Music Sales in the Age of File Sharing

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For my parents,

who make everything possible

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Abstract

In this paper I examine the effect of Internet access on compact disc sales. I combine U.S. census data on population characteristics with Nielson SoundScan data on CD sales for 99 metropolitan areas in the years 1998, 2000, and 2001. Controlling for year, income, and the fixed effects within each area, I estimate the relationship between Internet access and CD sales for four age groups. Overall, Internet access has a positive and statistically significant effect on CD sales. For children aged 5 to 14, Internet access has a negative but statistically insignificant effect on CD sales. For youths aged 15 to 24, Internet access has a negative and statistically significant effect on CD sales. And for the adult groups aged 25 to 44 and aged 45 and older, Internet access has a significant positive effect. My findings suggest that file sharing is not the cause of the recent decline in record sales, and that file sharing decreases the record purchases of younger people while increasing the purchases of older people.

I. Background

A. Introduction

"Napster hurt record sales," said Recording Industry Association of America (RIAA) president Hilary Rosen.[1] "Mass downloading from unauthorized file sharing on the internet and the massive proliferation of CD burning continues to be a major cause of the fall in CD sales globally," states an April 9, 2003 press release from the International Federation of the Phonographic Industry (IFPI).[2] Both the RIAA and the IFPI, representing the interests of the major companies in the recording industry, are convinced that the free downloading of music from the Internet has harmed album sales. The organizations are currently suing hundreds of people, inside and outside the U.S., that are sharing copyrighted music files.[3] But there are many, smaller voices that profess an opposing view. Janis Ian, a recording artist whose last hit album was in 1975, writes that she has earned an extra $2,700 a year from people who had bought her CD after downloading her music for free online.[4] And there are countless others who argue that the decline in sales is due to a bad economy, bad music, or numerous other factors – and that file sharing can be a positive influence on record sales. The recording industry ships more than $10 billion of recorded music each year, so there is a lot at stake in determining the effect of file sharing on music sales.[5] In this paper I will outline the statistical and theoretical arguments that support each side, as well as the academic papers related to

[1] The Associated Press, "Napster Said to Hurt CD Sales," The New York Times, 25 February 2001.
[2] International Federation of the Phonographic Industry, "Global Sales of Recorded Music Down 7% in 2002," 9 April 2003, <http://www.ifpi.org/site-content/press/20030409.html> (3 April 2004).
[3] Matt Hines, "File-sharing Lawsuits go Abroad," News.com, 30 March 2004, <http://news.com.com/2100-1027-5181872.html?tag=sas.email> (3 April 2004).
[4] Janis Ian, "The Internet Debacle – An Alternative View," Performing Songwriter Magazine, May 2002, <http://www.janisian.com/article-internet_debacle.html> (3 April 2004), para. 12.
[5] Recording Industry Association of America, "2003 Yearend Statistics," 2004, <www.riaa.com/news/marketingdata/pdf/year_end_2002.pdf> (3 April 2004).

piracy and the music industry. I will then undertake my own regression analysis to provide some new insight into the file sharing debate. Finally I will discuss the future prospects for the relationship between music and the Internet.

B. Technological Background

The age of free digital music began with Napster. Before Shawn Fanning started the service in 1999, downloading music from the Internet was a difficult process. A web surfer would have to search various websites and servers before finding a place that claimed to give access to a song, and then would often run into broken links or registration requirements. Napster was revolutionary because it made music downloading and uploading so easy, and brought nearly the entire community of online music collectors to one place. Napster's easy access to free music eventually attracted as many as 70 million registered users.[6]

Napster could not have succeeded without the groundwork laid by previous technological breakthroughs. The compact disc (CD) was the first digital music product widely embraced by consumers. Although some record executives initially believed CDs to be uncopyable, because the music is stored digitally it was inevitable that people would make perfect copies. Even content with substantial copy protection technology (DVDs, eBooks, and iTunes songs) has ended up being freely distributed, and CDs did not employ any encryption for their data. By the mid 1990's, consumers could transfer music tracks onto their computers using a standard CD-ROM drive or create physical copies of CDs (or mix CDs) with an affordable CD burner.

[6] Joseph Menn, All the Rave: The Rise and Fall of Shawn Fanning's Napster, (New York, NY: Crown Business, 2003), page 1.

The Internet did not play a major role in the distribution of music until the spread of the MP3. The MP3, a type of audio file compression, has been so successful that it has become almost synonymous with digital music. The Fraunhofer Institut owns the MP3 format, but because it licenses the technology to any developer willing to pay their fee, the format won out over formats with more controlling owners.[7] Additionally, the MP3 format did not contain any security features. This made it more appealing to developers because it was easier to work with, and to consumers because there were fewer restrictions on the use of their content. A three-minute song in CD audio format is 32 megabytes. The same song in MP3 format compresses to about 3 megabytes with little loss in quality. It takes two to three hours to download a CD audio song from a 56k modem operating a peak capacity.[8] The MP3 format cuts this time to 12 to 18 minutes. In 1997, the software Winamp was created, the first free, full featured, and easy to use MP3 player for Windows computers. In January 1999, Diamond launched the Rio, the first commercial portable MP3 player. Consumers could also convert MP3 files to CD audio files and then burn them onto CDs. Once MP3 had been established as the leading format, and once the means to listen to MP3 songs became universally available, the stage was set for Napster to become a phenomenally successful distributor of music.

Users downloaded and installed the Napster utility on their computers. Then they indicated the folder or folders that contained the music files they wanted to share with other Napster users. Napster was a type of peer-to-peer (P2P) network, that is, the files

[7] Christopher Jones, "MP3 Overview," Webmonkey: The Web Developer's Resource, 27 July 2000, <http://hotwired.lycos.com/webmonkey/00/31/index3a.html> (3 April 2004), page 2.
[8] Marshall Brain, "How MP3 Files Work," HowStuffWorks, <http://entertainment.howstuffworks.com/mp3.htm> (3 April 2004), page 2.

resided on users' computers instead of a central computer. The following is what happened when using Napster to download a song:

1) The Napster utility logged the user onto a central server. This server kept an index of the Napster users currently connected, but did not store any music files.
2) The user typed in the desired artist or song name.
3) The Napster utility queried the index server for other online Napster computers that had the requested song, and returned a list of users that were sharing the file.
4) The user indicated which of those files he or she wanted to download.
5) The user's copy of Napster attempted to establish a connection with the computer hosting the file the user selected.
6) If the connection was successful, the file began downloading directly to the user's computer.
7) Once the file was downloaded, the host computer broke the connection with the user's computer.[9]

After the download completed, a user could listen to the song whenever he wanted using standard media player software.

Napster's P2P architecture solved many of the major problems previously associated with downloading music from the Internet. Online storage space and bandwidth cost money. Napster servers did not have to store or transfer much more information than lists of users and their files, a tiny amount of information compared to the music files transferred between users. Because Napster had no need to duplicate the bandwidth and storage provided by their user base, it was able to remain a free service.

[9] Jeff Tyson, "How the Old Napster Worked," HowStuffWorks, <http://computer.howstuffworks.com/napster.htm> (3 April 2004), page 3.

Because the service was free, the only cost faced by new users was the time invested in downloading the software and learning the well-designed interface. Because each new user brings a library of shared files into the network, the value of the service to all users increases with each new user. This means that the number of users will grow at an increasing rate until total market saturation. Napster was able to handle all these users because the marginal infrastructure requirements were so low.

Additionally, Napster was culturally successful at turning its users into a community of digital music traders. Because P2P depends on people being nice enough to upload files, the system cannot work if people disconnect from the service as soon as they are done downloading or fail to share files that others might want. Napster attacked the P2P selfishness problem technically with its default settings. The default download directory was automatically shared, so if people did not bother to move their files out of that directory or indicate another download directory, all of the files that the user has downloaded are automatically shared. This did not solve the problem of users logging off as soon as their song finished downloading, but it did serve to promote sharing among even the least experienced of users. Napster attacked the selfishness problem socially with its chat rooms. By displaying the number of MP3s shared when browsing chat rooms, Napster created social pressure to be generous with shared music. Current P2P systems use other devices to promote sharing, such as minimum requirements for megabytes shared, download queue priority for high sharers, or only letting people download while they are simultaneously uploading. However, none of these devices solved the problem of users logging on to get a specific song, and then logging off as soon as it had completed downloading. Napster's chat rooms provided a reason to use the

software beyond downloading, and thus encouraged people to remain logged on with their libraries available.

Although Napster was extraordinarily successful in dealing with the technological and cultural problems of file sharing, it could not overcome the legal problem. Napster claimed not to infringe copyrights because it did not actually store any of the music that was transferred through its network, but Napster's popularity was rooted in copyright infringement. Almost all the music shared over the Napster network was made publicly available against the wishes of the copyright owners. Napster's service went live on June 1st, 1999; on December 7th 1999, the RIAA sued Napster for copyright infringement, asking for damages of $100,000 each time a song was copied; on July 11th 2001, a district court ruling shut down Napster because it could not block 100% of the content expressly designated by copyright holders.[10] In its two years of existence, Napster changed the music business and its relationship with consumers.

Today there are many more P2P services than there were in the time of Napster. Some specialize in music files, but most enable trading of any type of computer file. The problems faced by RIAA with Napster are being replicated with the Motion Picture Association of America (MPAA) with this next generation of P2P software. But these new services cannot be quashed as easily as Napster because they are entirely P2P. Because Napster ran a central server that indexed its users and song titles, a single court order against the company had the power to shut down the whole service. The new generation of P2P software does not rely on a central indexing server. Once the software is downloaded onto an individual's computer, the network would still function even if the

[10] Sandra Marcus, "The History of Napster," 6 December 2001, <http://web.archive.org/web/20030608065838/http://web.utk.edu/~smarcus/History.html> (3 April 2004).

company that provided that software ceased to exist. Although it is still an open question as to whether or not a company can legally distribute P2P software provided that it has no control over the ensuing network, its resolution will not significantly bear on the future of free P2P downloads. All that is required for a network is the distribution of some software, which can be written either by a business or by a small group of computer programmers. Even if the RIAA were successful in removing all possible profit from the creation of a P2P network, the current networks would continue to exist and grow so long as the client software was available on the Internet.

There has already been a case of an entertainment group trying to get a piece of software removed from the Internet. The MPAA has launched an all-out legal attack on DeCSS, which is software used to copy DVDs onto a computer. Despite the MPAA's threats against sites that distribute the code, and even sites that link to sites that distribute the code, DeCSS is easily available to anyone who wants it.[11] Attempts by the RIAA or any other group to remove all P2P software from the Internet are likewise doomed to failure. As average Internet connections get faster, P2P file sharing will grow even more attractive to the average user. No matter what the entertainment companies do, P2P is here to stay.

C. **Music Industry Background**

Record Labels

The record industry is dominated by the "big five" major recording labels – Sony Music, Universal, EMI, Warner Brothers, and Bertelsmann Music Group (BMG). Their

[11] E.g. David S. Touretzky, "Gallery of CSS Descramblers," 28 Jan 2004, <http://www-2.cs.cmu.edu/~dst/DeCSS/Gallery/> (3 April 2004).

combined U.S. revenue is over $14 billion yearly,[12] and they control about 75 percent of global recorded music sales.[13] The major labels control the networks of physical distribution, and occupy most of the time on the airwaves and shelf space in the chain stores. The big five have the financial resources necessary to put out a fully promoted release. They provide the capital for music videos, album artwork, promotional displays, radio play, and tour support. For a major-label release to be considered successful, it needs to sell at least 200,000 units.[14]

Independent labels comprise the rest of the prerecorded music industry. They range from fairly established players that can sell millions of copies of individual records to shoestring operations out of an entrepreneur's basement. So-called "indie labels" vary in their degree of independence. Many have distribution deals with the "big five," and many nominally "indie labels" are really former independents that have been bought out and brought under the umbrella of a major label. Independent labels cannot rely on widespread promotion, so many specialize in music of a particular genre in order to build consumer loyalty and brand recognition. Because independents operate on a different scale than the majors, they are freer to take chances on music that might never sell enough units to become a major label success.

Artists

Recording artists, although they supply the creativity at the core of the record industry, rarely get royalties for records released through major labels. In a standard recording contract, the costs of recording an album, promoting an album, making a music

[12] John Alderman, Sonic Boom: Napster, MP3, and the New Pioneers of Music, (Cambridge, MA: Perseus Publishing, 2001), page 23.
[13] Charles C. Mann, "The Year the Music Dies," Wired Magazine, February 2003, <http://www.wired.com/wired/archive/11.02/dirge.html> (3 April 2004).
[14] Alderman, page 23.

video, and tour losses are usually "recoupable expenses."[15] This means that these expenses are deducted from an artist's royalties before he or she gets paid. The costs of recording an album can easily reach several hundred thousand dollars, so an artist can only expect to earn royalties from an album if it sells over 500,000 copies. Only 5% of recordings attain this level of success, so most artists do not receive royalties based on the actual number of records sold. A record company may pay an artist an advance against royalties so they have money to live while recording the album, but the artist must pay back the advance before he or she earns additional royalties. This advance is usually the only money a band ever sees for a recording. According to performer/songwriter Janis Ian, "in 37 years as a recording artist, I've created 25+ albums for major labels, and I've *never once* received a royalty check that didn't show I owed *them* money. So I make the bulk of my living from live touring, playing for 80-1500 people a night, doing my own show."[16] An entry-level contract will usually stipulate a number of "options" (around five) for the record company.[17] An option is the ability to request an album from the artist at the royalty rate specified at the start of the contract. The band is obligated to deliver an album that is accepted by the recording company. If the album is shelved because it is creatively or commercially unacceptable, it does not count towards the number of albums owed to the company. Even after a moderately successful first album it is likely that the artist has not made enough in royalties to fully cover the recoupable expenses. The expenses not covered by the royalties generated by the first albums are deducted from the payments generated by subsequent albums. If an artist is not doing well enough to be kept

[15] Marshall Brain, "How Recording Contracts Work," HowStuffWorks, <http://entertainment.howstuffworks.com/recording-contract.htm> (3 April 2004), page 3.
[16] Ian, para. 25.
[17] Brain, page 6.

by the record company, the company usually owns all of the recordings in perpetuity, and the artist cannot re-record the same songs for another 5 to 10 years. Songwriters earn the legally prescribed royalties for public performances (radio, TV, bars, etc.), but under most circumstances recording artists do not.[18] Janis Ian said, "if we're not songwriters, and not hugely successful commercially (as in platinum-plus), we [recording artists] don't make a dime off our recordings."[19]

Radio Stations

Radio stations have a symbiotic relationship with record companies. Record labels need radio stations to give exposure to the music and performers they represent, and radio stations need the record companies to keep them constantly supplied with fresh material. Radio stations, which used to be locally controlled, are increasingly bought up by large companies. According to the Federal Communications Commission, there were 13,296 licensed radio stations as of September 2002.[20] 1,212 of those stations are owned by Clear Channel, which account for about one third of all radio listeners, and Clear Channel is continuing to buy more stations.[21] Decisions about what to play on the radio are made not by the on-air DJ's, but by programming directors. Owners or regional program directors now make more and more programming decisions.[22] Because of consolidation in radio, there is a perception that new music has no chance unless it is backed by a major label that already has a good relationship with the stations, and has the obvious widespread appeal needed by a corporation spanning many markets.

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[18] The exception is non-interactive digital webcasts, where the user does not choose the songs to hear.
[19] Ian, para. 47.
[20] Lee Ann Obringer, "How Top 40 Radio Works," HowStuffWorks, <http://entertainment.howstuffworks.com/top-40.htm> (3 April 2004), page 4.
[21] Inside Radio, "Who Owns What," 4 November 2002, <http://www.whoownsradio.com> (3 April 2004), page 2.
[22] Obringer, page 4.

Trade Groups

The Recording Industry Association of America (RIAA) is the trade group that represents the U.S. recording industry. It was formed in 1952 to represent the big five labels, but now represents around a thousand labels that create, manufacture, and/or distribute approximately 90% of the sound recordings produced and sold in the U.S.[23] The RIAA lobbies Congress to pass favorable laws and takes on adversaries in court.[24] According to the RIAA, its current mission is "to foster a business and legal climate that supports and promotes our members' creative and financial vitality." Although the job of the RIAA is to provide a unified front to promote the interests of the recording industry as a whole, there are no policies that can benefit every company in the industry. Because the big five hold a majority of the industry's money and power, the RIAA primarily follows the interests of the major labels.

The International Federation of the Phonographic Industry (IFPI) represents the international recording industry. It is concerned with promoting market access and strengthening copyright laws, but its main concern is fighting music piracy – the deliberate infringement of copyright for commercial gain.[25] According to the IFPI, there were 1.8 billion pirated units sold in 2002, which represents 40% of physical recordings sold worldwide. The people who profit are often members of organized criminal gangs involved in illegal activities besides piracy.[26] Physical piracy is most severe in countries with large but developing economies such as China and Russia because they place a low

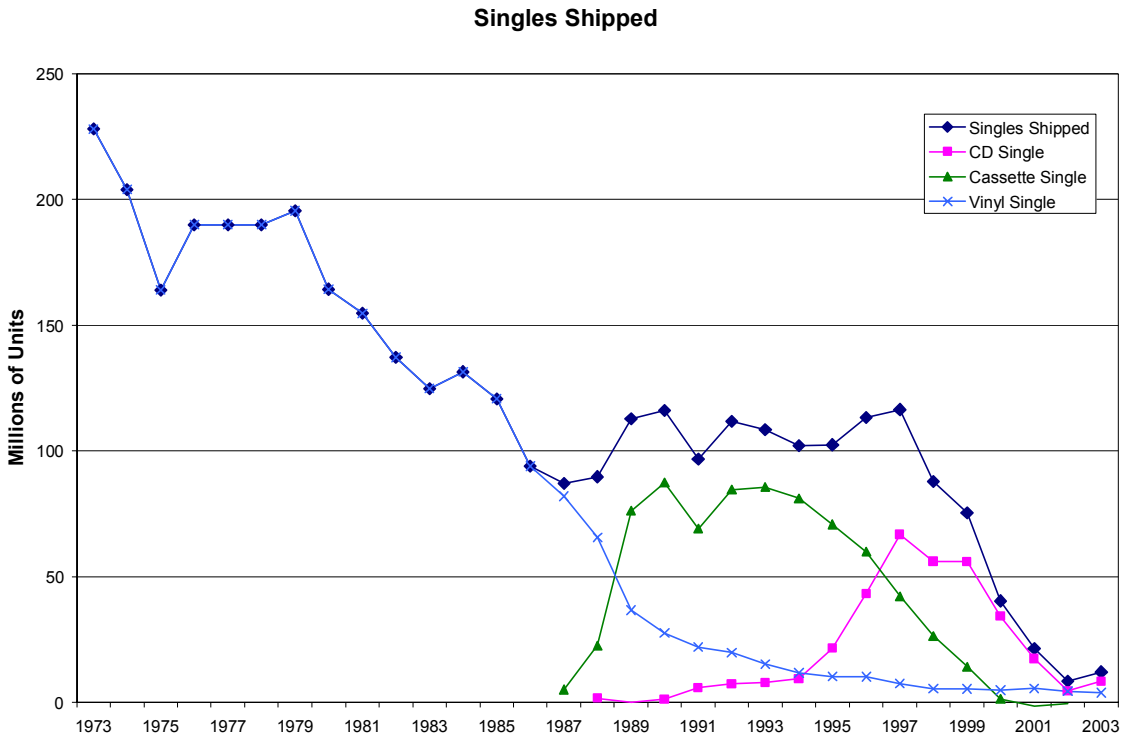
[23] Recording Industry Association of America, "About Us," 2003, <http://www.riaa.com/about/default.asp> (3 April 2004), para. 1.
[24] Alderman, page 81.
[25] International Federation of the Phonographic Industry, "What is IFPI?," <http://www.ifpi.org/site-content/about/mission.html> (3 April 2004).
[26] International Federation of the Phonographic Industry, "Commercial Piracy Report 2003," <http://www.ifpi.org/site-content/antipiracy/piracy2003-introduction.html> (3 April 2004), para. 3.

priority on intellectual property enforcement. Efforts to combat physical piracy are nowhere near as controversial as efforts to combat digital piracy because physical piracy is obviously illegal and harmful to the music industry.

II. Preliminary Analysis

A. Have Music Sales Been Hurt?

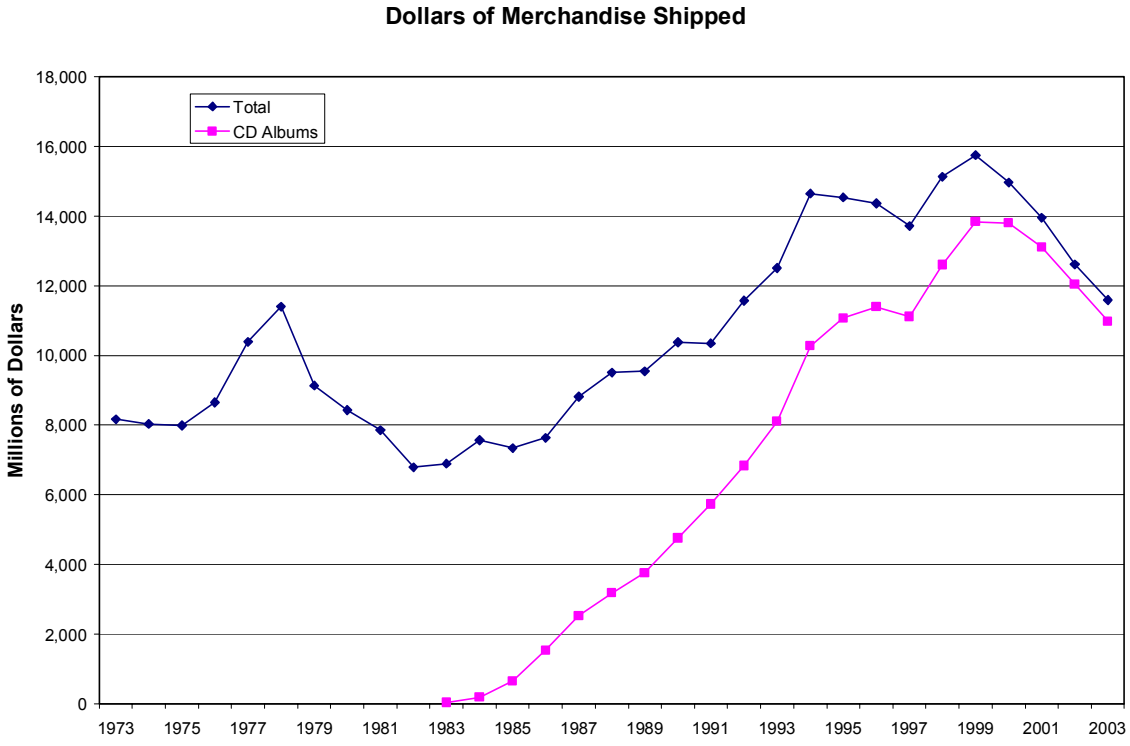
Before we consider the specific effects of P2P on music industry sales, we must first check if anything unusual has happened to sales in recent years. The most drastic change in recording revenues has been in the market for singles. A "singles" unit usually contains only one song or two, a sample of what can be heard on the full album. The following is a graph of the total number of singles shipped between 1973 and 2003, along with component parts of CD, cassette, and vinyl formats. [27]



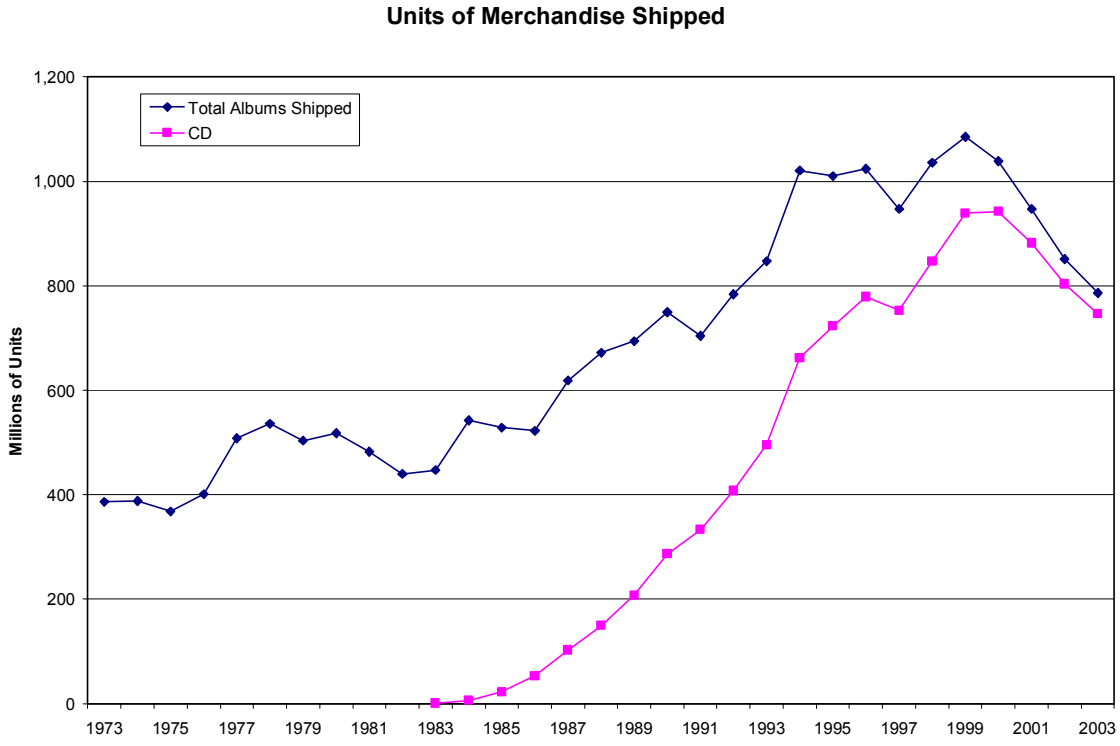
[27] Recording Industry Association of America, "Yearend Marketing Reports on U.S. Recorded Shipments," 2003, <http://www.riaa.com/news/marketingdata/yearend.asp> (3 April 2004), para. 1: "The figures, which are compiled by PricewaterhouseCoopers LLP, represent the total U.S. market. First, data is collected from RIAA member companies that distribute approximately 84% of the prerecorded music in the United States. To calculate unit shipments and retail dollar values for the remainder of the market, PwC utilizes retail sales data from SoundScan."

The singles market has been virtually annihilated. Cassette shipments in 2001 and 2002 were negative, meaning record companies received more returns than they distributed in new shipments. Singles have gone from 4.5% of revenues in 1992 to 0.3% of revenues in 2002. Even though the 1990's continued a long-term decline in singles revenue that started in the early 1970's, it is notable that the singles market has almost entirely disappeared.

When we look at music sales as a whole, the current changes are much less stark. The following two charts show dollars of merchandise shipped from 1973 to 2003 as reported by the RIAA. Dollars shipped are calculated using the suggested retail price for units shipped. Total dollars include CD albums, CD singles, cassette albums, cassette singles, vinyl albums, vinyl singles, DVD audio products, and music videos and DVDs. All dollar values are normalized to 2002 dollars using the consumer price index (CPI).



In terms of real dollars of music shipped, the decline from 1978 to 1982 is more severe than the current decline. Since looking at dollars shipped depends on the suggested retail prices listed by the RIAA and the inflation rate, it is also informative to look at the units shipped. The following graph shows the total albums shipped and CD albums shipped from 1973 to 2003.



Both total album shipments and total sales of music products peaked in 1999 and declined through 2003. These data lend credence to the music industry's claim of harm, and the timing of decline supports the theory that P2P file sharing is at least partially responsible for that harm. It is also worth noting that there were four dips in album unit sales prior to the current dip. These dips occurred in 1978-82 (20% decline), 1984-86 (9% decline), 1991 (7% decline), and 1994-97 (5% decline).[28] The current decline from 1999 to 2003 is a 31% decline over four years, which is larger than any of the other recent dips in the music business. The current decline in sales is not necessarily cause for alarm for the music industry because previous short-term declines have not indicated a

[28] Stan Liebowitz, "Will MP3 downloads Annihilate the Record Industry? The Evidence so Far," School of Management, University of Texas at Dallas, June 2003, <http://wwwpub.utdallas.edu/~liebowit/intprop/records.pdf> (3 April 2004).

long-term decline in revenues. However, the magnitude of the decline suggests that there could be something new going on in the industry.

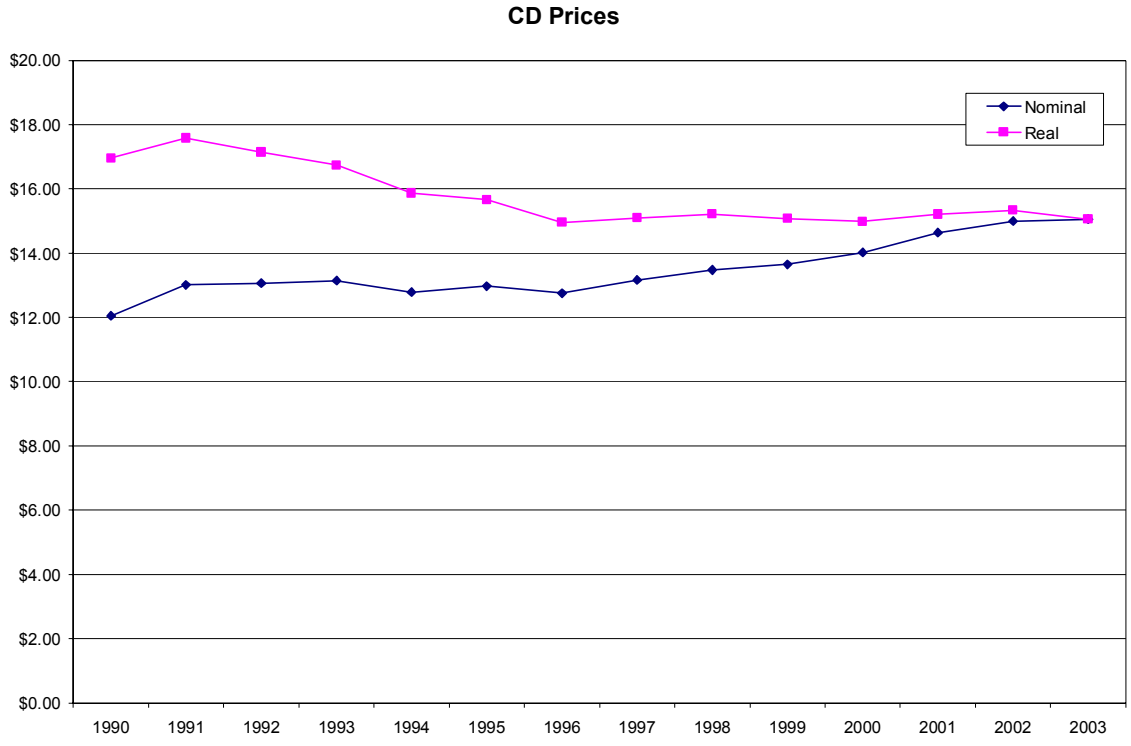
B. What Factors Affect Music Sales?

There are many factors beyond P2P usage that can influence music sales. If these factors both have a significant effect on music sales, and have changed contemporaneously with the adoption of P2P, we must take them into account when analyzing the recent decline in CD sales. In this section I will enumerate several of these factors, and discuss their significance in determining music sales and current trends.[29]

Album Prices

Some have made the argument that the music industry is hurting because CD prices are too high.[30] This argument is based on looking at nominal instead of real prices. Adjusting for inflation, record shipping prices have remained nearly constant during the last 20 years.[31] The following is a graph of CD prices since 1983, along with prices converted to 2003 dollars using the CPI.[32]

[29] This list is adapted from Liebowitz.
[30] Dan Bricklin, "The Recording Industry is Trying to Kill the Goose That Lays the Golden Egg," 9 September 2002, <http://www.bricklin.com/recordsales.htm> (3 April 2004).
[31] Liebowitz, page 13.
[32] CD prices calculated using dollars shipped and units shipped data from the RIAA.



Although nominal prices have increased recently, real prices have remained constant. Whatever the optimal price point of CDs, a rise in listed CD prices cannot explain the current decline in music sales.[33]

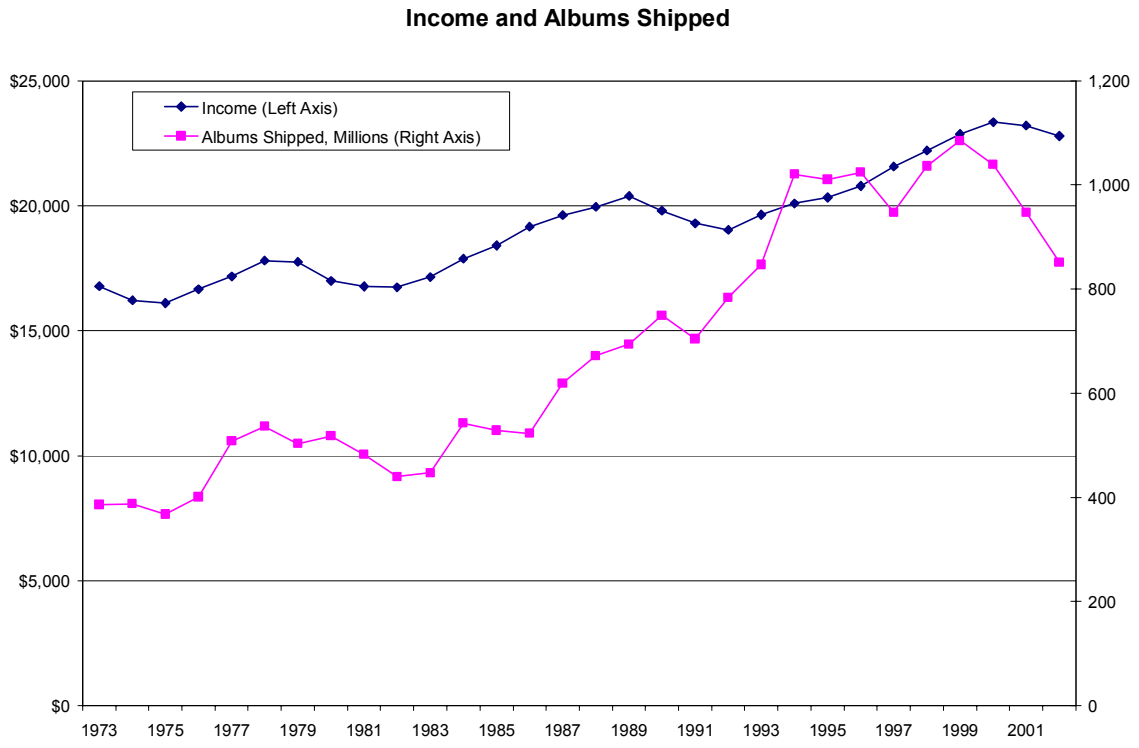
Consumer Income

We expect consumers to buy more music as their income goes up, particularly because music is a form of entertainment consumption and necessities are already purchased at lower levels of income. However, a time-constraint might mitigate the effect of increasing income. There are only so many hours in a day that can be allocated for music listening, and higher income does not necessarily suggest more free time. If incomes are sufficiently high or music is sufficiently essential, the time constraint might

[33] If retail markups have increased, consumers will experience a price increase that is not reflected in the numbers supplied by the RIAA. However, it is unlikely that average markup has increased, as I will discuss in the section on Distribution Channels.

be more important than the income constraint in determining entertainment consumption.[34]

The following is a graph of U.S. per capita income stated in 2002 dollars along with album sales.[35]



There does appear to be a significant relationship, for the dips in income and album sales occur around the same time periods. In order to estimate the effects of income on album sales, Liebowitz regressed first differences of per capita album sales on first differences of per capita real income and first differences in price.[36] Because of the

[34] Sabina L. Shaikh and Douglas M. Larson, "A Two Constraint Almost Ideal Demand Model of Recreation and Donation," The Review of Economics and Statistics, 85 (November 2003): 953-961. And N. E. Bockstael, et al., "Time and the Recreation Demand Model," American Journal of Agricultural Economics, 69 (May 1987): 293-302.
[35] Data for income from: United States Census Bureau, "Historical Income Tables – People," 30 September 2002, <http://www.census.gov/hhes/income/histinc/p01.html> (3 April 2004).
[36] Liebowitz, 14.

upward trends in both income and album sales, a regression using absolute values would have been biased. Liebowitz finds that the coefficient on the change in price was insignificant (p-value of .282) and the coefficient on the change in per capita income was significant and had the expected sign (0.0007286 with a p-value of .021). However, income has not significantly fallen between 1999 and 2002, so changes in income cannot be the cause of the current decline in CD sales. Even the largest decline in real per capita income in the last 30 years (from 1978 to 1980) would only have the predicted effect of lowering sales by .2 units per capita, while per capita record sales have declined by about 1 unit since 1999. Thus, even though income has a statistically significant effect on album sales and should be included in a model predicting CD sales, the effect is not large enough to fully explain the current decline.

Music Quality and Consumer Taste

"Music businesses have left no entrance for the serendipity that kept the pop industry lively," writes Slate Magazine's Mark Jenkins in August 2002.[37] The market research firm NPD group released a press statement claiming, "Nearly half of [age 36 and over] consumers report they are purchasing less music because there's less music they're interested in buying. Plus, fewer than 10 percent of this age group report purchasing less music because of downloading."[38] When the music industry is in decline, people often blame the hard-to-measure factors of music quality and consumer taste for the changes in sales.

[37] Mark Jenkins, "Hit Charade: The Music Industry's Self-Inflicted Wounds," 20 August 2002 <http://slate.msn.com/?id=2069732> (3 April 2004), para. 13.
[38] The NPD Group, Inc., "Declining Music Sales: It's Not All Digital Downloading, Saw the NPD Group," 5 June 2003, <http://www.npd.com/press/releases/press_030605.htm> (3 April 2004), para. 4.

One way in which the music quality of a year can vary is in the releases of superstar artists. A small group of artists can have a large effect on sales because the mass production of records at constant marginal cost means records with slight advantages in quality can capture large shares of the market. Crain and Tollison (2002) find that decreasing search costs for consumers lead to increasing returns for superstars.[39]

If an established superstar artist produces a dud album, sales for the year can be unexpectedly low. Or if a superstar releases an album in one year instead of another, it might make a significant difference in sales between the two years. In 2003, the top selling album represented 1% of total sales.[40] Unit sales declined 8.9% between 2001 and 2002, so the release of even the biggest superstar can only cause a small decline. Also, superstar release-timing cannot explain a multi-year decline in sales because a release delay of multiple years is not a timing choice, but a reflection on an artist's productivity. Unless there has been a change in superstar productivity over the last few years, we must look elsewhere for an explanation of the sales decline.

Liebowitz attempts to measure the elusive factors of music quality and taste by looking at concert sales and radio listening as a measure of interest in music.[41] He cites Pollstar Magazine's data on concert tour revenues from 1991 to 1999. The correlation between concert revenues and changes in record sales is .37, which indicates that the concert revenues have some, but not a lot, of predictive power for record sales. However, the years 2000 and 2001 had the largest real increases in concert revenues, which is evidence against the theory that there has been a recent decline in music interest.

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[39] W. Mark Crain and Robert D. Tollison, "Consumer Choice and the Popular Music Industry: A Test of the Superstar Theory," Empirica, (2002): 1-9.
[40] Business Wire, "Nielson SoundScan and Nielson BDS 2003 Year End Music Industry Report," 31 December 2003, <http://www.businesswire.com/webbox/bw.123103/233655222.htm> (3 April 2004).
[41] Liebowitz, 21.

There has been an 8% decline in radio listening between 1998 and 2002. Although the decline is highest for those aged 12 to 17 (12%), the decline is comparable across all age groups.[42] The largest decline in listening format was in "adult standards" (40%), while "contemporary hits" had an 11% increase. Although this statistic seems inconsistent with the theory that modern music quality has declined, one must not weight it heavily. There is a perception that radio station giant Clear Channel is "accelerating the homogenization of our airwaves" and skewing stations toward the "Top 40" format.[43] Since choices in music listening are also heavily influenced by music availability, change in radio station formats can easily influence these figures.

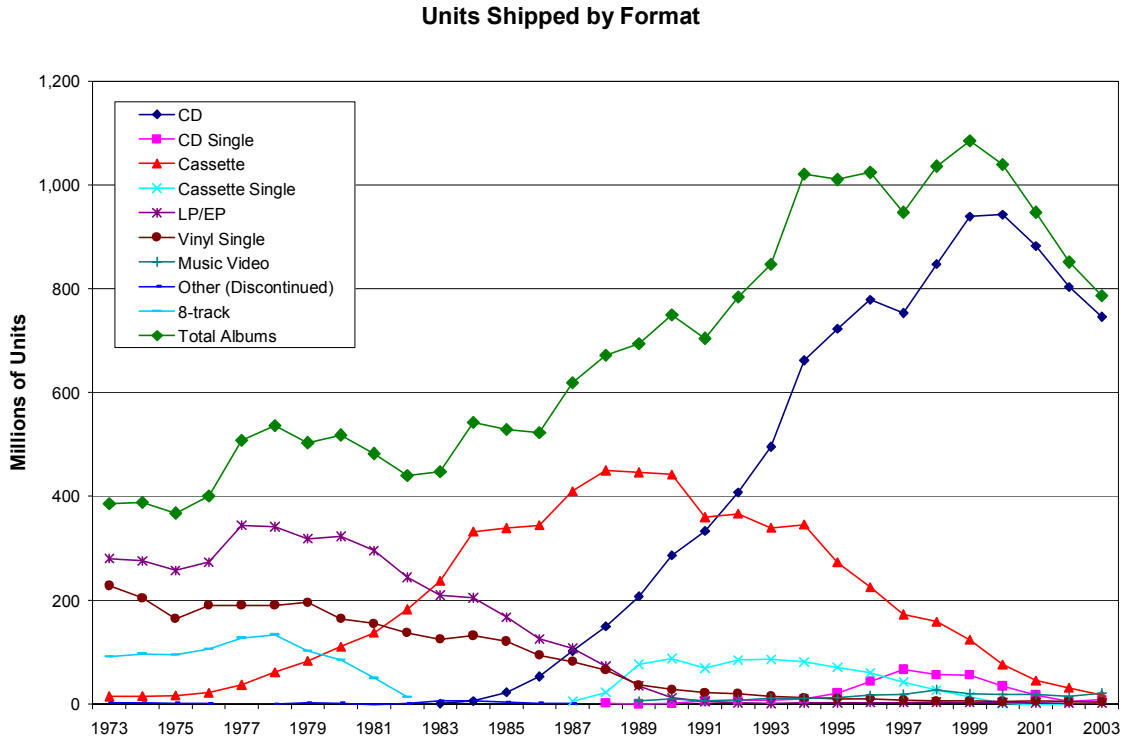
Although Liebowitz's statistics do not prove by themselves that there has been constant music quality and consumer tastes, they do suggest that no major changes have occurred. Critics have always complained about a dearth of quality music. Musical tastes are not created from scratch each year, forcing record executives to divine those tastes and create acts to match them. The music that is currently produced is fundamental in shaping the tastes of subsequent consumers and the music of subsequent artists. It is doubtful that the ability of music executives to keep up with consumer tastes can change fast enough to produce a significant part of the current decline in sales.

New Recording Formats

A new recording format might boost sales because it can induce consumers to purchase new copies of the works that they already own in the old format. Some have postulated that the current decline in CD sales results from consumers no longer being

[42] Liebowitz, 22.
[43] Jeff Perlstein, "Clear Channel: the Media Mammoth that Stole the Airwaves," 14 November 2002, <http://www.musicandfilmnetwork.com/mediamobster.htm> (3 April 2004).

driven by this "librarying" motive because they have already updated their collections.[44] The following is a graph of units sold in various recording formats, as well as total albums sold.[45]



If the librarying effect were significant, we would expect there to be an unusual increase in total albums sold with the rise of a successful new format. When cassettes started to become prominent in 1977, sales of vinyl records was falling by approximately the same amount that sales of cassettes was increasing, and 8-tracks were on their way to extinction. There was no significant increase in total albums sold. The sharp increase in albums sold was driven by the success of CDs from the late 80's onwards, but there is no evidence that the success of cassettes in the late 70's produced a similar effect. Album

[44] Liebowitz, 12.
[45] Data not available on website, faxed by RIAA.

sales declined from 1978 to 1983, which coincided with a recession. It is the economy that dominates the total number of albums sold rather than the introduction of a new format. If there is a positive effect that comes from the introduction of a new format by the recording industry, it is likely that the effect comes from technological improvements rather than librarying.

The other interesting feature of this graph is that a protracted decline in the units shipped of the leading format indicates the rise of a new format. Since CD's are declining, this suggests that MP3's will rise to supplant them as the major music format. MP3's have marginally inferior sound quality, but have the advantage that they are much easier to store and transport. New MP3 players make it possible to hold entire music collections in the palm of ones hand. Record companies are attempting to profit from purely digital formats with authorized download services, but they have had to compete with the free P2P networks that offer the songs with fewer restrictions. Although the introduction of a new format does not seem to have a significant effect on album sales in and of itself, if the recording industry is not the party selling the new format, their sales should decline.

Population Age

Different age groups buy different amounts of records per capita. Perhaps because of time constraints and musical culture, youths aged 15 to 19 have long been the heaviest purchasers of records, while people over 45 have been the lightest purchasers. If the age distribution in America has been changing in recent years, it is possible that the current decline in music sales could be a result of the population leaving the high-purchase groups and entering the low-purchase groups. The following table lists the percent of

record purchases[46] made by each age group according to the RIAA,[47] the number of people in each age group according to the U.S. census, and the imputed per capita album purchases, obtained by multiplying the first column by the total number of album purchases in 2000 and dividing by the second column.

Table 1: Album Purchases by Age Group

Age Group	Percent of records bought by age group (Yr 200)	Number of people in age group (Yr 2000)	Calculated per capita album purchases
Under 10	1.3%	39,701,280	0.34
10-14	8.9%	20,608,415	4.49
15-19	12.9%	20,249,959	6.62
20-24	12.5%	19,185,063	6.77
25-29	10.6%	19,316,817	5.70
30-34	9.8%	20,587,073	4.95
35-39	10.6%	22,648,354	4.86
40-44	9.6%	22,535,368	4.43
45+	23.8%	97,506,302	2.54

These per capita album purchases change yearly, but they do keep the same relative magnitudes. Using population data from 2001-2003, I will predict album sales assuming that per capita purchases by age group holds constant. The point of this exercise is to see how much, if any, of the decline in sales can be attributed to shifting demographics, rather than the changing behavior of people in the same demographic.

[46] CD albums, cassette albums, vinyl albums, singles, music video DVDs, and DVD audio.

[47] "Peter Hart Research conducts a national telephone survey of past month music buyers (over 3,000 per year). Data from the survey is weighted by age and sex, and then projected to reflect the U.S. Population age 10 and over. The reliability of the data is +/- 1.8% at the 95% confidence level." In my table, the Under 10 group was formed as the difference between 100% and the sum of the percentages of the age 10 and over groups." from Recording Industry Association of America, "2002 Consumer Profile," 2003, <http://www.riaa.com/news/marketingdata/pdf/2002consumerprofile.pdf> (3 April 2004).

Table 2: Effect of Changing Population Age on Album Sales		
Year	Actual Albums Sold	
2000	1,038,900,000	
Year	Predicted Albums Sold	Predicted Albums Sold (with constant 2000 population)
2001	1,047,911,045	1,038,038,510
2002	1,056,417,985	1,036,819,544
2003	1,064,648,176	1,035,298,837

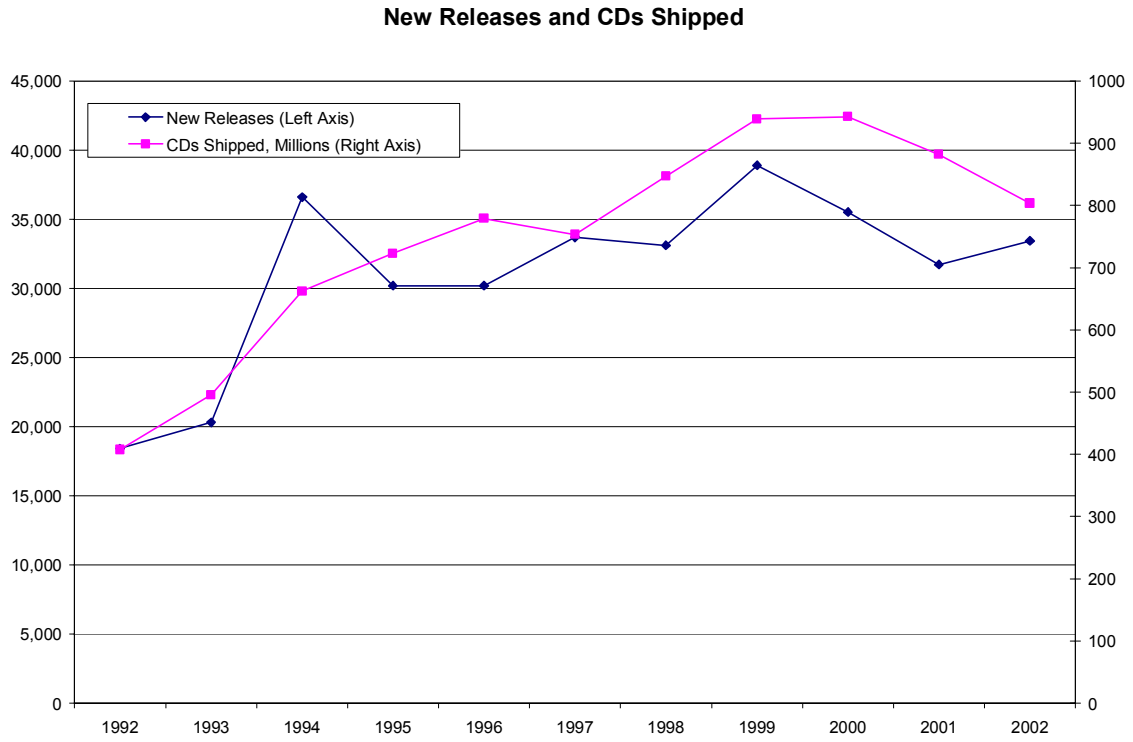
Predicted album sales are rising about 0.8% per year mainly because population is rising. This number combines the predicted effects of increasing total population along with changing population distribution. In the second column, I calculate predicted album sales holding total population constant, so the only changes are the age distribution within a set population. Here, predicted sales go down by about 0.1% per year. This number suggests that the age distribution is becoming less favorable for the music industry, but that the effect is tiny compared to the yearly fluctuations in sales. In order to explain the largest part of changes in sales, we must look at the changing behavior of the age groups rather than the number of people that fall into each group.

Number of Releases

Some critics have claimed that album sales have fallen because the record industry is releasing fewer albums.[48] Putting out a hit record is a hit or miss affair. According to the RIAA, "less than 10% [of recordings] are profitable, and in effect, it's these recordings that finance all the rest."[49] Given that it is hard to tell which recordings will be successful, we can expect revenues to be lower if the recording industry takes

[48] For example, George Ziemann, "RIAA's Statistics Don't Add Up to Piracy," 11 December 2002, <http://www.azoz.com/music/features/0008.html> (3 April 2004).
[49] Recording Industry Association of America, "Cost of a CD," 2003, <http://www.riaa.com/news/marketingdata/cost.asp> (3 April 2004), para. 7.

fewer risks by releasing fewer albums. The following graph shows the relationship between the number of new releases[50] and the number of CD's sold.



The correlation between new releases and CDs sold between 1992 and 2002 is 0.88, which is very high. The correlation from 1998 to 2002 is weaker, but still relatively high at 0.67. We have to be careful not to read too much into these correlations, since it is quite possible that outside variables, such as high demand, can lead to the simultaneous rise of both releases and CD sales. We also have to be careful not to mistake revenues for profits. Although the release of almost any CD will boost revenues, the effect of a new release on profits is uncertain. So we must not assume that even if a decline in new

[50] Nielson SoundScan statistics culled from Euromole, "RIAA Piracy Arguments, Figures Just Don't Add Up," The Inquirer, 20 April 2003, <http://www.theinquirer.net/?article=9048> (3 April 2004) and Ziemann (2002).

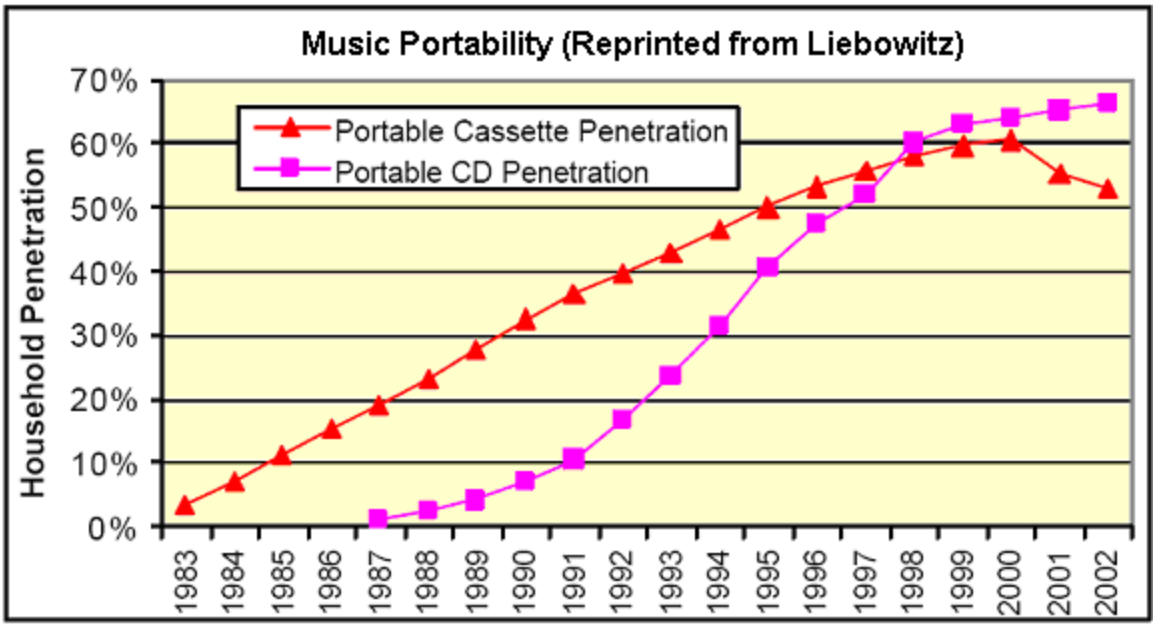
releases causes a decline in revenues, then the decline in new releases causes a decline in profits.

Since a new release can only push album sales upwards, it appears that at least some of the current decline in album sales can be attributed to a decline in new releases. New releases have declined in 2000-2002 from their 1999 peak. But in 2002, new releases were actually higher than they were in 2001. At least in the most recent years, something else must be going on to cause the decline in sales.

Portability

The amount of recorded music people listen to is limited by the places in which they can listen. The advent of 8-track tapes marked the first time that people were able to listen to music in their automobiles. In the 1980's, the Sony Walkman provided consumers with the opportunity to carry their music with them while walking or exercising. The rise of CD's in the 1990's coincided with the rise of portable CD players. Portable players drive the sale of recorded albums, and a new format for recorded albums drives the sales of portable players. The following is a graph of the portable market, reprinted from Liebowitz (2003).[51]

[51] Data owned by eBrain Market Research, a service of the Consumer Electronics Association <http://www.ebrain.org> (3 April 2004).



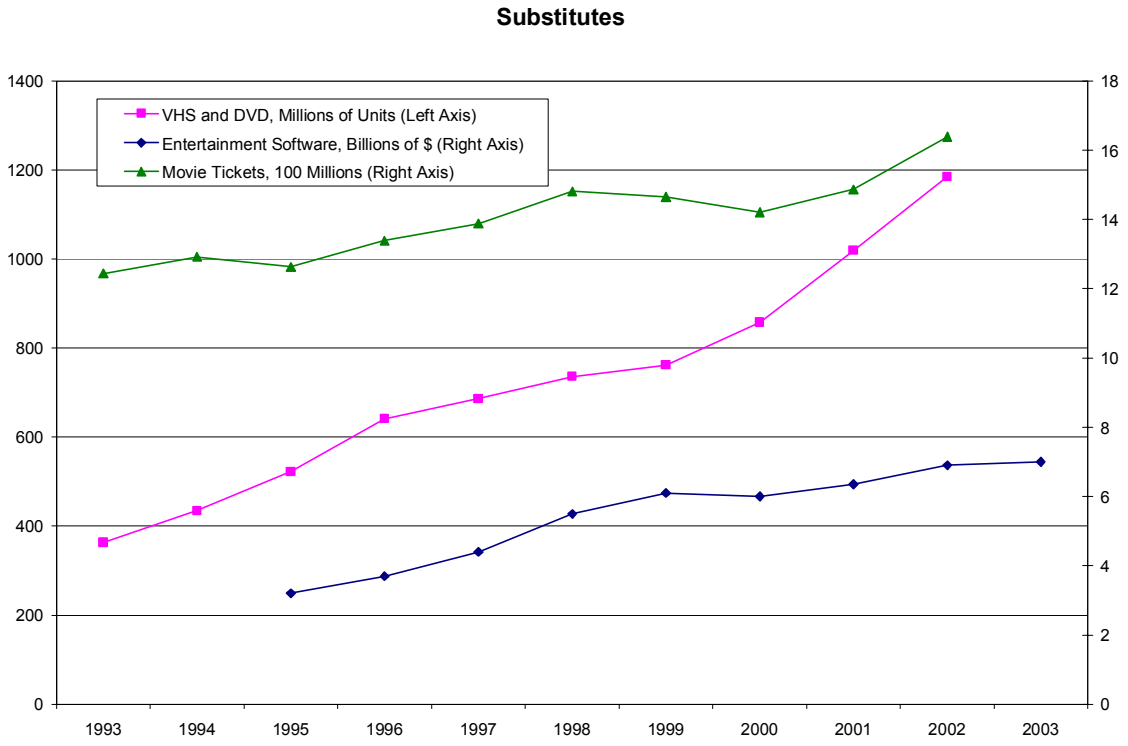
The large increase in the total number of portable players from 1983 to 2000 coincides with the rise of total albums sold. Although the portable market has leveled off in recent years, there has been no decline in CD portability, and only a minor decline in overall portability as portable cassette players are declining along with cassettes. While the growth of the portable market may well have driven past increases in sales, changes in the portable market cannot explain the current decline in sales.

Substitutes

Jay Berman, Chairman and CEO of the IFPI, attributed part of the 2002 decline in worldwide music sales to illegal downloads and "increased sales of other entertainment formats such as DVD films and new video game consoles."[52] Both DVDs and video games are forms of entertainment that can compete with recorded music both for consumer dollars and consumer time. The following is a depiction of the recent growth of

[52] International Federation of the Phonographic Industry, "Global Sales of Recorded Music Down 7% in 2002," 9 April 2003, <http://www.ifpi.org/site-content/press/20030409.html> (3 April 2004), para. 4.

three types of entertainment substitutes: DVDs and VHS tapes, entertainment software, and movie tickets:[53]



Liebowitz found a positive correlation between box office revenues and album revenues (years 1972-1999), between video game sales and album sales (1990-1999), and between VHS purchases per capita and CDs per capita (1990-1999).[54] It is likely that sales of these products are influenced to move in the same direction by a common factor, but he reasons that the data show that they are not such close substitutes as to have negative yearly correlations.

[53] Movie, DVD, and VHS data from Standard & Poor, "Movies & Home Entertainment," Standard & Poor's Industry Surveys. (New York: Standard & Poor's Corp., 12 February 2004), pages 9-10. Entertainment software data from Entertainment Software Association, "Industry Sales and Economic Data," 2004, <http://www.theesa.com/pressroom.html> (3 April 2004).
[54] Liebowitz, 19.

Liebowitz also cites Table 909 from the U.S. statistical abstract, which states that listening to prerecorded music took approximately 45 minutes of a person's time per day, going to the movies took 2 minutes, watching prerecorded movies took 9 minutes, and playing video games took 7 minutes. Although Liebowitz acknowledges there are reasons to doubt the veracity of the numbers,[55] he argues that the low time levels of usage for non-music activities mean that they cannot significantly impinge on recorded music sales.

However, I do not find Liebowtiz's arguments that videogames and DVDs cannot significantly affect music sales compelling. There is no reason to believe his assertion that an unmeasured factor that could be driving the correlations "does not appear to be overly strong." Also, it is likely that the time usage statistics do not adequately capture amount of attention used by the different forms of entertainment. Music is low-attention entertainment, which can be consumed while focusing on another activity such as driving or reading. DVDs and video games require the user to focus much more of his energies in order to enjoy the product. If entertainment money is budgeted by total attention given instead of time spent consuming it, then we would expect video games and DVDs to have a greater influence in CD purchases than the time usage numbers would suggest.

Even though it is possible that these substitute markets can significantly affect CD sales, it is doubtful that their current success is a major cause of the music industry's decline. For one thing, the supposedly competing products are not clear substitutes. An Edison Research survey found that 9% of 12 to 24 year olds reported that hearing a song

[55] Estimates of time usage were based on a formula using other statistics that most likely included record sales as an important factor. While this would render the statistics virtually useless for looking at how yearly changes in time spent with each activity relates to record sales, they can still give us an idea about the relative amount of time spent on each activity. Presumably at some point the time usage numbers were calibrated with actual survey data instead of constructed out of thin air. Still, it would be prudent not to place much weight on these numbers.

featured in a video game was influential in the last music CD they bought for themselves.[56] The soundtrack for "O Brother, Where Art Thou?" produced more revenue than the domestic box office.[57] Theatrical movies, take-home movies, and video games have been around for a long time. In the late 1970's, music industry apologists were blaming video games for undercutting record sales.[58] The market for forms of entertainment that compete with music has been growing, but the music market has been growing as well. It does not make sense to blame competitive forms of entertainment whenever the music industry experiences a few bad years; the music industry *always* has to compete with other forms of entertainment. Since there have been no major price drops in entertainment products that compete with music, we should not expect competitive entertainment markets to have a significantly different effect on music sales than they had while the music industry was booming.

Distribution Channels

In September 2003, the five major record companies and three large music retailers agreed to a $143 million settlement of a lawsuit that accused them of setting minimum music prices. These companies felt that such a drastic action was necessary because the increased influence of mass discount retailers such as Walmart and Target

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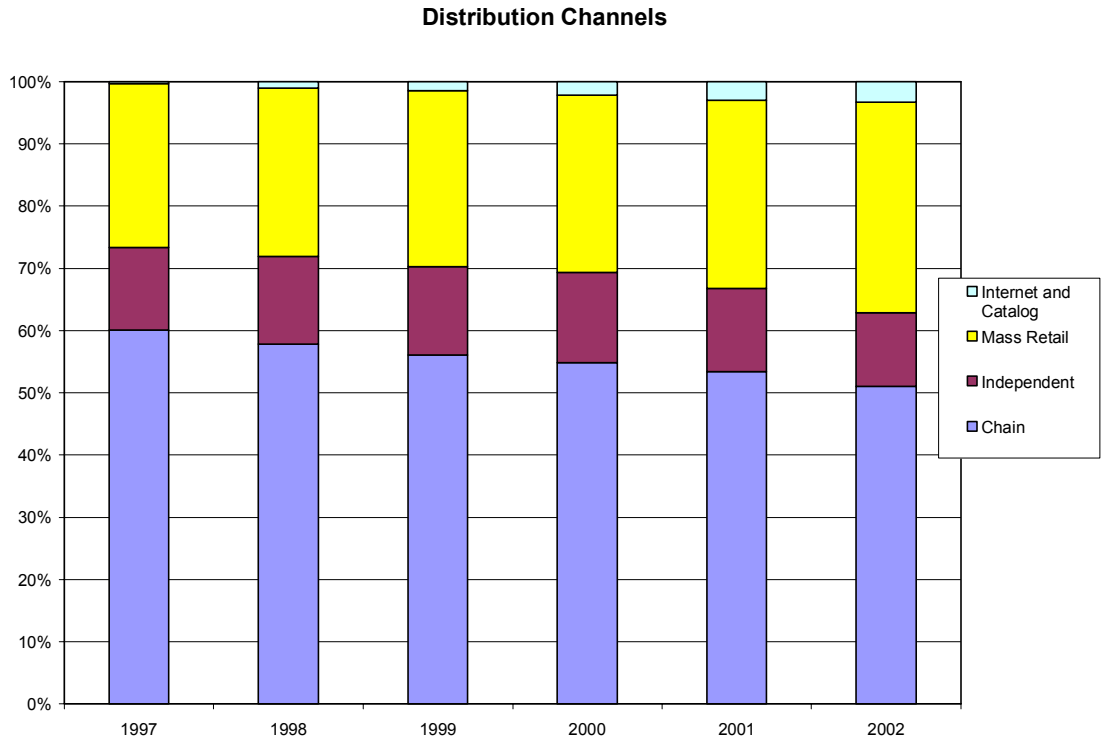
[56] Edison Media Research, "The Nation Record Buyers Study 3," 16 June 2003, <http://www.edisonresearch.com/RecordBuyersIIIPress.htm> (3 April 2004), para. 16.
[57] U.S. Gross: $45 million. Source: "O Brother, Where Art Thou?," Box Office Mojo, <http://www.boxofficemojo.com/movies/?id=obrotherwhereartthou.htm> (3 April 2004).
Total Albums Sold: 4 million+. "O Brother, Why Art Thou So Popular?," BBC News, 28 February 2002, <http://news.bbc.co.uk/2/hi/entertainment/1845962.stm> (3 April 2004).
[58] Jenkins, para. 6.

were driving prices too low to be profitable.[59] The following is a chart of market share by various types of retailer:[60]



Between 1997 and 2002, the market share for mass retailers grew from 26.3% to 33.8%. At the same time, chain record stores shrank from 60% of the market to 51% of the market, and independent record stores shrank from 13.3% of the market to 11.8% of the market. Internet sales also rose, which helped to accelerate the decline of the traditional music retailers.

Record companies dislike the rise of mass retailers because the mass retailers are able to use their monopsony power to drive down wholesale prices. Chain and independent record retailers dislike the mass retailers because they drive them out of

[59] Larry Neumeister, "Music Distributors, Retailers to Pay $143 Million to Settle CD Price-Fixing Case," The Associated Press, 30 September 2002.
[60] Data provided to author by Nielson SoundScan.

business. In February 2004, major music retailer Tower Records (one of the three retailers named in the antitrust suit) filed for bankruptcy. While some consumers might like the mass retailers because of their prices, many do not like the influence they have over the product. In 1996, when Wal-Mart was less influential in the markets, The *New York Times* published an article entitled, "Wal-Mart's CD Standards Are Changing Pop Music."[61] The article described Wal-Mart as "a world of shrink-wrapped packages marked 'edited,' 'clean' and 'sanitized for your protection.'" There is pressure for the record companies to produce material that will be acceptable to Wal-Mart.

While Internet music retailers increase record sales by providing a convenient avenue for music purchases, the effect of mass retailers on sales is ambiguous. On one hand, the pressure they put on record companies to produce music that is not aligned with consumer tastes should lead to a decrease in sales, and if they drive other retailers out of business, it could make it less convenient for consumers to purchase the music they desire. On the other hand, the downward pressure they put on wholesale prices and retail markups lowers the price to the consumer, and thus should increase the number of units sold. In addition, there is probably a subset of the population which prefers the option of letting their children shop freely in an obscenity-free environment. It does not seem plausible that a major part of the recent decline in unit sales is due to a slightly altered product or decreased convenience, especially when an increasing number of people are buying music over the Internet.

Summary

[61] Neil Strauss, "Wal-Mart's CD Standards are Changing Pop Music," The New York Times, 12 November 1996, A1.

This section has enumerated the various factors that might affect record sales. Taken individually, none of the factors measured explain a significant part of the current decline. It is possible that an amorphous factor like music quality or consumer taste can explain a large part of the decline. It is also possible that macroeconomic changes not captured by consumer income are having a significant effect on sales. But before we attribute significant explanatory power to an unmeasured factor we should address the central question of this paper: the effect of P2P file sharing.

C. What is the Predicted Effect of File Sharing?

Whether free digital downloads increase or decrease music sales is widely argued. File sharing can increase record sales because it gives people a low-cost way to try out music before they buy it. I will call this the "sampling" effect. Music singles were originally the way for consumers to sample recorded music, but file sharing gives cheaper and easier access to new music. Now that consumers have better access to new music, the sampling effect suggests they should buy more music because they will know of more music that satisfies their tastes. "Sampling" can lead consumers to develop a positive opinion both of the sampled work itself, and the artist who produced it.

The force that works in the opposite direction I will call the "replacement" effect. Illegally downloaded MP3s can serve as a substitute for purchased recorded music. People should be less likely to buy new music if they can get a similar product online for free. Illegally downloaded MP3s are not a perfect substitute for a purchased album; an album gives the consumer an easy way to experience the artist's full work in its intended form, and provides extras such as artwork and lyrics. But because the essence of the

product is the music itself, the replacement effect should put strong downward pressure on CD sales.

It is important to remember that not all parts of the music industry are affected by file sharing in the same way. Major releases already widely aired on radio and television do not receive as much benefit from the sampling effect. At the same time, they experience more harm from the replacement effect because people are already buying their albums. When arguing for the harm of digital downloads, the RIAA cites a decline in sales of the top 10 albums: 60 million units in 2000, 40 million in 2001, 34 million in 2002, and 33 million in 2003.[62] On the other hand, small independent releases that no one would hear unless the music were right in front of them can benefit tremendously from sampling, while they do not have much to lose from replacement. Also, most artists do not earn royalties and make their money from live performances. Sampling increases interest in those performances while in the short term most artists do not lose any money from albums replaced. Extremely successful artists can lose out on royalties, which explains why many of them oppose file sharing, but the major record companies have the most to lose. While an artist might benefit personally from fame and popularity, the record company can only profit if it translates that fame into record sales.

By July 2000, an estimated 21 million people in the United States had downloaded a music file to their computer. By October 2002, this number had risen to 36 million.[63] 1 billion files are currently available on P2P networks.[64] Clearly, file sharing is not a fringe activity. The sheer number of people participating in music downloading

[62] John Schwartz, "A Heretical View of File Sharing," The New York Times, 5 April 2004.
[63] PEW Internet & American Life Project, "America's Online Pursuits: The changing picture of who's online and what they do," 22 December 2003, <http://www.pewinternet.org/reports/pdfs/PIP_Online_Pursuits_Final.PDF> (3 April 2004), page 8.
[64] IFPI Estimate, cited in Hines, "File-sharing Lawsuits go Abroad."

means that it is important to understand the direction of the combined effects. Different surveys yield contradicting results about which effect dominates. A survey released in May 2002 by Jupiter Research found that 34% of veteran file swappers say they are spending more on music than they did before they started downloading music files, while only 14% say they are spending less.[65] A November 2002 survey by Peter Hart Research (and commissioned by the RIAA) found the opposite result: music consumers who say they are downloading free music report they are purchasing less music by nearly a 2-to-1 margin.[66] Surveys cannot provide conclusive evidence. It is likely that the biases of the surveyors play an important role in the results, and it is generally better to look actual market decisions rather than consumer self-reports.

[65] John Borland, "Study: File Sharing Boosts Music Sales," News.com, 3 May 2002, <http://news.com.com/2100-1023-898813.html> (3 April 2004).
[66] Recording Industry Association of America, "Actions Taken by Music Community to to Step Up Public Education Efforts in Just the Past Twelve Months," 25 June 2003, <http://www.riaa.com/news/newsletter/062503_d.asp> (3 April 2004).

III. Academic Research

I will discuss two major economic works that have looked at the effect of physical piracy on music sales. The model presented by Kai-Lung Hui and Ivan Png (2003) looks more specifically at the piracy variable,[67] while the models presented by K. Brad Stamm (2000) focus more on the demographic components of music demand.[68] These models were influential in developing the econometric specification used in my paper, so I will discuss the specifications used in each. I will also look at a paper by Felix Oberholzer and Koleman Strumpf (2004), which matches downloads from a file sharing service to weekly record sales in order to determine the effect of digital piracy. This work is useful because it provides a solid base from which to compare my results.

In *Piracy and the Legitimate Demand for Record Music*, Hui and Png examine international panel data for music CDs from 1994 to 1998. Hui and Png estimate the equation for per capita legitimate music demand:

$$Q_{L,it} = \gamma_0 + \gamma_1 P_{it} + \gamma_2 Y_{it} + \gamma_3 N_{it} + \gamma_4 M_t + \gamma_5 Q_{C,it} + \varepsilon_{it}$$

The "i" subscript represents the country, and the "t" subscript represents the year. The authors use a fixed-effect specification, with γ_0 representing a vector of national constants rather than a single intercept. Their dataset includes 28 countries for 140 total observations. The countries are drawn from all major continents and every band of piracy level defined by the IFPI.[69] "P" is average national CD price, "Y" is personal disposable income, "N" is CD player ownership, "M" is worldwide Music Television (MTV) subscriptions, and Q_C is the piracy level. Data on CD prices and national piracy rates

[67] Kai-Lung Hui and Ivan Png, "Piracy and the Legitimate Demand for Recorded Music," Contributions to Economic Analysis & Policy, 1 (2003), Article 11.
[68] K. Brad Stamm, Music Industry Economics: A Global Demand Model for Pre-Recorded Music, (Lewiston, NY: The Edwin Mellen Press, 2000).
[69] Less than 10%, 10-25%, 25-50%, and above 50%.

came from the IFPI. For the piracy estimates, the IFPI combined estimates from specialist market researchers for the difference between CD production capacity and legitimate sales by country, and direct estimates of piracy by the respective national recorded music organizations.[70] The number of worldwide MTV subscribers came from annual reports of VIACOM, the parent company of MTV Networks. All country variables were converted into per capita terms using the country's population reported by the Global Market Information Database (GMID).

Because the price of CDs might be endogenously determined, the authors searched for an instrument that would capture the variations in music CD prices while not being correlated with the quantity demanded. Since data on supply-side cost-shifters were not available, they used the price of non-internationally tradeable goods as an instrument to reflect the cost of land and labor. They constructed this instrument as a ratio of each country's purchasing power parity rate to its exchange rate relative to the U.S. dollar. Additionally, the quantity of music CDs pirated is endogenous, for it depends on the price of the legitimate item and the demand for the legitimate item. The authors used the piracy rates of two other information products as instruments: music cassettes and business computer software. The piracy of these goods is influenced by the same set of national characteristics (such as expected penalties for sale or use of pirated items), while it should not be affected by the demand for CDs. The authors also use the unemployment rate and total consumer expenditure as instruments, for they are exogenous factors which shift pirated quantity but are not affected by the legitimate demand for music CDs.[71]

[70] Hui and Png, page 9.
[71] Data on music cassette piracy were obtained from the IFPI. Data on business computer software piracy were obtained from the Business Software Association/Software & Information Industry Association (BSA/SIIA). Consumer expenditure and unemployment data was drawn from the GMID.

By running this model, Hui and Png found that on a per capita basis a one-unit increase in music CD piracy was associated with a 0.42 (±0.25) unit reduction in legitimate sales. This result is significant at the 10% level. Assuming the industry did not adjust CD prices in response to piracy, this suggests that the industry lost about 6.6 (±3.6)% of sales to piracy in 1998. In the various alternate regressions they ran (one constant instead of fixed effects, separate regressions for high-income and low-income countries, omitting the 0% piracy countries, including year-based dummies instead of the MTV variable), the coefficient on piracy ranged from –0.36 to –0.53.

In *Music Industry Economics: A Global Demand Model for Pre-Recorded Music,* K. Brad Stamm presents two basic types of models that look at the effect of piracy on music demand:

$$(1)\ SALES_{L,it} = \gamma_0 + \gamma_1(GNP)_{it} + \gamma_2(PIRACY)_{it} + \gamma_3(\%\ AGE\ 15\text{-}19)_{it} + \varepsilon_{it}$$

$$(2)\ SALES_{L,it} = \gamma_0 + \gamma_1(GNP)_{it} + \gamma_2(PIRACY)_{it} + \gamma_3(AGE\ 10\text{-}14)_{it} + \gamma_4(AGE\ 15\text{-}19)_{it} + \gamma_5(AGE\ 20\text{-}24)_{it} + \gamma_6(AGE\ 25\text{-}29) + \varepsilon_{it}$$

Stamm uses data from 67 countries, with the latest observations occurring in the year 1994. Because data on piracy and detailed demographics was at best available from 1989 onwards, the 67 countries yield a maximum of 224 observations. Stamm estimates the total sales of recorded music instead of just a single format. GNP is measured in U.S. dollars. Piracy is the estimated percentage of recorded music in a country that is pirated. In equation (1), γ_3 is the coefficient on the percentage of the population that is between 15 and 19 years of age. In equation (2), γ_3- γ_6 are coefficients on the total number of people in the country that fall into the specified age range. Stamm does not specifiy a fixed-

effects model that would allow each country to have its own intercept; γ_0 is the estimated intercept over all countries.

The theory behind Stamm's model is that because youths tend to buy more music than adults, a more youthful population should indicate more recording sales in a country. Despite the intuitive appeal of his theory, his results are mixed. Stamm runs these two models using all countries, and separately for groups of countries in different income bands. When running equation (1), the coefficient on "% AGE 15-19" is always positive and significant. When running equation (2), the coefficient on "AGE 15-19" was positive when it was significant, but sometimes was negative and insignificant. The coefficient on "AGE 20-24" was positive and significant for low-income and high-income countries done separately, but negative and significant for the all-country sample.

The coefficient on "PIRACY" is of varied signs and usually insignificant. For equation (2) run on the low-middle income sample, "PIRACY" is positive and significant; for equation (2) run on the high-income sample, "PIRACY" is negative and significant; for all other regressions "PIRACY" was insignificant.

I would not place much confidence in Stamm's results. The countries he studies are extremely different from one another, yet he does not include dummy variables for each country to account for those differences. There are also problems that come from comparing economies of vastly different sizes. The "PIRACY" and "% AGE 15-19" variables are measures of percentages that the model constrains to have the same effect on the total sales of all economies; but we would expect a 1% change in either of these variables to have a much larger effect on total sales of a large economy than it would have on a small economy. For "PIRACY", a potential solution would be to include a

measure of the total number of pirated units instead. But the model would still have the endogeneity problem addressed by Hui and Png, since the number of pirated units is determined at the same time as the demand for legitimate units.

The models of Hui and Png and the models of Stamm looked at the effect of physical piracy on record sales. Judging by the more reliable results of Hui and Png, the effect of physical piracy is significant and negative. While this result suggests the direction of the effect of illegal MP3 downloading on music sales, it does not provide conclusive evidence that the effect will be negative. The positive effects of sampling should be much greater for MP3s than for physical copies. The selection of music is wider on a P2P service, the monetary cost is lower, and the transaction is easier. The negative effects of replacement should also be less for MP3s than for physical copies. Illegal physical copies tend to be complete albums rather than individual songs, and money that is spent on pirated copies comes directly out of a consumer's music budget.

The previously discussed academic works have drawn their conclusions from international panel data. Even after controlling for the fixed differences between countries, the conclusions rest on data from vastly different economies. Even if a reliable average result of the effect of piracy could be found, it is not clear where this result would apply. Additionally, piracy rates are highly speculative because they involve the measurement of an underground activity. They are drawn from the IFPI, which has an incentive to inflate these rates to support its position.

In *The Effect of File Sharing on Record Sales: An Empirical Analysis*, Oberholzer and Strumpf (2004) perform the most rigorous economic modeling yet published that

uses data directly obtained from file sharing networks.[72] They analyze a dataset that includes 0.01% of the world's music downloads from the final 17 weeks of 2002. Downloads by users located in the U.S. are matched to the album on which those downloads are released. Oberholzer and Strumpf then use weekly sales for those albums to estimate a relationship between downloading and sales. To establish causality, they instrument for downloads using technical features related to file sharing (such as network congestion or song length) and international school holidays, both of which are plausibly exogenous to sales. They are able to obtain relatively precise estimates because the data contain over ten thousand observations.[73]

Oberholzer and Strumpf find that file sharing has had an insignificant aggregate effect on record sales. This estimated effect is statistically indistinguishable from zero despite the narrow standard errors that result from their large dataset. Even in their most pessimistic specification (which still yielded a statistically insignificant effect), five thousand downloads are needed to displace a single album sale. This means that illegal file sharing could only account for a 2 million unit decline in CD sales in 2002, which is a small proportion of the 139 million decline in total sales that occurred from 2000 to 2002.[74]

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[72] Felix Oberholzer and Koleman Strumpf, "The Effect of File Sharing on Record Sales: An Empircal Analyis," Harvard Business School and UNC Chapel Hill, March 2004 <http://www.unc.edu/~cigar/papers/FileSharing_March2004.pdf> (3 April 2004).

[73] Adapted from summary in Oberholzer and Strumpf, page 1.

[74] Oberholzer and Strumpf, quoted in David McGuire, "Study: File-Sharing No Threat to Music Sales," 30 March 2004, <http://news.yahoo.com/news?tmpl=story&u=/washpost/20040330/tc_washpost/a34300_2004mar29> (3 April 2004).

IV. Model

A. Overview

The Internet has revolutionized people's cultural and consumer behavior. How has it affected CD sales? I use a fixed-effects model to estimate the effect of Internet access on CD sales in 99 metropolitan areas of the United States. I combine U.S. census data on population characteristics with Nielson SoundScan data on CD sales over the years 1998, 2000, and 2001. Different U.S. metropolitan areas are much more similar than different countries, which should yield more accurate estimates than the internationally estimated models. The data come from reliable and unbiased sources, and are not susceptible to the self-reporting inaccuracies that plague survey studies. My results will be clearly applicable to the U.S. market.

I do not measure Internet piracy. Instead, I break down the population into different age groups in order to see how Internet access changes the predicted effect of each age group on CD sales. Youths are more likely than adults to download music illegally. Edison Research has found that while a majority of Americans under eighteen years old have downloaded music, only a fifth of those aged 35-44 have downloaded files.[75] Pew Internet Project has found that 51% of 18 to 29 year olds were downloading music in 2001, compared to 23% of 30 to 49 year olds, and 15% of those 50 and older.[76] Students have access to the high-speed Internet connections provided by their school. When the RIAA sued Napster, the evidence of harm they provided was a

[75] Edison Media Research, "National Record Buyers Study III" as quoted in Oberholzer and Strumpf, page 2.
[76] Pew Internet & American Life Project, "Pew Internet Project and Comscore Media Metrix Data Memo. Re: The impact of recording industry lawsuits against music swappers," January 2004, <http://www.pewinternet.org/reports/pdfs/PIP_File_Swapping_Memo_0104.pdf> (3 April 2004).

disproportionately large decline in record sales near college campuses.[77] Youths have less money to spend, less regard for the potential penalties of their actions, more time to spend searching for a song online, and more comfort with new technologies. If the effect of file sharing on CD sales is negative for all age groups, I expect the effect of Internet access on CD sales to be negative for all age groups, with the magnitudes corresponding to each group's tendency to engage in online piracy. But there are good reasons why the effects of file sharing on CD sales are not the same for all age groups. The replacement effect is likely stronger for youths than for adults, since they have a tighter income constraint. The sampling effect is likely stronger for adults than for youths, since adults are less likely to be satisfied with mass-marketed music and have the money to pay for alternatives they discover. Since Internet access correlates with file sharing, I would expect the effect of Internet access on CD sales to be more negative for youths than for adults, with the signs determined by the relative strengths of the replacement and sampling effects for each age group.

B. Data Sources

Data on population age, income, household size, and Internet access were drawn from the Census Bureau's Current Population Survey (CPS). CPS representatives conduct interviews each month at a sample of households throughout the United States. The primary purpose of the CPS is to provide data on the labor force, but the CPS periodically includes different supplemental questions. I used the three most recent surveys that included supplemental questions on Internet and computer use. The three

[77] Michael Fine, "Report of Michael Fine," A&M Records, Inc., et. al. v. Napster, Inc., 10 June 2000, <http://news.findlaw.com/hdocs/docs/napster/riaa/fine.pdf> (3 April 2004).

surveys used for my model were conducted in December 1998, August 2000, and September 2001. Each CPS survey contained about 50,000 households, which provided data for a total of 387,980 people. Although these years were chosen because of data availability, they are also very good for conceptual reasons. The year 1998 represents the pre-Napster period, while file sharing had already become entrenched by the years 2000 and 2001. Since my model will be estimated based on the changes that occurred within each metropolitan area in the span of those years, it will be estimating the effects that coincide with the rise of file sharing. Another good property of those years is that CDs are the clearly dominant medium for recorded music. Measuring the changes in CD sales will give a good picture on how various factors affect the music industry. If data from more recent years were used, the model would have to account for legitimate MP3 downloads sold by companies such as iTunes, which had not yet become prominent in 2001. Also, CD sales are not trending over the years studied. This is desirable because it means the model will not register misleading correlations between CDs and variables like income and population that have a strong time trend.

The households surveyed for the CPS are chosen such that data is drawn from representatives of about 800 statistical areas. After the data is collected, people are assigned a statistical weight so that weighted calculations are representative of known information about age, race, sex, and employment. The weight I use for my calculations is "PWSSWGT," which is the standard weight to use for demographic calculations. The weighting variable is the estimated number of people that the surveyed person represents, so all calculations of the number of people in a given category were made by summing the weights of the surveyed people that fell into that category.

Data on CD sales came from Neilson SoundScan, which tracks virtually all pre-recorded music that is distributed in the United States. SoundScan collects weekly point-of-sale data from over 14,000 retail stores, mass retailers, Internet sites, and mail order and concert venues.[78] Using this data, SoundScan employs a statistical formula to extrapolate the total weekly sales for the records it tracks. Most SoundScan clients are companies in the music industry keeping track of their artists or the competition. The top-10 charts in Billboard Magazine are constructed using SoundScan data. SoundScan provided me with yearly CD sales in the 100 largest U.S. metropolitan areas from 1997 to 2002. Also included were CD sales for areas that did not fall into any of the 100 metropolitan areas. SoundScan's designated metropolitan areas (DMAs) were constructed using the zip code of the retailer if it was a traditional sale, or the zip code of the purchaser if the product was shipped to him.

CPS and SoundScan provide their data using different geographic designations. The smallest area in the CPS data is the Metropolitan Statistical Area (MSA). There are 247 MSAs in the U.S. In order to combine the data from the CPS with the data from SoundScan, I had to reconstruct the DMAs from the MSAs. Using year 2000 zip codes and population numbers, I determined the largest zip code within each MSA.[79] I then assigned each MSA to a DMA according to the DMA of the largest zip code within the MSA. I was able to reconstruct 99 of the 100 DMAs in this manner.[80] 72% of people were assigned to the 99 DMAs, which accounts for 87% of CD sales.

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[78] Fine, page 6.
[79] Mable/Geocorr2K Geographic Correspondence Engine with Census 2000 Geography, <http://mcdc2.missouri.edu/websas/geocorr2k.html> (3 April 2004).
[80] The only DMA not recovered was the area around Paducah, Kentucky. Kentucky is represented by the Lexington, Louisville, and Cincinnati areas, so this is no cause for concern.

C. Variables

The following is an explanation of the variables included in my models.

sales

sales is the dependent variable of the model. It is the total number of CDs sold in a given year in a given metropolitan area. I use total sales instead of per capita sales to mitigate the effect of imperfect population measurements. In some of the smaller metropolitan areas, changes in the households sampled can lead to fluctuations in the measured population of the areas. Yearly changes in calculated CDs per capita can improperly switch signs because of this population measurement. Leaving the dependent variable as total CDs sold will avoid this problem. Also, using the level of CD sales will give the model coefficients that are more straightforward to interpret once the proper variables are constructed.

wsales

wsales is a weighted measure of sales used as the dependent variable in an alternate specification of the model. The measures of Internet access are essentially measures at a specific point in time that should relate to CD sales for the periods most closely surrounding that time. A CPS given in the middle of the year should have more bearing on sales for that year than a second CPS given at the end of the year, for the effects of the variables measured by the second CPS will spill over into next year's sales. *wsales* was constructed for each DMA in each year as a weighted average of the surrounding year's sales. *wsales* for 1998 was constructed as 6/12 of sales in 1998 plus 6/12 of sales in 1999 since the survey occurred in December; *wsales* for 2000 was constructed as 10/12 of sales in 2000 plus 2/12 of sales in 2001, since the survey occurred

in August; *wsales* for 2001 was constructed as 9/12 of sales in 2001 plus 3/12 of sales in 2002, since the survey occurred in September.

popavg

popavg is the average population in a metropolitan area based on data from CPSs conducted in 1997, 1998, 2000, and 2001. It serves as a measure of the size of the DMA that does not change yearly. It is used as an analytical weight in the regressions so that observations from the large DMAs are more important than those from small DMAs. This is desirable because the large DMAs have a lower variance in the measurement of their variables, and as such contain better information about their effects. I used *popavg* instead of the actual population for the weight so that each observation from a DMA was weighted the same, meaning the regression would not give more weight to later years due to population growth. I also use *popavg* in the construction of the income variables to convert per capita measures to total measures that are not related to yearly changes in population.

inclo* and *inchi

inclo is a measure of the income drawn from people with lower than the maximum recorded income. If a family reports a household income above $75,000 per year, the CPS records the income only as "$75,000 or more" in order to protect the family's anonymity. There are 13 reported levels of income below this maximum level, which I used to construct *inclo*. First, I estimated the average income of the lower income families by multiplying the number of people that fall into each income category by the midpoint of that category. Then I divided by average household size to get a measure of per capita income, and multiplied by the percentage of people who have "low" incomes.

Finally, I multiplied by *popavg* so that the coefficient on *inclo* will represent a constant per capita effect. The coefficient on *inclo* represents the marginal increase in CDs sold correlated with a $1 increase in the average income of a "low" income person.

inchi is the percentage of people who reported their household as earning above $75,000 per year multiplied by *popavg*. The coefficient on *inchi* represents the marginal change in CDs sold correlated with one more person entering the maximum income category.

Because income is positively related to entertainment expenditures, I expect the coefficients on both *inclo* and *inchi* to be positive.

ageXtoYni* and *ageXtoYyi

ageXtoYni is the number of people in a metropolitan area between ages X and Y that do not have Internet access at home. *ageXtoYyi* is the number of people in a metropolitan area between ages X and Y that do have Internet access at home. The sum of all the age category variables (*age0to4* included) is the population of the metropolitan area. In this way, the model controls for the population of the DMA. The following table shows how the presence of home Internet access varies with age:

Table 3: Internet Adoption by Age Group[81]

	5 to 14	15 to 24	25 to 44	45 to 65	65+
Dec, 1998	32.3%	32.7%	33.9%	32.1%	10.4%
Aug, 2000	51.2%	50.1%	51.6%	49.0%	20.9%
Sep, 2001	62.3%	60.7%	61.7%	59.0%	28.2%

Home Internet access is similar across every age group except for the oldest. This is not surprising because the access rate of the adult age groups determines the access rate for the children. There will be four of these age ranges in the standard model, which

[81] Data drawn from the CPS.

collectively span every age from 5 and up; the two oldest age categories are combined into a single category because they have similar CD purchase intensities, and to mirror the standard categories used in statistics released by the record industry.[82] An earlier table showed that the per capita purchases of CDs varied with age group, so overall we would expect the coefficients on variables that represent ages 15 to 24 to be greater than the coefficients for other age groups.

I theorize that Internet access has an effect on the CD purchases of a population segment. If Internet piracy is a major activity of that age group, and if the "replacement" effect outweighs the "sampling" effect, then I would expect Internet access for an age group to correlate negatively with CD sales. But if the main effect were that Internet access signals information about the level of consumer entertainment culture, then I would expect Internet access to correlate positively with CD sales. I will test this relationship by seeing if there is a significant difference between the coefficients on *ageXtoYni* and *ageXtoYyi* for the same age range.

age0to4

age0to4 represents the number of children 4 years old and below in a metropolitan area. Since this segment of the population is not making any purchasing decisions, I can see no reason why home Internet access in the home of this age group will significantly alter CD sales. I theorize that the coefficient on *age0to4* will be negative, since having a baby in the family means more resources will be devoted to caring for that child instead of entertainment expenditures. However, Hansmann, Mulder, and Verhoeff (1999) theorize the opposite; parents will devote more resources to home entertainment expenditures instead of going out, which would lead to an increase in sales.

[82] For instance, Recording Industry Association of America, "2002 Consumer Profile."

yr2000* and *yr2001

yr2000 is a dummy variable set to 1 for the year 2000 data, and *yr2001* is a dummy variable set to 1 for the year 2001 data. Even though overall CD sales are higher in 2000 and 2001 than they were in 1998, I expect the coefficients on both of these dummy variables to be negative. The music industry has been complaining about a decline from its 1999 peak, and these dummy variables will pick up the market factors not included in my model. The increasing popularity of substitutes and theorized decline in overall music quality would be captured by these dummy variables. Also captured would be a change in the level of piracy that cannot be captured by Internet usage statistics.

D. Specification

The following equation is used to estimate the model:

$$sales_{i,t} = \beta_0 + \beta_1(yr2000)_{it} + \beta_2(yr2001)_{it} + \beta_3(inclo)_{it} + \beta_4(inchi)_{it} + \beta_5(age0to4)_{it} + \beta_6(age5to14ni)_{it} + \beta_7(age5to14yi)_{it} + \beta_8(age15to24ni)_{it} + \beta_9(age15to24yi)_{it} + \beta_{10}(age25to44ni)_{it} + \beta_{11}(age25to44yi)_{it} + \beta_{12}(age45toMAXni)_{it} + \beta_{13}(age45toMAXyi)_{it} + \varepsilon_{it}$$

β_0 represents a vector of constants, one for each metropolitan area. Different areas have different base-level CD purchases, depending on factors such as size, number of music venues, and local culture. Having a separate dummy variable for each area ensures that fixed differences between areas do not bias the measured coefficients. A Hausman

test confirmed that a fixed effects model is appropriate instead of a random effects model. Thus, all effects are measured using only the variations within each metropolitan area. I also weight each observation by the square root of *popavg* because the measurements for each metropolitan area have variances that correspond to the number of people in that area.

My standard estimation uses data for all of the 99 categorized metropolitan areas. In order to test the model for robustness, I ran it with some minor alterations. The first alteration includes the data on the non-metropolitan population and CD sales as an extra observation for each year. I initially excluded this group because they are so geographically diverse, but because it is such a large minority of the population I wanted to see if including this group would have a significant effect on the coefficients. I also ran the model separately for the 54 largest and 55 smallest metropolitan areas to see if area size changes the measured coefficients. Finally, I ran the model using *wsales* as the dependent variable to see if adjusting sales for survey month produces any effect.

The predicted effect of Internet access on CD sales can be read from the "Difference" rows in the following table. These rows report the difference between the coefficient for the members of an age group who have Internet access and the coefficient for the members of that group who do not have Internet access. Also reported is the p-value of the F-test that determines the statistical significance of that difference. The conversion of one person from "no Internet" to "yes Internet" has the predicted effect of decreasing sales by the coefficient on "no Internet" and increasing sales by the coefficient on "yes Internet," meaning the difference is the appropriate measure for the effect of one person gaining Internet access. The units of this measure are CDs per capita.

Table 4: Models for Estimating Music CD Sales

Variable \ Data	Standard	Non-metro included	49 largest metro areas	50 smallest metro areas	*wsales* as dep. var.
yr2000 **β-hat**	-0.3487	-0.3593	-0.3778	0.3232	-0.4171
dummy for year 2000 **(std err)**	(0.0877)***	(0.0890)***	(0.1280)***	(0.1484)**	(0.9272)***
yr2001	-0.7890	-0.7401	-0.8337	0.2633	-0.9339
dummy for year 2001	(0.1412)***	(0.1431)***	(0.2060)***	(0.2343)	(0.1493)***
inclo	$1.141x10^{-4}$	$1.265x10^{-4}$	$1.200x10^{-4}$	$4.93\ x10^{-5}$	$1.574\ x10^{-4}$
Total income earned by "low" income people.	$(2.66x10^{-5})$***	$(2.66x10^{-5})$***	$(3.88x10^{-5})$***	$(5.23x10^{-5})$	$(2.81x10^{-5})$***
inchi	1.8129	2.1755	1.8523	2.279	2.5876
Number of people in "high" income households.	(0.6173)***	(0.5454)***	(0.8937)**	(1.6010)	(0.6525)***
age0to4	-0.3018	-1.0329	-0.3364	6.0203	-1.3473
Number of people ages 0 to 4 years old.	(1.4930)	(1.5134)	(2.1659)	(3.0495)*	(1.5782)
age5to14ni	4.8315	3.8197	5.0961	-1.3217	5.3846
Number of people ages 5 to 14, without Internet.	(1.3032)***	(1.2922)***	(1.8978)***	(2.5633)	(1.3775)***
age5to14yi	1.2458	-0.1228	1.0046	2.1852	3.3041
Number of people ages 5 to 14, with Internet.	(1.6349)	(1.5949)	(2.3979)	(2.7648)	(1.7282)**
Difference	**-3.59**	**-3.94**	**-4.09**	**-4.09**	**-2.08**
significance	**12.0%**	**8.9%**	**22.8%**	**34.1%**	**39.2%**
age15to24ni	7.1340	8.8808	7.0019	4.2341	8.4799
Number of people ages 15 to 24, without Internet.	(1.3196)***	(1.2291)***	(1.9245)***	(2.5137)*	(1.3949)***
age15to24yi	2.8973	0.9981	3.1269	-2.7116	2.8555
Number of people ages 15 to 24, with Internet.	(1.3623)**	(1.1335)	(1.9935)	(2.3318)	(1.4400)**
Difference	**-4.24**	**-7.88**	**-3.88**	**-6.95**	**-5.62**
	3.1%	**0.0%**	**17.9%**	**1.8%**	**0.7%**
age25to44ni	-2.2258	-0.9535	-2.2891	-0.8064	-2.2613
Number of people ages 25 to 44, without Internet.	(1.0261)**	(0.9610)	(1.4899)	(1.9599)	(1.0846)**
age25to44yi	2.9214	4.3876	3.1875	-4.9073	2.4713
Number of people ages 25 to 44, with Internet.	(1.2498)**	(1.1466)***	(1.8215)*	(2.3501)**	(1.3210)*
Difference	**5.15**	**5.34**	**5.48**	**4.10**	**4.73**
	0.2%	**0.1%**	**2.2%**	**15.0%**	**0.6%**
age45toMAXni	-0.5976	-0.8869	-0.5972	-0.4866	-1.3107
Number of people ages 45 and older, without Internet.	(0.9468)	(0.9296)	(1.3827)	(1.5352)	(1.0008)
age45toMAXyi	7.6145	8.3256	7.9085	2.3911	6.8625
Number of people ages 45 and older, with Internet.	(1.2219)***	(1.2284)***	(1.7831)***	(1.7831)	(1.2916)***
Difference	**8.21**	**9.21**	**8.51**	**2.88**	**8.17**
	0.0%	**0.0%**	**0.0%**	**21.6%**	**0.0%**
Num. Obs.	297	300	147	150	297
Adjusted R^2	0.9991	0.9998	0.9989	0.8978	0.9989

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

V. Results

A. Primary Results

For younger people, Internet access predicts a decrease in sales. For older people, Internet access predicts an increase in sales. The overall effect of Internet access is positive -- the magnitude of the Internet effect is larger in the older age groups, and the older age groups represent a greater proportion of the population. This strongly suggests that file sharing is not the cause of the recent decline in the record industry.

For the group aged 5 to 14, the predicted effect of Internet access on CD sales is consistently negative but insignificant. For the group aged 15 to 24, the effect of Internet is negative and significant at the 5% level. The effect remains negative in all alternate runs of the model, and significant in all runs except for the one limited to large metropolitan areas only. For both the group aged 25 to 44 and the group aged 45 and older, the effect of Internet access is positive and significant. The effect remains positive in all alternate runs of the model, and significant in all runs except for the one limited to small metropolitan areas only. The smallest measured Internet effect among every variation of the model is -2.08, meaning the effect of Internet access is economically significant as well as statistically significant. Insofar as the effect of Internet access on CD sales occurs through file sharing, I find that file sharing has a negative effect on the purchases of the young but a positive effect on the purchases of the old. These results support the hypothesis that replacement effects dominate for young people but sampling effects dominate for old people.

A July 2003 survey by Quantum Market Research (and sponsored by the Australian Recording Industry Association) asked consumers whether their CD purchases

increased, decreased, or stayed the same as a result of file sharing.[83] For people aged 10 to 17, the net change in CD purchases[84] was –20%; for ages 18 to 24, the net change was –15%. For ages 25 to 44, the net change was –12.5%, and for ages 45 and older, the net change was +8%. This survey supports the broad pattern suggested by my research, that the effect of file sharing for young people is negative, and the effect of file sharing for old people is positive.

The aggregate effect of the Internet on CD sales is positive and significant. I computed an aggregate effect of 3.47 CDs per capita by multiplying the estimated effect for each age group by the proportion of the examined population that belongs to that age group. Each old group was weighted about twice as heavily as each young group because they represent about twice as many people.[85] An F-test on this calculated number yielded a p-value of 0.000, so the result is highly significant. However, the coefficients for the younger age groups might contain more information about file sharing since those groups are more engaged in file sharing. An unweighted average of the Internet effects is 1.38 with a p-value of 0.031, still positive and significant. In order to get a negative aggregate effect from my estimated Internet effects, one would have to weight each young group twice as heavily as each old group. Since these weightings are so out of line with the percentage of the population that each group actually represents, I conclude that file sharing does not have a negative aggregate effect on CD sales.

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[83] Quantum Market Research, "Understanding CD Burning and Internet File Sharing and its Impact on the Australian Music Industry," July 2003, <http://www.aria.com.au/documents/AriaIllegalMusicResearchReport_Summary.pdf> (3 April 2004).

[84] (% of people who reported an increase) – (% of people who reported a decrease)

[85] Weightings: 15.9% aged 5 to 14, 15.2% aged 15 to 24, 31.6% aged 25 to 44, 37.2% aged 45 and older.

B. Caveats

Although my results suggest a negative effect of file sharing for young people and a positive effect for old people, Internet access reveals much more about a person than the ability to download MP3s. Home Internet access means there is a home computer, which people can use for either offline or online video games. Since video games (and other forms of entertainment) can serve as a substitute for CDs, we would expect the Internet effect to be more negative among the segments of the population that use computers for entertainment. Since young people are more likely to use computers for entertainment while older people are more likely to use computers for work, we would expect the Internet effect to be more negative for the young. Internet access can also signal wealth or cultural involvement. If an adult does not have Internet access, it signals that he either cannot afford it or is the type of person who is willing to accept a lack of connectedness with the rest of the world. If a child does not have Internet access, it signals this information about his parents. These signaling effects tend to cause the Internet effect to be positive, especially among the older age groups where the signals more aptly apply. Both the effects of entertainment substitutes and the effects of cultural and monetary signaling could be improperly strengthening my results.

However, it is highly unlikely that none of the measured effect of Internet access on CD sales is due to file sharing. There are many ways in which Internet access might affect CD sales, but the online activity that is by far the most directly related to the music industry is file sharing. On the negative side, MP3s are the nearest substitutes for CD purchases. On the positive side, the best way to learn about new music is to download that music. My results strongly correspond to the theoretical arguments and available

survey information about the different file sharing effects of different demographic segments. Thus, file sharing is the likely explanation for my results.

If Oberholzer and Strumpf are correct that file sharing has an insignificant aggregate effect on CD sales, then the effects of file sharing for young people and old people cancel each other out. This would bring into question whether the positive aggregate effect I calculated was actually a result of file sharing, or a result of the additional information revealed by Internet access. All of the estimated Internet effects were so large that one cannot reasonably interpret them as the change in a person's CD purchases due to his or her file sharing, or even due to his or her Internet access. The coefficients represent correlations, not causations. An additional young person with Internet can signal the rise of a culture that refuses to pay for music, leading to a citywide decrease in sales even if the young person himself buys some CDs. This also helps to explain some of the negative coefficients. A rise in people without Internet access in a city, while providing more potential CD purchasers, signals technological, cultural, and economic changes within that city that might lead to an overall decrease in sales.

C. Secondary Results

The *age0to4* variable was negative, but insignificant. It remained that way in all the alternate equations except for the small area one, in which it was positive and significant at the 10% level. Since the number of people aged 0 to 4 years old does not have a significant effect on the number of CDs sold in a metropolitan area, I conclude that the presence of very young child does not significantly alter the CD purchasing habits of a family.

Both of the year dummies are significant and have the expected negative sign. The coefficients suggest that the unmeasured factors in the year 2000 average a –0.35 impact on per capita CD sales and the unmeasured factors in 2001 average a –0.79 impact on per capita CD sales. Even though per capita and overall CD sales are higher in 2000 and 2001 than they were in 1998, the model measures a negative and statistically significant constant for the later years. While per capita CD sales rose slightly in those years, per capita album sales fell by about 0.5 albums.[86] The decline in album sales suggests a negative period for the music industry as a whole, even though it was not yet reflected in CD sales. My model measured such a negative overall effect despite rising CD sales, which lends credence to the music industry's claims of an increasingly difficult marketplace – though it says nothing as to whether the differences are externally generated (e.g. substitutes) or internally generated (e.g. music quality).

The income variables are also significant and have the expected sign. The coefficient on *inclo* suggests that a $7,000 increase in income per capita by people with lower incomes is correlated with a 1 CD per capita increase in sales. The coefficient on *inchi* suggests that a 1 person increase in the number of people belonging to high income families is correlated with a 1.8 CD per capita increase in sales. These coefficients remain positive in all of the alternate equations, and significant in all except for the one limited to small metropolitan areas.

The coefficients on the 15- to 24-year-old group have the highest average of any age group. This result concurs with the standard finding that 15- to 24-year-olds are the heaviest purchasers of recorded music, and Stamm's finding that the youth of a population positively affects a country's record sales. Although the average for 15- to 24-

[86] Liebowitz, 10.

year-olds[87] is about 1.2 units per capita higher than the next highest group, it is only statistically different from the 25- to 44-year-olds.

[87] Calculation: (% group with Internet access)* $\beta_{acyiXtoY}$ + (% without Internet access) * $\beta_{acniXtoY}$

VI. Conclusion

I have found that Internet access has a negative impact on the purchases of young people and a positive impact on the purchases of old people. This suggests that the impact of file sharing on CD sales is negative for young people, but positive for old people, since file sharing is the primary way that Internet access relates to CD sales. The overall effect of Internet access on CD sales is positive. My results strongly suggest that file sharing does not have a negative aggregate effect on CD sales, and certainly not a large enough effect to explain the current decline in record sales.

Even if the RIAA's lawsuits against file sharers successfully deter people from sharing music over P2P networks, I would not expect to see a short term increase in sales. If the older demographic is more responsive to the threat of legal action than the younger demographic, the lawsuits would even tend to decrease sales in the short run. Lawsuits are part of the RIAA's long-term strategy to eliminate the culture of free music, but they risk driving away people who use file sharing to sample new music.

My research has shown that different demographic groups respond differently to file sharing. Since so much of the file sharing debate has focused on the behavior of students, it would be interesting to study the effect of Internet access on their predicted purchases. Future research can also look at consumers with different speeds of Internet to see if the ease of file sharing affects record purchases.

In section II, I discussed various alternative factors that might affect CD sales. None of the factors measured could explain a large part of the decline. Since file sharing also could not explain the decline in sales, the causes of the current recording industry slump are still open to speculation. Future research should look more closely at the

effects of substitute entertainment products, radio station homogenization, or macroeconomic variables. Since there have been previous slumps in the recording industry, using a detailed time series approach might help to explain the recent one.

Despite the recent problems for the U.S. recording industry, 2003 was the best year ever for the Australian recording industry. The movie and software industries produce products that are actively downloaded, yet these industries have continued to grow in recent years. And as the record companies convert the Internet into a venue for paid digital distribution, the outlook will only improve. The age of file sharing does not entail an age of decreasing sales for the recording industry.

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