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by

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Digital Technology and the Allocation of Ownership in the Music Industry¹

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Abstract

We apply the property rights theory of Grossman-Hart-Moore in the music industry and study the optimal allocation of copyright between the artists who create music and the labels who promote and distribute it. Digital technology opens up a role for new intermediaries. We find that entry of online platforms occurs only if they are sufficiently more productive in distribution than the incumbent label. Furthermore, entry leads to a change in bargaining positions and it can become optimal for the copyright to be shifted from the label to the artist.

JEL classification: D23, L22, L23, L82, L86

Keywords: property rights theory, copyright, internet, music industry

1 Introduction

“Artists are at the point where they realize going back to the old model doesn’t make any sense,” says Brian Message, one of the managers of a new record label, Polyphonic, that was launched in July 2009. It will allow artists to own their copyright. (New York Times, 2009)

This recent news epitomizes the consequences of advances in information processing and transmission for the ownership of copyright. Our paper analyzes this impact of digital technology on the music industry and models it based on the property rights theory of the firm of Grossman and Hart (1986) and Hart and Moore (1990), henceforth GHM. Moreover, we build on features of Aghion and Tirole (1994) in analyzing the ownership of innovation rather than physical assets.

We study the innovation process of music goods from an organizational point of view. Artists, A , who create music and record labels, L , who produce, promote and distribute it are identified as the agents. They can invest effort or resources (writing songs and creating a promotion campaign, for instance) to improve the product. The outcome of their combined work (a song or album) is not predictable at the time they form the relationship. Therefore the exact nature of the piece of music is ill-defined *ex ante*. The contract between the artist and the label cannot specify the innovation itself but can only allocate the property rights of the innovation (the copyright).

The traditional music market is characterized by the labels’ control of the retail distribution network and therefore the labels are indispensable, as identified in Regner (2003). According to the property rights theory the indispensable label should hold the copyright, because ownership would not improve the artist’s bargaining position as she does not have access to the distribution market without the label. The results of the property rights model are therefore in line with the incumbent ownership structure in the music industry where labels own the copyright.

However, digital technology opens up alternative distribution and promotion channels. We conjecture a gradual decrease of the label’s power because

of the technological change and its impact on the industry, and therefore a shift in the allocation of property rights towards the artists. Recent trends in the music industry like the forming of an artist interest group¹ and the mentioned launch of the label Polyphonic confirm this.

Also, new technologies enable online platforms to enter as new intermediaries: a third agent (online platform, M) is introduced in the model. We analyze non-drastic technology change where the label is not replaced entirely, but the online platform takes over one task (distribution/promotion) from the label. We ask two questions in relation to the new intermediary. First, does the new intermediary add value so that it is optimal to allow him to enter? Second, does the entry of the new intermediary trigger a change in the ownership structure?

We show that entry of M increases holdup problems when the copyright remains in the label's hands. This is because a third agent is introduced in bargaining: in addition to the artist and the label, also the new intermediary has a stake. Therefore, M is allowed to enter only if he is sufficiently more productive than the incumbent L in distribution/promotion. A significantly more productive new intermediary would make a larger investment than the incumbent L despite greater power problems and via complementarities this would also increase the artist's and the label's investments. However, if the new intermediary is not sufficiently more productive than the label, there is no change: entry of M is not allowed.

Furthermore, we examine whether the entry of online platforms triggers a change in the ownership structure. We find that artist ownership can become optimal after entry of M although artist ownership is dominated in the two-agent setup. In our model A has a central role in the project so that the main interaction is between her and each intermediary and the project value is separable in the two intermediaries' investments. Then the value A and M can produce together does not depend on whether L is in the coalition or not. Since the main interaction is between the artist and each intermediary the $L - A$ relationship changes to a linear network $L - A - M$ when M joins in. The introduction of a new intermediary throws the $L - A$ relationship out of balance and gives A a central role. When the artist owns the copyright, he bargains separately with the two intermediaries and shares the gains from trade 50:50.² While if L owns the copyright, the bargaining over the value

¹The Featured Artists' Coalition campaigns for artists to have more control of their music and a much fairer share of the profits it generates in the digital age. (BBC, 2008)

²We apply Shapley value to solve the three player bargaining and find that with sepa-

A and M produce together is between three parties: A and M who interact with each other and L who owns the copyright. Therefore, A 's and M 's holdup problems are reduced under A ownership while naturally L 's holdup problem is increased when he loses the copyright. When A 's creative investment and M 's distribution/promotion investment are important relative to L 's production investment, entry of the online platform triggers a shift of copyright from the label to the artist. While if L 's production investment is very important, he keeps the copyright even after entry. Therefore, we distinguish between the *production of music* under label ownership where the label inputs matter most and the *creation of music* under artist ownership where the artistic input is essential.

Our main result is robust to an alternative production function where there are complementarities also between the two intermediaries' investments. In that case A ownership can arise after entry because L is no longer indispensable when A has alternative access to the distribution market via M . Therefore, ownership improves A 's incentives and A ownership becomes optimal when the artistic input is essential.

The above discussion refers to a joint surplus maximizing ownership structure. Artists may, however, be cash-constrained and unable to compensate the label for the loss of copyright. The new intermediary is not necessarily cash-constrained but it may not be willing to compensate the label for both its entry and the loss of copyright to the artist. In that case the label inefficiently keeps the copyright due to artist's cash constraints.

With reputation concerns (Baker et al. (2002) and Halonen (2002)) or applying a different bargaining model (Chiu (1998) and De Meza and Lockwood (1998)) the results of GHM can change. As the current allocation of ownership in the music industry is consistent with GHM we have chosen to work with the standard GHM-type model.

We have shown that there is a cost to M 's entry because he obtains holdup power over A and L . This effect is familiar from Rajan and Zingales (1998). Their result is to allow access to only one intermediary (or manager in their paper) when the investments are complementary. In our paper it can be optimal to let the second intermediary to join because we allow for heterogeneous agents. M may be more productive in the task he is taking over from L and therefore the benefit of a more productive agent can outweigh

able investments the bargaining outcome is as if A bargains separately with each intermediary.

the cost of his holdup power. We also importantly differ from Rajan and Zingales (1998) by analyzing whether the asset should change hands when the new agent is introduced. They take the owner of the asset as given.

The existing literature on copyright as summarized by Watt (2000) and Varian (2005) focuses on the strength of copyright protection and treats the owner of copyright as given. One recent example is Legros (2006) who studies the relationship between arts and the Internet. We complement this standard approach of the literature as we distinguish between artist and label ownership. This is similar in style to the analyses of creative industries in Caves (2000) and (2003), yet brings about quite different results as we analyze which ownership structure is more efficient after the impact of digital technology on the music industry. Also Connolly and Krueger (2006) analyze the economics of popular music but with an emphasis on concerts rather than recording and therefore copyright is not an issue.

This paper is also related to the literature examining the incentives of a platform owner to encourage entry of complementors (e.g. Farrell and Katz (2000) and Becchetti and Paganetto (2001)). The platform owner is found to allow entry of complementors when they have capabilities that the platform owner lacks. We are examining whether a new platform is allowed to enter and find that its capabilities are crucial to this decision.

The structure of the paper is as follows. We give some background and motivation in Section 2. Section 3 introduces our benchmark model of the music industry before the digital age. Entry of online platforms is analyzed in Section 4, while Section 5 examines whether entry will lead to change in ownership structure. Section 6 relates our results to the music industry. Section 7 examines extensions of the model and Section 8 concludes.

2 Digital technology in the music industry

2.1 Ownership in the music industry

The property rights theory of the firm is a very useful framework to understand the ownership structure between artists and labels in the market for pre-recorded music. It has also been adopted by Caves (2000) and (2003) who apply contract theory and property rights theory to creative industries finding that property rights are transferred from creators to 'humdrum' entrepreneurs as they invest in production and marketing activities. Also the

detailed case study of the music industry by Regner (2003) takes the property rights approach and analyzes the two most essential business areas of the industry (distribution and marketing).

We follow this path and study the recent changes in information technology culminating in peer-to-peer file sharing software like Napster in order to clarify their impact on the industry structure and the optimal allocation of copyright.

We assume the artist to be of a singer/songwriter type. He composes the songs and also plays and performs them. Thus, he provides all the artistic input.³ We also assume that owning copyright and having the right of first use coincide: The same agent – label or artist – owns both.⁴ Ownership of the copyright is the only instrument analyzed in this paper. We do not analyze royalties – contracts that reward artist according to the number of CDs sold. This is because the "labels keep the books" (Caves, 2000) and thus there are many ways they can conceal the true number of CDs sold. Krasilovsky and Shemel (2000, p. 21-22) report that the exact sales are diluted by promotional give aways and record clubs. Moreover, recording costs are recouped by the labels against the artist's royalties. This means that artists do not actually start getting paid according to the royalty unless their album is fairly successful. In fact, only the top 10% of artists make money selling records (Connolly and Krueger, 2006, p. 673). Contracts are for one album, but labels usually insist on subsequent options that may extend the length of the contract to up to six albums.

In the traditional music market (pre-Napster) the retail distribution network is dominated by labels without viable alternative. Also their marketing is generally more efficient. In the post-Napster scenario alternative ways of online distribution remove entry barriers from the distribution market. The artists are also able to promote their products more efficiently themselves with digital updates to their existing fan base or through the information externalities of file sharing networks, see Duchene and Waelbroeck (2005).

³In the conclusions we elaborate on the results if this assumption is lifted.

⁴It is also important to mention the "work for hire" aspect of copyright law which is very relevant to the music industry: Copyright will not be owned by the artist, if - by and large - the innovation has been commissioned by a company. Examples include a journalist whose articles are owned by the newspaper that employs him, whereas the contribution of a freelance writer remains his property. Although the contract situation seems less clear in the music market, songs are generally declared "works for hire" and copyrights are owned by the labels. See Krasilovsky and Shemel (2000).

2.2 Different artist types

Following Regner (2003) we can distinguish between two artist types: established artists and newcomers. The former are famous and successful. They have established a reputation and a substantial fan base exists. They can address this fan base directly with updates about new albums. Established artists may be well-off financially, so that they are able to compensate labels in order to realize an ownership change.⁵

Newcomers or less known artists benefit from the information externalities created by peer-to-peer file sharing networks (e.g. Napster, KaZaA, etc.) and web-based social networks (facebook, MySpace, etc.). However, they still have to compete for attention in a seemingly abundant field of new artists who are all able to utilize these information transmission channels. Intermediaries might offer new valuable services for newcomer artists targeting their "need for attention" in the networked world. Moreover, the new artists cannot simply buy out labels to get ownership even if this would provide better overall investment incentives, because they do not have the financial means.

2.3 New intermediaries enter

Our model is inspired by this demand for new intermediaries in digital content who address the need for attention and are able to distribute music efficiently. They may also provide newcomer artists with financial resources.

These new intermediaries can be seen as an online platform that promotes and distributes the music of artists. It may be an online business that sells downloadable music like Apple's iTunes or web-based social networks (see examples in the previous subsection). Their online promotion and distribution partly replaces former label tasks, while it does not eliminate the role of a label entirely.

We will strictly focus on the online platform's role as an information intermediary for promotion and distribution, leaving the financing part for later analysis.

⁵The artist "Prince" can be seen as an early precursor. He became exceptionally popular in the early 90s, but feuded with his record company in the middle of a long-term contract. He reluctantly fulfilled the deal and produced subsequent albums with a label he founded himself. However, his motives might not be purely based on a monetary gain, but simply because of antipathy towards music labels.

3 Benchmark model: music industry before the digital age

Our benchmark is a simplified version of Hart and Moore (1990) applied to the music industry. Like Aghion and Tirole (1994) we focus on the ownership of innovation rather than physical assets. There are two agents in our benchmark model: the artist, A , and the label, L . A composes and performs a piece of music, the innovation. L is needed to produce, promote and distribute the piece of music – the CD – to the final consumers. Our focus is on the question who should own the innovation, i.e. whether the artist or the label should have the copyright.

At the time A and L form the relationship the nature of the innovation is ill-defined: the song is yet to be composed. Therefore they cannot contract for the delivery of a specific innovation. Only an already composed song can be described fully. The agents can, however, contract on the ownership of the innovation, the copyright. If L has the ownership, the copyright of any song composed by A during the relationship belongs to L . While if A holds the property rights, he himself owns the copyright of his song.

Our focus is on the allocation of the copyright. We do not analyze royalties – contracts that reward A according to the number of CDs sold. Royalties have the problem that the label keeps the books that determine the artist's royalties (Caves (2000)). There are many examples of malfeasance, including Capitol/EMI whose misaccounting led to \$19 million of unpaid royalties to the Beatles (Connolly and Krueger (2006), p. 675.). In this paper we take the extreme view consistent with the property rights theory that ownership of copyright is the only instrument that can affect the incentives to invest.

Both agents can improve the value of the innovation by investment. The artist engages in the creative process of composing songs, practising and recording them. A 's investment is denoted by i_A . The label spends resources on the production of the music and invests in preliminary promotion and the distribution network. L 's investments in the two tasks (production and promotion/distribution) are denoted by i_L^1 and i_L^2 . The investments are specific to this very relationship. The artist's effort of creating a song is completely linked to the actual copyright of the work, which means that his investment is entirely relationship-specific. The label needs to plan a promotion campaign before the release of the CD. Moreover, it also has to allocate recording and video production resources for the artist. These investments are also

relationship-specific.

The minimum level of investment is normalized to be 0. This level already contains basic effort out of artistic curiosity, willingness to express and fun. The investments are observable to A and L , but they are not verifiable to others. The value of production, the revenue from the CD, depends on both agent's investments and is assumed to be additively separable, $f(i_A, i_L^1) + g(i_A, i_L^2)$, so that the main complementarities are between the artist's creative input and the label's tasks. The cost of investment is assumed to be linear.

Assumption 1. $f(i_A, i_L^1)$ is twice differentiable. $\frac{\partial f}{\partial i_j} > 0$, $\frac{\partial^2 f}{\partial i_j^2} < 0$ and $\frac{\partial^2 f}{\partial i_A \partial i_L^1} > 0$ for $i_j \in (0, \bar{i})$ with $\lim_{i_j \rightarrow 0} \frac{\partial f}{\partial i_j} = \infty$ and $\lim_{i_j \rightarrow \bar{i}} \frac{\partial f}{\partial i_j} = 0$. $g(i_A, i_L^2)$ has similar properties.

The timing of the model is the following. At date 0 the agents contract on the ownership of the innovation; either A or L has the ownership of the copyright. Then the agents choose their relationship-specific investments. At date 1 the final version of the album is recorded and sold and the revenues are shared according to Nash bargaining. Also the promotion campaign, concert tours and other promotional acts with the artist take place.

If under L ownership the relationship were to break down at date 1 – after the innovation is realized – L could produce and sell the CD without A 's contribution. That is, another artist would perform the song in the final recording and give concerts to promote the product. The value of the innovation without A 's contribution is given by $f(0, i_L^1) + g(0, i_L^2)$. Accordingly, we assume that none of A 's investment is sunk in the project. This is clearly an unrealistic assumption – the value of the song performed by another artist does depend on how well the song was composed – but it is not critical. We discuss relaxing this assumption in Section 7. A does not have any rights to the song he has composed and therefore he earns zero utility if the relationship breaks down.

If the agents split under A ownership, A can sell the song to the customers, but now without L promoting and distributing the product. The value of innovation is then $f(i_A, 0) + g(i_A, 0)$. We assume that L is indispensable: marginal value of A 's investment is zero without L since L controls the retail distribution network (before the digital age).

Assumption 2. $f_A(i_A, 0) = g_A(i_A, 0) = 0$.

Under A ownership L 's relationship-specific investments have no value and we assume that L 's outside option is equal to zero.

3.1 Results of the benchmark

Equations (1) – (3) give the first best investments i_A^* , i_L^{1*} and i_L^{2*} :

$$f_A(i_A^*, i_L^{1*}) + g_A(i_A^*, i_L^{2*}) = 1 \quad (1)$$

$$f_L(i_A^*, i_L^{1*}) = 1 \quad (2)$$

$$g_L(i_A^*, i_L^{2*}) = 1 \quad (3)$$

Since date 0 contracts can be written only on ownership, the bargaining takes place after the investments are sunk. Part of the surplus the agent generates is expropriated in the bargaining process, while he pays the full cost of this investment. This leads to the hold up problem. Our aim is to allocate the ownership of the copyright so that the holdups are minimized.

When *the label owns the copyright* the payoffs are according to Nash bargaining:

$$\Pi_A = \frac{1}{2} [f(i_A, i_L^1) + g(i_A, i_L^2)] - \frac{1}{2} [f(0, i_L^1) + g(0, i_L^2)] - i_A$$

$$\Pi_L = \frac{1}{2} [f(i_A, i_L^1) + g(i_A, i_L^2)] + \frac{1}{2} [f(0, i_L^1) + g(0, i_L^2)] - i_L^1 - i_L^2$$

Remember that artist on her own produces zero value since she does not hold the copyright.

Differentiating these payoffs yields the following incentives to invest:

$$\frac{1}{2} f_A(i_A, i_L^1) + \frac{1}{2} g_A(i_A, i_L^2) - 1 = 0 \quad (4)$$

$$\frac{1}{2} f_L(i_A, i_L^1) + \frac{1}{2} f_L(0, i_L^1) - 1 = 0 \quad (5)$$

$$\frac{1}{2}g_L(i_A, i_L^2) + \frac{1}{2}g_L(0, i_L^2) - 1 = 0 \quad (6)$$

Under *artist ownership* the payoffs are:

$$\Pi_A = \frac{1}{2} [f(i_A, i_L^1) + g(i_A, i_L^2)] + \frac{1}{2} [f(i_A, 0) + g(i_A, 0)] - i_A$$

$$\Pi_L = \frac{1}{2} [f(i_A, i_L^1) + g(i_A, i_L^2)] - \frac{1}{2} [f(i_A, 0) + g(i_A, 0)] - i_L^1 - i_L^2$$

Taking into account Assumption 2 the incentives are given by:

$$\frac{1}{2}f_A(i_A, i_L^1) + \frac{1}{2}g_A(i_A, i_L^2) - 1 = 0 \quad (7)$$

$$\frac{1}{2}f_L(i_A, i_L^1) - 1 = 0 \quad (8)$$

$$\frac{1}{2}g_L(i_A, i_L^2) - 1 = 0 \quad (9)$$

Optimal ownership structure maximizes investment incentives. Comparing equations (5) and (6) to (8) and (9) shows that L 's incentives are higher when he holds the copyright because of his improved bargaining position. While (4) and (7) show that A 's incentives do not depend on the ownership structure. The label is indispensable ($f_A(i_A, 0) = g_A(i_A, 0) = 0$) because only he can distribute the music to the customers. Therefore, there is no benefit of giving the ownership to A , only a cost in terms of lower incentives to L . Accordingly, it is optimal for the label to hold the copyright. The result of our benchmark is consistent with the current copyright regime and is an application of Hart and Moore (1990): an indispensable agent should own the asset.

4 Entry of online platforms

The new technologies of digitalization and the Internet remove entry barriers from the distribution market and open up a role for new intermediaries, the online platforms. In this section we examine how the incentives to introduce

the new intermediary depend on the ownership structure. In Section 5 we will examine the implications of the new intermediary on the optimal ownership of the copyright.

We now have three agents: the artist, A , and the intermediaries (the label, L , and the online platform, M). We analyze a situation where the technology change is non-drastic and gradual. It opens up new possibilities for distribution but does not replace the incumbent label altogether. We model this technological change as M taking over task 2 from L . We assume that M 's investment may be more productive than an equivalent investment by L . We capture this effect by introducing a parameter ω in the production function: $g(i_A, i_M; \omega)$. When $\omega = 1$, M is equally productive in distribution as incumbent L . We assume $\omega \geq 1$.⁶ L remains in the market and continues to work on task 1, production. We drop superscript 1 from L 's investment in production and denote it by i_L .

We continue to assume that the artist is unproductive on her own ($f_A(i_A, 0) = g_A(i_A, 0) = 0$). However, the artist in coalition with one of the intermediaries is productive: $f_A(i_A, i_L) > 0$ and $g_A(i_A, i_M; \omega) > 0$. It is the access to the distribution market that is crucial. A coalition of A and L can gain access by L reverting back to distribution, while a coalition of A and M can distribute via the Internet.

In order to solve the three player bargaining between A , L and M we adopt the Shapley value in line with Hart and Moore (1990) and Rajan and Zingales (1998).⁷ The Shapley value for agent j is:

$$\frac{1}{3}(v(i_j, i_k, i_l) - v(i_k, i_l)) + \frac{1}{6}(v(i_j, i_k) - v(i_k)) + \frac{1}{6}(v(i_j, i_l) - v(i_l)) + \frac{1}{3}v(i_j) \\ j, k, l = A, L, M, j \neq k \neq l$$

Here the agents included in the coalition are denoted by their investments in the value function. E.g. $v(i_A, i_M)$ denotes the value A and M can produce together without L 's contribution. Naturally, we assume that a coalition generates revenue only if one of their agents owns the copyright. Therefore $v(i_L, i_M) = v(i_L) = v(i_M) = 0$ when A has the copyright.

⁶We do not analyze the case of $\omega < 1$ as it cannot be value increasing to include a less productive agent in the team. Our interest is in if it ever can be value decreasing to include a more productive agent.

⁷The Shapley value with two agents is equivalent to the Nash bargaining solution we have used in Section 3.

4.1 Artist ownership

We will first analyze the incentives to introduce the new intermediary under A ownership. Applying Shapley value and taking into account that a coalition without the artist, the copyright holder, produces zero value, results in the following payoffs:

$$\begin{aligned}\Pi_A &= \frac{1}{3} [f(i_A, i_L) + g(i_A, i_M; \omega)] + \frac{1}{6} [f(i_A, i_L) + g(i_A, 0; \omega)] \\ &\quad + \frac{1}{6} [f(i_A, 0) + g(i_A, i_M; \omega)] + \frac{1}{3} [f(i_A, 0) + g(i_A, 0; \omega)] - i_A \\ &= \frac{1}{2} [f(i_A, i_L) + g(i_A, i_M; \omega) + f(i_A, 0) + g(i_A, 0; \omega)] - i_A\end{aligned}$$

$$\begin{aligned}\Pi_L &= \frac{1}{3} [f(i_A, i_L) + g(i_A, i_M; \omega) - f(i_A, 0) - g(i_A, i_M; \omega)] \\ &\quad + \frac{1}{6} [f(i_A, i_L) + g(i_A, 0; \omega) - f(i_A, 0) - g(i_A, 0; \omega)] - i_L \\ &= \frac{1}{2} [f(i_A, i_L) - f(i_A, 0)] - i_L\end{aligned}$$

$$\begin{aligned}\Pi_M &= \frac{1}{3} [f(i_A, i_L) + g(i_A, i_M; \omega) - f(i_A, i_L) - g(i_A, 0; \omega)] \\ &\quad + \frac{1}{6} [f(i_A, 0) + g(i_A, i_M; \omega) - f(i_A, 0) - g(i_A, 0; \omega)] - i_M \\ &= \frac{1}{2} [g(i_A, i_M; \omega) - g(i_A, 0; \omega)] - i_M\end{aligned}$$

The investment incentives are then:

$$\frac{1}{2}f_A(i_A, i_L) + \frac{1}{2}g_A(i_A, i_M; \omega) - 1 = 0 \quad (10)$$

$$\frac{1}{2}f_L(i_A, i_L) - 1 = 0 \quad (11)$$

$$\frac{1}{2}g_M(i_A, i_M; \omega) - 1 = 0 \quad (12)$$

Comparison of (10) - (12) to (7) - (9) shows clearly that if L and M are equally productive ($\omega = 1$), M taking over one task from L has no effect on the value of production under A ownership. The value function is separable in L 's and M 's investments and therefore the bargaining outcome is as if A negotiates independently with each intermediary. When L and M are identical in task 2, the bargaining outcome is the same as in the two agent case.⁸ Therefore, the incentives are the same too and the value of production remains unchanged when M joins in.

If M is more productive in task 2 than L , then including M in the coalition unambiguously increases the value of production. More productive M will make higher investment in task 2 than L would and via complementarities this increases also A 's and L 's investments. It is never value decreasing to introduce the new agent under A ownership because the bargaining outcome is not affected. This result is summarized in Proposition 1.

Proposition 1 *If A holds the copyright, it is optimal to introduce the new intermediary.*

Proof. Straightforward by comparing (10) - (12) to (7) - (9). Q.E.D.

4.2 Label ownership

Under label ownership the incentives to introduce M are different because bargaining outcome is affected by the third agent joining in. Shapley value gives the following payoffs (where we have taken into account that a coalition without copyright holder L produces zero value):

$$\begin{aligned}\Pi_A &= \frac{1}{3} [f(i_A, i_L) + g(i_A, i_M; \omega) - f(0, i_L) - g(0, i_M; \omega)] \\ &\quad + \frac{1}{6} [f(i_A, i_L) + g(i_A, 0; \omega) - f(0, i_L)] - i_A \\ &= \frac{1}{2} [f(i_A, i_L) - f(0, i_L)] + \frac{1}{3} [g(i_A, i_M; \omega) - g(0, i_M; \omega)] + \frac{1}{6} g(i_A, 0; \omega) - i_A\end{aligned}$$

⁸Apart from the fact that M rather than L is getting half of the surplus from task 2.

$$\begin{aligned}
\Pi_L &= \frac{1}{3} [f(i_A, i_L) + g(i_A, i_M; \omega)] + \frac{1}{6} [f(i_A, i_L) + g(i_A, 0; \omega)] + \\
&\quad \frac{1}{6} [f(0, i_L) + g(0, i_M; \omega)] + \frac{1}{3} f(0, i_L) - i_L \\
&= \frac{1}{2} [f(i_A, i_L) + f(0, i_L)] + \frac{1}{3} g(i_A, i_M; \omega) + \frac{1}{6} [g(0, i_M; \omega) + g(i_A, 0; \omega)] - i_L
\end{aligned}$$

$$\begin{aligned}
\Pi_M &= \frac{1}{3} [f(i_A, i_L) + g(i_A, i_M; \omega) - f(i_A, i_L) - g(i_A, 0; \omega)] \\
&\quad + \frac{1}{6} [f(0, i_L) + g(0, i_M; \omega) - f(0, i_L)] - i_M \\
&= \frac{1}{3} [g(i_A, i_M; \omega) - g(i_A, 0; \omega)] + \frac{1}{6} g(0, i_M; \omega) - i_M
\end{aligned}$$

Investments are given by:

$$\frac{1}{2} f_A(i_A, i_L) + \frac{1}{3} g_A(i_A, i_M; \omega) = 1 \quad (13)$$

$$\frac{1}{2} f_L(i_A, i_L) + \frac{1}{2} f_L(0, i_L) - 1 = 0 \quad (14)$$

$$\frac{1}{3} g_M(i_A, i_M; \omega) + \frac{1}{6} g_M(0, i_M; \omega) - 1 = 0 \quad (15)$$

Under label ownership 3-agent bargaining has an impact on the incentives. The agents bargain independently over the two parts of the production function, $f(i_A, i_L)$ and $g(i_A, i_M; \omega)$. The value of $f(i_A, i_L)$ is shared between A and L , which explains why f -terms are multiplied by $\frac{1}{2}$. The bargaining over $g(i_A, i_M; \omega)$ is between all three agents. A and M interact in production and L as the owner of the copyright has a stake, too. This is why g -terms are multiplied by $\frac{1}{3}$ and $\frac{1}{6}$.

We can then compare equations (13) - (15) to incentives under L ownership with 2 agents (equations (4) - (6)). If $\omega = 1$, M will only introduce power problems. A has reduced incentives because now she has to share the value of her investment with both M and L . M makes lower investment in distribution than L does in the 2-agent setup because the bargaining is between 3 agents. Furthermore, L 's investment is lower due to complementarities with A .

Therefore, it is value increasing to introduce the new intermediary under label ownership only if he is sufficiently more productive in distribution than

the incumbent L . Then – despite greater power problems – M would make a larger investment and via complementarities this would also increase A 's and L 's investments.

Proposition 2 *If L holds the copyright, it is value increasing to introduce the new intermediary if and only if $\omega > \hat{\omega}$ where $\hat{\omega} > 1$.*

Proof. If $\omega = 1$, comparison of (13) - (15) to (4) - (6) shows that the investments are strictly lower in the 3-agent setup. $\partial i_j / \partial \omega > 0$ for $i = A, L, M$ in the 3-agent case while investments in the 2-agent case do not depend on ω . Therefore, there exists an $\hat{\omega} > 1$ for which $S^L(2) = S^L(3; \hat{\omega})$ where $S^L(2)$ denotes joint surplus under L ownership and 2 agents while $S^L(3; \hat{\omega})$ denotes joint surplus under L ownership and 3 agents. Q.E.D.

This leads to the question if label ownership is still optimal after the entry of an online platform. Can the joint surplus be further increased by allocating the ownership differently? That is the focus of Section 5.

5 Optimal allocation of copyright after entry

In this section we analyze whether the introduction of the new intermediary triggers a change in the ownership structure. In the 2-agent benchmark of Section 3 artist ownership is dominated by label ownership since the label controls the retail distribution network. Can the introduction of the new intermediary change power relationships so that artist ownership can become optimal?

Comparison of equations (10) and (13) reveals that A has higher incentives under A ownership. Why does ownership improve A 's incentives in the 3-agent case although it did not have any effect in the 2-agent case? A has now alternative access to the distribution network via the online platform. However, since the value of production is separable in the two intermediaries' investments, this alternative access is not a source of bargaining power. A in effect bargains separately with the two intermediaries. Therefore ownership does not improve A 's incentives via an improved outside option. Instead A 's incentives are improved because she has a central position in the production process and giving her also the ownership limits the number of parties in

bargaining. When A is both the owner and the interaction partner, the bargaining over both parts of production is between just two agents. This is why the first-order condition under A ownership (equation (10)) only has $\frac{1}{2}$ as the multiplier. While if one of the intermediaries, L in this case, owns the copyright, one part of the bargaining is between three agents: the two agents that interact, A and M , and the owner of the copyright, L . This is why there is a multiplier $\frac{1}{3}$ in A 's incentives under L ownership in (13). Also M has improved incentives when A holds the copyright for the same reason: then L does not have a stake in M 's investment (compare equations (12) and (15)).

But the cost of A ownership is that L 's incentives are lower because L 's outside option is improved if he holds the copyright. Therefore, A ownership is optimal if A 's and M 's investments are important relative to L 's investment. Then the entry of M is coupled with a shift of copyright from L to A . This result is summarized in Proposition 3.

Proposition 3 *Entry of M triggers a shift of copyright from L to A*

- (i) *if A 's creative investment and M 's distribution investment are important relative to L 's production investment or*
- (ii) *if A is indispensable enough.*

Proof. In the Appendix.

Since the main interaction is between the artist and each intermediary, the $L - A$ relationship changes to a linear network $L - A - M$ when M joins in. The entry of the new intermediary throws the $L - A$ relationship out of balance and gives A a central role. Because of A 's central role, A ownership minimizes the number of bargaining parties and reduces holdup problems for A and M . If A 's creative investment and M 's distribution investment are important relative to L 's production investment, A ownership becomes optimal after the entry of M – although A ownership is dominated in the 2-agent setup. However, L ownership continues to be optimal in the 3-agent case if L 's production investment is relatively important.

Proposition 3 also shows that the more indispensable the artist is, the more likely it is that she becomes the copyright holder. When L holds the copyright, he could get another artist to perform A 's song. The value of L 's outside option depends on how indispensable A is. The more indispensable A is, the lower is L 's marginal productivity without A and consequently the

lower are L 's (and M 's) investments under L ownership. While the incentives under A ownership are not affected by A 's indispensability because the other agents can be productive only in coalition with the copyright holder A . In the limit when A is fully indispensable, L is unproductive on his own and there is no cost of shifting copyright to A , only the benefit of improved incentives for A and M . Therefore, A ownership is optimal when A is indispensable enough.⁹

In Section 4 we analyzed entry of M for a given ownership structure. Since entry can trigger a change in ownership structure we also have to examine when entry is allowed given it will lead to copyright being shifted to A . Therefore we need to compare A ownership with 3 agents to L ownership with 2 agents. This is done in Proposition 4.

Proposition 4 *When entry of M would trigger a shift of copyright from L to A , M is allowed to enter if and only if $\omega > \tilde{\omega}$ where $1 < \tilde{\omega} < \hat{\omega}$. $\tilde{\omega}$ is decreasing in A 's indispensability.*

Proof. In the Appendix.

Proposition 1 showed that entry is never harmful given A ownership because bargaining shares do not change. Now our starting point is not A ownership with 2 agents – as in Proposition 1 – but L ownership with 2 agents (which dominates A ownership with 2 agents) and we find that M is not allowed to enter when $\omega \leq \tilde{\omega}$. This result is driven by incentives for distribution investment. With 2 agents and L ownership L 's distribution investment is given by equation (6) :

$$\frac{1}{2}g_L(i_A, i_L^2) + \frac{1}{2}g_L(0, i_L^2) - 1 = 0$$

While with 3 agents and A ownership M 's distribution investment is given by equation (12) :

$$\frac{1}{2}g_M(i_A, i_M; \omega) - 1 = 0$$

M receives only half of the marginal value of his investment while L 's investment is boosted by his outside option when L holds the copyright. M is allowed to enter only if entry results in higher investment in distribution

⁹Note that in our 2-agent benchmark ownership is irrelevant if also A is indispensable.

which is possible only if ω is high enough. M makes a higher investment in distribution despite greater holdup problem if he is sufficiently more productive in distribution than L .

The cost of entry is that L has lower incentives in production investment as he would lose the copyright (compare equations (11) and (5)). While the change in A 's investment depends on which complementarities are more important as A 's incentive equation does not change (equations (4) and (10)). For ω high A 's investment is higher after entry as M 's large investment increases the marginal productivity of A 's investment. Therefore for $\omega > \tilde{\omega}$ the benefit of A 's and M 's larger investments outweighs the cost of L 's lower investment and M is allowed to enter and ownership of the copyright is shifted to A . While for $\omega \leq \tilde{\omega}$ there is no change. M is not allowed to enter although he is somewhat more efficient in distribution than L and L continues to hold the copyright.

Proposition 4 also shows that $\tilde{\omega} < \hat{\omega}$ (where $\hat{\omega}$ is the critical value in Proposition 2). This means that for intermediate productivity $\tilde{\omega} < \omega < \hat{\omega}$ M is allowed to enter only under A ownership. (Since Proposition 2 shows that entry is allowed under L ownership for $\omega > \hat{\omega}$.) In this parameter range copyright would first have to get shifted from the label to the artist. Only then introduction of the new intermediary is triggered. While for $\omega > \hat{\omega}$ entry is allowed whatever the initial ownership structure and copyright can be shifted to A after the entry of M .

The above discussion refers to the case where A 's and M 's investments are relatively important and entry of M would trigger a shift of copyright to A . If this is not the case, Proposition 2 is relevant. L continues to hold copyright even after entry and entry is allowed if and only if $\omega > \hat{\omega}$.

Propositions 2 and 4 together show that if ω is small, there is no change. Even if M is somewhat more productive in distribution than L , he is not allowed to enter and L continues to hold the copyright. If L ownership would be optimal after entry, M is not allowed to enter because adding a third agent to bargaining increases holdup problems. If A ownership would be optimal after entry, M is not allowed to enter because distribution investment would then be in the hands of a non-owner increasing the holdup problem.

Proposition 4 also shows that the more indispensable the artist is, the more likely it is that there is change: M is allowed to enter for lower values of ω triggering a shift of copyright from L to A . The more indispensable A is, the lower are L 's investments under L ownership. Since the surplus

under L ownership and 2 agents is decreasing in A 's indispensability and the surplus under A ownership is not affected, $\tilde{\omega}$ must be decreasing in A 's indispensability. Therefore the more indispensable A is, the less productive M needs to be to be allowed to enter.

Finally, we can make a further interesting observation. For high values of ω the artist's creative investment increases as a result of entry of online platforms and a shift from label ownership to artist ownership becomes more likely. Furthermore, the label's production investment decreases due to this change. Then if we look at the composition of the total value we find that when the technology change leads to a shift from label ownership to the artist holding the copyright the relative contribution of the artist in the total value of the piece of music is increased. In other words, the main element of music in the digital age is likely to be the improved quality of the music itself, while the era of label ownership can be described by relatively low quality music which is produced well.

5.1 Inefficient ownership structure?

In the property rights theory the agents contract on the ownership structure that maximizes joint surplus and at the time of contracting make any necessary lump sum transfers to make ownership changes individually optimal. This requires that there are no wealth constraints. However, artists – particularly the newcomers – may be cash-constrained. This may result in an inefficient ownership structure.¹⁰ Suppose artists do not have any cash and cannot compensate the label for the loss of copyright. However, the online platform is unlikely to be cash-constrained and may be able to compensate the label. Suppose also that that entry of M and A ownership maximize joint surplus.¹¹ Can A 's cash constraints lead to an inefficient ownership structure so that the copyright remains in the label's hands?

Before digital technology L ownership is optimal and L 's payoff is $\Pi_L^L(2)$

¹⁰Also in Aghion and Tirole (1994) a cash-constrained research unit may not be able to compensate the customer for the loss of ownership resulting in an inefficient ownership structure: integration where the research unit is owned by the customer. Note that our result is different because of entry of the third agent.

¹¹So the online platform is relatively more productive in distribution and the artist's creative investment and the online platform's distribution investment are relatively important.

where the subscript denotes the agent and the superscript the owner. After digital technology enables M to enter triggering shift of copyright to A L 's payoff is $\Pi_L^A(3, \omega)$. If $\Pi_L^A(3, \omega) > \Pi_L^L(2)$, then entry and loss of copyright increase L 's payoff and cash constraints do not matter. However, if $\Pi_L^A(3, \omega) < \Pi_L^L(2)$, then M has to compensate L for both the loss of copyright to A (due to A 's cash constraint) and the loss of distribution task to M . M is able to compensate L if and only if

$$\Pi_M^A(3, \omega) \geq \Pi_L^L(2) - \Pi_L^A(3, \omega). \quad (16)$$

But whether M is *willing* to compensate L depends on whether he would be better off just compensating L for the loss to distribution task. In fact, since M and L are not cash-constrained, they are able to implement an ownership structure that maximizes their joint payoff (excluding cash-constrained A). Proposition 5 shows when this will result in an inefficient structure.

Proposition 5 *Suppose entry by M and A ownership maximize joint surplus and A is cash-constrained. M is allowed to enter but L continues to hold the copyright if and only if $\Pi_M^L(3, \omega) + \Pi_L^L(3, \omega) \geq \max \{ \Pi_L^L(2), \Pi_M^A(3, \omega) + \Pi_L^A(3, \omega) \}$.*

Proof. Straightforward.

Proposition 5 shows that due to the artist being cash-constrained, the label may continue to hold the copyright although artist ownership would give the best incentives and produce the highest joint surplus. This is because it would be too expensive for M to compensate L for both entry and loss of copyright when A is the main beneficiary from gaining copyright.

6 Discussion

Music labels owned copyrights before the impact of digital technology (around 2000), in line with our benchmark model. Our results show that given label ownership, the entry of the new intermediary is optimal only if he is sufficiently more productive in distribution/promotion than the incumbent label. This is because the online platform obtains holdup power over the label and the artist. The current situation in online music resembles this. After labels failed to establish their own businesses in the promising market for online music (2002 - 2003), they decided to cooperate with online platforms like

iTunes (2003 - now).¹² The big labels did try to enter the online market themselves, but they were not successful. New intermediaries emerged with an arguably more productive concept for the online market and labels agreed to cooperate with them by licensing music to them.

Given three agents are involved we analyzed the effect of digital technology on the allocation of copyright and found that the introduction of online platforms leads to a shifting of bargaining powers so that it can become optimal for artist to own the copyright. Whether it is indeed optimal depends on the relative importance of the respective investments of A and M compared to L . For some types of music it may well be the case that the label's investment is still most important, even though it is not the sole promoter and distributor anymore. When the music's focus is on production, label ownership will continue to be optimal. As industry executive Brian Message puts it: "There are many artists who still want to go with labels, which do still have abilities to really ram home hit singles." (New York Times, 2009). This is particularly realistic when the artistic input does not come from one artist alone. If the assumption of the artist being a singer/songwriter is relaxed and we consider for instance so-called boygroups where the artists merely sing – with the label providing the rest of the artistic inputs (writing songs, choreography) plus the essential promotion of the band – then it becomes clearer that label ownership still has its place. In contrast, when the label's investment is relatively unimportant and the music's focus is on the creative part, label ownership is not optimal anymore. A switch to artist ownership will then lead to better investment incentives.

Two artist types can be distinguished in the music industry, newcomers and established artists who already have a large fan base. In the terms of our model established artists are less replaceable, more indispensable than newcomers. We showed that due to their higher degree of indispensability established artists would be more likely to own copyright for two reasons: it is (i) more likely that A ownership is optimal given 3 agents and (ii) more likely that entry is allowed given it triggers a shift of copyright to A . However, for intermediate productivity $\tilde{\omega} < \omega < \hat{\omega}$ M is allowed to enter only under A ownership. In this case the established artists may be stuck with a label, although it is beneficial for them to have ownership. If they are not able to buy out the contract with the label, they will have to wait until it expires. The 2008 Radiohead album is probably the most prominent

¹²See Regner et al. (2009) for more details.

example.¹³ After the usual label contract that binds a band to deliver six albums the band offered their seventh album online on their own web site, apparently with a lot of success.¹⁴ Newcomers, who do not have a contract with a label, would not face this dilemma. For $\tilde{\omega} < \omega \leq \hat{\omega}$ they would simply decide to keep ownership and cooperate with L and M . The reported launch of the label Polyphonic in 2009 marks the most prominent business venture so far that targets newcomer artists and offers them to retain copyright of their works. Even though newcomers are - at first glance - less likely to own copyright due to their lower indispensability, in reality they may own their works more often since they do not have to initiate an ownership change out of a current contract.

The new intermediary M can also be interpreted as an established, famous artist with some sort of entrepreneurial spirit (to invest their money) and faith in the success of the newcomer (to credibly promote them with their own reputation). Potentially, they also have the "capital" to provide new artists in the post-Napster scenario with an alternative to label promotion and distribution. They would function like a mentor, adopting a young artist they particularly like or one who they regard as very promising. Naturally, the established artist would pick a newcomer of his own artistic field who he can credibly recommend and promote. He serves customers as a guide leading down the long tail (see Anderson 2004) to content that is similar in style but yet unknown to large audiences. He would support by linking to the newcomer web site from his own well-visited web site and endorsing him there or by taking him to concert tours to perform before the main concert etc. Generally, he believes in, promotes and possibly as a venture capitalist finances the project of the newcomer.

7 Extensions

7.1 Artist's sunk investment

We have assumed that none of the artist's investment remains in the project if the agents separate under label ownership. However, in reality the value of the song performed by another artist does depend on how well the song was

¹³Other established artists who started to distribute their music independently in the past few years include Prince, George Michael and the Beastie Boys.

¹⁴See <http://en.wikipedia.org/wiki/Radiohead>

composed. If some of the artist's investment remains sunk in the project, then her higher investment improves the label's outside option and therefore the artist's incentives would be weaker under label ownership. While under artist ownership there is no such effect because the artist, as the owner of the copyright, never separates from the song she has composed. Including this in the model would favour artist ownership more both in the 2-agent and 3-agent case, but would not affect our results in a critical way.¹⁵

Including artists' sunk investment allows us to make a stronger statement about the composition of music in the digital age. In our main model when the technology change leads to a shift from label ownership to the entry of the new intermediary and a shift to artist ownership, the incentives equation for the artist remains unchanged (equations (4) and (10)) and the artist's investment increases only via complementarities. However, with sunk investments the artist's incentives would be additionally stronger after the technology change because the negative effect of improving the label's bargaining position is removed. Therefore, taking into account these spillovers from the artist's investment our result about changing composition of the total value is stronger. In the digital age the quality of the music itself is improved significantly at a cost of less resources spent on production.

7.2 M ownership

In our main model we have not examined the possibility that the new agent, M , could hold the copyright. Under M ownership the incentives would be the mirror image of L ownership (see equations (19) – (21) in the Appendix). It is straightforward to conclude that if M 's investment is very important (what it is for very large values of ω), M ownership is optimal. When M is the mentor and his investment is in promoting the newcomer, this is a possible scenario if the mentor's investment is very important relative to the artist's and the label's investments.

However, when M is the online platform and the investment is mainly in distribution M ownership is dominated. This is because in reality the distribution investment is not relationship specific. When M 's investment is not specific, then ownership is not needed to improve M 's incentives as his outside options are strong even when he does not hold the copyright. In that case M can realize the value $g(0, i_M; \omega)$ even if he is not in coalition

¹⁵See also De Meza and Lockwood (2004) for their analysis of spillovers.

with the copyright holder. (He would still lose the complementarities with A 's investment if they separate.) Then his incentives under A ownership would change to:

$$\frac{1}{2}g_M(i_A, i_M; \omega) + \frac{1}{2}g_M(0, i_M; \omega) - 1 = 0 \quad (17)$$

which is equivalent to his incentives under M ownership. While his incentives under L ownership would be:

$$\frac{1}{3}g_M(i_A, i_M; \omega) + \frac{2}{3}g_M(0, i_M; \omega) - 1 = 0 \quad (18)$$

Since M has equal incentives under M and A ownership, M ownership is dominated because both A and L have higher incentives under A ownership as then bargaining is just between two agents. This is why in our main model we do not consider M ownership.

Note that introducing a general distribution investment does not change our main results. In the 2-agent setup A ownership is still dominated. The distribution investment does not depend on who holds the copyright but L 's production investment is still boosted by L ownership. Also in the 3-agent setup there is a qualitatively similar tradeoff between A and L ownership. Even with a general distribution investment the benefit of A ownership is that A and M have better incentives while the cost is that L has worse incentives.

What would change is the critical value $\tilde{\omega}$ in Proposition 4. In particular, M would not have to be significantly more productive to be allowed to enter (when entry would trigger A ownership). This is because shifting the distribution investment to the hands of a non-owner does not worsen the incentives when the distribution investment is general. In fact, the distribution investment under A ownership (and 3 agents) is larger for any $\omega > 1$ than under L ownership (and 2 agents). Therefore, $\tilde{\omega}$ would be lower and entry is easier. However, entry would still not be allowed for M just slightly more efficient than L since entry would lower L 's incentives.

7.3 Fully complementary investments

We have assumed that there are complementarities between the artist and each intermediary but not between the intermediaries. Now we show that our main results are robust to allowing for full complementarities. Suppose the

value of production is $v(i_A, i_L, i_M; \omega)$ after entry where $\partial^2 v(i_A, i_L, i_M; \omega) / \partial i_j \partial i_k > 0$ for $j, k = A, L, M$ and $j \neq k$.

As in our benchmark A ownership is dominated before entry because L is indispensable ($v_A(i_A, 0, 0) = 0$) and A 's incentives under both A and L ownership are¹⁶:

$$\frac{1}{2}v_A(i_A, i_{L1}, i_{L2}) - 1 = 0$$

While after entry A has an alternative access to the distribution network ($v_A(i_A, 0, i_M; \omega) > 0$) and her incentives under A ownership are:

$$\frac{1}{3}v_A(i_A, i_L, i_M; \omega) + \frac{1}{6}v_A(i_A, i_L, 0; \omega) + \frac{1}{6}v_A(i_A, 0, i_M; \omega) = 1$$

compared to:

$$\frac{1}{3}v_A(i_A, i_L, i_M; \omega) + \frac{1}{6}v_A(i_A, i_L, 0; \omega) = 1$$

under L ownership. Ownership improves A 's incentives after M 's entry and therefore copyright can be shifted to A if her investment is important enough – just like in our main model. With fully complementary investments ownership improves A 's incentives via increased outside option rather than due to her central position in the production process.

Furthermore, entry increases holdup problems by introducing a third agent in bargaining and therefore entry is allowed only if M is sufficiently more productive than L . Therefore, our main results are robust to introducing full complementarities.

7.4 Drastic technology change

In our main model we have analyzed a non-drastic technology change where digital technology enables entry of online platforms but does not replace the label completely as he remains with the production task. However, technology change could be drastic making the label obsolete. The artist then cooperates with the online platform and other suppliers of general services for e.g. maintaining the online presence or even releasing albums from their

¹⁶Full analysis can be found in the Appendix.

own web site. There is even more case for artist ownership with drastic technology change as the artist is the only agent with a specific investment.

Funding can be an issue in this case, particularly for the newcomers. Venture capitalism either with an established artist, i. e. mentor, or traditional venture capitalists could provide funding for the newcomer.

8 Conclusions

Advances in information processing and transmission open up new distribution and promotion channels for music, an alternative to traditional labels. The paper analyzes the implications of this new technology for the allocation of ownership in the music industry.

Our model introduces an alternative arrangement where a new intermediary M (an online platform, possibly an established artist/mentor) joins in and partly replaces the label. We analyze non-drastic technology change where M takes over one of the label's traditional tasks (promotion/distribution) and the label focuses on the remaining one (production). In the case of label ownership of copyrights (the music industry's historic default) the new intermediary obtains holdup power over the label and the artist. Adding the third agent reduces the value of the project unless M 's investment is productive enough to compensate for the power problems.

We show that given the entry of the new intermediary, it may be optimal for the copyright to be shifted to the artist – although artist ownership was dominated before the digital age due to the label's control of the retail distribution market. Because of A 's central role, A ownership minimizes the number of bargaining parties and reduces holdup problems for A and M . If A 's creative investment and M 's distribution investment are important relative to L 's production investment, A ownership becomes optimal after the entry of M . Furthermore, the more indispensable the artist is, the more likely it is that A ownership is optimal. This is because L is more dependent on A under L ownership. For *established artists* this means that despite they are at an advantage due to their higher indispensability they would have to buy out labels out of a running contract in order to perform the ownership change. This may be difficult because of cash constraints. Even though *new-comer artists* are at a disadvantage in terms of indispensability, it is easier for them to establish the efficient ownership structure. Assuming the importance of their investment is high enough they can chose to keep copyright and take

on labels and online platforms as production/distribution/promotion partners. As discussed in Section 6 these model results are in line with the recent changes in the music industry.

Our model predicts several further changes for the music industry. One aspect of the model affects the actual quality of music. As label ownership becomes less likely, the relative contribution of the artist increases and the artistic input tends to dominate. While the label era could be described by relatively low quality music which is well produced and promoted, the main element of music in the digital age is likely to be improved quality of the music itself. However, as discussed in Section 6, label ownership is still optimal, if the music's focus is on production and the label's contribution remains very important. Hence, we distinguish between the *production of music* under label ownership where the label inputs matter most and the *creation of music* under artist ownership where the artistic input is essential and alternatives to labels exist.

The role of a new intermediary could also be taken up by established artists with some entrepreneurial drive. They can *mentor* new artists, providing alternatives to label promotion and distribution on their own web site. If their input is essential enough relative to the artist's and the label's, mentor ownership is a possible scenario. Then they invest in the fortunes of a new artist as a venture capitalist.

As a general consequence of an ownership change artists could obtain a significant stake in the larger market of record sales. Concerts became a larger source of income for artists than record sales by a ratio of 7.5 to 1. However, the total value of recording sales (\$11.8 billion in 2003 in the USA) is much larger than the total value of concert ticket sales (\$2.1 billion).¹⁷ Copyright would increase the artists' payoffs and incentives and we show that it may lead to overall improved productivity of the music industry.

Finally, it is useful to think in the future how these results can shed light on the allocation of ownership in other areas of digital content, e.g. publishing or digital art. An interesting application of the framework might be the realm of academic writing and publishing with researchers in academia taking the role of the artist, traditional publishers of journals in the role of the labels and upcoming electronic journals as the new intermediaries.

¹⁷Connolly and Krueger (2006), p. 673.

A Appendix

Incentives under M ownership are obtained from (13) – (15) by changing the roles of M and L .

$$\frac{1}{3}f_A(i_A, i_L) + \frac{1}{2}g_A(i_A, i_M; \omega) - 1 = 0 \quad (19)$$

$$\frac{1}{3}f_L(i_A, i_L) + \frac{1}{6}f_L(0, i_L) - 1 = 0 \quad (20)$$

$$\frac{1}{2}g_M(i_A, i_M; \omega) + \frac{1}{2}g_M(0, i_M; \omega) - 1 = 0 \quad (21)$$

Proof of Proposition 3.

(i) Straightforward by comparing (10) - (12) to (13) - (15).

(ii) The more indispensable A is, the lower are $f_L(0, i_L)$ and $g_M(0, i_M; \omega)$.

Denote by λ_A the degree of A 's indispensability, where $0 \leq \lambda_A \leq 1$. If $\lambda_A = 0$, A is dispensable so that $f_L(0, i_L) = f_L(i_A, i_L)$ and $g_M(0, i_M; \omega) = g_M(i_A, i_M; \omega)$. If $\lambda_A = 1$, A is fully indispensable and $f_L(0, i_L) = g_M(0, i_M; \omega) = 0$. Therefore $\partial f_L(0, i_L) / \partial \lambda_A < 0$ and $\partial g_M(0, i_M; \omega) / \partial \lambda_A < 0$. Equations (14) and (15) show that $\partial i_L / \partial \lambda_A < 0$ and $\partial i_M / \partial \lambda_A < 0$ under L ownership. The incentives under A ownership do not depend on λ_A because as a copyright holder A never leaves the project. Furthermore, if $\lambda_A = 1$, then comparison of (10) - (12) to (13) - (15) reveals that $S^A(3, \omega) > S^L(3, \omega)$. Since $\partial S^L(3, \omega) / \partial \lambda_A < 0$ and $\partial S^A(3, \omega) / \partial \lambda_A = 0$, it must be true that $S^A(3, \omega) > S^L(3, \omega)$ for λ_A high enough.

Q.E.D.

Proof of Proposition 4.

Suppose $S^L(3, \omega) < S^A(3, \omega)$ so that A ownership is optimal given 3 agents. To find out if entry of M is value increasing we have to compare $S^L(2)$ and $S^A(3, \omega)$. Investment incentives are given by equations (4) – (6) and (10) – (12). If $\omega = 1$, then equations (4) – (6) and (10) – (12) show that entry would lower all the investments. Therefore $S^A(3, \omega) < S^L(2)$ if $\omega = 1$. Furthermore, $\partial S^A(3, \omega) / \partial \omega > 0$ and $\partial S^L(2) / \partial \omega = 0$. Therefore there exists $\tilde{\omega} > 1$ such that $S^A(3, \tilde{\omega}) > S^L(2)$ if and only if $\omega > \tilde{\omega}$.

Next we will establish that $\tilde{\omega} < \hat{\omega}$ when $S^L(3, \omega) < S^A(3, \omega)$, that is under the conditions of Proposition 4. By definition of $\hat{\omega}$ $S^L(2) = S^L(3; \hat{\omega})$ and by definition of $\tilde{\omega}$ we have $S^A(3, \tilde{\omega}) = S^L(2)$. These imply that $S^L(3; \hat{\omega}) = S^A(3, \tilde{\omega})$. Since we are analysing the case where for given ω $S^L(3, \omega) < S^A(3, \omega)$ it has to be true that $\tilde{\omega} < \hat{\omega}$.

Finally, we prove that $\tilde{\omega}$ is decreasing in A 's indispensability. Following the proof of Proposition 3 it is clear that $\partial i_{Li} / \partial \lambda_A < 0$ under L ownership and 2 agents and accordingly $\partial S^L(2) / \partial \lambda_A < 0$. While $\partial S^A(3, \omega) / \partial \lambda_A = 0$. Since $\tilde{\omega}$ is defined by $S^A(3, \tilde{\omega}) = S^L(2)$ and $\partial S^A(3, \omega) / \partial \omega > 0$, it has to follow that $\partial \tilde{\omega} / \partial \lambda_A < 0$. Q.E.D.

Fully complementary investments

We apply Shapley value to find the incentives under various scenarios. Incentives under L ownership and two agents are:

$$\frac{1}{2} v_A(i_A, i_{L1}, i_{L2}) = 1$$

$$\frac{1}{2} v_L(i_A, i_{L1}, i_{L2}) + \frac{1}{2} v_L(0, i_{L1}, i_{L2}) = 1$$

Incentives under A ownership and two agents are:

$$\frac{1}{2} v_A(i_A, i_{L1}, i_{L2}) = 1$$

$$\frac{1}{2} v_L(i_A, i_{L1}, i_{L2}) = 1$$

Since L is indispensable $v_A(i_A, 0, 0) = 0$, ownership does not improve A 's incentives. L ownership dominates in the 2-agent case.

Incentives under L ownership and three agents are:

$$\frac{1}{3} v_A(i_A, i_L, i_M; \omega) + \frac{1}{6} v_A(i_A, i_L, 0; \omega) = 1$$

$$\frac{1}{3} v_L(i_A, i_L, i_M; \omega) + \frac{1}{6} v_L(i_A, i_L, 0; \omega) + \frac{1}{6} v_L(0, i_L, i_M; \omega) + \frac{1}{3} v_L(0, i_L, 0; \omega) = 1$$

$$\frac{1}{3} v_M(i_A, i_L, i_M; \omega) + \frac{1}{6} v_M(0, i_L, i_M; \omega) = 1$$

While incentives under A ownership and three agents are:

$$\frac{1}{3}v_A(i_A, i_L, i_M; \omega) + \frac{1}{6}v_A(i_A, i_L, 0; \omega) + \frac{1}{6}v_A(i_A, 0, i_M; \omega) = 1$$

$$\frac{1}{3}v_L(i_A, i_L, i_M; \omega) + \frac{1}{6}v_L(i_A, i_L, 0; \omega) = 1$$

$$\frac{1}{3}v_M(i_A, i_L, i_M; \omega) + \frac{1}{6}v_M(i_A, 0, i_M; \omega) = 1$$

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