Accounting for Ancillary Revenue Streams:
The Optimal Level of Copyright Protection in the Music Industry

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Submitted to the Department of Economics of Amherst College in partial fulfillment of the requirements for the degree of Bachelor of Arts with Distinction.

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April 27, 2001

I. INTRODUCTION

With each major technological innovation that further facilitates unauthorized copying of intellectual property, the battle over the harm resulting from this illegal reproduction resurfaces, renewing the struggle among the creators, policy makers, and consumers to assess the damages accurately. The photocopying machine, video home-recording devices, and digital audio tapes are all examples of technology that sparked heated debate over whether illegal copying hurt artists and/or society as a whole. The democratization of the Internet within the last few years and the consequent rapid and unregulated distribution of information have again put the future of copyright law into question. As cheap disk space becomes increasingly available and network connections continue to improve, all types of informational goods—from books to music to movies—become more vulnerable to illicit reproduction and exchange, threatening the sales of these goods in the traditional market.

Due to recent high profile court cases and the subsequent media attention, the context of these arguments, which was initially in the software field, has shifted to the music industry. The MP3—a digital sound file that can be quickly, cheaply, and infinitely reproduced with minimal loss in sound quality—is feared as posing a serious threat to the current music business model and to musicians in general.[1] Within the last year, those familiar with copyright law and the music industry have spent considerable time trying to determine the applicability of the traditional arguments regarding copying technology to the current problems posed by the MP3 and peer-to-peer file sharing

systems. Some argue that the MP3 will have essentially the same impact on the music industry as video recordings had on the movie industry: it will eventually prove a boon to musicians and to others who make a living from music. They argue that MP3s work as complements to music consumption, meaning that as people consume MP3s, they will consequently purchase more music and music-related goods.[2] However, others argue that the consumption of MP3s will be a substitute for listening to CDs or cassettes, and without the ability to appropriate revenue directly or indirectly to cover production costs, there will not be enough incentive to create the socially optimal quantity of music.[3] To begin approaching the present day dilemma in a more structured manner, we will begin with a brief overview of the history of the economic analysis of copyright law.

Economists argue for the existence of copyright law as simply a natural extension of property law: it encourages society to exploit resources efficiently. If property rights were not protected, no one would have an economic incentive to produce since one would not be assured an appropriate reward for the cost of his efforts. Incentives must also be protected for those who invest in ideas, and so copyright law may be seen simply as a subdivision of property law. An unregulated market in which artists did not have exclusive ownership of the right to reproduce and distribute their work would result in a supply of creative works less than the efficient level. Since copiers would not consider the negative externality of reducing artist profit (and thus creative incentive) through their piracy, consumers would continue to copy illegally, and artists would produce fewer

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[1] For the average music consumer, the loss in quality is basically indistinguishable since an MP3 file only lacks notes that are not easily recognized by the human ear. Only true audiophiles seem to notice a significant difference between the digital quality of a compact disc and that of an MP3.
[2] See, for example, Robert E. Hall's expert report for *A&M Records v. Napster, Inc.*
[3] Liebowitz, ironically one of the first to suggest that illicit copying may actually benefit producers (1985), is one of many people to make this argument (2000).

works than the socially optimal quantity. As technology has advanced, copyright law has evolved, particularly in the music industry, to incorporate the increased accessibility to machines that allow the public to make their own copies of music at low costs. Until recently, the law has adjusted well to these changes, permitting the media industry to thrive and prosper at levels that have unquestionably given artists incentives to produce.

The literature analyzing intellectual property law from an economic standpoint is abundant, and while much of it deals with patent or trademark issues, a considerable amount discusses the issues of copyright in the literary world. With the advent of the photocopying machine, the option to copy literary works became much more viable, and authors immediately began to analyze the potential effects on authors' and publishers' incentives. Breyer (1970) and Johnson (1985) both focus on the issues involved in copyright law with regard to the literature industry. Breyer wrote a legal analysis responding to proposed legislation meant to counteract the effects of the machines. His paper examines the standard moral and economic arguments for copyright and claims that though these lines of reasoning are weak, he cannot conclude that copyright should be abolished. However, he does find that all of the legislation that Congress was considering at the time would hurt society and that copyright protection should not be increased through the means proposed.

Johnson, in a formal mathematical analysis, attempts to determine the short and long run effects of copying through models with both fixed and varying costs. He finds that, in the short run, social loss will occur if the fixed costs of copying are significant enough or if there enough consumers who are highly willing to pay but become copiers. However, in the long run, not only is the proportion of high-value consumers who switch

to copying important, but the elasticity of supply and the utility consumers derive from product variety also help determine whether restrictions should be placed on copying.

Using an innovative approach to ensuring artist incentive, Liebowitz (1985) relies on an empirical study to suggest that for academic journals, the monopolist may be able to appropriate revenue from libraries indirectly since it can charge libraries significantly more for frequently copied journals. Furthermore, Liebowitz notes that unauthorized reproduction also has beneficial exposure effects as well, since the copying of journals permits more people to read and perhaps become regular consumers of the journal.

Among the more recent literature suggesting the overlooked benefits of copying, Takeyama, in two separate articles, studies the specifics of the software industry and shows that its structure may allow some companies to thrive from illegal copying. In her first article, Takeyama (1994) discusses the network externality aspect of copying in the software market. Because an increasing number of people using a computer program enhances the benefit that each consumer derives from use of the software, network externalities exist, and firms will have increased incentive to expand output. Allowing a certain amount of unauthorized reproduction may be an efficient way of increasing the installed base since the firm can price-discriminate among different classes of consumers. Ultimately, illegal copying may not only lead to greater firm profits when compared to a world with no copying, but it may also lead to a Pareto improvement in social welfare.

In her second article, Takeyama (1997) shows that due to the time-inconsistency problem, illegal copying can improve firm profits and social welfare since the firm may again price-discriminate, although this time in an intertemporal manner. She argues that if copies and originals are sufficiently substitutable so that copiers would only purchase

an original if the price of the original were less than the average avoidable cost, profits may indeed be higher. Since a firm will not price below average cost, it will be able to commit to higher prices in the first period, and differential enforcement of copyright law would be justified by the ability to price uniformly. As a result, firm profits may be higher with copying.

The relative dearth of literature dealing specifically with copyright as it applies to musical compositions may be because the ability to reproduce musical works was beyond the means of the average consumer until twenty years ago. Nevertheless, there is a significant difference in analysis of copyright within the music industry. As Hurt and Schuchman (1966, p. 421) explain while introducing their study of book and periodical copyright: "such an investigation [into the issues of copyrights in musical compositions] would, in all probability, require a separate paper." Though we will delve more deeply into the details of the music industry later on, it is important to note that the structure of the music industry and its interaction with copyright law is much more complex. An album generally has three different copyrights—the rights for the album as a whole, the performance rights for each of the songs on the album, and the mechanical rights for the physical copy of each song—and each different copyright generates royalties for various uses of the copyrighted work. Musicians may own one or all of these rights, depending on their role in creating an album and their contract with the record producer. As a consequence, each artist's flow of income from album sales alone can vary significantly.

Among the general literature more readily adaptable to the music industry, Novos and Waldman (1984) discuss the optimal level of copyright protection, studying two particular losses associated with copyright law: the social welfare loss due to the

underproduction of creative works and the loss due to the underutilization of these works. The loss due to underproduction is a result of the classic free rider problem of property law. Because an artist knows that he will not be remunerated for his efforts to create a work, he will have less incentive to create that work. The authors ultimately find that despite previous claims and general intuition, this type of loss may actually increase with copyright protection: though more consumers will be forced to buy from the monopolist as a result of increased protection, the increase in quality due to greater monopoly power will cause some consumers to switch from buying originals to acquiring copies, which may end up reducing overall profit for the artist.

The loss due to underutilization has two components. First, because copyright gives the music industry monopoly power, the consumers who would be willing to purchase the music at marginal cost are denied consumption (*i.e.* dead weight loss exists). Second, the authors point to the loss attributed to those who expend more resources than does the producer to reproduce the work. With respect to how this loss responds to changes in copyright, the authors again argue against intuition, stating that this loss will generally decrease with increased protection. Because the monopolist is pricing above marginal cost, when copyright protection increases, consumers at the margin will incur higher costs from copying than they would if they purchased the product from the monopolist. As a result, these consumers will switch from copying to purchasing the product, decreasing this loss.

Using Novos' and Waldman's basic model, Yoon (2000) similarly studies these two types of social welfare loss, although he views the problem in terms of quantity as opposed to quality. This difference has several implications. First, to imply that society

is underproducing intellectual property means that monopolists are not producing enough different works, not that the caliber of the work produced is too low. To study the number of works created, Yoon must break the production of a work into two different stages: that of development and that of production. If profits do not cover the development cost, the monopolist will not produce the work.

Yoon views the welfare loss due to underutilization in terms of too few people consuming the products relative to a socially optimal number. Consequently, Yoon's model implies that certain consumers refuse to use the product at all. A group of consumers rejecting the product also results from the fact that Yoon's model allows for heterogeneous valuations of the product by consumers, an assumption that is absent from Novos' and Waldman's model. Finally, Yoon does not assume that consumers' unauthorized reproduction costs are larger than the original producer's marginal cost, altering his findings from those of Novos and Waldman.

Ultimately, Yoon's model suggests that an increase in copyright protection may either increase or decrease the loss due to underutilization. The optimal level of protection must be either zero copyright protection, very low protection so that the monopolist's profit just covers development costs, or full copyright protection. In terms of the loss due to underproduction, Yoon's model agrees with the standard claim that an increasing level of copyright protection will decrease this loss, refuting Novos' and Waldman's findings. He finds that this loss decreases in an abrupt manner since it is a step function that drops to zero at a threshold level of protection.

Yoon's model can be adapted to the music industry because its basic assumptions hold true for musical works: artists incur large development costs relative to production

costs, consumers value musical goods heterogeneously, and so forth. This paper will use Yoon's adaptation of the Novos and Waldman model to determine what sort of impact ancillary revenue streams may have on an artist's profit and on the optimal level of copyright protection. As outlined above, other authors have attempted to assess the damages resulting from copying while suggesting that copying may have indirect benefits for both the producer and society. However, none has formally modeled the ancillary revenue streams resulting from consumer exposure to intellectual property.[4]

In this paper, we consider the possibility that as artists or groups gain increased exposure through consumption of nonexcludable albums, the sales of excludable goods related to their music may increase.[5] This possibility has two major implications. First, when deciding whether or not to produce an album, the artist should account for any ancillary revenue streams in the profit calculations. Second, copyright protection affects the consumer base, an implication that is indirectly related to the profit calculation. An increase in copyright protection will correspondingly increase consumers' reproduction costs, thereby reducing the total base of consumers (both those who purchase from the monopolist and those who copy). A smaller consumer base implies that ancillary revenue will be diminished. Consequently, artists will be concerned with copyright protection not only because it determines the number of people that purchase their album, but it also determines the size of their ancillary revenue stream, suggesting that increases in copyright protection have two contradictory effects on artist profit: increasing protection

[4] Breyer was one of the first to address the alternative benefits of less stringent protection, discussing the benefits of a wider dissemination of textbooks. More specifically, he mentions the academic community's greater recognition of a more widely read author, which translates into a higher salary as a professor.
[5] Determining when related goods sales are a significant part of artist revenue is certainly important, and it is an issue we will discuss in Section II as well as during the presentation of the model.

will increase the revenue that artists receive from album sales, but it will decrease the revenue generated by ancillary sources.

This paper will determine the level of copyright protection that is optimal for both the artist and for society as a whole. While our approach to these issues is similar to that of Yoon, that fact that we incorporate the ancillary revenue stream when calculating artist profit complicates the issue of establishing what is best for the artists. More specifically, we find that the level of protection that an artist prefers depends on the marginal cost of producing each album, the substitutability of pirated albums for those purchased from the monopolist, and the significance of related good sales relative to overall profits. We find in certain cases that the welfare loss due to underproduction may actually increase with copyright protection since an artist's profit may decrease with additional protection.

As for the loss due to underutilization, in situations where an artist's profit increases with protection, we agree with Yoon that this loss will tend to increase with more protection, although situations do exist where this loss can increase if the artist's marginal cost is low enough relative to the substitutability of the copy and/or ancillary revenues are a significant enough part of profit. However, we find that this welfare loss may not occur as frequently, again due to the fact that an artist's profit may decrease with increased protection. If an artist's profit is maximized with no protection, we find that social welfare must also be maximized with no protection, implying that the optimal level of protection may be no protection more often than Yoon suggests.

The paper is organized into four sections. Section II will give a brief overview of the Internet's effects on the music industry and make a case for the significance of ancillary revenue streams for some artists and for these streams' direct correlation with

album sales. Section III presents the model, which is broken down into two parts—one to deal with the development of the album and another to analyze the production of the album itself and the decisions of the artist and the consumers. The final section will contain some concluding remarks, noting some implications of our findings.

II. THE INTERNET, THE MUSIC INDUSTRY, AND THEIR INTERACTION

The rise of the Internet has threatened to upend the traditional rules of the music industry. Napster and other peer-to-peer file exchange systems have enabled people to find songs and even entire albums extremely quickly in the convenient MP3 format, jeopardizing artists' ability to sell music. While the exploration of the possible legal and technological solutions to the problem is beyond the scope of this paper, such solutions currently seem unlikely. While the major labels recently successfully sued Napster, dozens of other file-sharing systems have become available, many of which appear legally invulnerable since they operate as independent entities detached from a central server.[6] Furthermore, only a few days after Napster installed a filter to eliminate the exchange of songs owned by major labels, PulseMedia.com launched a software program dubbed "NapCameBack" to bypass this security feature. After only a few days, over 500,000 copies of the program were downloaded for free from the Internet (Music News Industry Network, 19 March 2001).

From an economic standpoint, enacting and enforcing a legal rule depends on its costs and benefits, according to Cooter and Ulen (2000, p. 22): if the cost of increasing

copyright protection by an additional unit outweighs its benefit, it is inefficient and thus undesirable. Given this rule, it appears that the precedent set by the Napster trial will not prove to be an efficient legal solution. The costs incurred by the major labels and Napster, Inc. in a lengthy court battle have been extraordinarily high, yet the benefits seem to be insignificant. While piracy through Napster has been partially curbed, the ruling is inconsequential for other peer-to-peer file exchange systems that operate independently of any partnership or server (such as Gnutella). Many of the people who used Napster may simply choose another one of the existing software programs, most of which can be obtained quickly and free from the Internet. Therefore, legal attempts to reign in illegal copying seem to offer no tenable solution.

Technological barriers appear equally problematic. The vast majority of experts believe that a secure digital file will never be found. To understand the futility of the situation, one must look no further than the history of the Secure Digital Music Initiative (SDMI). The SDMI is committee within which representatives for over 200 of the largest names in the recording, consumer electronics, and computer technology industries are trying to develop a standard framework for secure music distribution and use. The SDMI had hoped to develop this standard by the end of 2000. In the fall of 2000, it released several different watermarking technologies to hackers, offering a $10,000 prize to anyone who was able to crack the digital protection. Within a month, hackers cracked every encryption code (Salon.com, 12 October 2000). The SDMI seems destined to fail, and even members of the SDMI believe that the standard model of a secure music format is now antiquated (Salon.com, 3 October 2000).

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[6] Charles Mann (2000) compiles a rather extensive list of the available alternative software, some examples of which include Wrapster, Napigator, Gnutella, Scour Exchange, iMesh, FileSwap, and even one as boldly

However, the difficulties that an artist has *selling* music may or may not have a negative impact on his ability to make a living as a musician. In order to determine the impact of illegal reproduction on artist profit and social welfare, it is necessary to examine *all* of the streams of income that an artist's music generates, including questioning the traditional album sale. For musicians, revenue generally comes from four main sources: publishing royalties, mechanical royalties, merchandise royalties, and touring revenue. Their ability to collect from each source depends primarily on their record contract, which is determined by the type of label. Though major labels produce most records, artists also can sign with independent labels, which generally have different contract and royalty structures. Furthermore, independent label artists typically appeal to more specific music markets when compared with major label artists and thus have different expectations for album sales, concert venues, and general consumer base. As a consequence, we can expect artists signed with independent labels to rely on the various income flows differently.

Consider first artists signed with major labels. Though the retail price of a compact disc is $16.99, even relatively popular artists usually receive no money from album sales. Major label records have only a 5% success rate, meaning that only 5 out of every 100 albums sell 500,000 or more copies (Music Industry News Network, 28 February 2001). In 1999, less than 1 percent of the total number of albums released sold more than 10,000 copies, and an album generally must sell at least 200,000 copies to cover its expenses (The Washington Post, 21 February 2001). In order to recoup their losses from the many failing albums (which cost as much to produce and promote as the few successful ones), major labels must appropriate a large percentage of revenue from

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named as Metallicster.

album sales. For example, Steve Albini (1993, p. 31), a well-known producer, describes the case of one band who, after producing an album that sold over 250,000 copies, received only a nominal sum of money: each member collected only $4,000 dollars.

According to All You Need to Know About the Music Business (Passman, 2000, p. 108), artists, depending upon their past success, will receive a royalty rate anywhere from 9% (for a new artist) to 20% (for a "superstar"). However, royalty rates do not accurately reflect the revenue that artists receive from album sales. Record labels pay artists an advance on album royalties, and beyond this advance, artists typically will not receive any additional money from album sales. In Albini's example, the band still *owed* -$14,000 in royalties despite selling a quarter of a million albums.[7] Until record companies recoup their expenses, artists have very little chance to earn money from royalties beyond their advances.[8] Not only do monies paid directly to the artist count against royalties earned, but "recording costs are also recoupable from royalties, and so are some portion of video production costs, monies paid on behalf of the artist (for example, to buy equipment or to support a personal appearance tour), and anything else not nailed down" (Passman, p. 104).

Albini also describes the specifics of profits from merchandise and touring in a major label contract. The band in his example is given a net advance of $16,000 from the sale of merchandise. Once the merchandise sales have covered the costs, the artist can expect to receive royalties from this source at a rate of from 26% to 40% of the retail price, depending on the status of the artist (Passman, p. 360). Thus, the revenue from

[7] This deal assumes a 13% royalty rate of 90% of the retail price (10% of the price was deducted for the packaging cost). The royalties total $351,000, from which the advance, a percentage for the producer, a percentage for the band's former label, and $25,000 in promotion costs were deducted.

merchandise sales is more reliable because there are fewer middlemen to appropriate some of the profits. As for touring, the band in Albini's example loses money due to the high costs of travel. Passman reaffirms this situation, stating that only when an artist or group sells 750,000 to a million albums should it expect to break even or make any money from label-sponsored touring (p. 346). However, Passman notes that once artists begin producing multi-platinum records and have *established a large fan base*, they can expect to make much more money touring, more than they can expect to make from album sales. Album sales and touring revenues have a correlative relationship, and both increase with the fan base. By touring, one can "become better known, build an audience, sell more records, play bigger concerts, and generally further" one's career (Passman, p. 159).

While this correlative relationship also holds for those under independent label contracts, these artists can typically expect different flows of revenue due to the structure of their contracts and their smaller, more specific audiences. While independent labels also expect artists to cover the costs of producing an album, the costs of recording an independent album are often lower due to smaller budgets (Passman, p. 111). Moreover, beyond these costs, artists can expect independent labels to split the profits from album sales evenly (Toomey and Thomson, 2000). Consequently, revenue from album sales may be more significant for a lesser-known artist under an independent contract than for someone under a major label contract. By the same token, however, a lesser-known "indie" artist who serves a smaller audience may make more money touring. Fred von Lohmann, a visiting researcher at the Berkeley Center for Law and Technology, notes

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[8] As Albini notes, the ability to recoup may become successively harder since, in an effort to sell more records with the next album, more money is spent on production and promotion.

that folk musicians, for instance, can gain a local following by distributing albums for nominal profits while making a substantial amount of money playing weekly gigs at low costs. Passman similarly notes the advantages of obtaining a local following, claiming it can be a general stimulus to a budding musician's career as well as a viable source of income (p. 343). Finally, a member of a regional hip-hop group, the Skitzofreniks, noted that, "it can be very lucrative if you build that solid backing [that of a strong local following]."

Aside from this correlation with merchandise and concert ticket sales, exposure to an artist's work through its consumption may also lead to increased revenue flow for an artist in other forms of ancillary revenue. As a song is more widely distributed, commercial opportunities increase accordingly. If an artist owns his publishing rights (which is more likely under an independent contract), he can make substantial money from these opportunities. For example, if a motion picture uses a song during the opening credits, its producers will usually pay the artist $50,000 to $150,000, although "when there's an incredibly hot, recent song and the record company is salivating over it, the figures can get very high into the six figures" (Passman, p. 242).

Another form of ancillary revenue involves further album sales. Those who consume an album (in either original or pirated form) may then be encouraged to purchase an album for a friend as a gift. Also, increased exposure to an album can lead to subsequent album purchases.[9] Whether consuming a pirated album encourages some consumers to purchase an original copy from the artist or it simply results in some copiers purchasing the next album, both may be seen as sales of goods related to the

[9] Takeyama (2000) makes this argument, noting that consumers can use copying as a means of gaining more complete information about product quality prior to purchasing the good.

consumption of an artist's first album. In an expert report executed for Napster during its recent trial, Hall found strong evidence for both types of purchases as a result of the free music found through Internet services like Napster.

Because this paper focuses on how copyright protection impacts artist profit and social welfare, this paper will investigate how changes in this protection might affect *all* sources of revenue for artists, the most significant of which we have discussed above, and our model has been developed to determine how changes in copyright protection will impact artist profit and social welfare given the possibility of other revenue sources.

III. THE MODEL

Following Yoon (2000), we begin with the market for a copyrightable musical good (*e.g.* an album) produced by a monopolist. As previously noted, the production and sale of an album may be broken into two stages: that of development and that of production. In the first stage, artists must decide whether to produce and record an album given an exogenous level of copyright protection; this stage is referred to as the *production* stage. Artists may expect to incur a certain development cost, denoted as D, if they decide to create the album; if they decide not to create the album, they will incur no cost ($D = 0$). In the second stage, assuming that the product is developed, consumers will decide to either purchase the album from the artist, pirate a copy of the album, or not consume the album, given their own reproduction costs and the monopolist's price (p_1) for the album. This second stage is referred to as the *utilization* stage. In this stage, we assume that a constant marginal cost of c_1 is necessary to produce each additional album.

Thus, the total cost that each artist incurs when producing an album is $C(q)=D + c_1q$ when he produces q albums, and $C(0) = 0$.

The set of consumers considering consuming the album is denoted by I, while the valuation of the album by consumer $i \in I$ is designated by $v_{1i} \in V_1$, where V_1 is the set of all of the possible valuations of the album among the set of consumers. Those who are indifferent toward the album will have $v_i = 0$. Each consumer can obtain the album in one of two ways—purchasing the album from the monopolist or illegally copying the album. If the consumer purchases the album, he pays the price p_1 and his net utility is equal to the difference between his valuation for the album and the price set by the seller, given by $v_{1i} - p_1$. If the consumer obtains a pirated copy, then he must pay a certain cost for making the reproduction.[10] Such reproduction costs include the time spent acquiring the appropriate technology and the opportunity cost of the time spent searching for and downloading the song.[11] The reproduction costs for consumer i are denoted by z_i, and the set of all possible values of reproduction costs are represented by Z. Finally, the parameter y denotes the level of copyright protection and/or enforcement. We assume that as the level of copyright protection y increases, every consumer's reproduction costs will increase. Mathematically, this is represented by $\partial z_i/\partial y > 0$ for all $i \in I$.

Initially, it is assumed that a pirated copy is not a perfect substitute for an original. Many would argue, however, that such an assumption is not necessarily true due to the presence of CD burners, which allow consumers to copy MP3s on CDs and thus enjoy

[10] We will assume that the lender bears no cost and thus will not charge a price for lending the album. Such a model is known as a *direct appropriability model*, first used by Liebowitz (1985). Though this is true due to competition between lenders, in the case of MP3s, this assumption is reasonable due to a more obvious fact: once the track has been converted to the MP3 format and made available on a file-sharing network, the lender is hardly conscious of the fact that others are copying the work.

most of the benefits of owning the album with a practically indistinguishable loss in sound quality. We will relax this restriction later on, but initially we assume that the lack of certain benefits that one enjoys when purchasing an album (such as liner notes, moral benefits, etc.) results in a discounted valuation of a pirated copy compared to the original album. With regard to notation, the discounted utility from consuming a copy is $(1 - \alpha)v_{1i}$ for all $i \in I$, where $0 \leq \alpha \leq 1$. This gives a net utility from consuming a copy of $(1 - \alpha)v_{1i} - z_i$, which is the difference between the utility from consuming a copy and the cost of obtaining a copy. For ease of expression, the *gross reproduction cost* is defined as $w_i \equiv \alpha v_{1i} + z_i$, which is the sum of the cost of obtaining a copy and the value a consumer loses by consuming a copy rather than an original. More concisely, the net utility from consuming a copy of an album is $v_{1i} - w_i$.

Whether a consumer obtains a copy or an original, we assume that a certain proportion, ψ, of the set of consumers will want to consume some goods related to the album, like concert tickets or merchandise. Importantly, consumption of the album in either form is a necessary condition for a consumer to purchase the related goods. By listening to the album, consumers gain exposure to an artist, and we imply that some will be interested in consuming goods related to the artist and his music; if they do not consume the album, we assume that they will be equally uninterested in consuming any related goods. For simplicity, we assume a common valuation, v_2, for the proportion ψ of users that will consume these goods.[12] Thus, the proportion ψ of all people who consume the album also value related goods like concerts and t-shirts at v_2 while $(1 - \psi)$ of users

[11] Some may argue that the costs consumers incur now and can expect to incur in the future are negligible. The implications of varying costs of illegal copying will be discussed later within the context of the model.
[12] This assumption of homogeneity will not affect the basic qualitative conclusions of the model.

have no interest in the related goods (*i.e.* $v_2 = 0$).[13] Furthermore, it is assumed that the artist is able to extract consumers' full valuation of the related goods given the fact that these goods are normal, excludable goods. Thus, the price of related goods, p_2, will be equal to v_2.[14] As for the marginal cost, c_2, of producing each additional unit of the related good, note that if it is less than or equal to the price p_2 that the artist charges, he will decide not to produce any subsequent goods since they would add nothing to profit, and the model would be no different from that in Yoon's paper.[15] Consequently, we assume that $p_2 > c_2$, and for ease of exposition and comparison with Yoon's model, $c_2 = 0$.[16]

As stated earlier, the production-consumption problem of the copyrightable product will be modeled in two stages. First, the utilization stage is analyzed to determine what pricing and consumption decisions will occur given that a product is developed. Once these decisions have been revealed, we can turn to the production stage in order to establish whether the artist will produce, a decision that will depend on development cost D given an expected level of income and profit.

A. *The Second Stage: Utilization*

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[13] The model assumes that album sales sell related goods and not the reverse. Some artists tour in an effort to sell albums, and it appears that both album consumption and concerts work to increase the fan base, which in turn promises greater profits from these same sources. Therefore, while the model does capture the positive correlation between the two streams of revenue, it may overstate the impact of album consumption on the sale of related goods.

[14] Note that if we interpret related goods as commercial opportunities, then ψp_2 would be a general term for the amount of revenue an artist could expect from this secondary income source.

[15] Such an assumption does not account for any advertising value that related goods might have for albums, which is consistent with the limitation that we mention in footnote 13.

[16] To factor in the marginal cost of related goods would add nothing of qualitative value to the model. Note that in our model, the price p_2 may now also be interpreted as the margin of profit from selling related goods: the higher p_2 is, the more profit a monopolist can expect from this source of revenue.

Given that the album is developed in the first stage, we can disregard the sunk cost of production and recording when analyzing the underutilization problem that characterizes the second stage. Beginning first by examining consumers' behavior, we can say that consumer $i \in I$ will make the following choices depending on the relative magnitudes of the value v_{1i} that the consumer places on the album, the gross reproduction cost w_i, and the price p_1 that the artist charges for the album. If the album's price is the lowest of the three, the consumer will want to consume the album and will purchase it from the artist: he receives a larger surplus from purchasing rather than from copying. If the gross reproduction cost is the smallest of the three values, then the consumer will illegally copy the album; while unwilling to pay the monopolist's price for the album, he values the album more than the costs incurred when consuming a pirated copy. Finally, if the consumer's valuation of the album is smaller than both the price of the album and the cost of obtaining an unauthorized copy, then the consumer simply will not consume the album. These results may be summarized succinctly as follows:

(a) $p_1 = \min \{v_{1i}, w_i, p_1\}$: purchase from the monopolist

(b) $w_i = \min \{v_{1i}, w_i, p_1\}$: unauthorized reproduction

(c) $v_{1i} = \min \{v_{1i}, w_i, p_1\}$: no consumption

Taking the price p_1 and the level of copyright protection y as given, we may define the set $B(p_1; y) = \{i \in I \mid p_1 \leq v_{1i}, p_1 \leq w_i\}$ of consumers who buy the album from the artist, the set $U = (p_1; y) = \{ i \in I \mid w_i \leq v_{1i}, w_i < p_1\}$ of consumers who consume

copies of the album, and the set $N(p_1; y) = \{ i \in I \mid v_{1i} < p_1, v_{1i} < w_i \}$ of consumers who do not consume the album at all (that is, in either its original or copied form).[17]

After defining these sets, we have our first proposition.

PROPOSITION 1: *As the level of copyright protection y increases, given that all else remains constant, then (i) $U(p_1; y)$ is non-increasing, and (ii) $B(p; y)$ and $N(p;y)$ are non-decreasing. Formally, we can state that for all $y' > y$,*

$$U(p_1; y') \subseteq U(p_1; y);\ B(p; y) \subseteq B(p; y');\ N(p;y) \subseteq N(p;y').$$

Consequently, the artist's profit may increase or decrease with an increase in copyright protection. Its direction depends on ψ, the proportion of album consumers that purchase related goods, on how important this income is relative to the album sales component of profit, and on how sensitive the consumer base of $[\,|B(p_1;y)| + |U(p_1;y)|\,]$ is to changes in y.

PROOF:

The inclusion relationship of the sets follows in a straightforward manner from an analysis of the cases (a) through (c). However, the conclusion that profit may either decrease or increase with an increase in y is somewhat counterintuitive and disagrees with previous authors' findings. Why would profit not go up with greater copyright protection (and thus less copying)? The result can be deduced from the fact that both $B(p_1; y)$ and $N(p_1; y)$ are non-decreasing, leading to two conflicting forces that act on

[17] Here we are assuming that when consumers are indifferent between buying or making a reproduction ($p_1 = w_i = v_{1i}$), they will choose to buy; when indifferent between making reproductions or not consuming ($w_i = v_{1i}$), they will copy; when indifferent between buying and no consumption ($p_1 = v_{1i}$), they will buy.

artist profit as copyright protection increases. To elaborate, suppose the profit-maximizing level of price is denoted by p_1 and the corresponding profit by π when copyright protection is y. Further, when copyright protection is $y' > y$, we will denote the profit-maximizing level of price by p' and the corresponding profit by π'. Therefore we have $\pi = (p_1 - c_1) \bullet |B(p_1; y)| + \psi p_2 \bullet [|B(p_1;y)| + |U(p_1;y)|]$ and $\pi' = (p_1' - c_1) \bullet |B(p_1'; y')| + \psi p_2 \bullet [|B(p_1';y')| + |U(p_1';y')|]$.

While $(p_1 - c_1) \bullet |B(p_1; y)| < (p_1 - c_1) \bullet |B(p_1; y')| < (p_1' - c_1) \bullet |B(p_1'; y')|$, the fact that $\psi p_2 \bullet [|B(p_1;y)| + |U(p_1;y)|] > \psi p_2 \bullet [|B(p_1;y')| + |U(p_1;y')|] = \psi p_2 \bullet [|B(p_1';y')| + |U(p_1';y')|]$ may offset this gain in profits, leaving the total change in artist profit resulting from an increase in copyright protection y unclear.

For ease of analysis, we assume that consumers' valuations are uniformly distributed over the unit interval [0,1]. Furthermore, we assume that, at any given level of copyright protection y, consumers' reproduction costs are the same.[18] Mathematically, this assumption is represented as $z_i = z(y)$ for all i and y. Consumers' optimal choices can now be summarized given the price p_1 of the album and level of copyright protection y.

PROPOSITION 2: (CONSUMER CHOICE)

(i) $p_1 < z / (1 - \alpha)$: *In this case, consumers who belong to* $[0, p_1)$ *do not consume the album at all, and consumers who belong to* $[p_1, 1]$ *purchase the album*

[18] In today's environment, this assumption may not be very accurate; the difference between Internet connections and thus the time spent downloading can be significant. For example, someone with a 56K modem would not be able to download nearly as much within a given time frame as someone with a high-speed Internet connection (*e.g.* DSL, cable modem, etc.). Typically, the models generated by this body of literature introduce heterogeneity, either via intellectual property valuations or copying costs but not both.

from the monopolist. That is, $B(p_1; y) = [p_1, 1]$; $U(p_1; y) = \varnothing$; *and* $N(p_1; y) = [0, p_1)$.

(ii) $p_1 \geq z / (1 - \alpha)$: *In this case, consumers who belong to* $[0, z / (1 - \alpha))$ *do not consume the album at all, consumers who belong to* $[z / (1 - \alpha), (p_1 - z) / \alpha)$ *consume a copy of the album, and consumers who belong to* $[(p_1 - z)/\alpha, 1]$ *purchase the album from the artist. That is,* $B(p_1;y) = [(p_1 - z)/\alpha, 1]$; $U(p_1; y) = [z / (1 - \alpha), (p_1 - z) / \alpha)$; *and* $N(p_1; y) = [0, z / (1 - \alpha))$.

The threshold level of p_1 that determines whether consumers will purchase an album, copy an album, or choose not to consume at all was found by solving for when $v_1 = w$, or when the valuation of the consumption of the album is just equal to the gross reproduction cost. This expression is equivalent to $v_1 = \alpha v_1 + z$, which gives us $v_1 = z/(1 - \alpha)$. Using this equation, we determine which consumers will not consume the album, which ones will consume pirated copies, and which ones will purchase from the artist. If $p_1 < z/(1 - \alpha)$, consumers for whom $v_1 < p_1$ will not consume the album while those for whom $v_1 \geq p_1$ will purchase the album from the artist. Since the consumer can purchase the album at a price lower than the costs that would be incurred copying, no pirating will occur. If $p_1 > z/(1 - \alpha)$, then while consumers for whom $v_1 < z/(1 - \alpha)$ will not consume, consumers for whom $w_i < v_1 < p_1$ will copy. Note that these consumers will receive more surplus from copying than from purchasing the album so that $v_1 - \alpha v_1 - z > v_1 - p_1$. From this expression, consumers for whom $z/(1 - \alpha) \leq v_1 < (p_1 - z)/\alpha$ will copy the album and those for whom $v_1 \geq (p_1 - z)/\alpha$ will purchase from the monopolist.

Figure 1 provides a graphical representation of these various situations. Consumers belonging to $[0, z / (1 - \alpha))$ have $v_1 - p_1 < 0$ and $v_1 - w < 0$ and will neither purchase nor copy the album; they can expect to lose utility from consuming the album in either form. Similarly, consumers belonging to $[z / (1 - \alpha), (p_1 - z) / \alpha)$ have $p_1 - w > 0$ and $v_1 - w \geq 0$ and will choose to consume copies of the album; while they desire to consume the album, the surplus from copying is more than the surplus from purchasing the album so that they will copy the album. Finally, consumers belonging to $[(p_1 - z)/\alpha, 1]$ have $v_1 - p_1 \geq 0$ and $w - p_1 \geq 0$ and will choose to purchase an original album since they gain the most surplus by purchasing the album from the monopolist.

From Proposition 2 follows the demand function for an album:

$$D(p_1) = \begin{cases} 1 - (p_1 - z)/\alpha & \text{; when } p_1 \geq z/(1 - \alpha), \\ 1 - p_1 & \text{; when } p_1 < z/(1 - \alpha). \end{cases}$$

Additionally, we make the following assumption on the parameters:

ASSUMPTION 1: $c_1 < \alpha + z < 1$.

If $\alpha + z > 1$, then every consumer's gross reproduction cost would exceed even the valuation for the product since $w \equiv \alpha v_1 + z > v_1$. Such a situation implies that copying would never exist, which would render our paper a moot point and does not realistically describe actual consumer behavior. If $c_1 > \alpha + z$, then the marginal cost of the producer is higher than any consumer's gross reproduction cost, which is an unlikely situation since the monopolist generally has the most access to equipment facilitating exact reproductions of the master album. Thus, because he has this advantage, we will

assume that an artist would be able to produce copies of the original at the lowest cost. Under this assumption, we can draw the demand function as in Figure 2.

Consider the artist's total revenue—a function of the quantity q of albums sold:

$$TR(q) = \alpha q + zq - \alpha q^2 + \Psi p_2((1 - z/(1 - \alpha)) \text{ ; when } q \leq 1 - z/(1 - \alpha),$$

$$q - q^2 + (\Psi p_2)q \qquad \text{; when } q > 1 - z/(1 - \alpha).$$

Observe that the artist's total revenue has two components: revenue generated by direct album sales and that which is generated by the sale of related goods. The revenue generated by album sales is easily derived from the demand function. Note that when $q \leq 1 - z/(1 - \alpha)$ (or alternatively, when $p_1 \geq z/(1 - \alpha)$), the ancillary revenue component does not depend on the quantity q of albums *sold*, but on consumers' *exposure* to the music (*i.e.* the number of albums consumed in both the primary and secondary markets). The purchase of related goods is proportional to the number of people who consume the album, $(1 - (z/(1 - \alpha))$. The number of consumers who purchase related goods is therefore given by $\Psi((1 - z/(1 - \alpha))$, which we multiply by the price p_2 of related goods to obtain the term for ancillary revenue. When $q > 1 - z/(1 - \alpha)$ (or $p_1 < z/(1 - \alpha)$), the number of consumers that purchase related goods is strictly dependent on the quantity of albums sold. Since in this case copying does not occur, any change in the number of albums purchased from the artist will necessarily alter the exposure the artist has (and thus the revenues he receives from ancillary sources).

Next, taking the derivative of the total revenue function with respect to quantity ($\partial TR/\partial q$), we obtain the following expression for marginal revenue MR:

$$MR(q) = \qquad \alpha + z - 2\alpha q \quad \text{; when } q \leq 1 - z/(1 - \alpha),$$

$$1 - 2q + \Psi p_2 \text{ ; when } q > 1 - z/(1 - \alpha).$$

We have seen that in the presence of copying (*i.e.* when $q \leq 1 - z/(1 - \alpha)$), ancillary revenue is dependent on the number of albums *consumed*, not *sold*. If an additional album is sold, one less is copied, but the total number of consumers enjoying the product is unchanged; marginal revenue corresponds to the consumers choosing between copying and purchasing the album. Consequently, ψ and p_2 do not enter the expression for marginal revenue. On the other hand, when copying does not exist ($q > 1 - z/(1 - \alpha)$), then with each additional album sold, the total consumer base must grow by one as well, meaning that ancillary revenue will increase by a proportionate amount (ψp_2).

Importantly, marginal revenue in this case would be lower in the absence of the ancillary revenue component. However, by incorporating this source of revenue, marginal revenue is higher, implying that piracy might harm profit less than previous authors have claimed, since piracy enhances ancillary revenue. In fact, the marginal revenue from album sales ($1 - 2q$) could be less than the marginal cost c_1 of producing them, yet the artist could still earn positive profit. Piracy may in fact increase profit since, without it, an artist must rely solely on his ability to sell albums as a means of exposing people to his music. Any changes in copyright protection would affect revenue through two different channels: that of album sales and that of ancillary revenue.

Given this marginal revenue function, we find the profit-maximizing price of the album p_1^*, quantity q^*, and profit π^*. They are summarized in the following proposition:

PROPOSITION 3: (THE EQUILIBRIUM OUTCOME)

(i) $z \leq (1 - \alpha)(\alpha + c_1)/(1 + \alpha)$: outcome is given by

$\{p_1^*, q^*, \pi^*\} = \{(\alpha + z + c_1)/2, (\alpha + z - c_1)/2\alpha, (\alpha + z - c_1)^2/4\alpha +$

$\psi p_2(1 - z/(1 - \alpha))\}$,

and consumers' choices are given as follows:

$B(p_1;y) = [(\alpha + c_1 - z)/2\alpha\,,\ 1]$; $U(p_1;y) = [z/(1 - \alpha)\,,\ (\alpha + c_1 - z)/2\alpha)$; *and*

$N(p_1;y) = [0\,,\ z/(1 - \alpha))$.

(ii) $(1 - \alpha)(\alpha + c_1)/(1 + \alpha) < z \leq (1 - \alpha)(1 - \psi p_2 + c_1)/2$: outcome is given by

$\{p_1^*, q^*, \pi^*\} = \{z/(1 - \alpha),\ 1 - z/(1 - \alpha),\ (1 - z/(1 - \alpha))(z/(1 - \alpha) - c_1) +$

$\psi p_2(1 - z/(1 - \alpha))\}$,

and consumers' choices are given as follows:

$B(p_1;y) = [z/(1 - \alpha),\ 1]$; $U(p_1;y) = \varnothing$; $N(p_1;y) = [0\,,\ z/(1 - \alpha))$.

(iii) $z > (1 - \alpha)(1 - \psi p_2 + c_1)/2$: outcome is given by

$\{p_1^*, q^*, \pi^*\} = \{(1 - \psi p_2 + c_1)/2,\ (1 + \psi p_2 - c_1)/2,\ (1 - \psi p_2 - c_1)(1 + \psi p_2 - c_1)/4 +$

$\psi p_2(1 + \psi p_2 - c_1)/2\}$,

and consumers' choices are given as follows:

$B(p_1;y) = [(1 - \psi p_2 + c_1)/2,\ 1]$; $U(p_1;y) = \varnothing$; $N(p_1;y) = [0\,,\ (1 - \psi p_2 + c_1)/2]$.[19]

Note that in each of the first two cases, ancillary revenue does not help determine the equilibrium price and quantity. In the first case, a change in z within the constraints will change the price that artists charge for the album, thus affecting only the marginal consumers deciding between copying and purchasing. The total consumer base (and thus ancillary revenue) will remain unchanged. In case ii, since the artist's price is just low enough to prevent copying, the price is simply set according to z.

[19] See Appendix A for a proof of Proposition 3.

However, in case iii, which describes a world where *the possibility of copying does not exist*, the cost of reproduction z is high enough so that changes in z within these constraints are irrelevant to the price set by the artist. But now, the artist is concerned with ancillary revenue when setting p_1 since, regardless of z, any changes in p_1 affect the marginal consumers deciding between purchasing the album from the monopolist or not consuming it (implying that they will not consume any related goods either). More specifically, as the equation suggests with a negative sign in front of the amount of ancillary revenue ψp_2, the larger the amount of ancillary revenue that the monopolist can expect, the lower the price he will charge for the album. With a lower p_1, though the artist may see decreased profit from album sales, he can expect increased revenue from related good sales. Another consequence of more ancillary revenue is that a world where copying is not possible becomes even more likely, again due to the fact that a higher ψp_2 lowers price; a lower p_1 increases the likelihood that a consumer will prefer to purchase an album as opposed to pirating a copy.

This proposition gives some interesting results in terms of profit's behavior over z. First, note that when the artist cannot expect any additional profit from ancillary revenue (*e.g.* $\psi, p_2 = 0$), the profit function replicates that in the Yoon model so that profit is non-decreasing over z.[20] When ancillary revenue is a viable source (*i.e.* $\psi, p_2 \neq 0$), profit from album sales in the case where there is copying (*i.e.* case i) will always be positive, while profit from album sales in the third case where copying does not exist can

[20] See figure 3 for a graphical representation of this situation.

sometimes be negative. More specifically, $\pi_{iii\ (album\ sales)}^* < 0$ when $(1 - c_1) < \psi p_2$.[21] Thus, whether an artist in a world without copying loses money from selling an album depends both on how much revenue related goods generate and on the marginal cost of producing each additional album for consumption. The higher ψp_2 and/or c_1, the more likely it is that the artist will lose money from album sales (though he can then generate more revenue from related good sales). It becomes apparent that a musician could be better off allowing some copying (when album sale profits will always be positive) since albums may generate negative profit in a world without copying. Furthermore, for the same reason, an artist may rationally sell an album below profit in expectation of increased ancillary revenue. Nonetheless, by allowing copying, he may still earn some of this ancillary revenue without incurring a loss from album sales.

More generally, how the profit function behaves over z depends on the substitutability α between copies and originals, the marginal cost c_1 of producing an additional album, and the significance of ancillary revenue (as determined by ψ and p_2). Over the first region (case i), the function is convex to the origin since the second derivative of profit with respect to z is positive: $\partial^2 \pi_i/(\partial z)^2 = 1/2\alpha$. Eventually, it will reach a minimum value $((2\alpha\psi p_2/(1 - \alpha)) + c_1 - \alpha)$, and begin to rise. However, in the second region, the function becomes concave: $\partial^2 \pi_{ii}/(\partial z)^2 = -2/(1 - \alpha)^2$. Ultimately, this function will reach a maximum value at a z that is also the upper bound of case ii: $(1 - \alpha)(1 - \psi p_2 + c_1)/2$. Beyond this point, artist profit is not at all dependent on z ($\partial \pi_{iii}/\partial z = 0$) since case iii describes a world free from the threat of copying—changes in z do not

[21] We obtain this result by seeking when the album sale component of the equation for profit from case iii might be less than zero. Studying the equation, we may note that the numerator contains the term $(1-\psi p_2 - c_1)$, which, if negative, would imply that profits are negative as well.

affect the size or makeup of the consumer base. Hence, artists will desire either no protection, from which point their profit will decrease until case ii, or enough protection to eliminate the threat of copying (*i.e.* case iii).

As for whether artists prefer no protection (*i.e.* $z = 0$) or full protection as in case iii, we must compare the value of profit when $z = 0$ to when $z = (1 - \alpha)(1 - \psi p_2 + c_1)/2$. For profits to be higher when z is at a minimum, the following condition must hold:

$$(\alpha - c_1)^2/\alpha > (1 - \psi p_2 - c_1)(1 + \psi p_2 - c_1) - 2\psi p_2(1 - \psi p_2 + c_1).$$[22]

Though this condition is difficult to grasp analytically, we may note that as copies become less substitutable for originals relative to the other parameters, it becomes more likely that artist profit will be maximized when $z = 0$. This is a result of the fact that copies do not pose as much of a threat to album sales, and thus increases in z will have more of an impact on related good sales than on album sales. Additionally, as ψp_2 increases, the above condition also becomes more likely, as we would expect. By running numerical simulations, we determine more concretely in which types of situations profit is higher with full protection and when it is higher with no protection. Figures 4 and 5 represent each situation respectively. In figure 4, where artists would prefer full protection, pirated copies are not very substitutable for original albums ($\alpha = .3$) and the marginal cost of albums is rather large ($c_1 = .2$). The artist can expect a large proportion of his fans (*i.e.* those who have consumed his album in some form) to consume related goods ($\psi = .7$), and the price p_2 that they are able to charge for related

[22] This condition was found simply by solving for when an artist's profit in case i when $z = 0$ is greater than profit in case iii.

goods is .3. Though this price is relatively large compared to p_1 (p_1 = .25 when z = 0), artists can still expect to earn more from album sales with full protection.[23]

On the other hand, in the situation illustrated in figure 5 where artists would prefer no copyright protection, the parameters concerning albums are the same: $\alpha = .3$ and $c_1 = .2$. The artist can expect an equally large proportion of his fans to consume related goods ($\psi = .7$), but these consumers are willing to pay a price p_2 of .5, more than in the situation above. Consequently, artists will rely more on ancillary revenue, and the profit generated by this source will outweigh that from album sales. The artist will prefer no protection to ensure that as many people as possible will be exposed to his music.

As has been shown, different types of artists will prefer either one of two levels of copyright protection: no copyright protection or full copyright protection. Now that we have considered what is in the best interests of the artists, we may turn to the interests of the consumers. The consumer surplus CS for case i, the copying case, is as follows:

$$\int_{z/(1-\alpha)}^{(\alpha+c_1-z)/2\alpha} (v_1 - \alpha v_1 - z)dv_1 + \int_{(\alpha+c_1-z)/2\alpha}^{1} (v_1 - \frac{\alpha + z + c_1}{2})dv_1$$

$$= \frac{1}{8}(4 - 3\alpha - 2c_1 + \frac{c_1^2}{\alpha}) - \frac{1}{4}(3 + \frac{c_1}{\alpha})z + \frac{1+3\alpha}{8\alpha(1-\alpha)}z^2$$

Note that the equation for consumer surplus is identical to that in Yoon's model in the first case. The first component of consumer surplus captures the surplus value from people who consume pirated copies of the album, subtracting the gross reproduction cost ($w_i = \alpha v_{1i} + z$) from the value v_{1i} that each consumer places on an album. This is relevant for all consumers that value the album enough to copy it ($v_{1i} \geq z/(1 - \alpha)$) but not

[23] We may also view the price p_2 of related goods as the difference between the price and the cost of producing each related good. In this case, the profit margin on a related good is .3, while the profit margin

enough to purchase it from the monopolist ($v_{1i} < p_1 = (\alpha + c_1 - z)/2\alpha$). The second component captures the surplus value from all consumers who purchase albums from the monopolist (or, for whom $v_{1i} > p_1$).

Next, we factor in artist profit to determine the level of social welfare SW for all consumers who have $v_{1i} \in V_1$:

$$\int_{z/(1-\alpha)}^{(\alpha+c_1-z)/2\alpha} (v_1 - \alpha v_1 - z)dv_1 + \int_{(\alpha+c_1-z)/2\alpha}^{1} (v_1 - c_1)dv_1 + \psi p_2 (1 - \tfrac{z}{(1-\alpha)})$$

$$= \frac{1}{8}(4 - \alpha - 6c_1 + \frac{3c_1^2}{\alpha}) - \frac{1}{4}(1 + \frac{3c_1}{\alpha})z + \frac{3+\alpha}{8\alpha(1-\alpha)}z^2 + \psi p_2 (1 - \frac{z}{(1-\alpha)})$$

In terms of the social welfare resulting from album sales, this equation is very similar to that for consumer surplus, except that instead of subtracting the price of the album, we subtract the marginal cost c_1 of the album; we are interested in society's total surplus, not simply that of consumers. Furthermore, while this equation is again identical to that in Yoon's model with respect to album sales, our model also includes a term for the ancillary revenue component of artist profit. Ancillary revenue does not figure into the equation for consumer surplus due to the assumption that artists are able to capture completely the consumer surplus in the market for related goods. Thus, only an artist's calculation of profits will reflect the consumption of these goods.[24]

We are now ready to analyze the effects of changes in copyright protection y on consumer surplus and social welfare. As stated earlier, the inequality $\partial z/\partial y > 0$ holds so that we may study how consumer surplus and social welfare change as the cost of reproduction z changes. First, since the equation for consumer surplus does not change

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on an album is .05 ($p_1 - c_1 = .25 - .2 = .05$).

until the third region, the behavior of CS as z increases is exactly the same as that which is described in Yoon's paper: it decreases until case iii, at which point all pirating will be eliminated, and CS will no longer be dependent on z. However, consumer surplus in the third region will consistently be higher in this region than it is in Yoon's paper due to the addition of a term that accounts for ancillary revenues: given that ψ and p_2 are not zero, the price of albums will be less, meaning that more people will enjoy the album at a lower price.

As for social welfare, it too behaves in a manner similar to the function described in Yoon's paper. In the first region, we first note that since

$$\frac{\partial SW_i}{\partial dz} = \frac{\alpha+3}{4\alpha(1-\alpha)}z - \frac{1}{4}(1+\frac{c}{\alpha}) - \frac{\psi p_2}{(1-\alpha)} \text{ and } \frac{\partial^2 SW_i}{(\partial dz)^2} = \frac{\alpha+3}{4\alpha(1-\alpha)}z,$$

social welfare must be convex since the second derivative is positive, and the social welfare decreases initially when the costs of reproduction are zero ($z = 0$). However, in the second region, social welfare is concave: the second derivative of the social welfare function is negative ($\partial^2 SW_{ii}/(\partial z)^2 = -1/(1 - \alpha)^2$). In the third region, since the possibility of piracy does not exist, social welfare is independent of any changes in the cost of reproduction z. Since the social welfare function is decreasing over all relevant values of z in the second region, it becomes apparent that social welfare must be maximized either at no protection ($z = 0$) or at the upper limit of case i (that is, when $z = (1 - \alpha)(\alpha + c_1)/(1 + \alpha)$).[25] These results agree with those in Yoon's paper, although we may note a difference in the first region. Due to the additional impact of ancillary revenue on profit, social

[24] The consumer surplus and social welfare for the next two regions are found in a similar manner. See Appendix B for their expression.

welfare will decrease by an additional, proportionate amount as copyright protection increases. This additional amount is given by $-\partial z/\partial y*(\psi p_2/(1 - \alpha))$.

As a consequence of this additional negative impact on social welfare resulting from an increase in copyright protection, social welfare attains a minimum in the first region at a lower level of reproduction cost z. More specifically, the minimum will now occur when $z = (1 - \alpha)(\alpha + 3c_1)/(3 + \alpha) - \alpha\psi p_2/(\alpha + 3)$. Furthermore, while social welfare must eventually increase after this minimum in Yoon's paper, social welfare may still decrease or be at the minimum when it reaches the first region of z. When $z = (1 - \alpha)(\alpha + c_1)/(1 + \alpha)$, then $\partial SW/\partial z = 2(1 - c_1)/(1 + \alpha) - \psi p_2/(1 - \alpha)$, showing that while social welfare decreases when $0 \leq z \leq ((1 - \alpha)(\alpha + 3c_1)/(3 + \alpha) - \alpha\psi p_2/(\alpha + 3))$, it may not increase if the minimum occurs outside the region $[0, (1 - \alpha)(\alpha + c_1)/(1 + \alpha)]$.

Nonetheless, the social welfare function has a convex shape in the first region, which it owes to two conflicting effects that copyright protection increases have on welfare. First, increasing protection augments consumers' reproduction costs, implying that consumers will be expending more resources when making pirated copies of albums. This effect is given by $-\partial z/\partial y*((\alpha + c_1 - z)/2\alpha - z/(1 - \alpha))$, which we find simply by multiplying the number of consumers who make pirated copies by the increase in cost resulting from an incremental change in copyright protection y.

On the other hand, increasing these costs will cause some consumers to switch from making reproductions to purchasing the album from the monopolist. Such a switch is efficient since the marginal consumers who switch to purchasing the album must have

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[25] $\partial SW_{ii}/\partial z = -z/(1-\alpha)^2 + c_1/(1+\alpha) - \psi p_2/(1-\alpha)$. When we insert $z = (1 - \alpha)(\alpha + c_1)/(1 + \alpha)$ (the final relevant value of z in the first region) and combine the terms, we obtain $\alpha(c_1 - 1) - \psi p_2(1+\alpha)$ in the numerator, which is always negative.

a gross reproduction cost approximately equal to the price of the album p_1, which is greater than the marginal cost c_1. This effect is represented mathematically by $\partial z/\partial y^*(\alpha + z - c_1)/4\alpha$, derived by multiplying the change in profit with the change in z that occurs as copyright protection increases by one unit. Interpreting the shape of the overall function, we deduce that when the costs of reproduction z are low, the first effect dominates, and social welfare decreases initially as copyright protection raises these costs. However, when the costs of piracy are higher, the second, positive effect on social welfare is relatively more significant, and welfare will increase.

Explaining the behavior of social welfare beyond the first region is more straightforward. In the second region, as the costs of reproduction increase, the monopolist may charge a higher price, which decreases the social welfare through two avenues. First of all, consumer surplus decreases since fewer consumers will purchase the album—those at the margin have been turned away by the increase in p_1. This effect is given by $-\partial z/\partial y^*(1/(1 - \alpha))$, or the loss of utility multiplied by the change in reproduction cost. Secondly, artist profit will decrease with increased protection due to a smaller consumer base, which decreases ancillary revenues. This result is given by the term $-\partial z/\partial y^* \psi p_2/(1 - \alpha)$ that we derived earlier. As for social welfare in the third case, it is independent of changes in the cost of reproduction ($\partial SW_{iii}/\partial z = 0$). This region represents a world where copying is never a viable option, rendering reproduction costs irrelevant so that they will not figure into the determination of social welfare.

As has been shown, social welfare must be maximized either at the lowest level of copyright protection ($z = 0$), or at the upper limit of the first region ($z = (1 - \alpha)(\alpha + c_1)/(1 + \alpha)$). We will refer to this interior maximum as z^M, with y^M being the level of protection

at which this interior maximum is attained. Thus, when comparing social welfare at these two values of z, we may derive a general rule for when social welfare with no protection is greater than social welfare when the costs of copying are just high enough that marginal consumers are indifferent between purchasing or not consuming (*i.e.* z^M):

$$0 > (\alpha + c_1)(3 + \alpha)/2\alpha(1 + \alpha) - 1 - (3c_1/\alpha) - 4\psi p_2(\alpha + c_1)/(1 + \alpha).^{26}$$

Similar to our other inequality, this is rather difficult to grasp analytically, but upon running numerical simulations, we find that both situations may occur: depending on the parameters, social welfare can be higher either when there is full protection (z^M) or when there is no protection. Figures 6 and 7 represent each situation respectively.

Figure 6 depicts a situation where pirated copies are highly substitutable for original albums ($\alpha = .1$), the marginal cost of producing an album is insignificant ($c_1 = .01$), and only about a third of the consumers of the album will consume related goods, which are priced rather low ($p_2 = .1$). We may attribute the maximization of social welfare at z^M both to the behavior of artist profit and to a rather low c_1 relative to the substitutability of copies for originals. As we stated earlier, as the cost of reproduction approaches p_1, the welfare increase due to consumers switching from pirated copies to purchasing albums will outweigh the loss due to an increase in z. Because c_1 is so low relative to the substitutability of copies (and thus the gross reproduction cost w_i), it is considerably more efficient for consumers to purchase the album. As for the behavior of artist profit, it increases over z because the revenue generated by related goods appears to be rather nominal: only a third of an artist's fans consume them, and the profit margin on

[26] This inequality was found simply by solving for when social welfare when $z = 0$ is greater than social welfare when $z = (1 - \alpha)(\alpha + c_1)/(1 + \alpha)$.

these goods is relatively small. Consequently, as z increases, the increase in revenue from album sales more than offsets any loss in revenue from sales of related goods.

Figure 7 represents a situation where society would be better off with no copyright protection. While copies are as substitutable for originals as in the previous example, the marginal cost of producing an album is more substantial ($c_1 = .05$). Furthermore, artists can expect half of their fans to consume related goods, and the profit margin on these goods is higher ($p_2 = .3$). Upon analyzing this situation in the same fashion, we note that because c_1 is higher relative to α, the welfare increase from copiers becoming buyers is not as significant as z increases. Furthermore, in this case, ancillary revenues are a larger part of artist profit since half of the artist's fans consume related goods and these goods generate higher profit. Comparing this graph's profit function to the previous example, we may note that while it still increases, the difference in profit between no protection and full protection is not as large due to the more significant related goods revenue.

Through simple numerical exercises, the situation depicted in Figure 7 (*i.e.* when social welfare is maximized at $z = 0$) appears to be the general case, confirming the intuitive belief that increasing protection will increase the welfare loss due to underutilization. However, as noted above, if c_1 is low enough relative to the substitutability α of copies for originals and if ancillary revenue is insignificant enough, the welfare increase from consumers switching from pirating copies to purchasing original albums will be larger than the loss that results from increasing the cost of reproduction z. This implies that this loss can decrease overall.

Now that we have described the behavior of artist profit and social welfare, we shall turn to the determination of the optimal level of copyright enforcement.

B. The First Stage: Production

In the first stage, the decision of the artist to produce an album depends on whether he can expect π^* in the second stage to cover the development cost D so that an artist will only record an album if $\pi^* \geq D$. Consequently, we define the optimal level of copyright protection as that which maximizes social welfare while ensuring that an artist will cover D given consumers' and the artist's optimal choices. This problem is represented mathematically as

$$\arg\max_y \mathrm{SW}(z(y)) \text{ subject to } \pi^*(z(y)) \geq D.$$

When our function for profit increases over z, our results are similar to those of Yoon. That is, the optimal levels of copyright protection given the above condition are as follows: either full protection, just enough protection so that no unauthorized reproduction exists, or no protection. As D increases, the level of copyright protection necessary to ensure that artist profit will cover this cost must increase due to the fact that profit increases over z. Over the second and third region (where copying does not exist), social welfare unequivocally decreases. Therefore, if the development cost warrants such a high level of protection, y will be just high enough to ensure that $\pi^* = D$, but no higher.

However, while still studying the situation when profit increases over z, we find that when D is low enough that $\pi^*(z^M) < D$ (*i.e.* the first region), then the optimal level of copyright protection depends on whether social welfare has an interior maximum or is

maximized when $z = 0$. If it has an interior maximum, then the optimal level of copyright protection will be at y^M: social welfare is maximized while guaranteeing that D is covered. If social welfare is maximized when $z = 0$, then the optimal level of copyright protection depends on profit relative to D. We first define z^0 as the value for which social welfare is equal to social welfare when z^M.[27] If D is greater than π^* ($z = 0$) and greater than $\pi^*(z^0)$, then the optimal level of copyright protection is y^M. If it is less than $\pi^*(z^0)$ but still higher than $\pi^*(z = 0)$, profit will be just high enough to cover D. Finally, if $D < \pi^*(z = 0)$, then the optimal level of copyright protection will be no protection.

Again, these outcomes are appropriate when profit increases over the cost of reproduction z. However, the inclusion of the ancillary revenue component results in a profit function which is generally convex, is sometimes be higher when $z = 0$, and may even decrease over z, depending on where within the constraint $0 < z < z^M$ the function for profit attains a minimum (if at all). In the case where profit is convex but profit is still maximized at full protection, the outcomes are similar to those described above: the optimal level of protection can be no protection, full protection, or just enough protection to cover artist profit. However, when profit is greatest when $z = 0$, the optimal level of copyright protection must be no protection. Because social welfare is simply equal to the sum of consumer surplus and artist profit and since consumer surplus always decreases as the cost of reproduction z increases, then if artist profit is ever maximized when $z = 0$, it follows that social welfare must also be maximized at $z = y = 0$. Consequently, given varying levels of D, the optimal level of copyright protection will more frequently be no

[27] Again, the existence of a z^0 where $SW(z^0) = SW(z^M)$ is contingent upon the fact that social welfare is maximized when $z = 0$. Note that $0 < z^0 < z^M$.

protection due to the fact that profit can actually be higher with no copyright protection. This implies that the loss due to underutilization is not as frequent as Yoon suggests.

Furthermore, when profit is maximized with no protection, our results with respect to the social loss resulting from underproduction also change. If D is high enough, it may not be covered by artist profit when full protection is enforced, but it may be covered when copying is allowed. Therefore, while some albums would not be produced in a world without copying, those same albums would be produced if copying were allowed. That is, allowing copying may be an inexpensive means of increasing ancillary revenue as well as overall profit, and thus an efficient means of subsidizing the cost of development. Therefore, contrary to Yoon's argument, we find there exist some parameterizations for which the social welfare loss due to underproduction can increase with increased copyright protection.

IV. CONCLUSIONS AND EXTENSIONS

While we find that increasing copyright protection generally will increase the social welfare loss due to underutilization, we also find that it is possible that this loss may decrease with increases in protection. If an artist can produce albums cheaply while pirated copies are also not very close substitutes for monopolist-produced albums (*i.e.* the marginal cost is sufficiently low relative to the substitutability of a copy), then full protection will be the preferred level of protection since it induces copiers to purchase albums from the monopolist, who can produce albums much more efficiently. Even if

the development cost is nonexistent and we are not concerned with whether an artist can recoup expenditures, society may be better off with no copying.

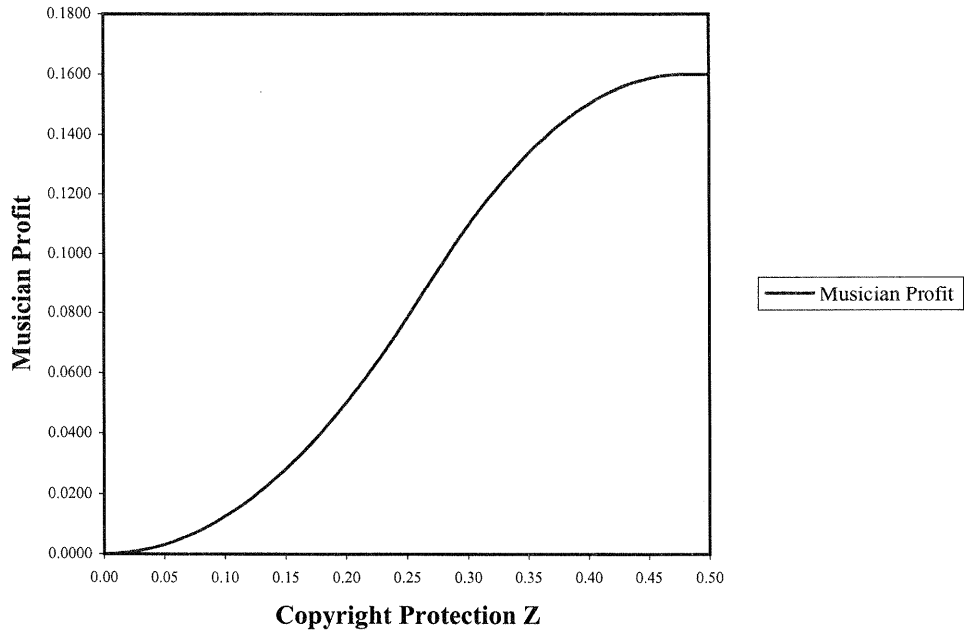
Yet, despite the fact that the loss due to underutilization generally increases with copyright protection, we find that full protection may not always be necessary to cover high development costs. There may be circumstances when artist profit is actually higher when there is no protection as opposed to when there is full protection. This finding becomes a possibility once one accounts for ancillary revenue generated by the consumption of goods related to the music. As copyright protection increases, the artist can expect to earn more from album sales as consumers switch from pirating copies to purchasing albums. However, the artist also can expect to lose some revenue because the total number of people listening to the music will decrease as the cost of reproduction increases since it induces some copiers to choose not to consume the album at all. As fewer people consume the album, fewer people will consume related goods. Artists therefore face a revenue trade-off as copyright protection increases, and if ancillary revenue is a sufficiently significant part of total revenue, they will prefer no protection.

The behavior of profit implies that the social welfare loss due to underproduction may increase with more protection, which is in contrast to Yoon's conclusion that this loss will unequivocally decrease. As an artist's profit declines with increased protection, then as copyright protection increases, it becomes more likely that an artist will be unable to cover a given cost of development. Furthermore, this suggests that an artist's concerns may not always be at odds with the concerns of society. If an artist can maximize profit when his work is completely unprotected, society also will prefer not to protect his music, so that enforcing protection would unambiguously increase both social welfare losses.

However, situations also exist when profit is maximized with full copyright protection, in which case we agree with Yoon's finding that the loss due to underproduction can decrease with more protection. Thus, aside from no protection, the socially optimal level of copyright protection can also be full protection or just enough protection to allow the artist to cover the cost of development, depending on this development cost. In this case, the artist's objectives may be at odds with those of society.

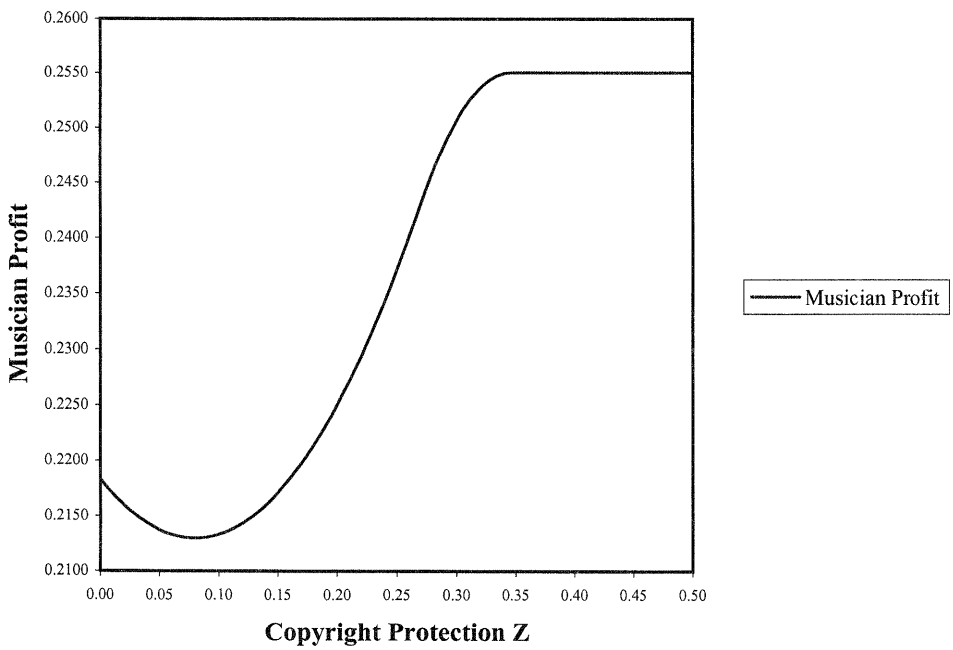
The results of this paper show that the preferred level of copyright for each artist's product will generally not be the same as that for other artists. More specifically, each artist depends on varying flows of income as a result of the sale of his music, and thus the optimal level of protection (from both the artist's and society's perspective) may be different from one artist to the next. Such findings may explain the great divide between musicians, whose opinions on the desirability of peer-to-peer exchange software like Napster vary enormously. As lawyers and the music industry are forced to rethink the rules regarding copyright in the digital age, the variety of income flows among musicians should not be overlooked. To disallow software like Napster from trading musical products that artists are willingly distributing for free may not only be alienating consumers, but it also may be against the best interests of some artists.

FIGURE 3. MUSICIAN PROFIT (NO ANCILLARY REVENUE)



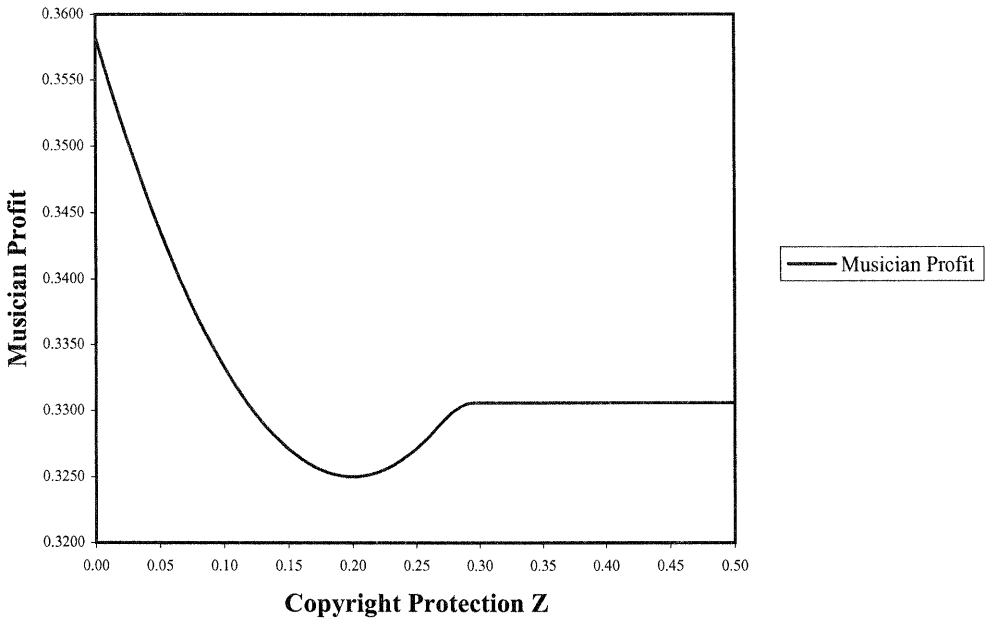
Alpha = .2; c = .2

FIGURE 4. MUSICIAN PROFIT (WITH ANCILLARY REVENUE)



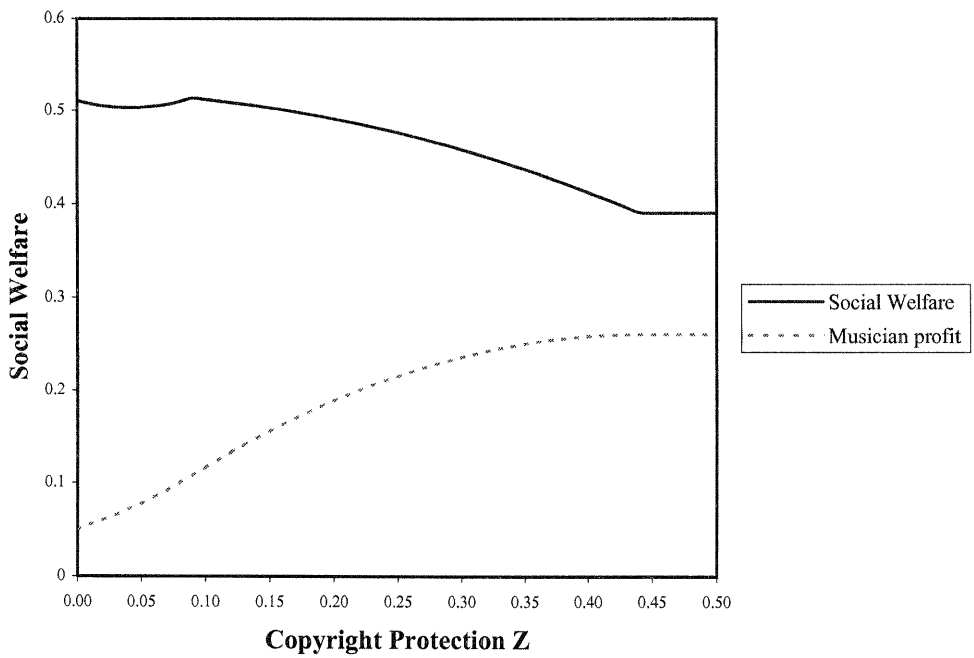
Alpha = .3; c = .2; psi = .7; p2 = .3

FIGURE 5. MUSICIAN PROFIT (WITH ANCILLARY REVENUE)



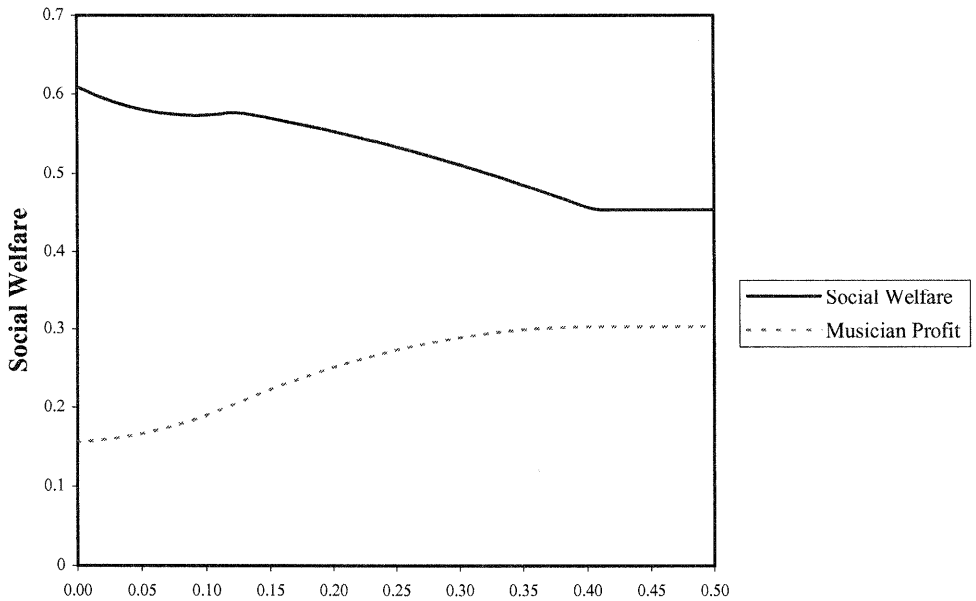
Alpha = .3; c = .2; psi = .7; p2 = .5

FIGURE 6. SOCIAL WELFARE



Alpha = .1, c = .01, psi = .3, p2 = .1

FIGURE 7. SOCIAL WELFARE



Alpha = .1, c= .05, psi = .5, p2 = .3

APPENDIX A: A PROOF OF PROPOSITION 3

To determine the profit-maximizing price p_1* and quantity q* of the album, we set marginal revene MR equal to marginal cost c_1 for each of the three situations suggested by the demand curve.

For case i, setting MR = c_1, we have $c_1 = \alpha + z - 2\alpha q$, which gives us $q^* = (\alpha + z - c_1)/2\alpha$. To find the price p*, we may insert q* into the demand function so that $(\alpha + z - c_1)/2\alpha = 1 - (p_1 - z)/\alpha$. Solving for p_1, we obtain $p_1^* = (\alpha + z + c_1)/2$. To find the appropriate values of z for this equilibrium, we simply insert q* into the constraint on q given by the MR function and solve for z: $(\alpha + z - c_1)/2\alpha \leq 1 - z/(1 - \alpha)$, implying that $z \leq (1 - \alpha)(\alpha - c_1)/(1 + \alpha)$. When z is less than this level, p_1* and q* are as noted above, and when c_1 is subtracted from their product, the following equation for profit is given: $\pi^* = (\alpha + z - c_1)^2/4\alpha$.

For case ii, p_1* is at the margin of the break between the two different demand functions and set equal to $z/(1 - \alpha)$. Then, p_1* can be plugged into either of the two functions for demand to obtain q*, which is $1 - z/(1 - \alpha)$. In this case, z must be between the lower limit as set by case i and the upper limit as set by case iii, which we now find.

The process for establishing p_{1iii}*, q_{iii}*, and thus the values of z for which these apply, is exactly the same as that for case i, except that p_1 is assumed to be less than $z/(1 - \alpha)$. Thus, when MR is set equal to c_1 under this constraint, q* is found to equal $(1 + \psi p_2 - c_1)/2$. Setting this into the appropriate equation for the demand function, $1 - p_1$, we find that $p_1^* = (1 - \psi p_2 + c_1)/2$. As for the values of z when this equilibrium holds, we may simply substitute q* into the constraint as defined by the function for MR, giving us the limit for z in the no-copying case, case iii: $z > (1 - \alpha)(1 - \psi p_2 + c_1)/2$.

APPENDIX B: CONSUMER SURPLUS AND SOCIAL WELFARE IN CASES II AND III

For case ii, consumer surplus is given by

$$\int_{z/(1-\alpha)}^{1} (v_1 - z/(1-\alpha))dv_1 = \frac{1}{2} - \frac{z}{(1-\alpha)} + \frac{z^2}{2(1-\alpha)^2}.$$

As in case i, we simply take the sum of the surplus of those consumers who purchase the album from the artist, subtracting the price they pay (z/(1 - α)) from their valuation of the album. As for social welfare, we only subtract the marginal cost from this valuation, and we also add in the term for ancillary revenue:

$$\int_{z/(1-\alpha)}^{1} (v_1 - c_1)dv_1 + \psi p_2(1 - \frac{z}{(1-\alpha)}) =$$

$$\frac{1}{2} + \frac{c_1}{(1-\alpha)}z - \frac{1}{2(1-\alpha)^2}z^2 + \psi p_2(1 - \frac{z}{(1-\alpha)}).$$

As for case iii, consumer surplus and social welfare are found in exactly the same manner. Consumer surplus is given by

$$\int_{(1-\psi p_2+c_1)/2}^{1} (v_1 - \frac{1-\psi p_2 + c_1}{2})dv_1 = \frac{1}{2} - \frac{1-\psi p_2 + c_1}{2} + \frac{(1-\psi p_2 + c_1)^2}{8}$$

and social welfare by

$$\int_{(1-\psi p_2+c_1)/2}^{1} (v_1 - c_1)dv_1 + \psi p_2(\frac{1+\psi p_2 - c_1}{2})$$

$$= \frac{1}{2} + \frac{(1-\psi p_2 + c_1)}{2}c_1 - \frac{(1-\psi p_2 + c_1)^2}{8} - c_1 + \psi p_2(\frac{1+\psi p_2 - c_1}{2}).$$

BIBLIOGRAPHY

Albini, Steve. 1993. "The Problem with Music." The Baffler, 5: pp. 31-38.

Berger, Eric. 1999. "The Legal Problems of the MP3." Temple Environmental Law and Technology Journal, 18 (Fall): pp. 1-25.

Besen, Stanley M. and Raskind, Leo J. 1991. "An Introduction to the Law and Economics of Intellectual Property." Journal of Economic Perspectives, 5, No. 1 (Winter): pp. 3-27.

Breyer, Stephen. 1970. "The Uneasy Case for Copyright." Harvard Law Review, 84: pp. 281-351.

Cooter, Robert and Thomas Ulen. 2000. Law and Economics, 3d ed. Reading: Addison Wesley Longman, Inc.

Deardorff, Alan V. 1995. "The Appropriate Extent of Intellectual Property Rights in Art." Journal of Cultural Economics, 19, No. 2: pp. 119-130.

Diction, Nick, <nickd@ughh.com>, to Geoff Tam-Scott, <gtamscott@amherst.edu>, 18 April 2001.

Hall, Robert E. 2000. Expert report performed for Napster, Inc. as testimony for *A&M Records v. Napster*. Available at <http://dl.napster.com/Hall_report_final.pdf> (15 April 2000).

Hurt, Robert M. and Robert M. Schuchman. 1966. "The Economic Rationale of Copyright." The American Economic Review, 56, No. 1 (March): pp. 421-432.

Johnson, William R. 1985. "The Economics of Copying." Journal of Political Economy, 93: pp. 158-174.

Landes, William M. and Richard A. Posner. 1989. "An Economic Analysis of Copyright Law." Journal of Legal Studies, 18: pp. 325-363.

Liebowitz, Stanley J. 1985. "Copyright Law, Photocopying, and Price Discrimination." The Journal of Political Economy, 93, No. 5: pp. 945-957.

Liebowitz, Stanley J. 2000. "Napster is No Betamax." Dallas: School of Management, Finance/Managerial Economics, http://wwwpub.utdallas.edu/~liebowit/intprop/napsterbeta.htm (15 April 2001).

MacKie-Mason, Jeffrey K. and Hal Varian. 1994. "Economic FAQs About the Internet." Journal of Economic Perspectives, 8, No. 3 (Summer): pp. 75-96.

Mann, Charles. 2000. "The Heavenly Jukebox." The Atlantic Monthly, 286, No. 3 (September): pp. 39-59.

National Research Council, Committee on Intellectual Property Rights in the Emerging Information Infrastructure. 2000. The Digital Dilemma; Intellectual Property in the Information Age. Washington, D.C.: National Academy Press.

Novos, Ian E. and Michael Waldman. 1984. "The Effects of Increased Copyright Protection: An Analytical Approach." Journal of Political Economy, 92, No. 2: pp. 236-246.

Plant, A. 1934. "The Economic Aspect of Copyright in Books." Economica, May: pp. 167-195.

Posner, Richard. 1988. The Economic Analysis of Law, 5th ed. New York: Aspen Publishers, Inc.

Takeyama, Lisa N. 1994. "The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Demand Network Externalities." Journal of Industrial Economics, 42, No. 2 (June): pp. 155-166.

_____. 1997. "The Intertemporal Consequences of Unauthorized Reproduction of Intellectual Property." Journal of Political Economy, 93: pp. 511-522.

_____. [2000]. "Piracy, Asymmetric Information, and Product Quality Revelation." Department of Economics, Amherst College.

Taylor, Millie and Ruth Towse. 1998. "The Value of Performers' Rights: An Economic Approach." Media, Culture and Society, 20: pp. 631-652.

Toomey, Jenny and Kristin Thomson. 2000. "Virtual Tip Jar or Charity Case?: Asking Artists to Take it Up the ARS." Insound.com, May: <http://www.insound.com/_insoundmachine.cfm?path=%2Fmachine%2Findex%2Ecfm> (15 April 2001).

Towse, Ruth. 1999. "Copyright and Economic Incentives: An Application to Performers' Rights in the Music Industry." Kyklos, 52, No. 3: pp. 369-390.

von Lohmann, Fred, visiting researcher at the Berkeley Center for Law and Technology. Phone interview by author, 30 March 2001, Amherst.

Yoon, Kiho. [2000]. "The Optimal Level of Copyright Protection." Department of Economics, Sogang University, available at <http://www.sogang.ac.kr/~kiho/> (15 April 2001).

Brown, Janelle. "SDMI cracked!" Salon.com, 12 October 2000, http://www.salon.com/tech/log/2000/10/12/sdmi_hacked/.

_____. "Is the SDMI Boycott Backfiring?" Salon.com, 3 October 2000, http://salon.com/tech/feature/2000/10/03/hacksdmi_fallout/index.html.

Curry, Philip A. 1998. "Copyright, Copy Protection and Feist." Ontario: The University of Western Ontario Department of Economics, University of Western Ontario.

Love, Courtney. 2001. "Courtney Love to Fellow Recording Artists." Music Industry News Network, 28 February 2001, http://mi2n.com/press.php3?press_nb=20014.

Mannering, Fred L. 1994. "Assessing the Impacts of Audio Home Copying Restrictions." The Quarterly Journal of Business and Economics, 33, No. 1 (Winter): pp. 30-46.

Merges, Robert P. 1995. "The Economic Impact of Intellectual Property Rights; An Overview and Guide." Journal of Cultural Economics, 19, No. 2: pp. 103-117.

Music News Industry Network. 2001. "NapCameBack.com Boasts Hottest Indie Software Launch Of 2001," 19 March 2001, http://mi2n.com/press.php3?press_nb=20087.

David Segal, "They Sell Songs the Whole World Sings: Mass Merchants Offer Convenience, Less Choice," Washington Post, 21 February 2001, p. A1.

Koboldt, Christian. 1995. "Intellectual Property and Optimal Copyright Protection." Journal of Cultural Economics, 19, No. 2: pp. 131-155.