Review of Economic Research on Copyright Issues, 2006, vol. 3(1), pp. 29-42

DIGITAL FILE SHARING AND ROYALTY CONTRACTS IN THE MUSIC INDUSTRY: A THEORETICAL ANALYSIS

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Abstract. Although several researchers have examined the impact of copying in other contexts, relatively little theoretical work exists that allows for the presence of a profit maximizing music industry as an intermediary between the creators of intellectual property and consumers. This paper develops a simple theoretical model of interactions between artists who create original musical compositions, record labels that distribute them, and consumers who have the option of copying rather than buying music. The model provides testable price and demand equations and suggests that file sharing may have been undertaken by consumers who were previously not in the market for music.

1. Introduction

The impact of new copying technology on the music industry has been hotly debated since the launch of the first file-sharing software, Napster, in 1999. Music industry representatives have charged that indiscriminate copying decreases compact disc (CD) sales, while supporters of free file sharing have alleged the practice is mostly innocuous.[1] Although several researchers have examined the impact of copying in other contexts, relatively little theoretical work exists that allows for the presence of a profit maximizing industry as an intermediary between the creators of intellectual property (artists) and the consumers of their output. The music industry serves in such an intermediary role, and this paper attempts to develop a simple theoretical model that captures the essential interactions of the music industry, artists, and consumers. A richer understanding of these relationships is needed to study the music industry, especially as technological advances redefine the role of the record company.

We imagine a process in three stages. In the last (third) stage, consumers choose between copying, purchasing music, and staying out of the market altogether. Prior to this choice, the music producer (record label) picks the profit maximizing price for a unit of music (a CD). In the first stage of the model, the record label bargains with an artist to obtain permission to reproduce the original creation. Consumers have access to a copying technology (such as Internet copying) that allows them to obtain

This paper is based on Chapters 3-5 of my Ph.D. dissertation (University of New Orleans, Dept. of Economics and Finance). I thank my co-chairs, Arja Turunen-Red and Oscar Varela, as well as Gerald Whitney, Stan Liebowitz, and my committee members for their helpful suggestions and comments. I also thank Tracy Foertsch and two anonymous referees. Any errors are solely my responsibility.

[1]Given the recent US Supreme Court decision in MGM Studios v. Grokster, the legality of file sharing does not appear to be an open question. Nothing in this paper should be construed to suggest that the author endorses or condones illegal file sharing.

music without paying the record label. Depending on their tastes, transaction costs of copying, the market price of music, and the relative quality of legitimate CDs and copies, consumers choose whether to purchase music, copy, or stay out of the market completely.

As the transaction cost of copying falls and the relative quality of copies rises, the model predicts that more consumers will *enter the market through copying*; these are consumers who formerly viewed music as not worth buying. This prediction suggests, given the recent dramatic increase in copy quality and decrease in the transaction costs of copying (provided by various file-sharing services), that some Internet file sharing may have been undertaken by consumers who previously did not buy significant amounts of music. Still, even if it can be shown that file sharing has not yet seriously impacted record sales, this does not constitute evidence against future harm to the music industry. For instance, if originals and copies are near perfect substitutes and copies are widely available at no charge, labels (and artists) may not be able to charge positive prices for music.

A paradox concerning digital Internet technologies is that they simultaneously threaten the ability to charge positive prices for music (an obvious disadvantage to artists) and to end the labels' distribution advantage (a boon to artists). The labels' main source of bargaining power with artists has been their ability to provide large-scale distribution of the artists' product. Digital technologies threaten this source of strength because they provide a relatively inexpensive distribution platform. Consequently, the new Internet technologies may force record labels to significantly alter how they provide intermediary services to artists. These relationships have received relatively little attention in the theoretical literature.

One innovation of this paper is that it provides a simple formalization for the bargaining arrangement between the record label and the creative artist. Peterson and Berger (1975), Belinfante and Johnson (1982), Baker (1991) and Klaes (1997) examine the music industry, but they focus almost exclusively on industry structure issues such as label competition, pricing, and concentration. We employ the Nash bargaining solution (Nash (1950)) and then examine implications of the artist-label bargaining within the current structure of the music industry. Much of the existing literature on the economics of copying bolsters the idea that small-scale sharing can increase the welfare of both consumers and producers provided that the producers can price discriminate (see, e.g., Liebowitz (1981), Liebowitz (1985), Besen (1986), Besen and Kirby (1989) and Bakos, Brynjolfsson, and Lichtman (1999)). The present model does not explore this notion but contributes to the literature by more fully describing consumers' choices and by simultaneously considering the interactions of firms, consumers, and artists.

Belinfante and Davis (1979), Anderson, Hesbacher, Etzkorn and Denisoff (1980), Alpert (1983) and Crain and Tollison (1997) model the demand for music, but they focus largely on specific demand characteristics, such as price, song type (genre), and lyrical content. In contrast to this approach, the present model relies on the idea that consumers have different tastes for music, and focuses more directly on consumers' choice between buying, copying, and staying out of the market. Similar to Johnson (1985), we apply a model of spatial differentiation to illustrate the consumer decision problem and to derive demand functions. The two key differences between Johnson and the present model are that Johnson models firms locating at

a point on a circle and does not consider the relationship of such firms with creative artists. We consider this additional factor and employ the standard linear model.

The remainder of this paper is structured as follows. Section 2 provides a brief overview of the music industry, Section 3 introduces the last two stages of the model (the consumer and firm interactions), Section 3 discusses the artist-label bargaining agreement, and Section 4 summarizes the theoretical results, and Section 5 concludes.

2. Overview of Music Industry

The current structure of the music industry is a combination of the monopoly, oligopoly, and monopolistic competition models; it consists of five major labels (Universal Music Group, Warner Music Group, Sony Music Group, Bertelsmann Music Group, and EMI Music Group) and thousands of independent labels. The majors are best described as conglomerations of smaller labels that typically focus on a particular music genre. Historically, the major labels have had a clear advantage over independents in national/international distribution and promotion on commercial radio. Yet, both majors and independents provide similar intermediary services to artists precisely because distribution and promotion requires real resources and entails the assumption of financial risk.

To mitigate risk, labels typically do not sign artists who do not already have some sort of professional recording, a basic following from live performances, and some minimal level of media exposure. In other words, artists have to convince labels that the product can be worked into a saleable album. Once convinced, both major and independent labels agree to perform (or arrange to have performed) the following tasks: (1) managing, (2) recording, (3) manufacturing, (4) promoting and (5) distributing. One complicating factor with regard to studying the industry is that many of the major labels mitigate their risk by looking to the independents for sources of new talent. When a major signs an artist already under contract with an independent, the two labels work out some sort of sharing arrangement (usually a 50/50 split of revenues), and the major distributes the music.

In virtually all cases, labels who contract with artists take on the risk of financing the intermediary functions until sales are made, and recording contracts are typically on an exclusive basis. Under these conditions, labels usually have a monopoly on a given recording artist's work, and the artist typically receives little money unless the label recovers its costs. All of these economic factors, in addition to statutory copyrights, contribute to the current structure of the music market. Summarizing the industry structure, we know the following: artists rely on labels to promote and distribute their music; labels typically have a monopoly on a particular version of a song; labels compete with other labels (typically within genres); major labels rely on independents for new artists; and the five major labels consist of groups of smaller labels. In the present paper, one goal is to further study the artist-label aspect of the industry.

Internet downloading technologies threaten to change the dependence of artists on record labels, but this aspect of the industry has received little attention in the literature. A key reason that labels have been able to provide intermediary services is that wide-spread distribution of albums requires significant investment. With relatively little investment, however, artists can easily distribute their own music through the Internet. A shift to self-distribution would also allow artists to retain

the copyrights for their own work, a change that many artists have long hoped for. When (or if) digital downloading becomes the preferred method of music distribution, it is likely that record labels will have to focus their intermediary services on marketing and promotion. Such a shift to digital downloading could also result in lower prices and more choices for consumers (i.e., a more competitive industry).

One new choice driven by these technologies, Internet file sharing, has created quite a controversy. From a purely competitive standpoint, the problem with Internet file sharing is that it allows consumers to obtain nearly perfect substitutes for artists' original digital copies free of charge. In the long-run, this problem is the familiar fallacy of composition: when most consumers can copy music for free, the music that they hope to copy in the future will, eventually, cease to exist. On the other hand, Internet file sharing may indirectly benefit artists (especially unknown artists) by increasing their popularity. Digital Internet technologies are likely to change many aspects of the music business in the near future, and studying these changes will require a richer theoretical understanding of the industry.

3. Consumer Demand and Firm Profit Maximization

3.1. **Basic Assumptions for the Consumer.** We assume that consumers are able to satisfy their taste for music through both purchasing compact discs (CDs) and obtaining copies. Consumers buy "music" as CDs, a homogenous product without any reference to a particular genre, and copying falls into one general category of "copying." Currently, consumers can choose between several forms of copying, such as using a CD recorder to copy a friend's CD, or using a file-sharing service to download digital copies of songs from the Internet. Of these types, Internet-based copying is likely to remain the most serious concern for the music industry. The number of consumers who can potentially copy one original is far greater than under older technologies because consumers do not need any sort of relationship with the individual who owns the "first" copy.[2] Because the industry's main method of distribution is (currently) to sell physical CDs in stores, the assumption that copying falls into one general category of "copying" appears non-problematic.

3.2. **Utility Function.** We use a spatial differentiation model to illustrate each consumer's choice and to derive demand functions for music CDs and copying. Consumers are distributed uniformly along a line segment of length one, with each consumer identified by *ability type*, $x \in [0, 1]$. The consumer of ability type $x = 0$ is one who has no ability to grasp the copy technology, while a consumer of type $x = 1$ is one who grasps the technology perfectly.[3] Consumers can buy music (CDs) at price p or they may copy at transaction cost $t(1 - x) > 0$, which reflects the "distance" of the consumer of type x from those who grasp the copy technology

[2]The music industry appears to have used this distinction to their advantage, choosing to bring lawsuits against individuals who make large numbers of songs available to sharing services, and largely ingnoring those who make copies of their friends' CDs (see Smith, 2003).

[3]Even consumers with "perfect" knowledge of the copy technology (perhaps those who repeatedly copy) will still have a small opportunity cost associated with making the copy.

perfectly ($x = 1$).[4] Additionally, a consumer taste parameter, θ, is distributed uniformly between zero and one, and is independent of ability type (x).

The parameters q^{CD} and q^{COPY} (between zero and one) are introduced to denote the *quality* of a legitimate CD and an illicit copy, respectively. In the case of q^{CD}, quality represents any set of characteristics which only the firm can include with the CD (such as original artwork, contests to win concert tickets, etc.), with a value of one being the highest quality and a value of zero being the lowest quality. In the case of q^{COPY}, quality represents the degree of substitutability between the original and the copy. A value of one represents a perfect substitute for a CD (a "high" quality copy) and a value of zero signifies a completely worthless copy. Additionally, the parameter q is used (without superscripts) to denote the difference in quality between the CD and the copy, i.e., $q = (q^{CD} - q^{COPY})$, with $q > 0$.[5]

Given the above assumptions, the consumer's utility function from choosing to buy, copy, or stay out of the market is taken to be of the following form[6]

$$U_x = \begin{cases} \theta q^{CD} - p & \text{if the consumer buys the CD} \\ \theta q^{COPY} - t(1-x) & \text{if the consumer copies} \\ 0 & \text{if the consumer does neither} \end{cases} \tag{1}$$

In the first case, the consumer whose ability type and taste parameter are x and θ pays the price p for any CD purchased. By purchasing the CD, the consumer obtains the surplus utility $\theta q^{CD} - p$, which is affected by the quality of the CD, q^{CD}. If $q^{CD} = 1$, then the consumer's utility is only reduced by the price of the CD. The consumer who copies incurs cost $t(1-x)$, the magnitude of which depends on ability type. The copying consumer's utility is reduced by any lack of copy quality, with $q^{COPY} = 1$ when the copy is a perfect substitute for the CD and $q^{COPY} = 0$ when the two are completely different. If the quality difference between the CD and the copy, q, is close to zero (the CD and the copy are very close substitutes), then the consumer's choice will depend largely on which cost, p or $t(1-x)$, is smaller.

3.3. **Market Demand for Music CDs and Copying.** The utility expressions of the three groups of consumers (those who buy, those who copy, and those who do not consume music at all) are now used to derive the demand for CDs for all pairs of taste parameter, θ, and ability type, x. Figure 1, which is drawn in (x, θ)-space, shows the parameter combination regions that correspond to CD purchasing, copying, and no consumption of music in any form.[7] The upward sloping line BB

[4]The implications of the model remain unchanged if either a fixed component is added to transaction cost or if transaction costs are quadratic (see Michel (2003), pp. 130-133). Of course, if copying costs are negligible, the viability of the music industry will depend largely on the quality differential between the copy and the original. These costs are included because the focus of the present model encompasses consumers who may not be in the market for music (as opposed to those who repeatedly copy and, in all likelihood, incur minor transaction costs).

[5]If $q = 0$, the two goods are perfect substitutes. However, even in the case of two identical digital goods, one offered by the firm and one obtained through copying, we could expect some small, positive difference, perhaps from some nominal feeling of guilt from consuming an illegal copy. Since both q^{CD} and q^{COPY} are between zero and one, and since q is restricted to being positive, $q^{CD} > q^{COPY}$.

[6]The utility function in (1) is a modified version of Tirole (2001), p. 96. Analogous utility functions are discussed in Shy (1995), pp. 150-163.

[7]Figure 1 illustrates the parameter combination regions that correspond to CD purchasing, copying, and no consumption of music in any form. The upward sloping line BB in Figure 1 separates the music buying consumers from the copiers for the complete range of ability types,

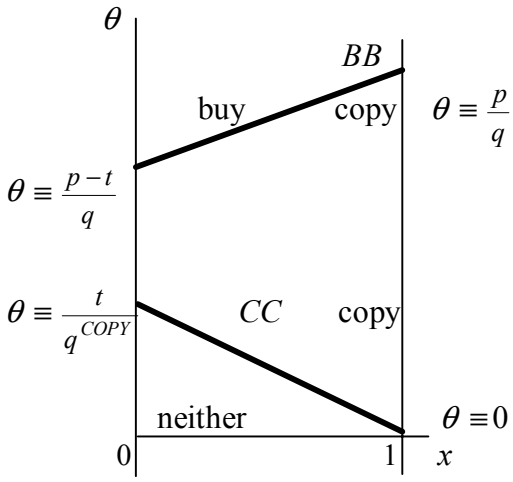

FIGURE 1. Demand for music (copy vs. purchase)

in Figure 1 that separates the music buying consumers from the copiers is obtained by setting the utility of buying and copying equal to each other; this line separates the choices of buying and copying music for the complete range of ability types, x.

When the taste parameter θ is greater than the critical value identified by the line BB, the consumer (of any ability type x) will buy the CD rather than copy. Below BB, consumers will copy, unless their taste for music is so low that they forgo consumption altogether. The downward sloping line CC in Figure 1 corresponds to those (x, θ) combinations for which the utility derived from copying is equal to the utility from not consuming (zero). The line CC divides the consumers, for any ability type x, into those who will copy music (above the line CC) and those who will not consume music (below the line). Both the BB and CC lines shift in response to changes in model parameters.

The BB line, for instance, shifts upward as the price of CDs (p) rises, such that the "buy" region will shrink and the "copy" region will grow. Similarly, the BB line shifts upward as copy transaction costs (t) and the quality difference between the copy and original (q) decrease. The CC line shifts downward as t decreases and copy quality (q^{COPY}) increases, thus contracting the "neither" region. Thus, from Figure 1 we obtain a key hypothesis of the model, i.e., that Internet file sharing, with its lower transaction costs and higher copy quality, could have induced consumers from the "neither" region of Figure 1 to move into the "copy" region. The decision to copy by these consumers does not result in an immediate economic loss to music sellers because these individuals' tastes were such that they previously stayed out

x. The downward sloping line CC in Figure 1 divides the consumers, for any ability type x, into those who will copy music (above the line CC) and those who will not consume music (below the line).

of the market altogether.[8] To fully study the file-sharing controversy, it is necessary to empirically establish the behavior of both the BB and CC lines.

Figure 1 is drawn assuming that $\frac{t}{q^{COPY}}$ is less than $\frac{p-t}{q}$. When $\frac{t}{q^{COPY}} = \frac{p-t}{q}$, the two lines, BB and CC in Figure 1, cut each other on the (vertical) θ axis. In this case, consumers of the highest ability type ($x = 1$) only buy or copy. This case poses stark implications for the music industry, given that digital downloading is predicted to become the main distribution platform. In this scenario, consumers may choose between near perfect substitutes, with only originals offered at a positive price. Since the market demand equation for buying CDs is the same in either of these cases (whether $\frac{t}{q^{COPY}}$ is less than or equal to $\frac{p-t}{q}$), only the case in which $\frac{t}{q^{COPY}} < \frac{p-t}{q}$ is discussed here.[9]

Using Figure 1, we obtain the demand equation for music CDs in two steps. First, we fix the taste parameter θ at a given level ($\theta \geq \frac{p-t}{q}$) and use the BB curve to determine the proportion of consumers who will buy, given the CD price, p, the quality difference, q, the transaction cost, t, and the fixed taste parameter, θ. This proportion of consumers equals

$$\text{Demand for CDs with } \theta \text{ given} = \frac{t - p + \theta q}{t} \tag{2}$$

Next, in order to obtain the *market demand for CDs*, we integrate equation (2) with respect to the taste parameter θ. The lower integration limit for equation (2) is found from the requirement that the demand for CDs is nonnegative (i.e., θ must be at least as large as $\frac{p-t}{q}$). Thus, the market demand function for CDs is as follows:

$$\text{Market Demand for CDs} = \int_{\frac{p-t}{q}}^{1} \frac{t - p + \theta q}{1} d\theta = 1 - \frac{p}{q} + \frac{t}{2q} \equiv y^{CD}(p; q, t) \tag{3}$$

The demand equation for CDs given in (3) responds negatively to a change in the price of a CD, p, positively to a change in the quality difference of the copy and the CD, q, and positively to a change in the transaction cost of copying, t.[10] Equation (3) implies that we would expect the market demand for CDs to have decreased with the introduction of Internet file sharing, a technology that substantially increased copy quality (thus reducing q) and decreased copy transaction costs (t).

3.4. **Basic Assumptions for the Firm.** The firm, the music producing label, is assumed to be a profit maximizing monopolist (reflecting the label's exclusive rights to a particular artist's music), and the product supplied to consumers is viewed as a "music" CD, a homogenous product without any reference to a particular genre. The terms "label" and "firm" are used interchangeably. By assuming the firm sells a homogenous product, we are implying that prices of other types of

[8]This prediction does not have unambiguous implications for the future viability of the music industry if file sharing remains pervasive. For a thorough discussion of opposing views, see Liebowitz (2004).

[9]If $\frac{t}{q^{COPY}} > \frac{p-t}{q}$, the difference in the quality of the CD and the copy is such that some consumers will either buy or stay out of the market altogether. This case seems unrealistic because it requires that the quality of copies must be grossly inferior to the quality of CDs. For a graphical representation, see Michel (2003), p. 52.

[10]Because the equations for copying demand are not integral to this paper they are not presented here, but it is noted that the partial derivatives for the copy demand function are signed opposite the corresponding partials for the CD demand function.

music do not affect the demand for this specific type of music.[11] The label's cost structure consists of fixed costs (recording and promotional costs) and variable costs (managing, manufacturing, and distributing costs), and the label is faced with a given copy technology. Instead of purchasing music as CDs supplied by the firm, a fraction of the market may copy. In this section of the paper, the artist's negotiated share of album sales is taken exogenously. In section 4, the artist-label bargaining agreement will be endogenized.

3.5. **The Firm's Choice of p.** The demand function (3) is now used to derive the firm's profit maximizing price for CDs. The label observes the demand for CDs, y^{CD}, and chooses the price of CDs so as to maximize the profit expression

$$\pi = (1-\mu^s)(py^{CD}(p)) - cy^{CD}(p) - F \geq 0 \tag{4}$$

where p is the price of the CD, c is the variable cost per CD (manufacturing, managing and distribution expenses), and F is the fixed cost (promotional and recording expenses). Due to current industry practice, we refer to μ^s as the *artist's* negotiated share of album sales (taken exogenously in this section), and we assume there will be a positive surplus. The profit expression (4) implies that the artist is paid a fixed percentage of the sales revenue from CDs (i.e., sales royalties), and this is consistent with current industry procedure. However, the label subtracts nearly all of its fixed and variable cost from the artist's gross royalties prior to remitting payment to the artist so that the artist typically receives nothing if there is no profit. This issue will be discussed in greater detail in Section 4.

Substituting equation (3) into (4) and maximizing with respect to price p results in the following solution for the optimal price:

$$p^*(\mu^s; q, t, c) = \frac{1}{2}\left(q + \frac{t}{2} + \frac{c}{1-\mu^s}\right) \tag{5}$$

The comparative statics on the optimal price equation (5) show that p^* responds positively to changes in μ^s, i.e., the profit maximizing label will raise the price of the CD as the artist's negotiated share of sales increases. By (5), the price p^* also responds positively to increases in the transaction costs of copying, t, the quality difference between the CD and the copy, q, and to the firm's marginal cost, c.

Next, substituting the optimal CD price, p^*, and the corresponding consumer demand, $y^{CD}(p^*)$, in the label's profit expression, we obtain the firm's profit as a function of the artist's share of sales:

$$\pi(\mu^s; q, t, c, F) = \frac{k^2}{q(1-\mu^s)} - F \tag{6}$$

where $k = p^*(\mu^s)(1-\mu^s) - c$, $\frac{\partial \pi}{\partial \mu^s} < 0$, $\frac{\partial^2 \pi}{\partial \mu^{s2}} > 0$, and $p^*(\mu^s)$ is defined in (5).[12] Accordingly, profit is a decreasing and convex function of the artist's share of sales. When the fixed cost F is zero, it can be readily shown that $\pi(\mu^s) > 0$ as μ^s approaches zero and $\pi(\mu^s) < 0$ as μ^s approaches one. As the fixed cost increases, profit uniformly declines for all μ^s; we assume that F is sufficiently small for profit to be positive for an interval of values $\mu^s \in [0, \overline{\mu}^s]$, where the upper limit for the artist's share, $\overline{\mu}^s$, solves $\pi(\overline{\mu}^s) = 0$.

[11] According to industry surveys, most consumers of a given style of music do tend to buy from within that particular genre (see the consumer profiles on the Recording Industry Association of America's website, www.riaa.org).

[12] Proofs of these results are available from the author upon request.

4. Endogenous Artist-Label Bargaining

4.1. **Overview of the Bargaining and Applicability of the Nash Bargaining Solution.** Having derived an expression for the optimized profit, we now apply the Nash cooperative bargaining model (see Nash, 1950, and Muthoo, 1999) to analyze the profit-sharing arrangement between the music producing firm and the creative artist. Binmore (1994) argues that when the actual bargaining environment approximates a non-cooperative game (such as the Rubinstein *alternating offers game*), use of the weighted Nash bargaining solution is justified as a "shortcut" to the non-cooperative solution.[13] Since the actual bargaining between record labels and artists can be regarded as an alternating offers game (the label makes an initial offer, the artist through her attorneys makes a counteroffer, and so on), applying the Nash bargaining solution to the artist-label profit-sharing arrangement appears to pass this test.

For both major and independent labels, the actual sharing arrangement between the firm and the artist is similar. In both cases, the sharing of revenues and profits hinges on a gross royalty rate (the fixed percentage of album sales paid to the artist represented by μ^s in equation (5)) and on the manner in which the label recovers its fixed and variable costs. The exact percentage of the artist's album royalty rate is negotiable, but most new artists receive (gross) between 10% and 12% of the retail price of the album, while proven artists can receive as much as 17% to 25%. Alternatively, the record label will double the artist's royalty percentage on the wholesale price of the album (which is roughly half of the retail list price). The net royalty rate the artist receives, however, can be significantly smaller than the negotiated gross rate because most contracts are designed to recover the label's fixed and variable costs (called recoupable expenses) before paying the artist.

Recording expenses, for example, are usually allocated to artists in the form of an advance and then fully recouped from the artist's gross royalties before the artist is paid. By the time a label makes an offer to an artist, the label is reasonably satisfied that the artist's potential is sufficient to sell enough albums to be profitable. Of course, the label is still taking a risk that the artist will sell a sufficient number of albums. As a result, the typical artist-label contract is on an exclusive basis for a given number of albums, with the label holding an option for several additional albums. The artist, however, typically does not have the option to choose against recording these additional albums. While there are exceptions, most artists and labels settle on fairly similar contracts and do not renege. New artists enter contract discussions with relatively little bargaining power, while industry stars can negotiate a relatively more favorable contract.

4.2. **Bargaining Over Variable Profit.** In this section, we consider the general bargaining problem that takes into account the dependence of the surplus $\pi(\mu^s)$ (defined in (6)) on the artist's share of sales. While the label ultimately agrees to pay the artist a fixed share of sales revenue, the label recoups virtually all costs before remitting payment to the artist. Therefore, we formulate the bargaining problem in terms of the profit expression (6), and we use the relationship between

[13]To fully justify using the weighted Nash solution, a bargaining situation's characteristics should be checked against the Nash axioms – the independence of utility calibration, independence of irrelevant alternatives, and Pareto efficiency axioms. For a detailed discussion of the application of the Nash solution to the artist-label arrangement, see Michel (2003), pp. 65 - 72.

the artist's share of sales (μ^s) and the artist's share of profits (μ^π) to illustrate the bargaining solution in terms of the profit share, μ^π. Because μ^s is increasing in μ^π, for any share of profit agreed upon, there is a corresponding μ^s over which the firm can maximize profit.[14]

The set of possible sharing agreements now equals

$$M = \{\mu^\pi : 0 \leq \mu^\pi \leq 1, \pi(\mu^s) \geq 0, \mu^s = \mu^s(\mu^\pi)\}$$

and the utility functions of the label and the artist are $U_L(\mu^\pi) = (1-\mu^\pi)\pi(\mu^s(\mu^\pi))$ and $U_A(\mu^\pi) = (\mu^\pi\pi(\mu^s(\mu^\pi)))^\gamma$, respectively, where the parameter γ represents the artist's risk aversion parameter (as the artist becomes less risk averse, γ approaches one). Accordingly, the firm is considered risk neutral and the artist risk averse. Of these, the payoff of the firm, $U_L(\mu^\pi)$ is decreasing for all μ^π in M, and the artist's utility $U_A(\mu^\pi)$ is increasing for all μ^π.

In the Nash bargaining framework, the artist's disagreement point ($d_A \geq 0$) represents her payoff if she does not sign with the label, and the label's disagreement point ($d_L \geq 0$) represents the label's profit from not signing the artist. It is natural to set $d_L = 0$. We also set $d_A = 0$ in this section.[15] Given these considerations, the Nash bargaining solution is defined as the artist's share of profit, μ^*, that solves the maximization problem

$$\max_{\mu^\pi} \; ((\mu^\pi\pi(\mu^s(\mu^\pi)))^\gamma)^\alpha \left((1-\mu^\pi)\pi(\mu^s(\mu^\pi))\right)^{1-\alpha} \tag{7}$$

Differentiation of the logarithm of the Nash product (7) yields the first order condition

$$\frac{\alpha\gamma}{\mu^\pi} - \frac{1-\alpha}{1-\mu^\pi} + \frac{1-\alpha(1-\gamma)}{\pi(\mu^s)}\frac{\partial\pi(\mu^s)}{\partial\mu^s}\frac{\partial\mu^s}{\partial\mu^\pi} = 0 \tag{8}$$

It can readily be shown that the first two terms on the left-hand side of (8) comprise the first order condition that characterizes the solution to the fixed surplus bargaining problem (i.e., independent of the artist's profit share, μ^π). The last term on the left-hand side of (8) reflects the impact of the artist's share on the available profit. Because the ratio $\frac{\partial\pi(\mu^s)}{\partial\mu^s}/\pi(\mu^s)$ is negative, and $\frac{\partial\mu^s}{\partial\mu^\pi}$ is positive, the model predicts that the artist yields some profit share when the endogeneity of the available surplus is taken into account (demanding a share higher than only increases the price of the CD and, therefore, results in fewer CDs sold).

Substituting in (8) the expressions for the profit and its derivative, we obtain the equation $g(\mu^*) - f(\mu^*) = 0$,

$$g(\mu^\pi) \equiv \frac{\alpha\gamma}{\mu^\pi} - \frac{1-\alpha}{1-\mu^\pi}, \;\; f(\mu^\pi) \equiv \frac{[1-\alpha(1-\gamma)]\,(-p^*(\mu^s))}{k}\frac{\partial\mu^s}{\partial\mu^\pi} \tag{9}$$

where $k = p^*(\mu^s)(1-\mu^s) - c$, and $p^*(\mu^s)$ is defined in (5). Figure 2 illustrates the solution to (9).[16] Of the two functions of μ^* defined in (9), it turns out that $g(\mu^\pi)$

[14]A proof of the effect of μ^π on μ^s is available from the author upon request.

[15]An analysis of the implications of a nonzero disagreement point for the artist ($d_A > 0$) is available upon request from the author.

[16]Figure 2 illustrates the solution to the bargaining problem (7). As presented in (9), the downward sloping $g(\mu)$ curve represents the first two terms of the first order condition (8), and the upward sloping $f(\mu)$ curve represents the third term of the first order condition (8). The solution to the bargaining problem (7) is obtained at the intersection of g and f (denoted by μ^*). As the equation $g(\mu) = 0$ yields the solution to the fixed surplus bargaining problem (denoted by $\widehat{\mu}^*$), Figure 2 graphically demonstrates the reduction in the artist's profit share when the dependence of profit on μ is taken into account.

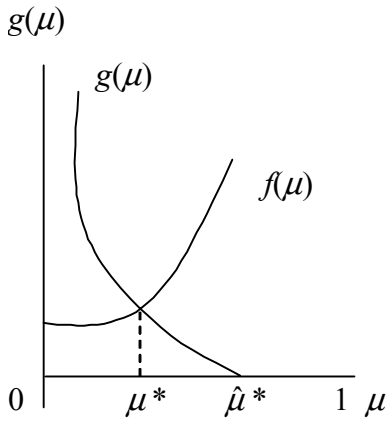

FIGURE 2. Bargaining solutions

is downward sloping and $f(\mu^\pi)$ is upward sloping.[17] The solution to the bargaining problem (7) is obtained at the intersection of g and f.[18] As the equation $g(\mu^\pi) = 0$ yields the solution to the fixed surplus bargaining problem, Figure 2 graphically demonstrates the reduction in the artist's profit share when the dependence of profit on μ^s is taken into account. Examining how the curves $g(\mu^\pi)$ and $f(\mu^\pi)$ respond to changes in parameter values provides insight into effects that determine the solution μ^*.

First, since g is increasing in α while f is decreasing, an increase in the artist's bargaining power (α) shifts both curves g and f to the right, thus increasing the artist's share, μ^*. When the artist becomes less risk averse (α increases), however, curve g shifts right but f shifts left, whereby the total effect on the artist's profit share cannot be signed without more detailed knowledge of the parameter values. This contrasts with the case of bargaining over a fixed surplus, where the artist will definitely demand a larger share of the profit as her risk aversion declines. Function $f(\mu)$ is decreasing in q and t, and increasing in c. Thus, as the difference in CD and copy quality (q) and copy transaction costs (t) decrease, curve f in Figure 2 shifts left thereby decreasing the artist's profit share. An increase in the marginal cost of production, c, as well as an increase in the fixed costs (F) also shift curve f left and thus reduce μ^*.

5. Summary: Effect of Digital Age on Music Industry

The impact of new Internet technologies on creative artists and the record labels that serve as intermediaries between artists and consumers manifests itself in two closely related phenomena: the ability of an increasing number of consumers to obtain close substitutes of marketed music through illicit copying, and the increase in efficiency that such technologies offer in music production and its legitimate

[17]Proofs are available upon request.

[18]In the variable profit case, a closed form solution is only possible when specific assumptions are made regarding the artist's preferences (in particular, her degree of risk aversion). However, in both the fixed and variable profit bargaining scenarios, the qualitative implications for the artist's share, CD prices, and CD demand are the same.

(secure) distribution. The long-term effect of these technologies on the profit of the industry and the payoff to artists remains uncertain. Based on our simple model, however, the following conclusions can be drawn.

First, Internet technology has greatly lowered the transaction costs of illegal music copying and increased the quality of the copies, suggesting music sales will suffer. The introduction of ever-simpler file swapping programs (such as Napster, Morpheus etc.) has allowed even the less technically adept to join in the anonymous exchange of music. As the copies are digital as well, it is harder to see an advantage in buying from legitimate sources, especially if the quality of separate songs on one CD varies greatly. In the above model, the increased substitutability between the CD and its copy and the reduced transaction costs of copying correspond to a decrease in the parameters q and t, respectively.

Figure 2 illustrates the effect of these changes on the artist's negotiated profit share. For artists, the effect of a reduction in either q or t is negative: the profit share the artist is able to collect (μ^π) is smaller. Therefore, for any given level of profit, the artist's income ($\mu^\pi\pi$) is smaller as well. Because $\mu^\pi\pi$ is positively related to a change in q and t, respectively, the label's income ($(1-\mu^\pi)\pi$) must be negatively related to changes in q and t. In other words, for a given level of profit, the artist's income is predicted to absorb the impact of the additional copying that corresponds to the lower q and t.

Next, provided that music can be sold from a secure digital platform (one that minimizes Internet copying), there are efficiency gains from the less costly production and distribution of music. Specifically, one digital music file could serve as a master copy for all consumers, thus drastically lowering both variable (c) and fixed costs (F). As illustrated with Figure 2, the corresponding reduction in c and F improves the artist's profit share (μ^π). Here, too, for any given level of profit, the artist's income ($\mu^\pi\pi$) will be larger and the firm's income ($(1-\mu^\pi)\pi$) will be smaller. For a given level of profit, the model predicts that the income gains from these lower costs will be captured by the artist (entirely plausible given that the label routinely passes these costs on to the artist).

Finally, the digital age increases the artist's bargaining power (α) and disagreement utility (d_A) because self-financing production and distribution becomes a credible option with the new Internet technologies. Correspondingly, the model predicts that an increase in both α and d_A leads to an increase in the artist's share (μ^π), an increase in the artist's income ($\mu^\pi\pi$) and, therefore, a decrease in the label's income ($(1-\mu^\pi)\pi$). While the model only captures these static changes on the artist-label relationship, it contributes to the literature by beginning to study this relationship in an industry context.

6. Conclusions and Ideas for Future Research

Our theoretical model suggests that, given the dramatic increase in copy quality and the reduction in the transaction costs of copying, some of the increased copying of music on the Internet in recent years may have been undertaken by consumers who previously did not participate in the music market. Nonetheless, this prediction should be used carefully when judging the long-term viability of the music industry in an environment where record labels (or artists) compete directly with free file-sharing services. Another key innovation of our theoretical model is

that the interactions of firms, consumers, and third party creators of intellectual property (artists) are considered.

The model predicts that actions by artists such as building a relatively large fan base and selling many albums as independents should result in a higher profit share for artists. While a more direct test of this hypothesis is desirable, artists' ability to build a solid fan-base and sell albums as independents has long been used by major labels as a predictor of artistic success. By improving artists' ability to increase their fan base and sell their own music, the Internet and digital downloading could strengthen artists' bargaining position and thus allow them to rely less on labels for distribution. However, it is not entirely clear that the artists (or the labels) would have a larger absolute payoff if digital downloading were the dominant form of distribution, and the future role of the record label could change because of these new technologies.

Irrespective of the role of the record label, the model provides a key implication for copyright law in such a market. Since the degree of substitutability between originals and copies would be quite high, and since the other factors of demand would equalize for both copies and originals, consumers would be choosing between near perfect substitutes – one with a positive price and one at no cost. In this scenario, it is difficult to see how a viable market for digital downloads could exist with unchecked Internet file sharing because any externalities would have to outweigh the negative impact of competing with free, near perfect substitutes. One way to ensure a viable market for music would be to selectively enforce copyrights, using the law to prevent large-scale sharing on the Internet, a strategy which appears to have been undertaken by major labels.

As for future research, little theoretical work has been done to jointly examine the relationships between the artists, labels, and consumers, and any contributions to this theory will greatly benefit future empirical work. In terms of the present model, possible extensions include: (1) making the artist's bargaining power and the total market demand jointly dependent; (2) modeling the taste and ability parameters (θ and x) as bivariate normal with a positive correlation (such that high valuation consumers also exhibit higher technical ability); (3) directly accounting for uncertainty (with regard to consumer demand for CDs) in the bargaining process; and (4) modeling the artist-label bargaining in an intertemporal framework to account for artists gaining popularity. Alternatively, instead of using the Nash bargaining framework, incentive contract theory could be applied to the artist-label relationship. This relationship could perhaps be modeled in terms of investing in a long-lived asset as well.

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