FILE SHARING: CREATIVE DESTRUCTION OR JUST PLAIN DESTRUCTION?*

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ABSTRACT

The sharing of sound recordings over the Internet is the newest controversy in a long-running battle between copyright owners and copying technologies. In order to provide some context, perspective, and background, this paper examines the short history of file sharing, the longer history of record sales, various explanations for the change in record sales, and some analysis of the economics of copying. Although file sharing has been imperfectly and inconsistently measured, it nevertheless appears to reveal a fairly close linkage between changes in file sharing and changes in record sales. Explanations, other than file sharing, for the recent decline in record sales seem to have little or no support. Because economic theories of the impacts of copying hold out little hope for a benign impact of file sharing, these results should not be surprising. These findings reinforce the econometric results from most of an expanding literature.

I. INTRODUCTION

TEN years ago the term "file sharing" was unknown. Then Napster arrived, and both file sharing and Napster quickly became etched into the public's consciousness. Although Napster was effectively shut down as an unauthorized file-sharing service within 2 years of its birth, its progeny live on, as do new habits of music listeners. These dramatic changes have given us the now familiar additions to the lexicon such as "ripping" files from CDs, listening to MP3s on iPods, and, of course, downloading files online using programs such as Kazaa or Grokster.

Yet the file-sharing saga and the controversy surrounding it might appear a mere replaying of a narrative we have encountered several times before. The photocopier, introduced by Xerox in 1959, allowed individuals to cheaply and conveniently copy printed pages. Audiotaping, which became popular in the 1970s, made it easy and inexpensive for individuals to copy sound

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recordings, with dual cassette decks intended for high-speed copying becoming commonplace. Videotaping, which became popular in the 1980s, allowed individuals to copy broadcasts and prerecorded movies.

The copyright industries reacted negatively when each of these copying technologies appeared. The publishing industry complained about photocopying, although an analysis by Liebowitz (1985) concluded that photocopying was beneficial to the industry. The movie and television industries brought suit to stop the video recorder, but after the Supreme Court's ruling (*Sony Corp. of America v. Universal City Studios,* 464 U.S. 417 [1984]) went against these industries, a new market emerged—prerecorded video—which, although largely unanticipated, now provides the movie industry with revenues far in excess of box office revenues.[1]

The sound-recording industry had an equally negative response to copying technology. No less a luminary than Alan Greenspan, prior to his becoming chairman of the Federal Reserve Bank, stated, "At present . . . severe economic damage [is being done] to the property rights of owners of copyrights in sound recordings and musical compositions. . . . [U]nder present and emerging conditions, the industry simply has no out. . . . Unless something meaningful is done to respond to the . . . problem, the industry itself is at risk" (U.S. Senate 1983). Sales of sound recordings began a decade-long expansion not long after this testimony (ending a 4-year decline), once again making the claims of concern by the copyright industry appear unwarranted.

Nevertheless, as explained in Section IV, the role of these older copying technologies as economic precedents is limited both because there are important differences between file sharing and these prior copying technologies and because the impacts of these technologies were not so clear-cut.

Each of the previous copying technologies brought forth some work by economists on the economics of copying, although the focus was more on theory than empirics (for surveys, see Varian 2005; Watt 2004). Among the problems with conducting empirical analyses of these older technologies was the difficulty in measuring the extent of unauthorized copying. One of the incidental benefits of the new digital copying technology should be to provide better data, although a great deal of imprecision remains.

This current copying technology of file sharing was personified by Shawn Fanning, who created Napster with the purpose of allowing music files to be shared among strangers. Napster began operations in mid-1999 and quickly rose to international prominence. The sound-recording industry experienced a dramatic swoon in sales beginning the next year, continuing unabated (with one informative exception) through 2005. The industry has blamed this sales decline on the rapid growth of file sharing and, in an attempt to stem the decline, has sued thousands of individuals heavily engaged in file sharing

[1] See Liebowitz (2004a), where prerecorded video revenues were estimated to be twice as high as revenues from theatrical showings.

(as well as suing the file-sharing services).[2] These lawsuits have led to a heated debate, often uninformed by facts. We are fortunate to have in this issue a detailed study by Bhattacharjee and colleagues (2006) that examines the impacts of those lawsuits on the amount of file sharing.

File sharing has generated far more attention than earlier copying technologies.[3] It is easy to dismiss the intense media coverage, as evidenced by *Time* magazine's putting Fanning on its cover (October 2, 2000), as just another case of romanticizing the impact of a new technology. Yet Napster truly began a revolution in music listening with a still uncertain impact on the entire economic model that has been used by the sound-recording industry for much of the last century. Copyright industries also tend to attract more attention than might appear warranted by their share of gross domestic product (GDP) alone.[4] This is most likely due to the fact that consuming these products occupies a majority of the time that individuals spend on leisure activities, with the average American watching 4.5 hours of television and listening to more than 3 hours of music each day (U.S. Census Bureau 2003). Thus the impact of these industries on the collective consciousness is very large.

Naturally, the current concern over the impacts of file sharing brought forth among economists a renewed interest in the economic consequences of copying. Recent econometric studies include, but are not limited to, the two very fine empirical examinations found in this issue—one by Rafael Rob and Joel Waldfogel (2006) and the other by Alejandro Zentner (2006; see also Blackburn 2004; Hong 2004; Michel 2005; Oberholzer-Gee and Strumpf 2005; Peitz and Waelbroeck 2004; Zentner 2005). Although neither of these two papers attempts to measure the impact of file sharing on the full U.S. sound-recording market, which is my focus in this paper, a recent econometric study (Liebowitz 2006) examines that specific question. All of the papers of which I am aware, except one, find that file sharing brings about some degree of harm to copyright owners.[5]

[2] According to the Recording Industry Association of America (RIAA) Web site, the recording industry announced plans to bring lawsuits against file sharers on June 25, 2003 (RIAA 2003c). On September 8, 2003, the RIAA brought what they referred to as the "first wave" of lawsuits against 261 individuals (RIAA 2003b).

[3] Besides the economic studies discussed in this paper, there are papers of a more philosophical legal bent, particularly from some very vocal critics who have voiced their unhappiness with copyright law and the entertainment industry. These copyright critics, sometimes associated with the concept of the "creative commons" and the Electronic Frontier Foundation, argue that copyright laws are being used by the sound recording, movie, and software industries to thwart innovative forces that would otherwise open up the market to new competition. See, for example, Lessig (2004).

[4] It is estimated to be between 5 and 7 percent of the gross domestic product (GDP), according to a report produced for a copyright trade association (Siwek 2002).

[5] The one paper that does not find file sharing to harm record sales is Oberholzer-Gee and Strumpf (2005). Of the other papers, which cover different countries, different time periods, and different approaches, some find results that could be classified as consistent with the

Econometric studies are usually self-contained, but they do not, or should not, occur in a vacuum. In order to make an informed judgment about the impact of file sharing it is useful to understand the industry background. This should include examining the nature and size of file sharing as best we know it and investigating the history of the sound-recording market to gain some perspective on the current decline. It is also useful to examine the economic theories of copying that have been suggested. Finally, no judgment would be complete without examining the range of possible sources of evidence, particularly sources that might not be amenable to inclusion in econometric studies. This paper attempts to perform some of these tasks.

II. The Brief History of File Sharing and Its Measurement

File sharing, simply put, allows one computer on the Internet to search for and access files on the hard drives of other computers that are connected to the Internet. Any individual on a file-sharing network can make available any file on his or her hard drive to all other members of the file-sharing network.

The term "file sharing" is actually something of a misnomer, however. Individuals do not "share" the files that move back and forth on the Internet. They do not experience these files together nor are they likely to ever meet or even know one another. Nor do they lend or trade the files among one another, since the files are not borrowed or given back. A more appropriate term might be "anonymous file copying," since that reflects what actually occurs. The end result of file sharing is that individuals who do not own and have not purchased a particular song or movie can nevertheless obtain that song or movie from unknown third parties.

Currently, file sharing encompasses sound recordings, films and television programs, computer software, various forms of pornography, and other products that can be digitized. Because music files are easily compressed, relatively small, very popular, and the primary type of file downloaded, they appear to be the best candidate for assessing the impact of file sharing itself.[6] As Internet transmission speeds increase, file sharing is likely to focus more

possibility that the entire decline might be due to file sharing (Blackburn 2004; Liebowitz 2006; Zentner 2005), while others (Hong 2004) apportion only a part of the decline to file sharing, and yet others are difficult to classify in this manner. A detailed discussion of this literature can be found in Liebowitz (2005).

[6] IDATE (2003) claimed that the ratio of audio files to video files was 100:1 in an October 28 report. Note, however, that the IDATE report seems of somewhat questionable value, as discussed below. Lyman and Varian (2003) report in their table 8.9 that although shared video files took up twice as much hard drive space as shared audio files, audio files were nevertheless 10 times as common as video files in 2003. An Organisation for Economic Co-operation and Development (2004, figure 5) report using data from BigChampagne claimed that the number of audio files transferred was only twice the number of video files in 2003. This claim seems somewhat implausible (unless most of these are short clips of pornography), given the enormous size of movie files.

on full-length movies and computer programs. This threatens or promises, depending on your point of view, to do for the movie and software industries what it has done for the sound-recording industry, which is one reason it is so important to understand its impacts.

Napster was, for all intents and purposes, shut down by a preliminary injunction granted to the recording industry in February 2001 (*A&M Records v. Napster*, 239 F.3d 1004 [9th Cir. 2001]). Into the void stepped numerous other file-sharing programs, particularly those that, unlike Napster, were not based on a central server. Figure 1 provides an estimate of the number of home-based file sharers in the United States during this transition. (Data are from Jupiter Media Metrix 2001; comScore Networks 2002.) The legal "victory" of the recording industry over Napster is not in evidence in these statistics, since the number of file sharers continued its upward trend within months of Napster's shutdown.

The impact of file sharing is something of a moving target, so we should not expect a single-sized impact at all times and all places. When Napster first came into existence in 1999, most downloaders would not have had in place CD burners, and MP3 players did not yet exist. MP3 files, therefore, were not terribly good substitutes for music purchased on a CD since the downloaded music was tethered to the computer. Any negative impact of file sharing at that time should have been quite small. Since then, devices that can play MP3 files have become increasingly popular, CD writers have become ubiquitous, and Internet speeds have increased as broadband has become more common, shortening the time needed to download songs.[7] Because file sharing currently produces files that are much better substitutes for purchased CDs than was the case at the time of Napster, any negative impact of file sharing per shared file should be greater now than it was in, say, 2000.[8]

The digital and public nature of file sharing would seem to make it more amenable to analysis than prior methods of copying. The reality of file-sharing measurements, however, does not yet live up to this promise.

Although there have been numerous news stories reporting statistics on

[7] In June 2002, according to Ipsos/Tempo (Ipsos-Reid 2002), 53 percent of American file sharers had CD burners, which was more than twice as high as for the general population as a whole. Ipsos/Tempo also reported that the penetration of CD burners for the general population increased from 22 percent to 31 percent from the first quarter of 2002 to the first quarter of 2004 ("Ownership of Digital Music Peripherals Trending" [slide], provided by Matt Kleinschmidt, senior research manager, Ipsos). If the growth in penetration for the population of downloaders was similar, this would have led to a penetration rate of 75 percent among those engaged in file sharing. Nielsen NetRatings reported that Broadband users represented 64 percent of Internet users in October 2005, up from less than 10 percent at the time of Napster, although the growth in broadband appeared to be slowing (data were provided by Kaizad Gotla, senior Internet analyst, Neilsen/NetRatings, September 2004).

[8] Nevertheless, they are not quite perfect substitutes. The compression involved with MP3 files reduces sonic quality, according to audio purists. Also, it takes some time and effort to download the files, so they are not quite free.

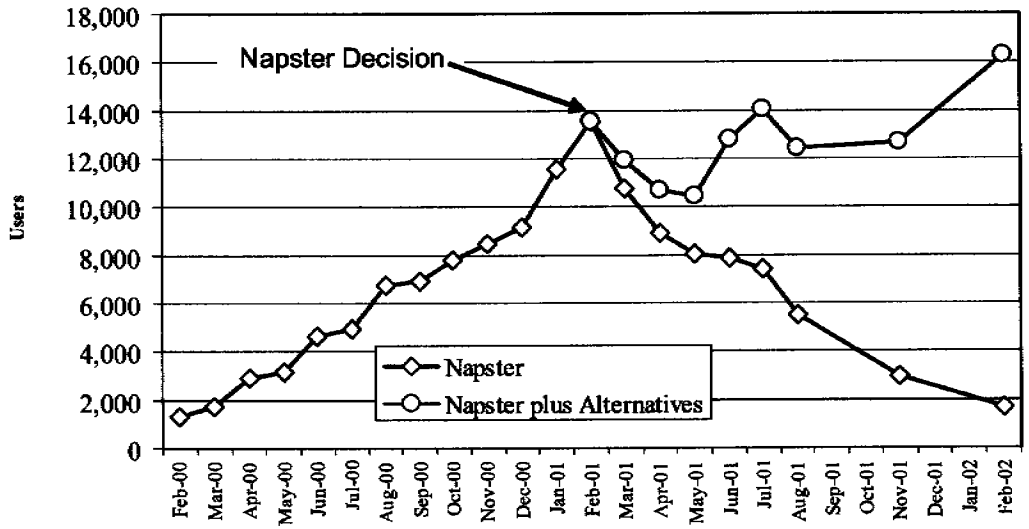

FIGURE 1.—American file sharers at home (1,000s)

file sharing, these reports generally cite the same few sources. At the time of Napster, the press quoted Webnoize almost exclusively regarding the number of files that were being downloaded (Evangelista 2001). It is not clear what methodology the (now defunct) Webnoize used, but it reported that 2.79 billion files had been transferred in Napster's peak month (February 2001) and that by August 2001 the number of files transferred on the four leading Napster replacements (FastTrack, Audiogalaxy, iMesh, and Gnutella) had reached above 3.05 billion per month (Geralds 2001). To put this in perspective, worldwide sales of music amounted to about 3 billion songs per month in 2000, so one might conclude from these figures that the number of songs being downloaded on file-sharing networks was equivalent to the number of songs purchased in the authorized retail market (IFPI 2001).[9] IDATE (2003) claims that worldwide file sharing was four times as large as worldwide sales in 2003.

The statistics reported for the American market, the focus of our analysis, also come from just a few key sources. At the high end, there are claims that up to 60 million Americans have used peer-to-peer networks,[10] that perhaps as many as 5 billion music files are downloaded by Americans in a typical month (18 files for every man, woman, and child!),[11] and that perhaps 60 percent or more of all Internet bandwidth is taken up by file sharing (Reuters 2003).[12] Although these are among the more striking numbers that have been put forward, even the more modest estimates appear less reliable than we would like. Before discussing the actual measurements, however, a brief discussion of the methodologies is in order.

There are various methodologies for measuring file sharing. Most count the number of participants in file-sharing activities (for example, comScore Media Metrix, Nielsen NetRatings, BigChampagne, the Pew Internet, and American Life Project). Nielsen and comScore examine the number of users of particular file-sharing programs, such as Kazaa or BitTorrent, on the basis

[9] IFPI (2001) reports 3.5 billion albums per year. If we assume 10 songs per album, this works out to 2.91 billion songs per month.

[10] The Electronic Frontier Foundation reports that 60 million Americans use file-sharing software (File Sharing: It's Music to Our Ears, at http://www.eff.org/share/), but it is not clear where that estimate comes from.

[11] According to IDATE (2003), there were either 65 billion audio files downloaded in the United States in 2003 or 12 billion in the world, depending on which of two seemingly inconsistent statements you wish to believe. The breathless prose goes on to predict that by 2007 broadband users will download an average of 4,300 audio files per year, which seems somewhat fanciful.

[12] IDATE (2003) reports that "According to virtually all the experts in this field, P2P represents on average between 50% and 60% of all broadband traffic during the daytime, and as much as 80% to 90% of all night time traffic."

of panels of users.[13] Since the number of programs available to users is large and growing, data based on the number of users of a particular program have become less reliable over time as a measure of aggregate downloads.[14] BigChampagne measures the number of users of file-sharing networks.[15] BigChampagne's method of measuring the activity on file-sharing networks is proprietary and therefore difficult to judge.[16] The NPD Group is the only organization, to my knowledge, that attempts to monitor the number of files actually transferred by a panel of users. The Pew Internet and Society Project conducts numerous surveys on Internet usage, as do Ipsos/Tempo and Forrester. The hearings that led to the preliminary injunction against Napster featured dueling surveys offering opposing opinions about the impact of file sharing (on the Napster surveys, see Liebowitz 2002, chap. 7).

Unfortunately, each data source, regardless of data type or methodology, suffers from one or more imperfections. All panel-based data sources are open to the criticism that the panel might not reflect the user population. For example, it is plausible that voluntary Internet panels might underrepresent the population of people actively engaged in file sharing, as those users may be particularly reluctant to have their computers monitored by third-party software.[17]

[13] Panel members agree to allow a program to monitor and report their computer usage in return for some nominal compensation. These panels range from a few thousand to the hundreds of thousands. Alternatively, it is possible to create a panel whose members are unaware of being monitored, as Bhattacharjee et al. (2006) have done.

[14] If file sharers were migrating away from monitored programs toward programs that were not monitored, such measurements will undercount users. Companies such as comScore tried to update their list of programs to keep up to date, but this always lagged somewhat behind the behavior of users. In August 2005 I was told that comScore was no longer reporting these measurements because they did not feel they could keep up with all the new programs (Graham Mudd, industry analysis manager, comScore Networks, telephone conversation with the author, August 1, 2005). The number of users followed by Bhattacharjee et al. (2006) would also suffer from this same problem.

[15] There are often several different software programs that use the same network. These networks are not identical to the programs that use these networks. For example, Kazaa, Grokster, Kazaa Lite (a competitor to Kazaa), and iMesh all use the FastTrack network, but there are also other networks, such as Gnutella and DirectConnect, that are used by other programs.

[16] For a critique of BigChampagne's methods, see Lawrence (2003). I have a concern with the claimed peak and average values, which seem too close to one another. The peak monthly values (measured every few minutes) are only about 60 percent above the average values in the last half of 2003 and only about 30 percent higher in the first half of 2004. Eric Garland, chief executive officer of BigChampagne, suggests that this small difference between peak and average monthly values is due to the fact that many Internet users keep their computers and file-sharing software running 24 hours a day (e-mailed correspondence with the author, October 2004). I find it unlikely that dial-up users (who were in the majority) keep their phone lines occupied 24 hours a day, but further analysis would be useful.

[17] This criticism loses some force from the fact that most file-sharing software (for example, Kazaa) includes spyware and adware, which monitor the usage of the computer for vendors of various products. This means that many file sharers have already allowed third-party software on their computer and in many cases they were aware of it.

TABLE 1

PERCENTAGE OF ADULT POPULATION ANSWERING YES TO THE QUESTION, "DO YOU EVER DOWNLOAD MUSIC FILES ONTO YOUR COMPUTER SO YOU CAN PLAY THEM AT ANY TIME YOU WANT?"

	July–August 2000	August–September 2001	October 2002	June 2003	November 2003	May–June 2004	February 2005
Overall	11	15	19	19	9	13	13
18–29	25	36	41	43	23	31	32
30–49	11	16	21	20	9	11	13
50–64	3	6	8	8	4	6	7
65+	2	2	3	1	2	2	1
Men	12	19	22	23	12	17	14
Women	10	13	16	15	7	9	12

SOURCE.—Pew Internet Project, "Usage over Time" (spreadsheet) (http://www.pewinternet.org/trends/UsageOverTime.xls).

Metrics based on the number of users alone might fail to capture increases or decreases in the number of files exchanged per user. Such changes can be large even when the number of individuals using file-sharing software is stable, as, for example, when users are shifting to broadband. Finally, to the extent that movies, video games, and computer files take up changing shares of the file-sharing universe, measures of overall file sharing might not properly reflect the downloading of music files.

Surveys suffer from potential problems where consumers might not know the answers to the questions they are being asked or where they might be reluctant to tell the truth if that means possibly incriminating themselves or (in their minds) inviting a lawsuit. These fears should tend to generate answers that understate the extent of file sharing. The survey used by Zentner (2006) is based on consumers in Europe, where this controversy has been less political and at a time when such lawsuits had not yet come into existence. The surveys used by Rob and Waldfogel (2006) were conducted in conditions where the respondents knew the identity of those giving the surveys and the purpose of the survey. In each of these cases the likelihood of intentionally incorrect answers was lessened. Nevertheless, the expectation in each case would be that the answers might be somewhat biased toward lowering the impact of file sharing. The Pew surveys suffer more seriously from this problem, particularly after the lawsuits began in mid-2003.

With these caveats in place, what do the data tell us about file sharing? Results from the Pew Internet and American Life project indicate that music file sharers tend to be young and male and more likely to be poor and less educated (see Rainie et al. 2004, p. 4). Table 1 provides some of their statistics.[18] These numbers are consistent with a view that file sharing is a

[18] To construct this table, I multiplied the percentage of respondents answering this question in the affirmative, which was asked only to those with Internet access, by the number of respondents claiming to have Internet access.

very popular activity.[19] The sharp decline from June 2003 to November 2003 is also fully consistent with the Bhattacharjee et al. (2006) finding that the initiation of Recording Industry Association of America (RIAA) lawsuits reduced file sharing. These numbers appear to be considerably higher than the European value of 9 percent reported by Zentner (2006) based on the October 2001 European Forrester Research survey, but that survey asked if users "regularly" downloaded music, so the two are not strictly comparable. A slightly later Forrester survey (Stagia 2002) had numbers closer to, but still lower than, the Pew values.[20]

What do the other data sources have to say about the number of file sharers? ComScore claims that there were 40 million unduplicated users of file-sharing software during January 2003, which is in general agreement with the Pew numbers. BigChampagne measured the average number of "simultaneous" users in January 2003 to be just shy of 4 million users. It is difficult to compare BigChampagne numbers with comScore since comScore essentially measures, by way of analogy to television and radio, the reach per month, which is always a higher number than average audience.

Do these data allow us to draw any conclusions about the historical trend in organized file sharing? Clearly, organized file sharing stood at zero in 1998. We know from Figure 1 that the important growth did not start until 2000. The Pew surveys in Table 1 indicate an increase in the popularity of file sharing on the order of 70 percent from the summer of 2000 to October of 2002, which is smaller than what comScore reports in Figure 1, even though the comScore figures only go through February 2002.

In Figure 2, which allows examination of the more recent trends, each of three data sets is normalized so that its starting measurement is 1 in order to make the numbers somewhat comparable. Both of the data sets with full-year 2003 data indicate a substantial drop during 2003, with comScore (and Pew in Table 1) matching these declines directly to the RIAA lawsuits (as do Bhattacharjee et al. 2006), although BigChampagne shows the declines beginning before the lawsuits were announced.[21] File sharing appears to have

[19] If the question "Do you ever . . . " were interpreted in the past tense, such as "Have you ever . . . " we would not expect the numbers to ever fall as long as respondents are being truthful. The decline that does occur can be taken either as evidence that the question is not interpreted as "Have you ever . . . " or that some respondents might have begun to lie because of fear of prosecution. It is also possible that some respondents might have stopped downloading but still answer the question in the affirmative because they interpret the question to mean "Have you ever . . . ?"

[20] A Forrester survey in the second quarter of 2002 indicated that 29 percent of European Internet users had ever downloaded music, and since slightly more than half of the population used the Internet, this would imply that on the order of 15 percent of the population had downloaded music, which is fairly close but still slightly below the American Pew figure.

[21] Pew and comScore produced a joint report directly crediting the lawsuits with decline in file sharers (Madden and Lenhart 2004). This result is not without contention. Some have argued that the lawsuits have had virtually no impact (Karagiannis et al. 2004). The Karagiannis et al. paper bases its results on a single 1-hour observation prior to the lawsuits and a single 1-hour observation after the lawsuits, with very few controls.

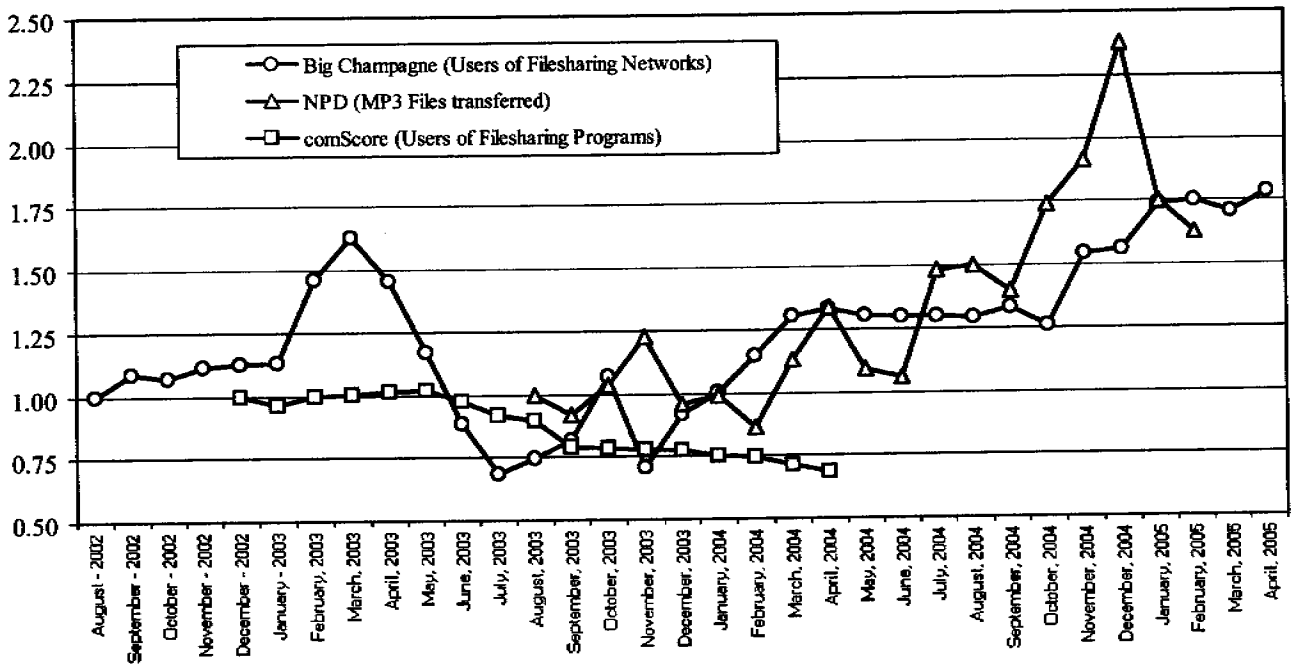

FIGURE 2.—Various measurements of file sharing

increased again in 2004, although BigChampagne shows file sharing returning to (and then surpassing) its 2003 peak, whereas the Pew surveys indicate that it did not return to its prior peak through 2004.[22]

This brings us to measurements of the absolute size of file-sharing activities. The dispersion of estimates is nothing short of remarkable. If the Webnoize statistics on Napster use had been accurate, and if the United States contributed 30 percent of the world usage of Napster, this would have implied about 1 billion files per month downloaded by Americans.[23] By way of comparison, there were about 800 million albums sold yearly in 2003 and 2004, which works out to 800 million files per month if there were 12 songs per album. The Webonize estimate is lower than the more recent statistic of 5 billion files per month reported by IDATE, which was mentioned at the beginning of this section. But both of these estimates are in stark contrast to the numbers reported by NPD.

NPD reports that for 2004 there were 225 million music files downloaded in the United States. This is less than one-twentieth the monthly estimates reported by IDATE and less than one-fourth the numbers reported by Webnoize for a period 3 years earlier. Since the methodology behind NPD's numbers is fairly transparent, whereas that of Webnoize is unknown, and since some of IDATE's prognostications appear rather incredible, it is tempting to accept the NPD data as correct. Although it is probably premature to go that far, the NPD data should probably be taken as the current standard.

The NPD data, if correct, indicate that file-sharing activity, instead of surpassing the legitimate music business in size, is actually considerably dwarfed by the legitimate market (legitimate market purchases were approximately three times as large in 2004).

The absolute size of file-sharing activities has an importance quite separate from the information found in the trends of file-sharing activities. When downloads appear much more numerous than any possible decline in sales, as is the case with Webnoize and IDATE estimates, it is obvious that a large portion of downloaded files do not replace the purchase of originals. This would be consistent with Rob and Waldfogel's (2006) ordinary least squares estimates that they take to be a likely underestimate of the impact of file sharing for their population of users (college students). If the NPD figures are correct, however, the number of files shared is fairly similar to the decline in sales, a result that would be consistent with Rob and Waldfogel's larger instrumental variables estimate if file sharing were the sole cause of the sales decline.

[22] ComScore did not report this upturn in 2004, but it stopped reporting in 2004 after throwing in the towel on its methodology, as explained in note 14.

[23] NUA reports that in August 2001 there were 515 million Internet users worldwide and 166 million in the United States and Canada. See http://web.archive.org/web/20050331085826/www.nua.ie/surveys/how_many_online/.

In conclusion, we can state that file sharing is a very popular activity. Although claims have been made that more music files are obtained this way than through retail purchases, these claims may exaggerate somewhat the size of file-sharing activity. File sharing grew very rapidly in its first year or two and then continued to grow until the introduction of the RIAA lawsuits. The lawsuits caused a diminution of file-sharing activity, although this activity has since increased. File-sharing activity appeared to be higher in 2005 than it had been prior to the lawsuits, although there is no complete agreement on this claim. Although a history can be pieced together, the data do not allow easy and transparent analysis.

III. The History of Record Sales

Data on the sales of recorded music in the United States are available from the RIAA as well as for purchase from Nielsen SoundScan. The RIAA reports information on all shipments (net of returns), whereas SoundScan reports shipments based on data from retail outlets. Although the two sources of data should and do provide similar results most of the time, there are some notable differences.[24] SoundScan, although it includes Internet retailers, does not include information on nonretail outlets such as record clubs and direct selling on television, which were responsible for 25 percent of all units sold in the late 1990s. The recent decline in sound-recording sales has fallen disproportionately on nonretail units (nonretail outlets accounted for 42 percent of the total decline in units that has occurred since 1999), so there is a danger in underestimating the impact of file sharing by using SoundScan data (used in regressions by Blackburn 2004; Liebowitz 2006; and Oberholzer-Gee and Strumpf 2005).

Figure 3 represents (as closed circles) the per capita sale of full-length albums sold in the United States since 1973 using RIAA data (RIAA 2003a).[25] Although the RIAA data include unit quantities and dollar revenues, the revenues are merely hypothetical numbers based on list prices and are not actual transaction revenues. The RIAA unit measurements, therefore, are to be preferred to the RIAA revenue values. Prerecorded singles are excluded from the analysis (except for downloaded digital songs, which are included but grouped into virtual albums by dividing the number of such digital songs by 10) because they have experienced a very strong decline as part of what appears to be a long secular trend quite separate from file sharing. The 2005

[24] SoundScan data report the sales decline beginning after 2000 instead of 1999. The severity of the decline is considerably greater with RIAA numbers than with SoundScan numbers, even after correcting for record clubs, although it is not clear why.

[25] The data begin in 1973 because that is when units sold were first reported. For prior years only the industry revenues were reported. Pre-1990 data are from Joseph Jones, RIAA, communication with the author, August 2002.

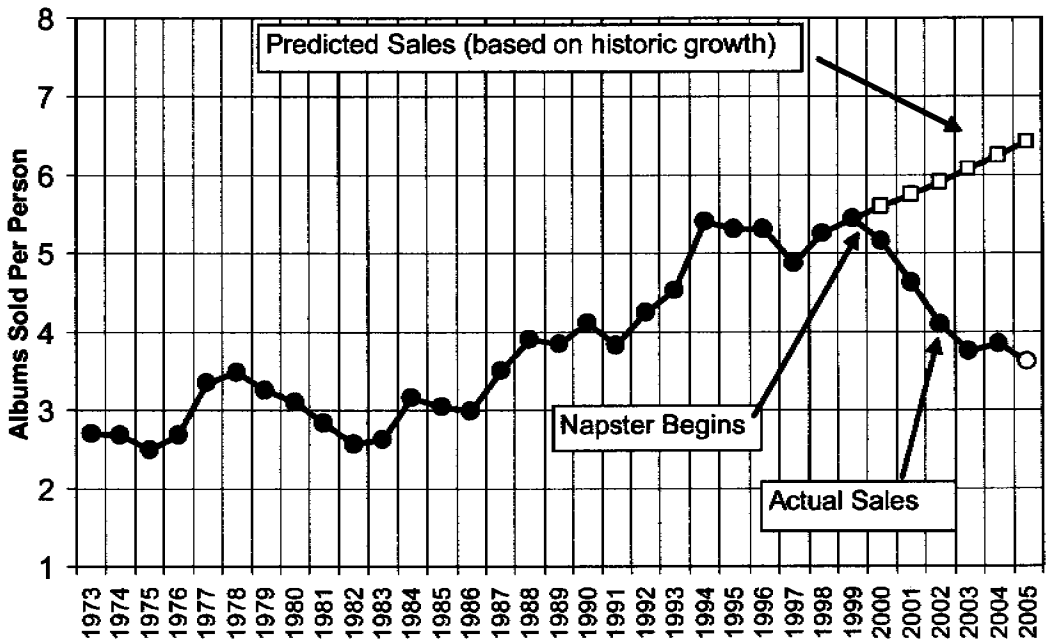

FIGURE 3.—Albums sold per capita

TABLE 2

YEAR-TO-YEAR PERCENTAGE CHANGES IN HALF-YEAR UNIT SALES OF ALBUMS

Period	Change	Period	Change
2000-1	1.25	2003-1	−16.7
2000-2	−8.24	2003-2	−1.15
2001-1	−8.36	2004-1	5.32
2001-2	−9.40	2004-2	2.15
2002-1	−8.06	2005-1	−4.14
2002-2	−11.62		

SOURCE.—Recording Industry Association of America (2003a).

value (appearing as an empty circle) is an estimate based on SoundScan results since full-year RIAA results were not yet available for 2005.[26]

The sales decline that begins in 2000 is clearly the largest that has occurred in this period. The timing of this decline is quite striking. This decline begins the year after the arrival of Napster and, as can be seen from Figure 1, the year that Napster ramped up its user base. The pattern of file sharing's birth and rapid growth followed immediately by the unusually large decline in the sound-recording market is in itself a strong clue that file sharing is responsible for the sales decline.

Figure 3 also reports what sales would have been if, counterfactually, they had continued to grow at their prior average rate after Napster's introduction, represented by the squares.[27] Looked at this way, the sales deficit might be considerably larger than the sales decline.

The year 2004 might appear to be something of an anomaly since it is the only year after the advent of file sharing without a sales decline. Some press reports (and economists) have suggested that the failure of sales to fall was evidence that file sharing did not have the pernicious impacts that had been attributed to it.[28] Although one could always just write off this sales increase as being a random fluctuation in sales due to factors such as an abundant crop of popular albums being released, the results actually fit into a pattern consistent with the hypothesis that file sharing is harmful to industry sales.

Table 2 provides details on half-year unit sales of full-length albums using

[26] Sales for combined CDs and digital downloads were down approximately 5 percent for 2005, according to reports based on SoundScan data. Midyear statistics from the RIAA reported a sales decline of −4.14 percent.

[27] If one regresses unit sales on either disposable income or GDP through 1999 and calculates predicted values of album sales, one gets an almost identical predicted sales line.

[28] See Charman (2004), which includes quotes from economists. She states, "[T]here is one final fly in the ointment that can't easily be explained away: during the past nine months, CD sales in America have increased by 7%, despite continued growth in file sharing."

TABLE 3

ALBUM SALES BY GENRE (1,000s)

	Classical	Jazz	Hard	Alternative	Rap	R&B	Country
2000	16,403	18,416	89,924	131,138	105,515	197,141	67,115
2001	15,846	19,514	88,158	131,594	89,279	195,498	67,241
2002	14,776	19,901	74,677	125,752	83,346	160,183	75,362
2003	17,727	22,366	74,629	128,344	75,854	149,972	70,944
2004	19,098	19,156	76,887	135,317	81,558	165,364	82,041
% Change:							
2000–2004	16.43	4.02	−14.50	3.19	−22.70	−16.12	22.24
2000–2003	8.07	21.45	−17.01	−2.13	−28.11	−23.93	5.71

SOURCE.—Data purchased from Nielsen SoundScan.

for more detail.[32] Nevertheless, at the most basic level it is plausible that two genres that are less likely to be downloaded in file-sharing systems, classical and jazz, did not participate in the sales decline, whereas other genres that are more likely to be heavily affected by file sharing (hard rock, rap, alternative, R&B) generally did participate in the decline. Since the sales decline paused in 2004, the yearly changes are calculated for periods ending in both 2003 and 2004.

IV. ECONOMIC THEORY OF FILE SHARING'S IMPACT

In the last few decades, economists have come to understand that unauthorized copying of originals need not have negative effects on copyright owners. The question becomes the relative strength of potentially competing economic impacts.

The first of these potential impacts is that the unauthorized downloading of a copyrighted file can be a substitute for the purchase of that copyrighted work. The substitution of a downloaded copy for a purchased original obviously has a negative impact on sales. It is hard to imagine that this substitution effect does not play an important role for some reasonable subset of the downloading population.

The second potential behavior engendered by file sharing might occur if users downloaded songs with the purpose of finding those songs and albums that most closely matched their tastes. These consumers would then adjust their purchases in accordance with this new information. Although this idea can be traced back several decades, and was originally referred to as the exposure effect (Liebowitz 1985), it is currently called the sampling effect.

This sampling hypothesis is usually accompanied by a claim that the seller

[32] Genre statistics are quite unreliable because of changes in genre definition and double counting of albums in multiple genres, which is discussed in Liebowitz (2006). That paper performs regressions using genre-based sales in cities as one of the sets of dependent variables. The results from the regressions are in general agreement with these simple statistics.

will benefit if consumers are allowed to become more familiar with the product before they purchase it.[33] As I have argued (Liebowitz 2005), however, sampling in the market for music files has an ambiguous impact on record sales. Using an insight of Jack Hirshleifer (1971), the basic idea is that albums that have more prescreening by consumers will contain, on average, music that provides greater utility than would otherwise be the case, or a greater amount of what we can call "music service." This prescreening has the effect of rotating the demand for albums clockwise. Because the initial albums purchased will have more music-listening services, this will raise the price intercept, but because satiation of music-listening services can be achieved with a smaller number of albums, the quantity intercept declines. Even if one were to argue that the demand for music services is never satiated (which implies that time is the constraint on consumption), a seemingly reasonable assumption that consumers spend more time listening to albums with more music-listening services would also lead to the conclusion that sampling will reduce the number of albums they listen to in their fixed amount of time. Therefore, even if a large subset of file sharers engaged in sampling, there would be no reason to believe it would counterbalance the negative impacts of the substitution effect.

A third potential impact of file sharing is related to possible network effects in music listening. Models such as those found in Conner and Rumelt (1991) and Takeyama (1994) demonstrate that under certain conditions unauthorized users of an intellectual product might create sufficient additional value to the purchasers of legitimate copies that sellers might benefit from the unauthorized use. For example, if individuals become familiar with a spreadsheet by using an unauthorized copy, then their employers, who purchase legitimate copies, might place higher values on purchasing spreadsheets because of the now lower training costs. Several issues arise in trying to apply this logic to sound recordings, as has recently been attempted by Gayer and Shy (2005). The first is whether there are network effects at all for music listening. A second issue is whether such network effects, if they exist, would work to alter the size of the total market, as assumed by these theorists, or merely shift demand among different sound recordings. Finally, a simple but practical difficulty with applying the network effects model to file sharing is that radio already allows unlimited music listening at zero cost. Thus, it is difficult to imagine that file sharing would provide any new network effects.

Some additional support for a skeptical view of network effects and sampling comes from examining the impact of radio play (which should allow

[33] This claim has been made, for example, by Hall (2000) in his expert report in the *Napster* case.

sampling and create network effects) on overall record sales, where there does not appear to be a positive relationship.[34]

A final possible impact of copying is indirect appropriability. This is a concept coined by Liebowitz (1985) and recently championed by Boldrin and Levine (2004). The basic idea is that demand for originals from which copies are made might increase as those making copies of originals capture some of the value from those receiving the copies. In order for indirect appropriability to work, however, one of two market conditions must hold. Either the variability in the number of copies made must be small, as would be the case if everyone made one copy of a CD for use in his or her automobile. Alternatively, the seller would need to be able to identify those originals from which the most copies are made and then charge higher prices for those originals, just as journal publishers charge higher prices to libraries than to individual subscribers.

Because there is great variability in the copies made from each original on file-sharing systems and the sellers of originals cannot identify which originals are going to be used on file-sharing systems, the mechanisms that allow indirect appropriability to function will not work, as noted in Klein, Lerner, and Murphy (2002). Perhaps even more fundamental, indirect appropriability requires a mechanism that transmits the values from those using copies to those providing copies—indirect appropriability requires appropriation. The pure anonymity and zero payments involved with file sharing preclude this possibility.

In sum, economic theory provides only a very thin foundation on which to support any expected impact of file sharing on sales of sound recordings other than a negative one. Nor does the history of copyright owners trying to suppress new copying technologies, only to discover the benefits after losing the battle, provide much support for a claim that critics of copying are generally myopic. The two prior technologies that are thought to have most clearly benefited copyright owners, photocopying and VCRs, had some unique characteristics not shared by file sharing.

Photocopying was well positioned for strong indirect appropriability because the copyrighted products most heavily photocopied were journal articles and that copying took place mainly in libraries. Thus, publishers were able to identify the originals that were being copied (library subscriptions) and charge higher prices to libraries than to individuals. Liebowitz (1985) documents that this price discrimination began contemporaneously with the adoption of photocopiers and that the price differentials were related to the frequency with which articles were copied.

The net impact of VCRs on copyright owners was also positive, but for a very different reason. Although producers of movies and television pro-

[34] The impact of radio play on record sales has been examined in historical context in Liebowitz (2004a) and using econometrics in Liebowitz (2006).

grams sued to stop the VCR, it was not out of fear that prerecorded movies would be harmed but instead that television advertising would be harmed. When the original Betamax VCR (for which the case was popularly named) came on the market, it was not even capable of recording a movie since its playing time was limited to 1 hour. Any impact of VCRs on the television market turned out to be small for several reasons, the most basic being that recording television programs did not become an important activity (relative to overall viewing) for viewers. Instead, VCRs were mainly used to view rented and purchased prerecorded movies, an extremely popular activity that provided an enormous boost to movie producers.

Although movie producers clearly benefited from the VCR, the copying ability of VCRs might nevertheless have reduced somewhat the market for prerecorded movies. Since making an unauthorized copy of a movie would have required two VCRs or a machine capable of holding two cassettes, both fairly rare occurrences, any impact would likely have been minor. Even so, some prerecorded tapes eventually came with a form of copy protection, which indicates that there was at least some concern about this type of copying.

The impact of audio cassette taping on the market for sound recordings is not clear. Although Alan Greenspan attributed the decline in sales from 1978 to 1982 to audiotaping (U.S. Senate 1983), the market turned around shortly after, even as audiotaping continued to increase. Complicating the measurements were the new uses for prerecorded music brought about by the advent of audio cassettes—the ability to play prerecorded music on portable devices and in automobiles.[35] Even if audio copying per se had a consequential negative impact on sales, it might have been overwhelmed by the positive impact of the new markets opened up by audio cassettes.

If digital files such as MP3s open up new markets, a similar confounding of results might occur, but as ubiquitous as iPods might have seemed on college campuses, unit sales of MP3 players were still only half those of portable CD players in 2004, and the installed base was far smaller, seemingly too small to have an important impact on the amount of music listening. Further, although MP3 players hold more music and are smaller than prior portable players, it is not clear whether they will open up new listening locations the way that cassette players did. Of course, if iPod sales continue to grow at their recent explosive rate and do lead to a boom in music listening, the resulting increase in music usage might overcome the pernicious effects of file sharing, and the sales decline may come to an end in spite of increases in file sharing.

There are two other important differences between audiotaping and file

[35] Prior to the cassette, the only portable form of music was radio. The growth in albums during the later 1980s closely matches the growth in penetration of portable cassette and CD players. See Liebowitz (2004b).

sharing. First, audiotaping required getting an original from a personal acquaintance. The library of albums held by acquaintances is limited. Second, since the quality of a taped copy degraded with each generation, copies could not travel very far down a network of acquaintances. Since those making copies needed to be in proximity to those purchasing originals, there was a natural damping mechanism on the impacts of copying.

File sharing has neither of these attributes. Copies are made from complete strangers and, thanks to digitization, there is no limit to how many generations deep a copy might be while still retaining its original audio quality. Further, the collection of songs held on file-sharing networks is enormous. File sharing, therefore, would seem likely to exert a more negative impact on sales than did prior analog copying technologies.

V. Investigating Alternative Explanations

There are obviously many factors that could have had an impact on record sales besides file sharing, many of which cannot be easily fit into an econometric study. Although it is not necessarily the burden of any individual paper to answer, a finding that file sharing played little or no role in the unusually large CD sales decline would leave us with the instant question, what did? Alternatively, if econometric studies indicate that file sharing is responsible for most of the decline, a look at other plausible explanations provides an additional check on the econometric results.

I have examined some of these alternative factors in prior work (Liebowitz 2004b) and will summarize that work here. The factors considered were album prices, income, music quality (measured by concerts and radio listenership), markets for substitutes and complements, the opening of new listening venues (portability), and "librarying"—the act of replenishing album collections as formats change, such as replacing prerecorded cassettes with CDs. The findings were (1) that list prices adjusted for inflation have been virtually constant for the last decade, disallowing price (as far as we can measure it) as an explanation of the sales decline. (2) Real GDP (and disposable income) was related to record sales, but the recession of 2001 was insufficient to account for even a small part of the sales decline and cannot explain the continued sales decline. (3) Trends in videogame receipts and movie box office receipts did not change in or around the year 2000. (4) The increased portability of prerecorded music brought about by audiocassettes (and CDs) appears to have played an important role in the increased sales of prerecorded music, but there has been no ascertainable decrease in portability, and the rise of the iPod would make such a claim risible. (5) There was no noticeable impact of librarying, whether from LPs to cassettes or cassettes to CDs. (6) Although overall radio listenership has fallen over this period, the decline was centered on categories of old music; the audience for contemporary music actually increased.

Finally, it has been suggested by Oberholzer-Gee and Strumpf (2005, p. 35) that DVD growth might be the primary alternative suspect for the fall in CD sales: "A shift in entertainment spending towards recorded movies alone can largely explain the reduction in music sales. The sales of DVDs and VHS tapes increased by over $5 billion between 1999 and 2003. This figure more than offsets the $2.6 billion reduction in album sales since 1999. The shift in spending in part reflects a sharp change in relative prices: since 1999 CD prices increased 10% while DVD prices decreased by 20%, and the price of DVD players fell by 60%."

Could the noted increase in DVD sales (and decline in DVD price) be responsible for the decline in CD sales?[36] The evidence, more fully presented, does not support this view.

The main difficulty with this claim is that it isolates the DVD market as sui generis and limits its scope to a time when the prerecorded video market was going through an important format transition. It seems more appropriate to examine the entire video market, which was mainly VHS in 1999 and remained primarily VHS until 2002. Unlike DVDs, prerecorded movies as a whole have not undergone a sustained a price drop but instead have had essentially flat real prices over this interval.[37] Since CD prices were also constant, in real terms, the relative prices of video and audio has largely been unchanged over this period.

Further, the video market has changed in an important but more subtle way. On initial inspection the combined sales of VHS and DVD movies has increased substantially, and it is even the case that an acceleration in revenue growth appears to have occurred in the period 1999–2000, which would seem to support their thesis. This is shown as the bottom line in Figure 4.

A closer inspection of the markets, however, reveals that the increase in sales of prerecorded movies that has occurred in the last few years came largely at the expense video rentals. The top line in Figure 4 represents (real per capita) expenditures on combined video sales and rentals. By way of contrast, this trend shows little in the way of any change around the year 2000. That is because expenditures on rentals fell 18 percent in this period.

Finally, if one wanted to test the suggestion that the prerecorded video market was likely to influence the sales of sound recordings, the period from 1983 to 1989 would obviously be the place to look since the increase in video revenues during that period dwarfs that from any other period. Yet not only was there was no pronounced decline in record sales during the mid to

[36] We should note that while it is true that real DVD prices fell during this period, the real list prices of CDs can be more accurately said to have remained constant, rising 3.2 percent from 1999 to 2003 but falling 1.1 percent from 1999 to 2004.

[37] According to data purchased from Adams Media Research (27865 Berwick Drive, Carmel, CA 93923), the real price (in 1998 dollars) of all prerecorded movies was $12.96, $13.44, $13.66, $13.19, $13.23, and $13.17 from 1998 through 2003. DVD prices, which were initially much higher than VHS prices, dropped 33 percent during this same period.

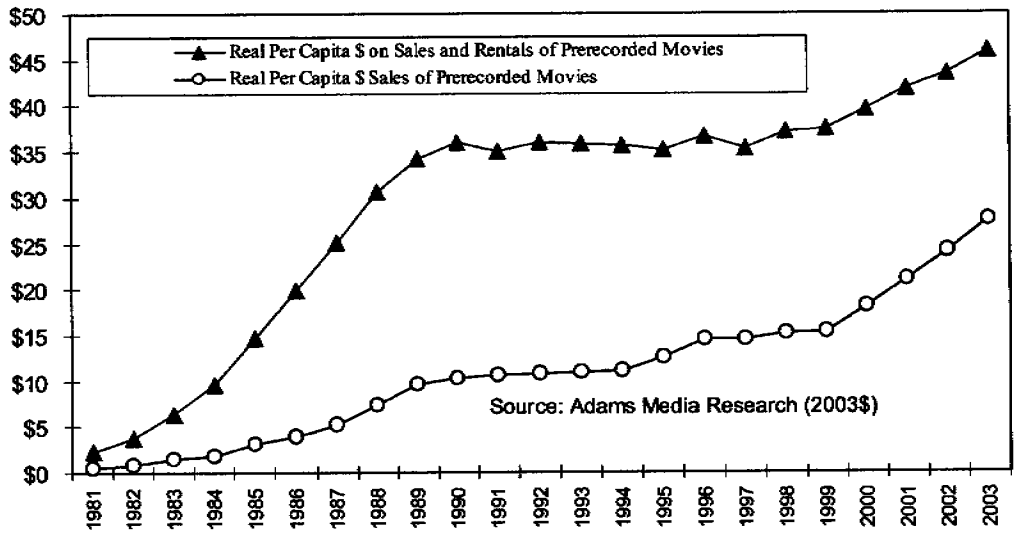

FIGURE 4.—Change in prerecorded movie sales and rentals

late 1980s, there was a fairly robust increase. Thus, the evidence from the prerecorded video market, as was the case with other substitutes, does not support a claim that consumers suddenly abandoned music for alternative forms of entertainment. We thus appear left with no viable alternative explanation other than file sharing.

VI. Conclusions

File sharing is the newest and most publicized copying technology. With the advent of each of the earlier copying technologies, questions were raised about the impact of the new technology on copyright owners. Data, however, were sparse, and only a small number of statistical studies were undertaken. Instead, answers tended to come through the rearview mirror as is the case with video recorders, where 20 years after their arrival the movie industry is observed to derive more revenues from selling prerecorded videotapes than from theatrical exhibitions.

The digital characteristic of file sharing, and the fact that it is undertaken through computers—devices capable of measuring the activity we wish to analyze—seemed as if it would provide economists with an unprecedented cornucopia of high-quality data. The data have not yet lived up to this expectation. Nevertheless, various examinations of the impact of file sharing have been undertaken, although many of them depend on old-fashioned survey results.

One needs to be careful in wading through the data that are there. There are inconsistencies among these data sets in terms of both the fluctuations and the quantity of file sharing that is taking place. Even such seemingly straightforward measures as the number of sound recordings sold have hidden traps for the unwary analyst.

All the same, the evidence here supports the current findings from almost all econometric studies that have been undertaken to date, including those in this issue—file sharing has brought significant harm to the recording industry. The birth of file sharing and the very large decline in CD sales that immediately followed is a powerful piece of evidence on its own. The 2004 increase in CD sales, temporarily reversing the decline, largely matches a reversal in the amount of file-sharing activity. Furthermore, analysis of the various possible alternative explanations for the decline in CD sales fails to find any viable candidates.

This conclusion, preliminary though it might be, should not be much of a surprise. Common sense is, or should be, the handmaiden of economic analysis. When given the choice of free and convenient high-quality copies versus purchased originals, is it really a surprise that a significant number of individuals will choose to substitute the free copy for the purchase? The conditions needed to override this basic intuition are demanding and seemingly not met in the case of file sharing.

Nevertheless, real markets are always difficult subjects of study. We do not yet have enough evidence to draw any but a preliminary conclusion. The papers in this symposium can be thought to represent the end of the beginning stage of research, not the beginning of the end stage. Further work is called for to provide additional evidence on this subject. With a technology this young, and markets changing this fast, it would be most unwise to claim too much given the risk that the future may prove a current conclusion to be incorrect.

References

Austin, Ian. 2004. "Most Wanted: Drilling Down/Compact Discs; Falling Prices." *New York Times*, July 5.

Bhattacharjee, Sudip, Ram D. Gopal, Kaveepan Lertwachara, and James R. Marsden. 2006. "Impact of Legal Threats on Online Music Sharing Activity: An Analysis of Music Industry Legal Actions." *Journal of Law and Economics* 49:91–114.

Blackburn, David. 2004. "Does File Sharing Affect Record Sales?" Working paper. Harvard University, Department of Economics, Cambridge, Mass., April.

Boldrin, Michele, and David K. Levine. 2004. "The Case against Intellectual Monopoly." *International Economic Review* 45:327–50.

Charman, Suw. 2004. "Listen to the Flip Side." *Guardian Unlimited,* July 22. http://www.guardian.co.uk/print/0,3858,4975370-110837,00.html.

comScore Networks. 2002. "Online Music Sales Declining Three Times Faster than Overall Music Shipments, as File Sharing Applications Continue to Thrive." Press release. Reston, Va., November 4. http://www.comscore.com/press/release.asp?press=295.

Conner, Kathleen Reavis, and Richard P. Rumelt. 1991. "Software Piracy—an Analysis of Protection Strategies." *Management Science* 37:125–39.

Evangelista, Benny. 2001. "Napster Users Turn Down the Volume: Downloads Fall Sharply in April." *San Francisco Chronicle,* May 2.

Gayer, Amit, and Oz Shy. 2005. "Copyright Enforcement in the Digital Era." *CESifo Economic Studies* 51:477–89.

Geralds, John. 2001. "Music Downloads on the Rise." http://www.infomaticsonline.co.uk/news/1125301.

Hall, Robert E. 2000. "Expert Report." *A&M Records, Inc. v. Napster, Inc.* 114 F. Supp. 2d 896.

Hirshleifer, Jack. 1971. "Suppression of Inventions." *Journal of Political Economy* 79:382–83.

Hong, Seung-Hyun. 2004. "The Effect of Napster on Recorded Music Sales: Evidence from the Consumer Expenditure Survey." SIEPR Discussion Paper No. 03-18. Stanford University, Stanford, Calif., January 30.

IDATE. 2003. "Taking Advantage of Peer-to-Peer: What Is at Stake for the

Content Industry?" IDATE News No. 282. IDATE, Montpellier, October 28. http://www.idate.fr/an/_qdn/an-03/IF282/index_a.htm.

IFPI (International Federation of the Phonographic Industry). 2001. *2000 Recording Industry World Sales.* London: International Federation of the Phonographic Industry.

Ipsos-Reid. 2002. "Filesharing and CD Burners Proliferate." Press release. Minneapolis, June 12. http://www.ipsos-insight.com/act_dsp?view.pdf.aspx ?name = mr020612-1.pdf&id = 1542.

Jupiter Media Metrix. 2001. "Napster Service Continues Rapid Growth, Reports Jupiter Media Metrix." Press release. New York, February 12. http: //www.comscore.com/press/displaycontent.asp?press = 2358&suffix = htm.

Karagiannis, Thomas, Andre Broido, Nevil Brownlee, kc claffy, and Michalis Faloutsos. 2004. "Is P2P Dying or Just Hiding?" IEEE Globecom, Dallas, November.

Klein, Benjamin, Andres V. Lerner, and Kevin M. Murphy. 2002. "Intellectual Property: Do We Need It? The Economics of Copyright 'Fair Use' in a Networked World." *American Economic Review: Papers and Proceedings* 92:206–8.

Lawrence, David. 2003. "Bursting BigChampagne's Bubble." *Online Tonight* editorial. http://www.onlinetonight.net/archives/001415.html.

Lessig, Lawrence. 2004. *Free Culture.* New York: Penguin Press.

Liebowitz, Stan J. 1985. "Copying and Indirect Appropriability: Photocopying of Journals." *Journal of Political Economy* 93:945–57.

———. 2002. *Rethinking the Network Economy.* New York: Amacom.

———. 2004a. "The Elusive Symbiosis: The Impact of Radio on the Record Industry." *Review of Economic Research on Copyright Issues* 1:20–45.

———. 2004b. "Will MP3 Downloads Annihilate the Record Industry? The Evidence So Far." *Advances in the Study of Entrepreneurship, Innovation, and Economic Growth* 15:229–60.

———. 2005. "Pitfalls in Measuring the Impact of File-Sharing." *CESifo Economic Studies* 51:435–73.

———. 2006. "Testing File-Sharing's Impact by Examining Record Sales in Cities." Working paper. University of Texas at Dallas, School of Management.

Lyman, Peter, and Hal R. Varian. 2003. "How Much Information?" University of California, Berkeley, School of Information Management and Systems. http://www.sims.berkeley.edu/research/projects/how-much-info-2003.

Madden, Mary, and Amanda Lenhart. 2004. "Sharp Decline in Music File Swappers" Data Memo from PIP and comScore Media Metrix. January 4. http://www.pewinternet.org/PPF/r/109/report_display.asp.

McCarthy, Michael. 2003. "CD Prices Hit Sour Note with Retailers, Buyers." *USATODAY,* December 8.

Michel, Norbert J. 2005. "The Impact of Digital File Sharing on the Music

Industry: A Theoretical and Empirical Analysis." Working paper. Nicholls State University, Department of Finance and Economics, Thibodaux, La.

Oberholzer-Gee, Felix, and Koleman Strumpf. 2005. "The Effect of File Sharing on Record Sales: An Empirical Analysis." Working paper. University of North Carolina, Department of Economics, June.

Organisation for Economic Co-operation and Development. 2004. "OECD Information Technology Outlook 2004: Peer To Peer Networks in OECD Countries, Pre-release of Section from Chapter 5." http://www.oecd.org/dataoecd/55/57/32927686.pdf.

Peitz, Martin, and Patrick Waelbroeck. 2004. "The Effect of Internet Piracy on Music Sales: Cross-Section Evidence." *Review of Economic Research on Copyright Issues* 1:71–79.

Rainie, Lee, Mary Madden, Dan Hess, and Graham Mudd. 2004. "RE: The Impact of Recording Industry Suits against Music File Swappers." Pew Internet Project and comScore Media Metrix Data Memo, January.

Reuters. 2003. "ISPs Reel from P2P Bandwidth Hogs." May 23. http://www.cachelogic.com/news/pdf/zdnet.com_230503.pdf.

RIAA (Recording Industry Association of America). 2003a. "Facts and Figures: Manufacturer's Unit Shipments and Dollar Value Charts." http://www.riaa.com/news/marketingdata/facts.adp#unit.

———. 2003b. "Recording Industry Begins Suing P2P File Sharers Who Illegally Offer Copyrighted Music Online." September 8. http://www.riaa.com/news/newsletter/090803.asp.

———. 2003c. "Recording Industry to Begin Collecting Evidence and Preparing Lawsuits against File 'Sharers' Who Illegally Offer Music Online." June 25. http://www.riaa.com/news/newsletter/062503.asp.

Rob, Rafael, and Joel Waldfogel. 2006. "Piracy on the High C's: Music Downloading, Sales Displacement, and Social Welfare in a Sample of College Students." *Journal of Law and Economics* 49:29–62.

Siwek, Stephen E. 2002. "Copyright Industries in the U.S. Economy: The 2002 Report." Washington, D.C.: Economists Incorporated.

Stagia, Ioanna. 2002. "Europe: 2 Billion Music Downloads per Year." Business View Brief. Forrester Research, Cambridge, Mass., September 25.

Takeyama, Lisa N. 1994. "The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Demand Network Externalities." *Journal of Industrial Economics* 42:155–66.

U.S. Census Bureau. 2003. "Media Usage and Consumer Spending: 1998 to 2006." Table 1125 in *Statistical Abstract of the United States*. Washington, D.C.: U.S. Census Bureau.

U.S. Senate. 1983. Committee on the Judiciary. *Video and Audio Home Taping*. Hearing before the Subcommittee on Patents, Copyrights, and Trademarks (testimony of Alan Greenspan). 98th Cong., 1st Sess., October 25.

Varian, Hal R. 2005. "Copying and Copyright." *Journal of Economic Perspectives* 19:121–38.

Watt, Richard. 2004. "The Past and the Future of the Economics of Copyright." *Review of Economic Research on Copyright Issues* 1:1–11.

Zentner, Alejandro. 2005. "File Sharing and International Sales of Copyrighted Music: An Empirical Analysis with a Panel of Countries." *Topics in Economic Analysis and Policy* 5, art. 21, pp. 1–15. http://www.bepress.com/bejeap/topics/vol5/iss1/art21.

———. 2006. "Measuring the Effect of File Sharing on Music Purchases." *Journal of Law and Economics* 49:63–90.