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File Sharing, Copyright, and the Optimal Production of Music

Gerald R. Faulhaber
University of Pennsylvania

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"Music for nothin' and the flicks are free"

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Much economic, political, judicial and legal attention has been showered on the significant changes currently taking place within the music production and distribution business forced by the use of the Internet for both file sharing (of unauthorized copyrighted material) and more recent online (legal) music distribution. The strong demand for music, coupled with the low cost of distributing illegal copies via peer-to-peer (P2P) systems, is unraveling the business model by which music has traditionally been created, developed, and distributed. Application of traditional copyright law has been ineffective in stopping the loss of business in the traditional channels. Producers have implemented forms of Digital Rights Management ("DRM") in an attempt to protect their property via technologically self-enforcing contracts. Past DRM efforts have alienated customers, resulted in defective products, and, in some cases, been laughably easy to defeat by "hackers." Producers assert that if the problem isn't solved, music production will be sharply curtailed. The cost of "free" music via P2P is less music produced and fewer choices, an outcome that all seem to agree is bad. In this Article, I attempt to answer the question whether or not a reduction in music choice is, in fact, bad. I model the music industry as a Hotelling-Salop differentiated products market and, using

* Professor of Business and Public Policy, Wharton School, University of Pennsylvania. The research reported in this Article was undertaken while visiting University of Pennsylvania Law School. I am indebted to Professors Polk Wagner, Gideon Parchamovsky and Chris Sanchirico of Penn Law. Professor Joel Waldfogel provided help in assessing the relevant literature. My conversations with Professor Molly Van Houweling formerly of the University of Michigan Law School focused my attention on this problem. I am also indebted to participants at Penn Law's Ad Hoc Summer Workshop, July 19, 2005, Wharton's Applied Economics Workshop, August 10, 2005, Kennedy School's New Directions in Regulation Seminar, October 20, 2005, and Wharton's Colloquium on Media Law, October 28, 2005. Dr. Ted To suggested the subtitle, with apologies to Dire Straits.

results from Bhaskar and To,[1] *I show that significant overproduction of music may occur. The worst hypothesized loss from file sharing tends to reduce this overproduction, but does not eliminate it. Applying effective DRM simply returns the market to overproduction. Taking account of potential externalities (using rough preliminary estimates) of creative material suggests that overproduction of music is still the most likely outcome. Further empirical research is needed, but, on the basis of this model, the most likely outcome is that the displacement of CD sales by P2P file sharing actually increases welfare by constraining the overproduction of music that results from its unique market structure. The very tentative policy conclusion is that legitimizing file sharing under the doctrine of fair use is likely to be welfare enhancing.*

INTRODUCTION

The music business is in turmoil today; the traditional business model of the industry is being undermined by file sharing of copyrighted material over the Internet using peer-to-peer (P2P) systems. The recording industry claims that file sharing has led to substantial losses in their traditional market of CD sales and has attempted to stem this loss

1. V. Bhaskar & Ted To, *Is Perfect Price Discrimination Really Efficient? An Analysis of Free Entry*, 35 (4) RAND J. ECON., 762, 764–65 (2004).

by both legal and technological means.[2] They claim that if performing, producing, and distributing music becomes less profitable due to P2P file sharing, then less music will be produced.[3]

The threat of a copyright lawsuit has been ineffective against P2P file sharing. To preserve their rights in the absence of a lawsuit, the industry has started to use software locks embedded in their products to prevent or limit copying. The initial deployment of this Digital Rights Management (DRM) went very badly for producers and customers alike.[4] More recent evidence from the market, however, suggests that the latest forms of DRM are gaining substantial customer acceptance, although are still not without problems.[5]

If P2P is a genuine threat to the profits of artists and producers, less music will be performed, produced, and distributed, which has been generally presumed to constitute a net social loss.[6] Ultimately, the P2P controversy is actually a debate about the appropriate level of music production. Several previous economic studies have focused on the extent to which file sharing has impacted CD sales and industry profits. Other studies have focused on the extent to which DRM can recoup such sales without imposing substantial costs on customers.

In this Article, I model the music market as a differentiated products market, reconciling the obvious abundance of music in the market with copyright's grant of a monopoly to the artist/producer. Such models have a rich history in economics, beginning with Hotelling's well-known paper in location theory.[7] I use recent results[8] applied to the music industry to show that we should expect substantial excess entry into the music market (and differentiated product markets in general). For a wide range of plausible parameters, entry in equilibrium exceeds efficient entry by 40–60%. File sharing reduces industry profits and therefore reduces

2. Martin Peitz & Patrick Waelbroeck, *An Economist's Guide to Digital Music* 43, 45 (CESifo Working Paper Series No. 1333, 2004), *available at* http://ssrn.com/abstract=628961.

3. Advocates of file sharing do not accept this argument; they contend that file sharing is likely to increase music production as an alternative music distribution channel and a means by which customers can sample unpublicized artists. *See* Tim O'Reilly, *Piracy is Progressive Taxation, and Other Thoughts on the Evolution of Online Distribution*, OPENP2P.COM, Dec. 11, 2002, http://www.openp2p.com/lpt/a/3015.

4. *See* EFF.com, Digital Rights Management and Copy Protection Schemes, http://www.eff.org/IP/DRM/ (last visited Oct. 6, 2006).

5. *See* Wikipedia, FairPlay, http://en.wikipedia.org/wiki/FairPlay (last visited Oct. 6, 2006) (explaining the Apple iPod DRM "Fairplay").

6. There is growing literature on the estimation of the loss of CD sales due to file sharing. *See* Stan Leibowitz, *File Sharing: Creative Destruction or Just Plain Destruction?* 49 J.L. & ECON. 1 (2006) (citing many recent articles). The unstated assumption of this literature is that a loss of music sales is welfare-decreasing, presumably because a competitive market in (protected) music must be producing the optimum amount of music.

7. Harold Hotelling, *Stability and Competition*, 34 ECON. J. 39, 41–57 (1929).

8. Bhaskar & To, *supra* note 1.

entry, but even using the very high estimates of P2P displacement of CD sales claimed by the recording industry, there is still overproduction.

Intellectual property can also generate spillovers. Wagner plausibly asserts that such spillovers exist in the creative works, such as music and movies.[9] If present, such spillovers would *ceteris paribus* lead to underproduction. Depending on the magnitude of such spillovers, private excess entry may in fact be socially optimal when the incentive for underproduction in the presence of spillovers is accounted for. No measures of this spillover currently exist; I propose plausible bounds on the size of these spillovers based on other work. I find that, taking all factors into account, overproduction or underproduction are both possible. The most important factors in determining which outcome occurs are (i) the shape of customer preferences; and (ii) the size of the spillover. Losses of CD sales to P2P file sharing and the effectiveness of DRM have relatively smaller effects. It is unfortunate that the least important factors are the easiest to measure and have attracted the most economic research. The more important factors constitute a substantial measurement challenge for empirical work.

I. HISTORY AND BACKGROUND

Traditionally, the music business encoded its product on a physical medium, such as a vinyl record, magnetic tape, or CD and sold the physical medium through stores and other retail outlets. Their product was protected by copyright, which governed the relations among artists, producers, distributors, radio stations, jukebox operators, and other consumers of music. Customers listened to the music on devices sold separately, and occasionally copied the music (say, tape-to-tape copying) for personal or family use. However, mass copying was much too costly for customers, and so copyright enforcement at the customer level was not necessary to protect the economic interests of the artists and industry.

The advent of the Internet and P2P networks changed this stable situation dramatically. In 1999, Napster was invented and deployed over the Internet by Shawn Fanning.[10] The service consisted of a program that could be downloaded and executed on a personal computer (the "client" computer) connected to the Napster servers via the Internet.[11] The program cataloged the music files on the client computer (at the direction of the computer's owner) and transmitted the information to Napster's serv-

9. R. Polk Wagner, *Information Wants to Be Free: Intellectual Property and the Mythologies of Control*, 103 COLUM. L. REV. 995, 1009 (2003).

10. Peitz & Wallbroek, *supra* note 2, at 42.

11. *See generally, id.*

ers where the information was cataloged. Any Napster customer interested in acquiring a music file could query Napster's servers for the location of the music on other computers, connect to a computer with the file, and download the music to her own machine. Computer owners who "ripped" music from a CD to their computer could thus share the CD with the entire Napster community. The availability of free music attracted an enormous customer base, especially among high school and college students, and trading of copyrighted music soared.[12]

Napster did not keep copyrighted music on its servers; it merely helped customers find the music they were looking for. They hoped to avoid prosecution as a copyright infringer by claiming that it was the customers who shared the material, and not Napster itself.[13] Of course, the cost of bringing copyright enforcement actions against the millions of individual Napster users was prohibitively large. Instead, music producers targeted Napster itself as a copyright infringer. Napster was sued successfully, and shut down in 2001.

After Napster was shut down, new firms sprang up, such as Grokster, KaZaA, and Morpheus, offering similar services.[14] A key difference was that these services did not depend on a central server; their programs ran on client computers. When a customer wished to download a specific music file, her request went over the Internet to whichever computers were nearby (in cyberspace) running the same program.[15] The suppliers of these new programs thought that the absence of a central server meant there would be no copyright liability. They were also physically located outside the U.S., and operated by distributing their product over the Internet. Grokster was recently sued by MGM and others for facilitating copyright infringement and, despite the absence of a central server, the content industry won a victory at the Supreme Court.[16]

A. *Copyright—When Does It Work?*

Copyright law is clear: individuals who are sharing files of copyrighted music over the Internet are guilty of copyright infringement. So, why is the law an insufficient incentive to stop file sharing of such

12. *Id.* at 30–31, 34.

13. *Id.* at 43.

14. *See generally, id.*

15. See *Metro-Goldwyn-Mayer Studios Inc. v. Grokster, Ltd.*, 125 S.Ct. 2764, 2770–71 (2005), for a discussion of how these types of P2P programs work.

16. *Grokster*, 125 S.Ct. 2764. Grokster had been awarded summary judgment in District Court, upheld by the Ninth Circuit, on the basis of an earlier ruling in *Sony Corp. of Am. v. Universal City Studios, Inc.*, 464 U.S. 417 (1984), permitting the sale of videocassette recorders. The Supreme Court reversed the Ninth Circuit and remanded the case to the District Court. While this decision is a victory for the entertainment industry, it is highly unlikely that this will end P2P file sharing.

material? Why does copyright infringement, which has been effective as the legal underpinning of the music industry's traditional business model, fail to work in a world of P2P?

The answer lies with the technology of mass distribution and the transaction costs of copyright enforcement. In the traditional model, copying and mass distribution was relatively expensive; only large entities could afford the costs and (possibly) turn a profit through (illegal) sales. Copyright enforcement was a "business to business" proposition.[17] Should a distributor, radio station, or other producer illegally distribute another producer's copyrighted material, the act was easily detected, the infringer was easily identified, and the loss to the producer more likely to be large enough to justify the transaction costs of an infringement suit. The total number of potential infringers numbered perhaps in the low hundreds. In contrast, the technology of ripping music and sharing it over the Internet using P2P reduces the cost of copying and distribution to near zero.[18] As a result, up to 40% of music aficionados share billions of copyrighted songs on a regular basis.[19] While sharing may or may not cause the recording industry economic loss, it is clear that bringing copyright infringement suits against millions or even thousands of customers is far too costly to be practical.

Traditionally, customer copyright infringement has been controlled by the high costs of copying and mass distribution. Small scale copying, while no doubt ubiquitous, posed no threat to the recording industry's business model. Business to customer infringement enforcement was neither necessary nor feasible. All this changed with the advent of the Internet and P2P. With new technology, the costs of copying and distribution became negligible but the costs of enforcement remained high.[20]

Much recent effort by the recording industry has been focused on P2P intermediaries, such as Internet Service Providers (ISPs) and the creators of P2P client software such as Grokster and KaZaA. For example, the RIAA successfully brought suit against Verizon Communications, forcing Verizon to divulge the identities of KaZaA users.[21] In targeting intermediary firms, rather than customers, the recording industry is attempting to control file sharing by copyright enforcement in a business-to-business

17. This point was brought home to me in a discussion with Fred Wilf of Morgan Lewis, Philadelphia, PA.

18. Peitz & Waelbroeck, *supra* note 2, at 35.

19. *Id.* at 12–15. The surveys were conducted in 2003. The distribution of file sharers is highly skewed, with a very small fraction of file sharers responsible for most activity. The age distribution is also highly skewed toward the 18–24 year-old demographic.

20. In 2003, the recording industry launched thousands of suits against individual file sharers, and the amount of file sharing was reported to have dropped 15–20%. Peitz & Waelbroeck, *supra* note 2 at 44. However, it soon recovered to its previous level.

21. Peitz & Waelbroeck, *supra* note 2, at 44.

model, rather than a business-to-customer model. Whether or not they will be successful in this attempt is unclear as of this writing.

1. Digital Rights Management

In light of this perceived threat to its business model, the recording industry also experimented with and deployed technological methods of protecting their intellectual property in the form of software locks embedded within the music content (either on a CD or as legally digitally distributed over the Internet) that limit the ability of customers to copy the music.[22] More broadly, customers were sold not only the music, but rights to use the music. In this way, music producers sought to reduce the losses they claimed to be suffering from P2P file sharing. Producers believed that music protected by DRM ("DRM music") could not be shared, and would thus protect copyrighted materials from infringement by customers in a way that copyright law itself could not. While DRM could be viewed as a substitute for copyright law, this argument is unpersuasive. The practical purview of copyright law is generally business to business relationships, where DRM has little effect. Instead, DRM is targeted towards the business to customer relationship, where application of copyright law is only theoretical and has no practical significance. Thus, DRM augments, rather than displaces, copyright protection.

The initial rollout of DRM is generally regarded as a disaster. Early versions of DRM forbade all copying, and often did not work on certain types of devices, such as computers. On top of that, CDs that were DRM-enabled were not labeled as such, so customers did not know what they were buying, and retail stores often didn't know what they were selling. When customers took their new purchase home and found that the CD did not play on their computer, they were outraged and attempted to return the CD to the retail store. Often, the retail outlet refused to return their money. In 2001, a significant customer backlash began, with websites authored by outraged music fans listing albums with DRM attached and urging boycotts not only of those albums but also of the artists and producers that performed and sold them. Clearly, music fans' expectations were not met and there was a strong negative reaction against the industry.

It is possible that this strong negative customer reaction would have been tolerable if the early DRM had actually controlled file sharing. Virtually every DRM scheme, however, has been "cracked" by software hackers within weeks after coming on the market. In one particularly embarrassing incident, Sunncomm's MediaMax DRM software for music CDs was bypassed simply by holding down the shift key on the

22. *Id.* at 35, 45.

computer while loading the CD into the reader.[23] The Princeton graduate student who discovered this made the bypass known on the web and through the news media. Sunncomm originally threatened to prosecute the student under the DMCA, but the embarrassing publicity from the incident proved too much, and they corrected the flaw instead.[24]

Extant economics work on the effectiveness of DRM has reflected this experience. The level of DRM (severity vs. laxness) is traditionally modeled as a tradeoff between protecting against illicit copying and degrading the product for listeners.[25] In this model, stringent DRM can limit copying only at a cost to the quality of the product itself. On the other hand, meeting customer expectations by a more relaxed DRM would lead to more copying. However, subsequent developments in the market suggest that this model is inappropriate. In 2001, Apple released the iPod and its iTunes online music store. These products have been wildly successful, with close to 60 million iPods sold through June 2006.[26] iTunes music is protected by a DRM called FairPlay. FairPlay permits the music to be accessed on up to five computers simultaneously, burned on an unlimited number of CDs, and downloaded onto an unlimited number of iPods.[27] As a result of this more relaxed DRM, customer response to the iPod/iTunes combination has been enthusiastic, as measured by commercial success. The irate reaction of customers to early DRM has not been repeated for iTunes. Apparently, FairPlay meets the expectations of legitimate customers by permitting them to do what they normally expect to be able to do.

It should be noted that FairPlay was cracked almost immediately after it came on the market.[28] However, the iTunes pricing model and the absence of constraints on legitimate customer uses have maintained the iPod/iTunes business model in spite of cracks and file sharing. A newer entry into Internet distribution, RealNetworks' Rhapsody service, uses a DRM scheme similar to FairPlay. These early indicators suggest the market will move toward DRM schemes that meet customer expectations with no loss of value to legitimate customers but still protect against

23. *See* J. Alex Halderman, Analysis of the MediaMax CD3 Copy-Prevention System, (Oct. 6, 2003), http://www.cs.princeton.edu/~jhalderm/cd3/ (describing the MediaMax DRM and the simple "crack" Mr. Halderman discovered).

24. *See* Declan McCullagh, *SunnComm Won't Sue Grad Student*, CNET NEWS.COM, Oct. 10, 2003, http://news.com.com/2100-1027-5089448.html.

25. *See, e.g.*, Arun Sundararajan, *Managing Digital Piracy: Pricing and Protection*, 15 INFO. SYS. RES. 287, 288 (2004) ("[I]mplementing effective DRM-based technological deterrence often necessitates a direct reduction in the value of the *legal product*.").

26. Wikipedia, iPod, http://en.wikipedia.org/wiki/IPod (last visited Oct. 6, 2006).

27. Wikipedia, FairPlay, *supra* note 5.

28. *See* posting of Ken "Caesar" Fisher to Ars Technica, http://arstechnica.com/news/posts/1081206124.html (April 5, 2004, 6:02 PM) (providing details of the "PlayFair" crack for the FairPlay DRM system).

unlimited mass distribution. However, we can also continue to expect that new DRM protections will be cracked, and that the decode scripts will be available on the web.

Despite iTunes' and Rhapsody's relative success with their relaxed DRM, music distributors continue their missteps. In 2005, Sony BMG released a large number of music CDs containing Sunncomm XCP DRM, which upon loading on a computer installs a rootkit into the heart of the computer's operating system, cloaks itself so that it is virtually impossible to remove, and opens a backdoor exploitable by viruses and worms.[29] When the nature of the XCP DRM was revealed on a security expert's website, there was negative publicity for Sony BMG, and they eventually backed down, settling several lawsuits on terms favorable to customers.[30] While there is a fairly clear path to an effective and acceptable DRM (e.g., iTunes and Rhapsody), it is apparent that it may take the industry some time before it arrives at this endpoint.

2. Fair Use

Fair use is a legal doctrine under which copyrighted materials may be used without permission or payment for certain restricted uses.[31] One function of fair use in music is to permit customers to make a small number of copies for personal or family use. Since copyright is not economically enforceable at the customer level, fair use is usefully viewed as simply a means to decriminalize a rarely prosecuted activity (personal copying) with little impact on the economics of the music industry. Fair use, then, allows copyright law to conform to customer expectations.

The initial rollout of DRM violated what customers believed to be their fair use "rights" to copy purchased music for personal use. In fact, music sold with DRM and the accompanying end user license agreement ("EULA") constitutes a contract (the EULA) together with a mechanism to enforce that contract (the DRM). The combination of the EULA and an effective DRM scheme renders the music sold copyable only under the terms of the EULA, thereby circumventing the consumer's fair use rights. However, I argue that the fair use copying exception is irrelevant in the long run. *Far more important than fair use rights is the customer's expectation of use.* The early DRM rollout demonstrated that failing to meet customer expectations is more likely to induce music distributors to

29. *See* J. Alex Halderman & Edward Felton, *Lessons from the Sony CD DRM Episode* 1-2 (Princeton University, May 16, 2006), *available at* http://itpolicy.princeton.edu/pub/sonydrm-ext.pdf.

30. *See* Wikipedia, 2005 Sony BMG CD copy protection scandal, http://en.wikipedia.org/wiki/2005_Sony_CD_copy_protection_controversy (last visited September 21, 2006).

31. *See* 17 U.S.C. § 107. This analysis grew out of a discussion with Professor Van Houweling on DRM and fair use.

change their behavior than are fair use rights. In fact, there is evidence that music producers are moving to meet consumer expectations.[32] In the long run, if effective DRM schemes are indeed possible, they must meet customer expectations in order to survive in the marketplace.[33]

B. *Has File Sharing Displaced CD Sales?*

At the core of the file sharing and music production problem is the empirical issue of whether or not file sharing actually displaces CD sales, and if so, by how much. Concern about the long-term viability of the current music business is not misplaced. It is generally agreed that the Hong Kong movie industry was driven out of business by wholesale piracy of DVDs originating in Asia.[34] Certainly, the economics literature has focused on this issue, as has the industry itself. On its website, the RIAA claims that between one-third and two-fifths of CD sales have been displaced by illegal file downloads.[35] Since the music industry has an interest in finding a large number of illegal downloads in order to garner support for Congressional action, we may take this number as an upper bound on the true displacement.

Liebowitz estimates that file sharing has displaced about 20% of CD sales, a number he describes as "not small" but unlikely to "annihilate" the industry.[36] In a more recent paper, Liebowitz adopted a more alarmist position, indicating that old econometric studies suggest "file sharing has brought significant harm to the recording industry."[37] Although, this Article provides no independent empirical estimate of the reduction of CD sales due to file sharing, Peitz and Waelbroeck arrive at the same 20% estimate, using cross-sectional evidence.[38] Rob and Waldfogel use a survey of University of Pennsylvania students and estimate that file sharing

32. For example, the relaxed DRM in the Apple FairPlay and Rhapsody music distribution systems.

33. A DRM solution that meets customers' expectations while protecting producers' interests is the likely outcome of any market, even one in which producers exercise market power. Even monopolists wish to make their product as attractive as possible; annoying one's customers simply lowers the value of the product and thus, the amount customers are willing to pay for it.

34. *See, e.g.*, *Curtain Closes on Hong Kong's Film Industry*, TAIPEI TIMES, May 6, 2005, at 17, *available at* http://www.taipeitimes.com/News/feat/archives/2005/05/06/2003253454.

35. Recording Industry Association of America, http://www.riaa.com/issues/piracy/default.asp (last visited Sep. 26, 2006).

36. Stan Liebowitz, *Will MP3 Downloads Annihilate the Music Industry? The Evidence So Far* 26–31 (Univ. of Tex. at Dallas, Working Paper, 2003), *available at* http://ssrn.com/abstract=414162.

37. Liebowitz, *supra* note 6, at 24.

38. Martin Peitz & Patrick Waelbroeck, *The Effect of Internet Piracy on Music Sales: Cross-Section Evidence*, 1 REV. ECON. RES. ON COPYRIGHT ISSUES, 71, 78 (2004), http://www.serci.org/docs_1_2/waelbroeck.pdf.

displaces about 10% of CD sales based on post-download purchase behavior.[39] Oberholzer-Gee and Strumpf look at a very large sample of downloaded music and contemporaneous CD sales and find that downloads have no statistically significant effect on CD sales.[40] Hong uses the Consumer Expenditure Survey to estimate that between 33% and 45% of the downturn in CD sales from 1999–2000 was due to Napster/file sharing.[41] Since this downturn in expenditures was 9.7%, the estimated total impact of file sharing is less than 5%. Zentner uses a cross-section of French consumers to estimate that file sharers are 30% less likely to buy music; his best estimate of the loss of CD sales is 7.8%.[42]

The empirical issue is not yet settled: even among academic researchers, who presumably have no financial interest in the answer, the range of estimates of displacement in music sales is disappointingly large. Assuming the loss of CD sales to P2P is in the range of 10%–20%, is this loss "large"? For music industry executives, the loss is quite large; from a public policy perspective, the loss appears rather modest. Indeed, from an economist's point of view, it is surprising that that any music is sold at all. After all, if music is available for free, why does anyone buy it?

In fact, downloading music is costly to most customers, for a variety of reasons:

- File sharing is easier for customers with a broadband connection to the Internet. As of June, 2005, only 35% of U.S. residential households subscribed to broadband service.[43]
- File sharing requires a modicum of experience with a computer and the Internet; it not only involves downloading the music itself, but downloading the software, installing it, and then burning the music to a CD. It is safe to assume that not every member of the 35% of households with broadband has these skills.

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39. Rafael Rob & Joel Waldfogel, *Piracy on the High C's: Music Downloading, Sales Displacement, and Social Welfare in a Sample of College Students*, 49 J.L. & ECON. 29, 30 (2006).

40. Felix Oberholzer-Gee & Koleman Strumpf, *The Effect of File Sharing on Record Sales* 3 (Univ. of N.C., Working Paper, 2004), *available at* http://www.unc.edu/~cigar/papers/FileSharing_March2004.pdf.

41. Seung-Hyun Hong, *The Effect of Napster on Recorded Music Sales: Evidence from the Consumer Expenditure Survey*, 28 (Stan. Inst. Econ. Pol'y Res., Discussion Paper No. 03-18, 2004), *available at* http://siepr.stanford.edu/Papers/pdf/03-18.html.

42. Alejandro Zentner, *Measuring the Effect of Music Downloads on Music Purchases*, 49 J.L. & ECON. 63, 66 (2006) (study based on 2002 data).

43. FEDERAL COMMUNICATIONS COMMISSION, HIGH SPEED SERVICES FOR INTERNET ACCESS: STATUS AS OF JUNE 30, 2005 (2006), *available at* http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-264744A1.pdf

- Downloading a music file takes time, and may result in a corrupted or fake file. This suggests that file sharers have a low value of time. Consumers who value their time highly are unlikely to have the patience for file sharing.
- There are substantial risks of viruses, worms and Trojan horses being downloaded to a file sharer's computer, with the attendant cost to the customer.[44]
- Most P2P programs come with spyware included and do not function if the spyware is removed.[45] Thus, even without actual downloading, P2P software involves a loss of computer resources from the spyware constantly running unannounced in the background, as well as a loss of privacy.
- Some customers refuse to share music files because it is illegal. Just like most hotel guests don't steal the towels (even if they won't be caught), the relatively low cost of legitimate downloads (e.g., from iTunes) makes theft, even if undetectable, unattractive to some.

File sharers have a high level of computer and Internet skills, a low value of time, a belief that they will remain virus-free, and a somewhat blunted sense of guilt over theft of intellectual property. It is unlikely that this profile fits all or even most Americans, so file sharing and loss of CD sales is likely to be bounded. The modest estimates of CD sales displacement (10%–20%) bear out this intuition.

C. *Spillovers*

Intellectual property occupies a unique position in economics, law, and policy not only for its dilemma of nonappropriability, but also for its alleged spillovers.[46] The lack of appropriability has led to the creation of intellectual property laws, such as patents, trademarks, and copyright, as a means of socially constructing appropriability. However, intellectual property is also perceived to create spillovers: a new idea, creation, or invention may lead others to the next new idea, creation, or invention.

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44. For a list of the most prevalent worms on P2P networks in 2004, see Peitz & Waelbroeck, *supra* note 2, at 11.

45. "Spyware is a general term used for software that performs certain behaviors such as advertising, collecting personal information, or changing the configuration of your computer, generally without appropriately obtaining your consent." What is Spyware?, http://www.microsoft.com/athome/security/spyware/spywarewhat.mspx (last visited November 4, 2006).

46. *See* Wagner, *supra* note 9, at 1005–09.

Wagner identifies three types of information associated with inventions or creations.[47] Type 1 is the invention or creation itself: the transistor, the movie, the song. Type 2 information is directly related material, such as the movie characters or guitar riffs from the music. Type 3 is indirectly related material, such as the popularity of a movie about fantastic creatures (as in *Shrek*) or the popularity of spoken lyrics (as in hip-hop). Type 1 is always covered under IP law, while Type 2 may or may not be included in IP law. Type 3 cannot be covered by IP law, and thus constitutes what economists call a spillover, an effect of the invention or creation which benefits others[48] but which cannot be captured by the inventor/creator. The focus in this Article is on Type 3 information: the spillover effect.

In science, the spillover from one idea to the next, from one invention to the next, has the noble provenance of Sir Isaac Newton: "If I have seen further [than you and Descartes] it is by standing upon the shoulders of giants."[49] This quotation emphasizes not only the spillover from one generation of scientists to the next, but also the *technologically cumulative* nature of the spillover. What we learn from one invention becomes the basis of the next invention; the existing technology is "baked into" the new technology. The transistor becomes the basis of the integrated circuit; the second is built upon the first. The recognition that these spillovers occur and the presumption that they are significant give rise to concerns that technology is underprovided.[50] Since inventors cannot internalize all the benefits of their invention, there is less incentive to invent than is socially optimal. If the benefits of technological innovation cannot be entirely captured by the innovator, there will be less than optimal resources devoted to invention.

This has led to efforts by successive generations of economists to measure this spillover. Early work by Jaffe[51] and Bernstein and Nadiri[52] was summed and generalized by Griliches, who estimated that the

47. *Id.*

48. A creative work may also result in negative spillovers if it hurts others. For example, it could incite people to riot, foster ethnic hatred, or be perceived as blasphemous by a religion.

49. Newton made this comment regarding the importance of the work of his predecessors in his own discoveries. *See* THE COLUMBIA WORLD OF QUOTATIONS (1996), http://www.bartleby.com/66/18/41418.html (quoting Newton's letter to Robert Hooke, Feb. 5, 1675).

50. *See generally* Nick Bloom et al., *Identifying Technological Spillovers and Product Market Rivalry*, LSE RES. ONLINE (2005), http://eprints.lse.ac.uk/archive/00000780.

51. Adam B. Jaffe, *Technological Opportunity and Spillovers of R & D: Evidence from Firms' Patents, Profits, and Market Value*, 76 AM. ECON. REV. 984 (1986).

52. Jeffrey I. Bernstein & M. Ishaq Nadiri, *Research and Development and Intra-industry Spillovers: An Empirical Application of Dynamic Duality*, 56 REV. ECON. STUD. 249 (1989).

spillover from (patent-producing) R&D was between 0.5 and 1.5 of the private benefit.[53] The most recent work by Bloom, Schankerman and van Reenen estimates this spillover at 2.5 times the private benefit of the R&D, after correcting for the impact of the R&D on product market rivalry.[54] Clearly, the magnitude of these spillovers is substantial.

In contrast to the attention paid in the economics literature to technological spillovers, there is little work estimating the impact of spillovers in the creative arts. Wagner suggests that spillovers are present in both creative works and in technological invention.[55] For example, the success of the movie *Gone with the Wind* revealed a preference among moviegoers for romantic movies set during a historical war. The success of the first *Survivor* television show suggested that "reality-based" television would garner large audiences, spawning a host of imitator shows. While the copyright holder to the original *Survivor* show had the exclusive right to make follow-on shows, he did not have the right to block other producers from airing *The Amazing Race*, *Big Brother*, or any other television show that made use of the idea of "reality-based" entertainment. The creators of the original show were thus unable to capture the full social benefit of their creation; this is a case of true spillovers.[56] These examples suggest that spillovers in the creative arts are *preference revealing* rather than cumulative, as they are in science and technology. This suggests that spillovers in the creative arts have a more limited impact than in science and technology.[57] The fact that such spillovers have not been estimated necessitates an educated guess that the value of creative spillovers is likely at the low end of the estimates for technology spillovers.

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53. Zvi Griliches, *The Search for R&D Spillovers*, 94 SCANDINAVIAN J. ECON. (Supplement) S29, S43–S44 (1992).

54. Bloom et al., *supra* note 50, at 25.

55. *See* Wagner, *supra* note 9, at 1005–09.

56. While the creators of *Survivor* can capture the direct value of the TV show and its characters via copyright, they are not able to protect the *idea* of a reality TV show; copyright protection does not extend to cover all similar programs. However, the *idea* of a reality TV show generates social benefits because other reality-based shows create social value that the original creators of Survivor cannot capture.

57. This is merely a first approximation. In fact, there are a number of examples in which spillovers in the creative arts are cumulative. In animated films, the works of Dreamworks (MADAGASCAR (Dreamworks SKG 2005) and SHREK (Dreamworks SKG 2001)), Pixar Studios (FINDING NEMO (Pixar Animation Studios 2003) and THE INCREDIBLES (Pixar Animation Studios 2004)), and Miyazaki (SPIRITED AWAY (Studio Ghibli 2001)) clearly influence each other, and in turn are influenced by the earlier works of Disney (SNOW WHITE (Walt Disney Productions 1939) and STEAMBOAT WILLIE (Walt Disney Productions 1928)).

D. *What Is the Problem and Why Do We Care?*

File sharing and DRM have welfare impacts beyond the financial health of music producers and artists. If the only issue was that technological change in the form of the Internet and P2P was driving a restructuring of the music business, it would hardly be cause for more general concern. However, there are also potential welfare effects. Rob and Waldfogel estimate the welfare gains and losses associated with file sharing.[58] They note that the marginal cost of music is effectively zero,[59] and find a net gain in social welfare from file sharing.[60] However, they do not account for the potential welfare impact of possible reductions in the amount of music produced, including direct welfare losses due to less music and indirect losses due to reduced spillovers.[61]

In this Article, I focus exclusively on the issue of the amount of music produced. This issue appears to be the core welfare issue and the reason we care about file sharing and DRM. In a pre-file-sharing market, is the privately efficient level of music being produced? Does file sharing (as modified by DRM) reduce or increase the efficiency of this market? Normally, we would expect that the presence of spillovers would *ceteris paribus* lead to underproduction; does this occur in the music market? Does file sharing/DRM exacerbate this problem? The focus of this model, then, is to determine both the private and social efficiency of music production, with and without file sharing/DRM, to determine the benefits and costs of file sharing/DRM.

I draw a sharp distinction between music performed, produced, and distributed by artists who wish only to have their music heard by others with no thought of immediate financial reward (independent music), and music performed, produced, and distributed for financial reward (popular music). Artists performing independent music are doing it for "love," and the actual production of the music is a benefit, not a cost. Artists (and other actors in the music business) producing popular music are doing it to make money, and the production, marketing, and distribution of this music is both risky and costly. This Article focuses exclusively on popular music, which can be analyzed as a market for services that are costly to produce and are bought and sold. This analysis has no relevance to music produced for "love."

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58. Rob & Waldfogel, *supra* note 39, at 36.
59. *Id.* at 36.
60. *Id.* at 60.
61. *Id.* at 33.

In Section 3, I develop a simplified model of the music market[62] as a differentiated products market. Using recent results from Bhaskar and To,[63] I show that the traditional market for music is likely to produce too much music. File sharing (at least in the range of current empirical results) reduces the amount of music produced relative to the privately efficient level, but there is still excess entry. Deployment of "reasonable" DRM simply increases this excess capacity. Using very rough estimates of the size of the spillovers from music production, I compare the equilibrium level of music production to the socially efficient level. Spillovers leads to less overproduction and, for certain parameter values, even underproduction (the usual result with spillovers). Even accounting for spillovers, however, the likely result is overproduction. Section 4 covers the caveats, exceptions, and simplifications of the model. Section 5 summarizes this Article and includes some very tentative policy conclusions.

II. THE MODEL

I assume that the market for music consists of a continuum of potential customers uniformly distributed over a single dimensional product space (unit interval) according to their musical tastes. Each customer t ($0 \leq t \leq 1$) has a preferred type of music, corresponding to her location on the unit interval; consuming a unit of her preferred music yields a common utility level of U. Consuming music of another type x yields a common utility level $U - f(|t-x|)$, $f(0) = 0, f'>0$. The function f is often referred to as the "transport" function, following Hotelling's original formulation[64] of this problem as a location model.[65]

Modeling customer preferences for music in a spatial model imposes strict limitations on the structure of demand. One could, for example, use a more classical demand formulation, in which the demand vector (including all n artists) is a function of the price vector (including all n artists): $q = Q(p)$, which places no prior restrictions on demand. In music, however, we know that most of the demand interactions (cross-

62. I specifically do not model the music *industry*; this is a complex industry with attributes of venture capitalists picking "stars," very intense marketing and merchandising, and difficult contractual issues with its artists. My focus in this Article is how the *consumer market* works; the music industry is presumed to produce artists and their copyrighted material, which it introduces into a differentiated product market to end consumers.

63. Bhaskar & To, *supra* note 1, at 763.

64. Hotelling, *supra* note 7, at 46–47.

65. This is not the first Article to suggest that viewing music as a differentiated product market is a useful idea; *see* Christopher Yoo, *Copyright and Product Differentiation*, 79 N.Y.U. L. REV. 212 (2004) (describing the applicability of the model to copyright issues).

partials) among pairs of artists are zero; Britney Spears does not compete with the Philadelphia Orchestra which does not compete with Garth Brooks, etc. Imposing a spatial model on demand focuses attention on competition among artists that are similarly located in product space, and therefore vying for the same music customers. Whether or not this is a reasonable model for the music market is a matter of modeling taste, and ultimately of whether or not it explains the observed facts. In addition, the use of a spatial model forces attention to the issues of entry and location. The central questions of spatial models are where artists locate and how many artists enter, and this endogenous entry is at the core of the question of this Article.

The unit of production is the artist; music producers introduce artists at specific points in the unit interval product space; introduction involves fixed costs. An artist is conceived as a bundle of services and products;[66] although I do not explicitly include time in the model, it is useful to think of the artist producing a stream of services over time. Since there are fixed costs to entry, there will be a finite number of artists, which we assume indexed by their location a, $\{a = 1,2, \ldots ,n\}$ in the interval $[0,1]$. Consumers choose an artist to consume that generates the most net value for them: if artist a charges customer t a price p_{at}, then customer t will select the artist $a(t)$ that maximizes $U\text{-}f(|t\text{-}a|)\text{-}p_{at}$. Let $a'(t)$ be the artist preferred second by customer t. I assume free entry, and that an artist is able to change her location in the interval in response to changing market conditions.

The various services offered by artists include CDs, concerts, T-shirts, coffee mugs, fan clubs, memorabilia, etc., which I assume can be supplied at a marginal cost of zero. These services permit artists to price discriminate among customers by intensity of preference (relative to the customer's next best alternative). Ardent fans buy all the services of the artist, more relaxed fans might only buy a CD from the remainder bin at Wal-Mart. I assume this price discrimination captures the entire available surplus.[67] I argue in Appendix B why this assumption is likely to be approximately true, based on the rather unique characteristics of the industry.

66. I use the term "artist" to include not only the actual performer but also the entire music industry that provides market services for that artist: actual CD production, marketing music via radio play and advertising, distribution of product either through stores or electronically, managers, concert venue owners, and providers of financing services. Clearly, the music industry has a very rich and complex structure; it is not my intent to model this industry in this Article.

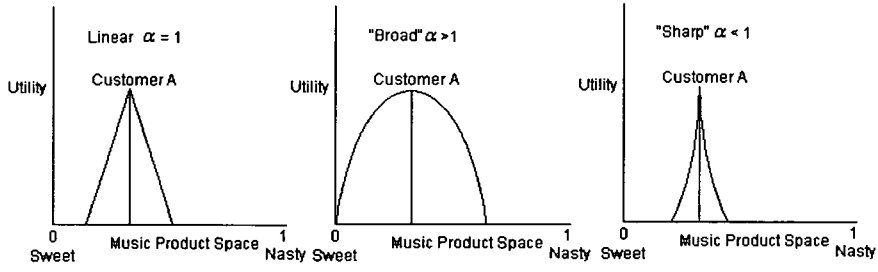
67. Online music distribution is likely to substantially increase the ability of music producers and online retailers to price discriminate.

In equilibrium, artists will be equally spaced in the unit interval; artists will enter until entry profits are zero. Customers will buy from the artist nearest them in product space; each customer is charged the difference in value between her preferred artist and her second-preferred artist: $p_{at} = f(|t-a'(t)|-f(|t-a(t)|)$.[68]

The spatial model of this Article is highly simplified for analytic ease; it is intended as suggestive rather than definitive. Bhaskar and To use a similar simple model to illustrate their more general model and general results, which I discuss at length below.[69] The simpler model fixes ideas, frames questions, and illustrates results; its purpose is to motivate deeper theoretical and empirical research. My exposition here is primarily graphical; derivations of some of the results of this simple model are contained in Appendix A.[70]

It is helpful to adopt the power function $f(x) = \beta \cdot x^{\alpha}$, $\beta > 0$, $\alpha > 0$ as a rather general parametric form for the transport function, which I do for the remainder of this Article. For $\alpha > 1$, utility is concave, or "broad"; music in the neighborhood of a customer's preferred music is valued almost as highly as the preferred music, dropping off more steeply with increasing distance. For $\alpha < 1$, utility is convex, or "sharp"; music in the neighborhood of a customer's preferred music is disdained by the customer. For $\alpha = 1$, utility is linear, dropping off at a constant rate the further is the music from the customer's ideal. These three shapes are illustrated below:

FIGURE 1
PREFERENCE SHAPES



By way of example, "sharp" preferences would correspond to customers enjoying one artist only, with little interest in other artists, even if

68. *See generally* Bhaskar & To, *supra* note 1 (discussing equilibrium and space); *see also*, Jean Gabszewicz & Jacques-Francoise Thisse, *Location*, in 1 HANDBOOK OF GAME THEORY WITH ECONOMIC APPLICATIONS 294–98 (Robert J. Aumann & Sergiu Hart eds., 1992).

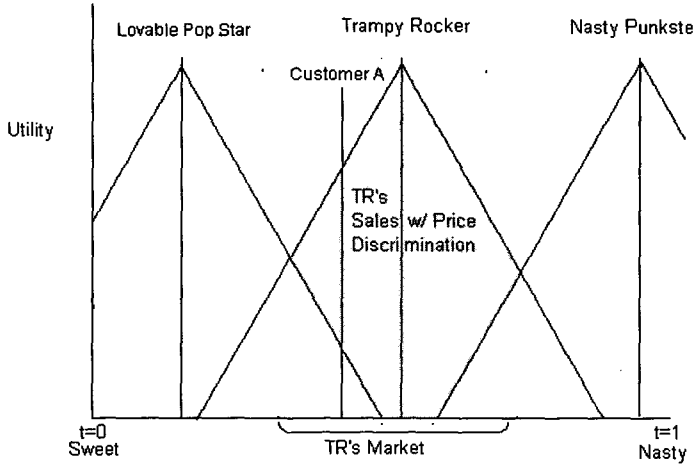
69. Bhaskar & To, *supra* note 1, at 764–766.

70. For more formal proofs in the general model, see *id.*

quite similar. For example, a pop music customer may only enjoy listening to Christina Aguilera and not be at all interested in singers of a similar genre. "Broad" preferences would correspond to customers enjoying a number of artists within a genre, perhaps preferring one specific artist, but deriving value from similar artists. For example, a pop music customer may have a preference for Christina Aguilera, but derive almost as much value from listening to Britney Spears or Avril Lavigne, two artists who are similar to Aguilera, but with distinctive styles and personalities.

In equilibrium, artists are equally spaced in [0,1] and are able to price discriminate. The result is illustrated below, with three artists assumed (and linear utility):

FIGURE 2
ARTIST LOCATION AND PRICE DISCRIMINATION

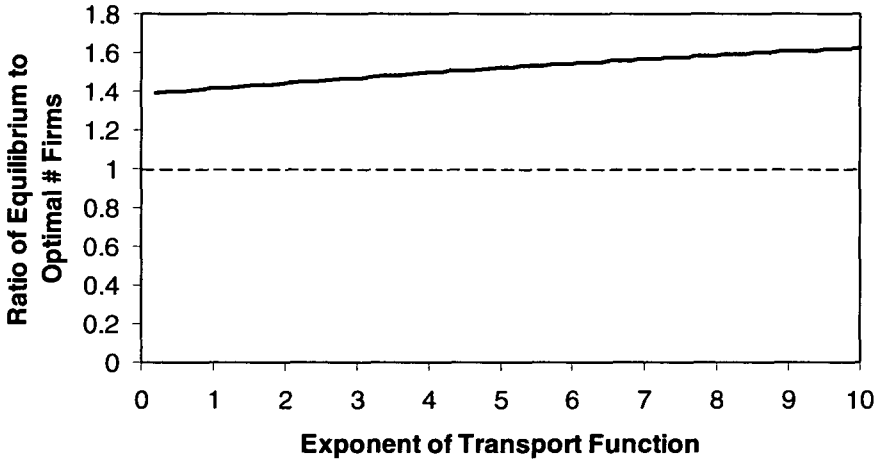


In Appendix A, I derive the *market equilibrium* number of artists under conditions of free entry. This derivation depends upon the value and shape of the transport function and the cost of artist entry. I also derive the *welfare maximizing* number of artists, which also depends upon the same parameters. As it turns out, the equilibrium number of artists n^* is not equal to the welfare maximizing number $\hat{n}$; the ratio of the two is Equation (5) from Appendix A:

$$\frac{n^*}{\hat{n}} = 2\left(\frac{1-2^{-\alpha}}{\alpha}\right)^{\frac{1}{1+\alpha}}$$

where α is the shape parameter of the transport function. As an empirical matter, α is not known; however, for all α the ratio is greater than unity. In the linear case, $\alpha = 1$ and the ratio $n^*/\hat{n} = \sqrt{2} \approx 1.414$, so that in equilibrium there is over 40% excess entry. The chart below displays this ratio for a broad range of α, over which it varies from 40% to 60% excess capacity.

FIGURE 3
EXCESS ENTRY



In equilibrium, pricing, consumption, and location is efficient; it is only entry that is inefficiently excessive.

A. *Intuition and Generalizability*

The intuition for this result can be seen as follows. Begin with a small number of artists: say, five, arranged optimally in product space. Consider an artist that wishes to enter; she chooses a location in product space, thereby generating value for customers at or near that location. Additionally, other artists will be obliged to accommodate her entry (it is optimal for them to do so), reducing profits for the five incumbent artists. The addition of the sixth artist increases the total value of the industry, but decreases the profits of incumbents. The entrant is able to capture (via price discrimination) all the value she creates, plus the lost profits of the incumbents. Her prospective profits are greater than the value she creates, and therefore the incentives to enter are excessive. If the market equilibrium number of artists is, say, one hundred, then the one hundredth artist to enter realizes zero profits (this is the defining property of the equilibrium number of artists) and therefore must gener-

ate a loss in total net value (i.e., value to customers less cost of entry). This result is quite similar to the well-known congestion externality: when a driver enters a crowded highway, she makes the entry decision based on the observed congestion and its cost to her. However, she does not include in that calculation the congestion cost she imposes on others on the highway. As a result, private incentives create too much congestion and excess entry.

The simplicity of this model belies the generality of the Bhaskar-To model. In their general model:

1. The product space can be of arbitrary dimension, rather than the single dimension of the simple model.
2. Each customer can buy more than one unit, rather than the single unit of the simple model.
3. There can be many customers at each point, rather than the single customer of the simple model.
4. Customers can have a preference for variety, so they purchase the music of more than one artist, rather than the single purchase of the simple model.

In this general model, pricing, consumption, and location are efficient, but there is excess entry. The key results generalize to this richer model.[71] However, as with the simple model, the result depends on three key assumptions:

1. Free entry. The apparently unending flow of new artists into the music market would appear to support this assumption. Clearly, there is a fixed cost to entry, but any artist willing to pay this fixed cost can enter.
2. There is no cost for artists to change location in response to market conditions. This assumption would seem close to the facts, as Madonna's constant reinvention confirms.
3. Artists can perfectly price discriminate. This is clearly wrong if the unit of analysis is the CD. But it appears closer to how the market functions; both fans and recording firms focus on the artist and her stream of services and complementary products. This stream yields a rich source of rent extraction from more and less faithful fans. In Appendix B, I show that with a small number of complementary products (beyond the music

71. There are a number of assumptions that are common to all spatial models, and deserve mention here: customers are uniformly distributed throughout product space; customer preferences are identical up to their location, and customer preferences are symmetric.

> CD itself), this method of approximating perfect price discrimination is very good. Since we actually observe many such complementary products being offered under artists' names in practice, it is safe to assume that price discrimination is both an accurate and a robust model of actual market behavior.

These results are quite surprising, as economists assumed the last word on this issue was from the influential work of Michael Spence: ". . . if sellers can price discriminate in an appropriate sense, the welfare aspects of the product choice problem are eliminated."[72] It is also surprising that the computed excess capacity is so flat over a wide range of the shape parameter α.[73] This suggests that excess capacity is buried quite deeply into the structure of differentiated product markets.

B. *What About File Sharing and DRM?*

The result of excess capacity given by this model completely reverses the core issue of music production. In the previous section, the underlying assumption was that file sharing could reduce the incentives to produce music, leading to the underproduction of music. The differentiated product market model strongly suggests that (without file sharing) there is substantial overproduction of music. Could it be that file sharing has a positive effect on music production, not by helping to create more music, but rather by reducing excess entry? If this is the case, the adoption of DRM to reduce file sharing may have a negative effect on welfare by causing music production to inefficiently increase.

To answer this question, I extend the model to incorporate the effects of file sharing. Again, I make simplifying assumptions: customers divide into those who will never file share and those who will, and the latter do not find it costly to do so. The two groups are otherwise identical. Those who file share may displace CD sales, and their perception is that the downloaded product is a perfect substitute for the CD. Displaced CD sales correspond to an equivalent loss of revenue to the music producer.[74] However, downloaded music results in the same welfare as purchased music. I do not account for shared files with value to the customer less

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72. Bhaskar and To, *supra* note 1, at 762 (quoting Michael Spence, *Product Selection, Fixed Costs and Monopolistic Competition*, 43 REVIEW OF ECONOMIC STUDIES, 217–18 (1976)).

73. Obviously, the numerical results are for the simple model only, not the fully generalized model of Bhaskar and To.

74. This assumes (incorrectly) that file sharers will not purchase non-CD products such as concert tickets, memorabilia, etc., and that the music producers lose all revenue from file sharers. It is straightforward to construct a more general model, which would lead to greater incentives for entry and increase the ratio of equilibrium to optimal number of artists.

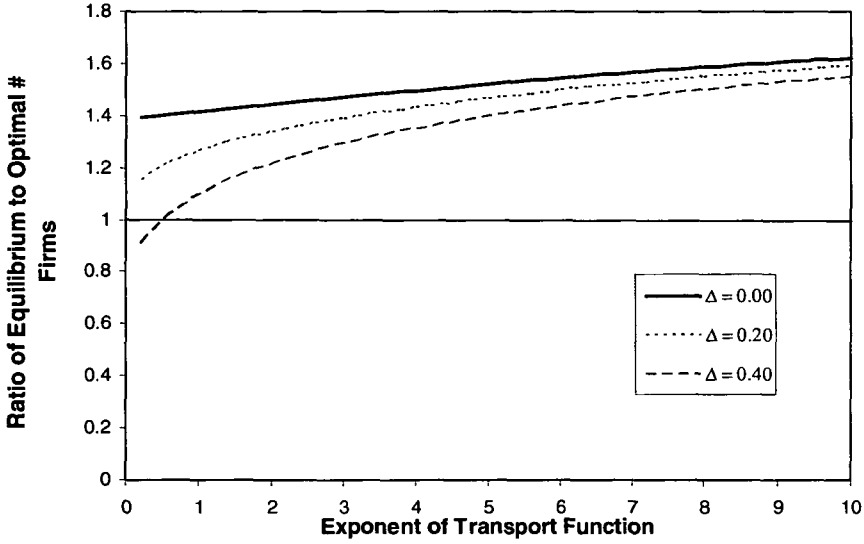
than the purchase price but more than the marginal cost of zero,[75] as my assumption of price discrimination eliminates that welfare loss. The result of these two simplifying assumptions is that the maximal welfare with m artists with file sharing is exactly the same as maximal welfare with m artists without file sharing, that is, $\hat{n}$. However, the operating profit per artist is reduced with file sharing in proportion to displaced CDs.

In Appendix A, I derive the market equilibrium number of artists n_S^* assuming that the fraction Δ of CD sales is displaced by file sharing. The ratio of equilibrium to optimal number of artists is:

$$\frac{n_s^*}{\hat{n}} = 2\left(\frac{(1-2^{-\alpha})(1-\Delta)}{\alpha}\right)^{\frac{1}{1+\alpha}} < \frac{n^*}{\hat{n}} \tag{7}$$

Clearly, file sharing decreases the excess capacity. But, by how much? In the following chart, I use the full range of empirical results: $\Delta = 0, 0.2, 0.4$:

FIGURE 4
EXCESS ENTRY



For all but the most fanciful estimate of file sharing displacement of CD sales, excess capacity is still substantial. While file sharing works to

75. This measure of welfare gain is a key issue in Rob & Waldfogel, *supra* note 39; including it here would increase welfare and therefore decrease the ratio of equilibrium to optimal number of artists.

reduce the excess capacity that results from the differentiated product market, it is not sufficient to lead to efficient entry. In fact, the actual story may be worse; as noted above, this model assumes that a customer that downloads a song or album and does not buy the corresponding CD also does not buy any fan-related material, such as coffee mugs, T-shirts, etc. We would expect that some fans would indeed purchase such material, which would increase the profitability of music and of entry, relative to the prediction of the model above.

DRM was introduced as a counter-measure to file sharing, a technological means to protect copyrighted work and restore incentives[76] to produce music. For all its ills, DRM had the one benefit of ensuring that artists and recording companies still had incentives to produce music as before. In light of the results of this section, however, restoring incentives to produce music to pre-file sharing levels actually increases inefficiency by encouraging excess entry.

I assume that current market trends (as exemplified by iTunes and Rhapsody) result in DRM mechanisms in which (non-uploading) customers do not feel constrained by copying limitations, so their expectations are fully realized and DRM is not costly to them. Specifically, I assume that the use of DRM does not reduce welfare. The pricing of online music and the acceptance of "reasonable" DRM suggests that the displacement of legitimate CD sales by file sharing will likely be substantially reduced by DRM. However, the fact that even these "reasonable" DRM mechanisms have been cracked suggests that we may continue to see some displacement of legitimate sales, but at a reduced level. The reduction of displacement using DRM may be as little as 50% or it may be as much as complete elimination. Combining these estimates, a plausible range of displacement of legitimate sales with a "reasonable" DRM deployed is 0%–20%. Revisiting the graph above, I conclude that excess capacity with both file sharing and "reasonable" DRM schemes likely falls between the $\Delta = 0.00$ and $\Delta = 0.20$ curves.

What is striking about these results is that the current debates about file sharing, DRM, and the attendant threat of underproduction of music are overshadowed by the magnitude of excess entry predicted by the model. Even the worst case equilibrium with the direst predictions of unrestricted file sharing makes only a modest dent in this excess capacity. While the legal and economic research communities have been focused on the "headline" issues of file sharing and DRM, we appear to

76. There are no claims that file sharing has actually led to the reduction of music production as of this date. The fears of reduced music production are prospective: if file sharing continues, so goes the story, it will eventually lead to a reduction. This would be an equilibrium result which could take some time to be realized.

have missed the much larger issue of excess entry in differentiated product markets such as music.

C. *Accounting for Spillovers*

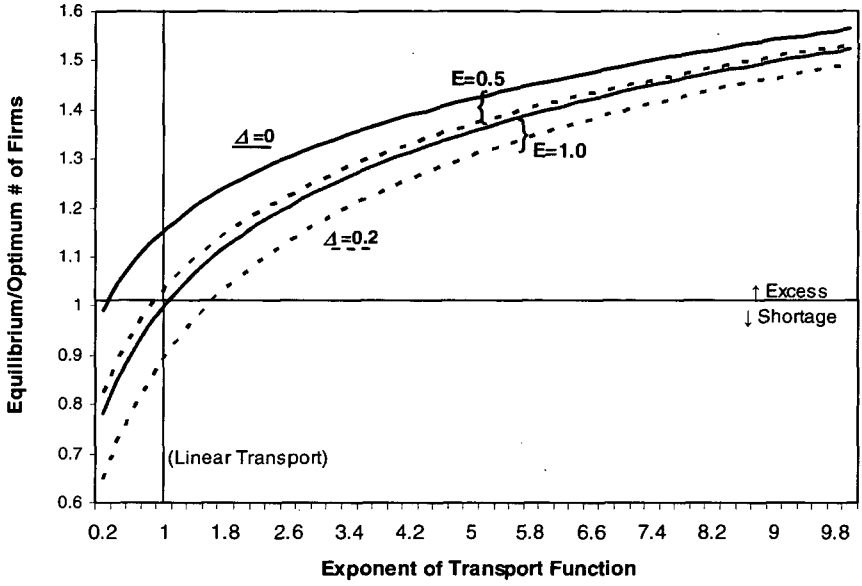
The likely presence of positive spillovers from the production of music suggests that *ceteris paribus* the market outcome will result in the underproduction of music. However, the *differentiated product* market equilibrium results in overproduction of music. If we take account of both the (privately) excess entry of the market together with the possible underproduction of music due to spillovers, will the result be over- or under-production of music?

In Appendix A, I derive the welfare maximizing number of artists $\hat{n}_E$ if the spillover value of music production is E times the private value. Finally, the ratio of the equilibrium number of artists with file sharing (adjusted for DRM) losses of Δ (from equation (6) in Appendix A) to the welfare maximizing number of artists with spillover E (from equation (7) in Appendix A) is:

$$\frac{n_s^*}{\hat{n}_E} = 2\left(\frac{(1-2^{-\alpha})(1-\Delta)}{\alpha\cdot(1+E)}\right)^{\frac{1}{1+\alpha}} \tag{9}$$

The ratio of equilibrium to optimum number of artists is plotted below. I show this ratio for file sharing (with "reasonable" DRM) displacement of $\Delta = 0.0$ and 0.2, and for spillover E toward the low end of that estimated for technology spillovers, $E = 0.5$ and 1.0:

FIGURE 5
EXCESS ENTRY



The possibility of spillovers somewhat mitigates the problem of excess entry. However, while excess entry is reduced in the presence of spillovers, optimum or under-production occurs only under optimistic views of spillovers, pessimistic views of displacement due to file sharing, and a view that customers have "sharp" preferences ($\alpha < 1$).

Without further evidence or even plausible assumptions to guide us, I conclude that while excess capacity is a likely outcome, the final answer must await empirical evidence.

III. EMPIRICAL IMPLICATIONS

The model provides guidance as to what evidence we should be looking for. Empirical work thus far has focused on measuring displaced CD sales due to file sharing, and determining how DRM may affect that. However, the above chart suggests that these two variables are of lesser importance in determining whether or not music is to be under- or over-produced. Far more important are the shape of customer preferences over the music product space and the existence and size of music spillovers. Unfortunately, it would appear that these variables are the least likely to be easily measured. For example, economists have worked for over twenty years estimating the spillovers in technology using patent

data.[77] But, there is no similarly rich and available data set for content creation, and no reason to suspect that spillover measurement for creative works would be any easier. In particular, the literature on technological spillovers has benefited from a readily available data source: patents.[78] There is no obvious data source for creative works. Nevertheless, the rich history of dealing with estimation problems in measuring technological spillovers may help in measuring spillovers in creative works. But, the empirical problems are still daunting.

I also note that measuring the shape of customer preferences in a spatial model in which the relevant artist characteristics are unobserved presents a significant empirical challenge. Steven Berry has authored the foundation paper for discrete choice estimation with unobserved characteristics.[79] This Article develops a method of inverting a mapping from mean utility levels to market shares under certain conditions, permitting (when inversion is possible) recovery of the mean utilities from market share data. Relevant characteristics may be recoverable using instrumental variables. However, this approach appears to be dependent upon uniform pricing and exogenous artists; Berry is quite clear that his approach is unlikely to generalize to endogenous location decisions, which are the crux of the model of this Article.

There are many papers that estimate demand with observed characteristics; an early paper is Bresnahan (1987).[80] More recent work includes Cohen and Mazzeo (2004),[81] which estimates demand for banks with geographic location and other measurable characteristics of banks. Another is Netz and Taylor (2002),[82] which estimates demand for gasoline retailers using location data and other observed characteristics of gas stations. Pinkse and Slade (2004)[83] analyze the United Kingdom beer market based on observed characteristics; they formally incorporate unobserved characteristics by including a random variable that they assume (problematically) is mean independent of the observed characteristics

77. *See, e.g.*, Bloom, *supra* note 54.

78. *See generally, id.*

79. Steven Berry, *Estimating Discrete Choice Models of Product Differentiation*, 25 RAND J. ECON. 242 (1994).

80. Tim Bresnahan, *Competition and Collusion in the American Automobile Industry: the 1955 Price War*, 35 J. INDUS. ECON. 457 (1987).

81. Andrew Cohen & Michael Mazzeo, *Competition, Product Differentiation and Quality Provision: An Empirical Equilibrium Analysis of Bank Branching Decisions*, FEDERAL RESERVE BOARD, FINANCE AND ECONOMICS DISCUSSION SERIES 2004–46 (2004), http://www.federalreserve.gov/pubs/feds/2004/200446/200446pap.pdf

82. Janet Netz & Beck Taylor, *Maximum or Minimum Differentiation? Location Patterns of Retail Outlets*, 84 REV. ECON. & STAT. 162, 162–75 (2002).

83. Joris Pinkse & Margaret E. Slade, *Mergers, Brand Competition, and the Price of a Pint*, 48 EUR. ECON. REV. 617–43 (2004).

and is uncorrelated with prices, thus finessing the problem of estimating unobserved characteristics.

Closest in spirit to the model of this Article is Goettler and Shachar (2001),[84] who estimate a spatial model of television programs in the U.S., using microdata on 3,286 individual viewers over a one-week period in 1992 from Nielson Media Research. They are able to identify the attribute space, product locations in this space, and the distribution of customer preferences. This problem bears at least some resemblance to the music market, and the variables they are able to identify and estimate are similar to those required to estimate the model of this Article. They use maximum simulated likelihood estimation, coupled with methods designed to improve simulation performance. On the basis of the work of Goettler and Shachar, it appears that estimation of the model in this Article is possible in principle. Development of an appropriate microdata set and the empirical methods necessary to estimate the model awaits further research.

The old saw concerning the person looking for her lost watch underneath the street lamp because the light is so much better there is perhaps relevant. The model of this Article suggests that we have been looking under the streetlight (file sharing and DRM), but, if we wish to find the important results, we must return to the middle of the block (shape of preferences and spillovers), where it is very dark. I leave this as a challenge to my empirically oriented colleagues.

IV. Caveats and Cautions

The surprising nature of the results of the model invites very close scrutiny of the application of the model to the problem at hand, as well as the plausibility of the range of estimates of file sharing losses (Δ) and spillovers (E). I make no effort to defend the latter; plausibility is certainly in the eye of the beholder, and these estimates appear to me to be plausible. The reader is invited to make her own judgments, and explore the implications using equation (9).

The suitability of this particular model to the music market is more amenable to analysis. There are several levels at which questions can be raised:

> *Is a differentiated products spatial model appropriate to the music market?* Applying a spatial model on the music market appears intuitive and plausible, but it comes at a cost of impos-

84. Ronald L. Goettler & Ron Shachar, *Spatial Competition in the Network Television Industry*, 32 RAND J. Econ. 624–656 (2001).

ing restrictions on demand interactions. The power of the model to incorporate both demand and supply conditions in a rich context that appears to conform to our (or at least my) intuition of how the market works seems persuasive.

Does the model generalize to something more realistic? The model of this Article has only a single dimensional product space, customers purchase only a single unit, and preferences are symmetric and identical up to location. Price discrimination, free entry, and artists' ability to modify their location are assumed. Bhaskar and To present a much more general and richer spatial model, and find that as long as price discrimination, free entry, and artist flexibility hold, excess capacity is the result. The numerical results of this Article only encompass the simpler model; a similar analysis of the more general model awaits further research.

Do artists price discriminate and are they flexible in their location in the face of new entry? These are the most important assumptions that drive the excess entry result. If either is false, then the results as derived do not hold. In this Article, I assert that the appropriate unit of analysis is the artist. In this view, artists and their music producers have a wide range of services and products that allow fans to express their intensity of preference. The ability to price these services, as discussed in the text, is, in fact, the ability to price discriminate.[85] The arguments of Appendix B on both the availability of instruments of price discrimination and the theoretical limits of how closely perfect price discrimination can be approximated seem compelling to me; the reader will have to decide for herself. Other authors (e.g., Rob and Waldfogel[86]) have taken the CD as the unit of market analysis and assert that no price discrimination can occur. Clearly, the CD is the physical product that shows up on the music store rack, and is the unit of the transaction. However, simple observation suggests that fans are loyal to and interested in artists, and recording firms invest heavily in developing and promoting artists. The focus on the artist as the product in the music business suggests a similar focus in the model.

85. The most well known treatment of price discrimination in the context of information goods is CARL SHAPIRO & HAL VARIAN, INFORMATION RULES (1998).

86. Rob & Waldfogel, *supra* note 39.

The ability of artists to shift their location in response to market forces appears to be fairly obvious.[87] Pop and country singers often evolve their music in response to market demands,[88] and even symphony orchestras can make marginal changes in their market position. If, however, we take the view that the CD is the unit of analysis, then obviously the CD is what it is and cannot change in response to market demands. But, as I note above, the appropriate focus is on the artist rather than the CD.

Are there spillovers from musical works and what is their magnitude? This is the most problematic issue of this Article; there is no research suggesting these spillovers exist or are important. While it seems plausible that such spillovers might exist, it is impossible to tell whether or not they are important. My use of an estimate range of $E = 0.5$ to 1.0 seems very optimistic; it could easily be much smaller. Unfortunately, estimating the magnitude of these spillovers promises to be a daunting task, at least as difficult as the estimation of technological spillovers. Yet it appears that the magnitude of the spillover is likely an important determinant of the optimal level of music production.

A broader issue is whether or not the model of this Article proves too much. If there is overproduction of music, then why not overproduction of movies, books, videogames, and perhaps other industries? In fact, the potential inefficiency of entry in spatially differentiated markets has been recognized since the earliest work by Hotelling.[89] In general, whether there is too little or too much entry depends on a number of factors; in this model, the ability to price discriminate (as well as the other assumptions) leads to excessive entry. Models of markets with uniform prices may lead to either too much or too little entry. In one of the few empirical papers addressing this issue, Berry and Waldfogel apply a differentiated product model to radio stations in the U.S., estimating that

87. In a recent interview, Liz Phair spoke of her musical shift since her early albums and her fans' unhappiness at that move, saying, "If you are an old fan and [my new album] doesn't fit what you need, don't buy the disc." David Carr, *The Independence of Liz Phair*, N. Y. TIMES, Aug. 2, 2005 at E1, E7.

88. Some obvious cases in point: Britney Spears has evolved her music from "bubble gum" music targeted at 13-year-old girls to a more mainline pop style as she herself has grown older. Madonna appears to change with every new album. On the other hand, it is unlikely that the Rolling Stones can ever change their particular location in music space; their long history playing a particular kind of music suggests a sunk cost in their location choice.

89. Hotelling, *supra* note 7, at 49–54.

excess entry results in a 40% loss of social welfare.[90] This suggests that many spatially differentiated markets may be subject to the type of inefficiencies highlighted in this Article. On the other hand, there are few industries with the ability to create such enthusiasm among its customers (in the form of "fans") and to be able to capture that enthusiasm (i.e., surplus) through the sale of complementary goods. It seems unlikely that movies or books, for example, offer the same opportunities for price discrimination as popular music, and so the results of this model may not apply to these industries.

There are many open questions about the modeling approach of this Article and consequently, about the results. Careful scrutiny of the model suggests a need for future theoretical and empirical work to ensure that its application to the music market yields credible results.

CONCLUSION

The turmoil in the music industry due to P2P file sharing has attracted scholarly attention in both economics and the law. The primary issue has been the extent to which file sharing (with or without DRM) displaces CD sales, with the focus on welfare changes due to (*inter alia*) reduced music production. In this Article, I introduce a differentiated product model of the music market, and find that the form of the market induces excess entry in equilibrium. File sharing, to the extent it reduces profits from music production, reduces this excess entry, but not to the efficient level. A "reasonable" DRM mechanism would increase entry (by making file sharing less attractive), but that simply makes matters worse. I then consider the possibility of spillovers from music production, which would be expected to drive a wedge between private and social benefits. Indeed, accounting for possible spillovers reduces entry closer to the efficient level, but only if the spillover is relatively large and customer preferences are "sharp." Thus, while the previous literature was concerned with sales displacement due to file sharing and the attendant concern of underproduction of music, this Article suggests that the overproduction of music resulting from the structure of the music market is a much more serious issue. Empirically, the efficiency of entry is principally determined by the shape of customer preferences and the size of (potential) spillovers; the effect of file sharing and DRM is relatively small in comparison.

90. Steven Berry & Joel Waldfogel, *Free Entry and Social Inefficiency in Radio Broadcasting*, 30 RAND J. ECON. 397 (1999). The authors also point out that similar industries such as software, television, and print media may suffer the same fate of excess entry.

The implications for empirical research are clear but daunting. Both the magnitude of spillovers and the shape of customer preferences present substantial measurement difficulties. The Goettler and Shachar[91] paper offers a way forward, and estimation of the model of this Article presents a fresh challenge to my empirically oriented colleagues.

91. Goettler & Shacar, *supra* note 84.

APPENDIX A

Derivation of Market Equilibrium: Base Case

With n artists in the market, the operating profit of artist a for the general transport function f is

$$\pi_a = \int_{a-1/2n}^{a+1/2n} \min_{j \neq a} f(|j-x|) - f(|a-x|)dx = \frac{2}{n} \cdot \int_{1/2}^{1} f\left(\frac{z}{n}\right) - f\left(\frac{1-z}{n}\right)dz \quad (1)$$

using the change of variable $x = i + (z-1)/n$.

Under the power function assumption, profit for each artist (including the actual artist and the music firm representing the artist) is

$$\begin{aligned} \pi &= \frac{2}{n} \cdot \int_{1/2}^{1} b \cdot \left(\frac{z}{n}\right)^{\alpha} - b \cdot \left(\frac{1-z}{n}\right)^{\alpha} dz = \frac{2b}{n^{\alpha+1}} \int_{1/2}^{1} z^{\alpha} - (1-z)^{\alpha} dz \\ &= \frac{2b}{n^{\alpha+1}} \left[\frac{z^{\alpha+1}}{\alpha+1} + \frac{(1-z)^{\alpha+1}}{\alpha+1}\right]_{1/2}^{1} = \frac{2b\left(1-\frac{1}{2^{\alpha}}\right)}{(\alpha+1)n^{\alpha+1}} \end{aligned} \quad (2)$$

With fixed cost of F, the free entry zero profit equilibrium results in n^* artists, satisfying

$$F = \frac{2b}{(\alpha+1)n^{\alpha+1}}\left(1-\left(\frac{1}{2}\right)^{\alpha}\right), \text{ or } n^* = \left(\frac{2b\left(1-\frac{1}{2^{\alpha}}\right)}{(\alpha+1)F}\right)^{\frac{1}{\alpha+1}} = \left(\frac{2b(2^{\alpha}-1)}{(\alpha+1)\cdot F \cdot 2^{\alpha}}\right)^{\frac{1}{\alpha+1}} \quad (3)$$

which fully characterizes the equilibrium.

Social welfare W is

$$W = \left(U - 2n\int_{0}^{1/2} \frac{1}{n} n\left(\frac{z}{n}\right)^{\alpha} dz\right) - nF = \left(U - \frac{2b}{(\alpha+1)\cdot n^{\alpha}\cdot 2^{\alpha+1}}\right) - nF$$

Welfare is maximized at $\hat{n}$ artists, satisfying

$$\begin{aligned} \frac{dW}{dn} &= \frac{\alpha}{(\alpha+1)}\frac{b}{2^{\alpha}} n^{-(\alpha+1)} - F = 0 \\ \hat{n} &= \left(\frac{b\cdot\alpha}{(\alpha+1)\cdot F\cdot 2^{\alpha}}\right)^{\frac{1}{\alpha+1}} \end{aligned} \quad (4)$$

If the free entry equilibrium resulted in the welfare-maximizing number of artists, then the ratio $n^*/\hat{n}$ would be unity. Unfortunately, such is not the case:

$$\frac{n^*}{\hat{n}} = 2\left(\frac{1-2^{-\alpha}}{\alpha}\right)^{\frac{1}{1+\alpha}} \tag{5}$$

Note that this ratio depends only on the *shape* of the transport function, determined by α, but for all α the ratio is greater than unity.

Market Equilibrium with File Sharing

Denote the fraction of CD sales displaced by file sharing as Δ; if the fraction Δ of revenue is lost to file sharing, then the number of artists that enter is

$$n_s^* = \left(\frac{2b(2^{\alpha}-1)(1-\Delta)}{(\alpha+1)\cdot F\cdot 2^{\alpha}}\right)^{\frac{1}{\alpha+1}} \tag{6}$$

Welfare Maximization with Spillovers

Denote the value of the spillover as a fraction of the private value of the artist's music by E. Then total welfare including spillovers with n artists optimally located is:

$$W_E = (1+E)\cdot\left(U - \frac{2b}{(\alpha+1)\cdot n^{\alpha}\cdot 2^{\alpha+1}}\right) - nF$$

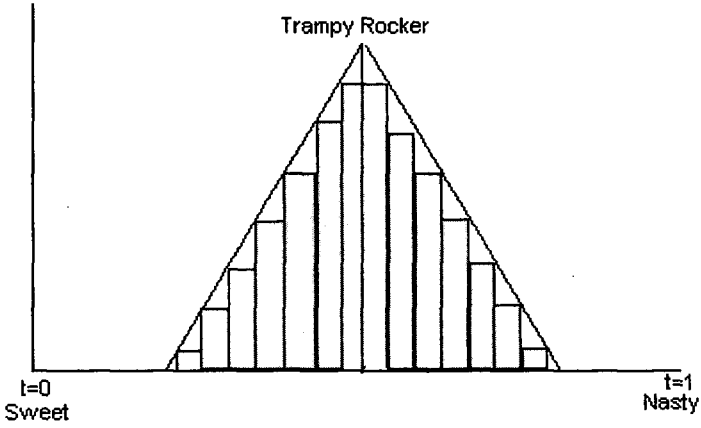
so the efficient number of artists is:

$$\hat{n}_E = \left(\frac{(1+E)\cdot b\cdot \alpha}{(\alpha+1)\cdot F\cdot 2^{\alpha}}\right)^{\frac{1}{\alpha+1}} \tag{7}$$

APPENDIX B

The assumption of perfect price discrimination is impossible to realize in practice (as is any "perfection"). The question is whether or not the actual price discrimination that occurs in the real world is close enough to perfect price discrimination that the model is valid. In the case of music, it is tempting to view the product as the CD that the customers buys from any number of retailers; in this view, music is a pure commodity and a single price should be the rule. The view of this Article is that the appropriate unit of analysis is the artist, not the CD. Artists and music distribution companies can market and sell a range of complementary products to music customers that can differentially capture the surplus that the artist generates among fans of varying enthusiasm. Such complementary products include coffee mugs, T-shirts, posters, and hats, as well as fan clubs (with varying degrees of commitment and price for access to the artist) and even cosmetics lines. Customers who derive little benefit from an artist may purchase her CD in the remainder bin at Wal-Mart for very little money. Those who are bigger fans may purchase the CD and perhaps a camisole with the artist's picture. Even bigger fans may join the fan club and purchase hats, T-shirts, and yoga pants. More rabid fans can also purchase clocks, key chains, buttons, and baby-doll shirts. The artist and music distribution firms use these ancillary products as a means of price discrimination; each possible bundle of ancillary goods captures a small portion of customers' locations in product space, as illustrated below:

FIGURE B1



For expositional ease, only a single artist is represented, and a linear transport function is assumed. Each vertical column represents a bundle

of complementary goods, such as the bundle {poster, rhinestone camisole, hat, DVD}. The base of the column measures the location space/customers that buy this bundle, and the height of the column measures the profits from this bundle. In the Figure, seven bundles are represented (symmetric around the ideal point).

How good is the approximation of the area under the columns to the area under the curve itself? If the approximation is close, then we can conclude that perfect price discrimination is a reasonable assumption; if not, then the assumption is not a good one.

If there are n bundles (columns in the Figure), then the error in approximating the area under the actual curve with the sum of the areas in the columns is given by the formula[92]

$$e = \frac{M(b-a)}{24n^2}$$

where M is an upper bound on the derivative of the function being approximated and [a,b] is the interval over which the integral is taken. Shifting the origin to the ideal point (so the location space is [-½,+½]) and normalizing U to unity, the right-hand side function is $1-\beta t^{\alpha}, t \in [0, \beta^{\frac{1}{\alpha}}] = [a,b]$. Over this interval, its derivative is maximized at the end point (for $\alpha > 1$), so $M = -\alpha\beta^{\frac{1}{\alpha}}$. The integral itself is $\int_0^{\beta^{-\frac{1}{\alpha}}} 1-\beta t^{\alpha} dt = \beta^{-\frac{1}{\alpha}}\left(\frac{\alpha}{\alpha+1}\right)$. Therefore, the error as a fraction of the integral is $= \frac{\alpha+1}{24\beta^{-\frac{1}{\alpha}}n^2}$. This function is increasing in β, but β is constrained by the assumption that the preference function is defined only over the unit interval, so $\beta^{-\frac{1}{\alpha}} \leq ½$. For any α, the error fraction is maximized at $\beta = 2^{\alpha}$, max error = $\frac{\alpha+1}{12n^2}$ (a similar derivation applies for $\alpha < 1$).

For α in the range [.1, 10] used above, the maximum error with 10 bundles (columns) is less than 1%. For 7 bundles, the maximum error is 1.8%. In either case, the case for a close approximation to perfect price discrimination with 7–10 bundles is very strong.

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92. The reader familiar with calculus will recognize the summation of columns as Riemann sums; as the number of approximating columns approaches infinity, the Riemann sums approach the area under the curve, i.e., the definite integral of the function. This approximation can be found in standard calculus texts or at http://archives.math.utk.edu/visual.calculus/4/approx.2/index.html.

Do real artists offer as many as 10 bundles? A check of the Britney Spears' online store reveals 40 individual items for sale, not including her extensive line of cosmetics, and not including individual CDs. The number of *bundles* of these 40 items numbers in the thousands, suggesting price discrimination based on a musical artist is very good indeed.

This analysis suggests that a well-designed set of products complementary to an artist's music can capture over 98% of the available surplus. I demonstrate that the music industry has sufficient instruments at its command to capture this surplus, in principle. The analysis does not, of course, constitute an empirical demonstration that the music industry actually achieves this. It could well be that the complementary goods and services are not sufficiently valuable to customers and fans to capture all or most of the consumer surplus. Alternatively, it could well be that the consumer surplus can be captured, but the music industry is not clever enough to design goods and services that can do the job. It would be surprising if a mature industry with sophisticated players selling to enthusiastic fans/customers was unable to capitalize on the tools available to them to extract economic rents. However, my result is limited to a theoretical showing of the rent extraction possibilities.

Some readers might note that the revenues from the sale of coffee mugs, T-shirts, etc., go to the artists and not to the music distributors. In the model of this Article, the division of rents between artist and distributors is irrelevant; between them, almost all available rents are extracted and the division among the upstream players does not matter.