentage (from 0 – 100%): _____

3c. What percentage of your music downloads did you purchase from a fee-based Internet music service?

Specify an approximate percentage (from 0 – 100%): _____

3d. If yes to Q.3, why do you download music? (check all that apply)

to save money___ to save time___ to obtain hard-to-find music___

4. Do you think Internet sites that allow individuals to download music for free (without the permission of the artist) should be shut down? Yes___ No___

5. Do you believe copying music or using file-sharing services is unfair to:

music artists? Yes___ No___
music distributors? Yes___ No___
music stores? Yes___ No___

Appendix 2 continued

6. If an Internet music service allows you to download any music for a fee, what price (if any) would you be willing to pay per song, on average?

   Specify an approximate amount (be specific): _____

7. The RIAA and other music associations have recently begun the process of pursuing litigation against individuals for file-sharing copyrighted music. Assuming a group of 100 average music file-sharers, how many do you think will actually face litigation, on average?

   Specify a number between 0 and 100: _____

8. If the music industry is successful in its litigation against individuals, what do you think will be the amount of money (if any) that guilty individuals will need to pay in fines, on average?

   Specify an amount of $: _____

9. Have you ever known anyone (either personally or in the news) who has been caught and punished for copyright piracy? Yes___ No___

   9a. If yes, did you know this person(s) personally? Yes___ No___

   9b. If yes, what type of media was being pirated? (check all that apply)
   Music___ Software___ Movies___ Books___ Other___

10. Are you familiar with any of the following programs on campus?

   10a. University Anti-Piracy Awareness Campaigns: Yes___ No___

   10b. Cases where a student was punished for plagiarism: Yes___ No___

   10c. Cases where the university has accused students or faculty of software or music copyright violations: Yes___ No___

Your Profile:

General Risk Perceptions:

a) When you make a major purchase (TV, Computer, etc), do you typically purchase the extended warranty if available?
   Always___ Usually___ Sometimes___ Rarely___ Never___

b) Do you currently have an insurance policy on your personal belongings?
   Renters insurance___ Home insurance___ Other___ None___

c) Whenever you take an exam, does the thought (or possibility) of cheating ever occur?
   Never___ Occasionally___ Usually___ Often___ Always___

Age:_____ Gender: F___ M___ Major_____

How do you classify your ethnicity? White/Caucasian___ Hispanic___
Asian___ Black/African-American___ Native American___ Other___

Class standing: Freshman___ Sophomore___ Junior___ Senior___ Grad Student___

Do you live on campus? Yes___ No___

Do you currently work? Yes, full-time___ Yes, part-time___ No___

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