Licensing and Revenue Sharing for Digital Content Co-Production

Jhih-Hua Jhang-Li
National Central University, jhangli@mgt.ncu.edu.tw

Robert Chiang
Fordham University, ichiang@fordham.edu

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Jhih-Hua Jhang-Li
National Central University
Taoyuan City 32001, Taiwan
jhangli@mgt.ncu.edu.tw

I. Robert Chiang
Gabelli School of Business
Fordham University
New York 10023
ichiang@fordham.edu

Abstract

Social media platforms foster creativity by helping creators monetize their content and resolving their disputes with copyright holders. These disputes often occur when content creators use prior work (e.g., musical works, movie or show clips, and video game plays) as baseline materials. We develop a content co-production mechanism for copyright owners to set a revenue-sharing split with content creators. Content creators, aiming for higher ad revenue, can dispute the copyright claim within a specific timeframe. We suggest how the proposed mechanism can help the two sides settle and avoid a trial in court with a sensible revenue-sharing ratio and dispute timeframe. We also show how the share of ad revenue can be made proportional to the contribution of the baseline materials.

Keywords: derivative work, content co-production, licensing, windowing, pre-trial settlement

Introduction

Besides gaining exposure and name recognition on social media platforms, content creators seek revenue from original content as well as derived work that incorporates materials from fellow creators (Tang et al., 2012). A derivative work[1] is defined as "a work based upon one or more pre-existing works" or "a work consisting of editorial revisions, annotations, elaborations, or other modifications which, as a whole, represent an original work of authorship." Copyright disputes have been persistent on social media platforms between copyright owners and content creators. These disputes often occur when content creators use musical works, movie or show clips, or other digitalized products (e.g., streaming of console game playing) as their baseline materials for their videos.

The perspectives and laws related to derivative works vary and can be controversial (Baldwin, 2020). Depending on local copyright laws, derivative works may be blocked by social media platforms in some countries or regions without fair use protections (Lacerna, 2022), while copyright owners can still dispute in other territories. The over-protection from copyright law may stifle creativity and innovation (Chen & Png, 2003; Yoon, 2002), causing the loss of opportunity to monetize copyrighted content if content creators switch to royalty-free materials instead.

Creators of original content can benefit from the platform's add-on mechanism without formal registration because copyright protection is assumed in law.[2] Using YouTube's content identification

[1] 17 U.S.C. § 101 (2000). (https://www.law.cornell.edu/uscode/text/17/101)
[2] https://www.copyright.gov/help/faq/faq-general.html

(Content ID)[3] as an example, each time a work is submitted, YouTube creates a "fingerprint" to check against future uploads. Potential infringement gets a Content ID warning, and content creators can dispute the claim. Content ID claims are issued mostly through an automation system; YouTube, on average, issues 4 million content ID claims per day (Sar, 2021), and 0.5% of content creators receiving a Content ID claim would dispute it (Geigner, 2021). YouTube provides warnings and handles payments but does not claim to be the final arbiter of resolving copyright controversies. As a result, some recent cases have gone to court (Barnes, 2022).

Securing permission from a copyright owner may be preferred over imposing penalties such as blocking videos, deleting accounts, or facing litigations. However, the rules in the copyright laws could complicate the licensing process. To speed up the licensing process and grow the Shorts content to counter TikTok, YouTube recently unveiled a revenue-sharing mechanism in which content creators share the ad revenue from their derivative works with copyright owners in lieu of lengthy license negotiation (Dahl, 2017). YouTube's official web pages provided an example of how copyright owners and content creators can equally share the ad revenue.[4] Facebook also offers a similar policy in which content creators can keep a portion of the in-stream ad revenue.[5]

Motivated by the need for efficient content licensing, this study proposes a mechanism in which copyright owners can upload their content (e.g., sounds, images, or videos) to apply for copyrights and then monetize their content through content co-production. If a derivative work is flagged for Content ID, the system can split the ad revenue according to a predefined revenue-sharing ratio set by a copyright owner. Content creators can either take no further action or dispute within a timeframe to keep all ad revenue after filing the dispute. This approach, known as windowing, adds flexibility for both the copyright owners and content creators, as they can adjust their share of ad revenues according to the performance of the derivative work and their respective contributions. Prior studies on windowing focus on the dispute either between cinemas and cable TVs (Calzada & Valletti, 2012) or between cable TVs and streaming providers (Chiang & Jhang-Li, 2020). Our contribution is to mitigate disputes by suggesting revenue splits between copyright owners and content creators. The time and cost of "see you in court" presents the needed incentive to achieve a pretrial settlement (Nalebuff, 1987; Reinganum & Wilde, 1986).

Given the rapidly evolving landscape of social media platforms for speeding up the creation process of high-quality derivative works, our primary research questions are: How would a copyright owner set the revenue-sharing ratio acceptable to most content creators? If a content creator would dispute, when should the dispute take place, and how should the copyright owner react?

Literature Review

Content platforms supplement their subscription revenue with advertisements by monetizing customer attention (Kumar & Sethi, 2009). Studies show that the access pattern in traditional video streaming platforms is statistically different from that on social media platforms (e.g., YouTube), where videos are viewed mostly right after an upload (Cheng et al., 2013; Zhou et al., 2016). To benefit participants in the ecosystem (platform provider, advertisers, viewers, and content producers,) advanced tools and algorithms for ad rendering, marketing analytics, ad matching, and revenue sharing between platforms and content producers are essential (Bhargava, 2022).

To better understand the competition among creators and the motivation of content creation, prior studies (e.g., Liu & Feng, 2021) highlight the importance of ad revenue-sharing policy in social media platforms to encourage the creation of high-quality content. This is because the effort exerted by content creators could be based on the connection between their decisions and future rewards (Tang et al., 2012). Moreover, donations made by viewers could be another key driving force to fuel the production of high-quality content (Jain & Qian, 2021). Bhargava (2022) advocated the need to improve one-rate-for-all creators to accommodate the diversity of content creators better.

Social video platforms based on crowd economy differ from traditional (brick and mortar) establishments because consumers can binge-watch titles. The theoretical analysis by Jain and Qian (2021) shows an

[3] How Content ID works. (https://support.google.com/youtube/answer/2797370?hl=en)
[4] https://support.google.com/youtube/answer/12657860?hl=en
[5] https://about.fb.com/news/2022/07/music-revenue-sharing-for-video-creators-on-facebook/

interesting perspective that the increased competition among content producers (as measured by the headcount) can increase profits because the platform is willing to compensate production costs and the demand attrition for retaining those time-leisure consumers with high-quality content. Another factor for evaluating a social video platform is the size of the subscriber base. To derive benefit from the network effect, platform providers often develop their own original titles and contract with other complementary producers to help reach the critical mass. Though complementary producers are incentivized to sell their works on multiple platforms, exclusivity can help ease competition by increasing differentiation among competitors (Mantena et al., 2010).

In the context of producing a derivative work, the typical creative process in co-production (or co-creation) recombines existing components such as sounds, images, or other media content (Lang et al., 2009). The concept of co-production can also be applied to knowledge-intensive projects with essential distinction. Moral hazard problems may exist in knowledge-intensive projects because multiple parties need to exert their efforts as a team to make progress in such projects (Andritsos & Tang, 2018; Rahmani et al., 2017) while resolving infringement on the existing copyrighted raw materials is the essence of co-production for a derivative work. The research in content co-production models for digital goods was pioneered by Lang et al. (2009), in which content transmutation is permitted on either the consumer side or the producer side. In their experimental framework, the right of reusing or recombining digital content can be traded between content producers in a B2B market or sourced by consumers through a B2C market. Their experiment results show both approaches can enhance total surplus without lowering content producers' profits. Based on the specifications they proposed, our research model can be viewed as an alternative to this B2B market for satisfying the need for content transmutation through acquiring *ex-post* permission from copyright owners.

In prior studies, the fee authorized by a licenser is often measured by a fixed fee, a royalty fee, or a two-part tariff. When licensing a cost-reducing technology patent to competitors, a patent-holding firm can employ the cost advantage from a royalty licensing to gain more profit because the licensee's pricing decision is based on the royalty fee. On the other hand, fixed-fee licensing will enable them to compete on equal footing because the sunk cost does not affect a licensee's production decision (Wang, 1998, 2002). In the model of Mukherjee and Mukherjee (2013), a similar argument can be found because the optimal two-part tariff licensing in their work degenerates to royalty licensing when the licenser and licensee bargain over the license expense. Moreover, royalty licensing can ease the competition between licenser and licensee if both parties vie for the same customers in the market. For example, in Costa and Dierickx (2002), the licenser knows that the royalty revenue is cannibalized when both parties use the same technology but earn royalty revenue solely from the licenser instead. In the case that both licenser and licensee are competitors, Niu (2017) advocated that the government can intervene in profit-sharing licensing because the industry output under this contract will drop to hurt the interests of consumers.

In lieu of dealing with licensing on their own, copyright owners can monetize their works by transferring the copyrights to an association that serves as a representative of these authors to grant licenses and collect royalties (Hollander, 1984). If a product incorporates multiple intellectual property rights belonging to different licensers, Lerner and Tirole (2004) suggested that these right owners can collaborate to offer a single bundle composed of all essential rights, known as a "patent pool," to bring in more revenue. The analysis regarding the decentralized licensing of multiple complementary intellectual property rights has also been explored by Meniere and Parlane (2010). However, historical records in US courts showed that a licenser might face the challenge raised by potential licensees because half of the patent litigations were invalidated by a court (Allison & Lemley, 1998). In the case of many licensees, the argument that deterring litigation is better than accommodation is confirmed by Amir et al. (2014), indicating the advantage of adopting a per-unit royalty contract for licensers holding patents but facing uncertain risks in court.

The basis of our research resembles, to some extent, the model of settlement and litigation in prior economic studies. In the general model of settlement and litigation, a plaintiff can raise the settlement demand to resolve the dispute through pretrial negotiation because using the court system could be costly for both parties. However, a defendant may not accept the settlement demand because the plaintiff may exaggerate the loss of true damage. If the measure of court accuracy is common knowledge, Reinganum and Wilde (1986) showed that the allocation of trial costs does not affect the expected gain of the plaintiff from settlement versus litigation. Moreover, Nalebuff (1987) used a similar setup, in which the plaintiff's loss of damage is common knowledge, but the actual liability of the defendant is private information and

showed that the success of pretrial negotiation depends on the court costs, while pretrial settlement may fail if the value of litigation is uncertain. In our model, both the respective contribution of two sides can be evaluated by the licenser and licensee since the derivative work uploaded to social media platforms can be accessed by the public. Therefore, both sides can reach pretrial settlement without going to court because we assume that all information are compete and public.

The Model

Consider a social media platform on which creators can register their content (e.g., a music track) for copyright protection. When other creators upload materials, the platform checks them against the archive and issues an identification claim (ID Claim) for suspected copyright infringements. While copyright owners can block submissions with copyright violations, they may instead monetize such "co-produced" content. The platform operator can arrange revenue sharing by allowing copyright owners to receive a percentage (ϕ) of ad revenue from the derived works. Upon receiving an ID claim, the content creator can withdraw the submission, agree to the revenue-sharing ratio, or dispute the claim within a timeframe. Although the dispute is mainly to counter incorrect ID claims, we also view it as a possible means for content creators to retain a higher proportion of ad revenue. Assume that content creators can dispute each ID claim once and only once at time t_{cc}, beyond which the copyright owner either accepts the dispute and stops receiving the ad revenue or elects to refute the dispute. In case of accepting the dispute, the ad revenue share already received (before t_{cc}) can be viewed as an up-front license fee for the rights owner. The mechanism for revenue sharing and dispute resolution in content co-production is shown in Figure 1.

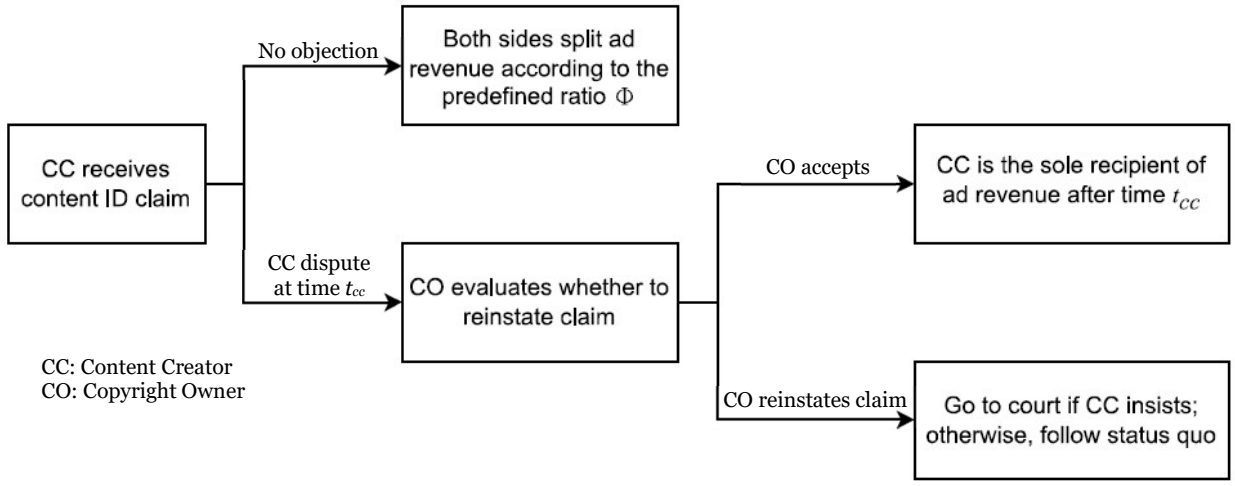

Figure 1. The flow of the revenue-sharing mechanism

The stages of our model are specified in detail as follows. First, the copyright owner registers original work in the social media platform and sets an ad revenue-sharing ratio. Second, a content creator uploads the derivative work and then receives an ID claim. Third, the content creator can dispute at any time but only once. This procedure ends if the content creator decides to accept the existing revenue-sharing policy. Fourth, if receiving the dispute request at time t_{cc} , the copyright owner can either release or reinstate the ID claim. If releasing the ID claim, the copyright owner receives no ad revenue after time t_{cc}. If the copyright owner reinstates the ID claim, the choice is either entering litigation or following status quo.

The ad revenue declines with time because the viewing wanes as the video ages (Cheng et al., 2013; Zhou et al., 2016). Empirical literature (Li & Thorson, 2015; Sun & Zhu, 2013; Tang et al., 2012) also shows that content creators incentivized by revenue sharing will attempt higher viewing rate, and analytical studies (Bhargava, 2022; Jain & Qian, 2021; Lorenzon, 2022) on platform economics and content industry assumed a positive relationship between the advertising revenue and content quality. We model the value of the derivative work as $a \equiv F(q_{co}, q_{cc})$ where q_{co} and q_{cc} are the content contributions from the copyright owner and content creator, respectively. Moreover, since the content popularity drops with time, we use an exponential function $v(t)$ to estimate the ad revenue rendered from the work:

$$\int_{t_{start}}^{t_{end}} v(t)dt = \int_{t_{start}}^{t_{end}} ae^{-bt}dt, \quad (1)$$

where parameter b measures how well the content value stands against the test of time (Chiang & Jhang-Li, 2020).

When setting the revenue-sharing ratio , the copyright owner does not know how extensively the copyrighted material will be used in the derivative work. Therefore, we consider q_{cc} a uniform random variable and normalize it to a range of [0,1]. The value of q_{cc} is revealed once the derivative work is uploaded. Under revenue-sharing, the copyright owner and content creator will gain $\phi \int_0^\infty v(t)dt$ and $(1-\phi)\int_0^\infty v(t)dt$, respectively, if the content creator has no objection. On the other hand, if the content creator disputes at the time t_{cc}, and the copyright owner releases the ID claim to forgo future earnings, the payoff for the copyright owner is $\phi \int_0^{t_{cc}} v(t)dt$, and the payoff for the content creator is $(1-\phi)\int_0^{t_{cc}} v(t)dt + \int_{t_{cc}}^\infty v(t)dt$ for being the sole recipient of the ad revenue after time t_{cc}.

If the copyright owner reinstates the ID claim, the content creator can opt for a lawsuit in court. We assume the copyright owner and content creator are risk-neutral revenue maximizers. If the content creator commences litigation, both sides rationally expect that their ad revenues from the derivative work will be "reallocated" according to their respective contribution. Following prior literature on settlement and litigation (Meurer, 1989; Nalebuff, 1987), we assume that the litigation costs of both sides are L_{cc} and L_{co} (Reinganum & Wilde, 1986), and the expected payoff of the copyright owner and content creator going to court are

$$\frac{q_{co}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{co} \text{ and } \frac{q_{cc}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{cc}\text{, respectively.} \quad (2)$$

A properly designed revenue-sharing mechanism should discourage litigation. A high likelihood of lawsuits lowers future content creator's interest in co-production. To analyze the equilibrium in Figure 1 and how the copyright owner sets the optimal revenue-sharing ratio, the content creator will agree to the ratio ϕ if the content creator's litigation cost is too high, which can be expressed as

$$\frac{q_{cc}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{cc} \le (1-\phi)\int_0^\infty v(t)dt \quad (3)$$

In case the content creator disputes while (3) holds, the copyright owner's best strategy is to reinstate the ID claim because the content creator will not seek litigation. In that situation, disputing at any time after receiving the ID claim will not improve the content creator's payoff. The litigate threat becomes credible when (3) is not held.

When the litigate cost for the copyright owner is high, and the content creator can benefit from a trial, the copyright owner releases the ID claim when the content creator disputes, or

$$\frac{q_{co}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt \le L_{co} \text{ and } (1-\phi)\int_0^\infty v(t)dt < \frac{q_{cc}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{cc} \quad . \quad (4)$$

In this case, the optimal strategy for the content creator is to file a lawsuit from the very beginning (i.e., $t_{cc}^* = 0$). The following lemma helps simplify the analysis in Figure 1.

Lemma 1. When compared with the payoff in the revenue-sharing mechanism, no more than one side can benefit from a trial in court.

Though the court can reallocate the ad revenue in light of the respective contributions of the two sides, the overall welfare is reduced due to the litigation costs. The following two inequalities, thus, *cannot* hold at the same time:

$$(1-\phi)\int_0^\infty v(t)dt < \frac{q_{cc}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{cc} \text{ and } \phi\int_0^\infty v(t)dt \le \frac{q_{co}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{co} \quad (5)$$

After (3), (4), and (5), what remains to be solved is

$$(1-\phi)\int_0^\infty v(t)dt < \frac{q_{cc}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{cc} \text{ and } \frac{q_{co}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - \phi\int_0^\infty v(t)dt < L_{co} < \frac{q_{co}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt \quad (6)$$

In (6), the content creator has the incentive to litigate because the expected payoff from going to court is better than the current revenue sharing. Moreover, the copyright owner receives more ad revenue than the expected value of going to court if there is enough time to accrue ad revenue. The content creator can find

a window $[0, t_{cc}]$ such that the copyright owner is indifferent between reinstating and releasing the ID claim if the content creator disputes it at time t_{cc}, or

$$\phi \int_0^{t_{cc}} v(t)dt = \frac{q_{co}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt - L_{co} \tag{7}$$

When resolving the revenue issue through a trial in court, the content creator can initiate the dispute at any time before t_{cc}, and both sides will go to court because the copyright owner always reinstates the ID claim within such a short timeframe. Comparing the two choices can lead to the following result.

Lemma 2. When $(1-\phi)\int_0^{\infty} v(t)dt < \frac{q_{cc}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt - L_{cc}$ and $\frac{q_{co}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt - \phi \int_0^{\infty} v(t)dt < L_{co} < \frac{q_{co}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt$, the content creator will dispute at the time t_{cc} where $\phi \int_0^{t_{cc}} v(t)dt = \frac{q_{co}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt - L_{co}$. Moreover, the copyright owner agrees to release the ID claim.

Lemma 2 shows the feasibility of applying windowing to resolving the revenue dispute between the copyright owner and the content creator, as shown in Figure 2. Based on Lemma 1, $\underline{L}_{co}$ and $\overline{L}_{cc}$, the two thresholds in Figure 2 represent the actions of the copyright owner and content creator and cannot be positive at the same time. When either threshold is negative, the benefit from the revenue-sharing mechanism is more than the expected value in court, even if the litigation cost is not factored in. Therefore, when $\overline{L}_{cc} \leq 0$, the content creator has no incentive to dispute regardless of how small L_{cc} is. Similarly, if $\overline{L}_{cc} > 0$ holds, the copyright owner also dislikes litigation because $\underline{L}_{co} < 0$. In addition, when the content creator's litigation cost is lower than $\overline{L}_{cc}$ in Figure 1, the content creator can benefit more from a dispute. Therefore, the content creator has the incentive to dispute at a specific time, which depends on whether the copyright owner's litigation cost is higher or lower than $\overline{L}_{co}$, that represents the copyright owner's expected payoff in court. When the copyright owner's litigation cost is higher than $\overline{L}_{co}$, the content creator will dispute immediately, and the copyright owner will release the ID claim to avoid the loss due to litigation. On the other hand, if $L_{co} < \overline{L}_{co}$, the copyright owner can receive a positive expected payoff in court, so the content creator has to find a suitable window $[0, t_{cc}]$ to make the copyright owner agree to release the ID claim, which is what Lemma 2 states.

Optimal Revenue Sharing

To assess how many content creators would not object vs. how many would dispute after receiving an ID claim, the copyright owner can find an indifferent point $\hat{x} \in [0,1]$ such that the content creator with $q_{cc} = \hat{x}$ can satisfy $L_{cc} = \overline{L}_{cc}$ in Figure 1, who is indifferent between the revenue-sharing mechanism and the expected payoff in court. Formally,

$$\frac{\hat{x}}{\hat{x}+q_{co}} \int_0^{\infty} v(t)dt - (1-\phi)\int_0^{\infty} v(t)dt = L_{cc} \tag{8}$$

A content creator will go by the status quo when $q_{cc} \leq \hat{x}$ while others will find the optimal time t_{cc} that satisfies (7) to file a dispute. Moreover, the copyright owner, after receiving the dispute issued by a content creator, may release the ID claim immediately, which depends on whether the litigation cost of the copyright owner is higher than $\overline{L}_{co}$ in Figure 1. Therefore, the copyright owner's payoff can be rewritten as follows:

$$\pi_{co} = \begin{cases} \phi \int_0^{\hat{x}} \int_0^{\infty} v(t)dt\, dq_{cc}\,, & if\ \ L_{co} \geq \frac{q_{co}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt \\ \phi \int_0^{\hat{x}} \int_0^{\infty} v(t)dt\, dq_{cc} + \int_{\hat{x}}^{1} \left(\frac{q_{co}}{\hat{x}+q_{co}} \int_0^{\infty} v(t)dt - L_{co} \right) dq_{cc}\,, & if\ L_{co} < \frac{q_{co}}{q_{cc}+q_{co}} \int_0^{\infty} v(t)dt \end{cases} \tag{9}$$

To ease the exposition, we consider $a \equiv q_{co} + q_{cc}$ as the value of the derivative work, this approach ensures that both parties receive more payoffs from the derivative work when the contribution from the content creator increases. In other words, a high contribution from the content creator deserves more payoff, while the copyright owner still receives a base payment. As a result, the copyright owner's optimal revenue-sharing ratio and the content creator's optimal dispute time are summarized in Proposition 1.

Proposition 1. (Optimal revenue-sharing mechanism and window)

$$(1)\ \phi^* = \begin{cases} max\left\{\frac{\sqrt{(q_{co}+bL_{cc})(q_{co}-bL_{cc}-2bL_{co})}}{q_{co}}, \frac{q_{co}+bL_{cc}}{1+q_{co}}\right\}, & \text{if } bL_{cc}+2bL_{co} < q_{co} \text{ and } \frac{q_{co}}{b} > L_{co} \\ Min\left\{\frac{q_{co}+bL_{cc}}{1+q_{co}}, 1\right\}, & otherwise \end{cases}$$

$$(2)\ t_{cc}^* = ln\left(1 - \frac{q_{co}-bL_{co}}{\phi(q_{co}+q_{cc})}\right)^{-\frac{1}{b}}$$

In Proposition 1, there are two cases for the optimal revenue-sharing ratio ϕ, as demonstrated in Figures 3 and 4. Figure 3 shows Case I, where the copyright owner having high litigation cost would choose a low revenue-sharing ratio to avoid disputes from the content creator (that is, $\hat{x} = 1$). Figure 4 depicts Case II, where the copyright owner with a low litigation cost would demand a high revenue-sharing ratio. The optimal revenue-sharing ϕ in Figure 4 is higher than $(q_{co} + bL_{cc})/(1 + q_{co})$ so that some content creators (with $q_{cc} \in [\hat{x}, 1]$) will claim at t_{cc} and then the copyright owner will release the ID claim. Moreover, if the copyright owner's contribution is too low, the two lines in Figure 4 will coincide, and Case II will degenerate to Case I. Finally, the equilibrium based on the respective contribution made by the copyright owner and content creator is shown in Figure 5. In this figure, Case I at the left of the vertical dashed line occurs when the contribution of the content creator is too low, while Case II is composed of two zones. In Case II, only the content creators with high contributions will dispute at time t_{cc}^* as prescribed in Proposition 1, which is the shaded zone on the right-up corner.

Corollary 1.

1. ϕ^* increases with q_{co}

2. The content creator has no incentive to ask for the release of the copyright from the rights owner immediately (that is, $t_{cc}^* > 0$).

A few interesting observations from Proposition 1 are as follows. First, the window of $[0, q_{cc}]$ occurs only when the copyright owner's contribution is sufficiently large, which implies that the dispute window helps the copyright owner, especially those with high-quality content for significant contribution, resolve revenue disputes with content creators. Therefore, the revenue-sharing ratio ϕ will increase with what the copyright owner can contribute to content co-production. Second, content creators do not dispute at the very beginning of our analysis. The copyright owner understands that content creators will dispute only when they can gain more payoff, whether the copyright owner will release the ID claim or not. Foreseeing this, the copyright owner will set a revenue-sharing ratio so that any content creator has no incentive to dispute immediately when receiving the ID claim, and this would allow revenue sharing to occur.

We shed light on the inadequacy of equal revenue split in the current practice. Instead, our analysis shows that the copyright owner will adjust the revenue-sharing ratio to avoid triggering objections.

Extensions

Timing of Revenue Reallocation

In this research, we assume that both copyright owners and content creators in a lawsuit would expect their cumulated ad revenue from the first day of viewing to be "reallocated" according to their respective contributions. That is, the income from the first day to the dispute date would be redistributed according to the trial of litigation. However, how would the result change if going to court leads to a new revenue stream starting from the date of dispute (rather than from the date of viewing) so that the content creator has to accept the outcome before the dispute date as a fait accompli? We apply this rule to our model and observe its impacts.

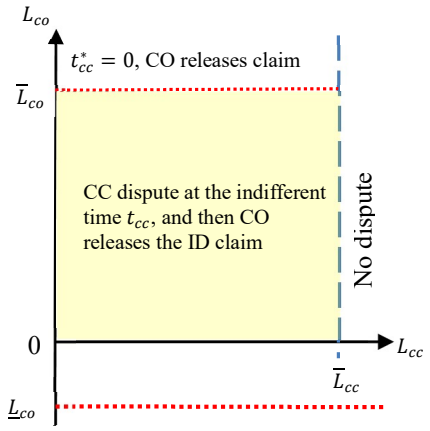

Figure 2. The equilibrium when ϕ is given where $\overline{L}_{co} \equiv \frac{q_{co}}{q_{cc}+q_{co}} \int_0^\infty v(t)dt$, $\underline{L}_{co} \equiv \frac{q_{co}}{q_{cc}+q_{co}} \int_0^\infty v(t)dt - \phi \int_0^\infty v(t)dt$, and $\overline{L}_{cc} = \frac{q_{cc}}{q_{cc}+q_{co}} \int_0^\infty v(t)dt - (1-\phi) \int_0^\infty v(t)dt$

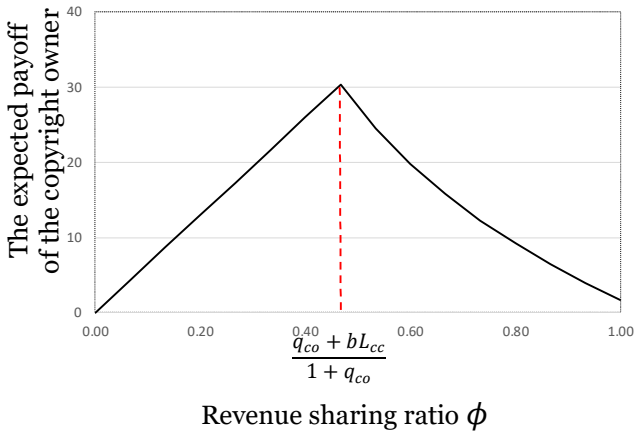

Figure 3. The copyright owner's expected payoff when $\frac{q_{co}}{b} \leq L_{co}$

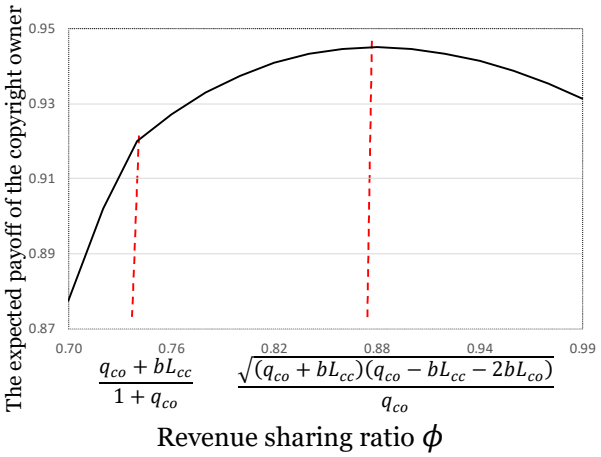

Figure 4. The copyright owner's expected payoff when $\frac{q_{co}}{b} > L_{co}$ and $bL_{cc} + 2bL_{co} < q_{co}$

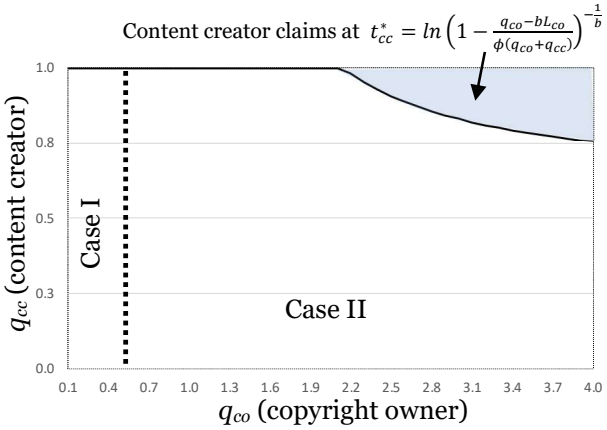

Figure 5. The equilibrium map based on the respective contribution made by the copyright owner and content creator

First, the expected payoffs of the copyright owner and content creator, if going to court, are updated as

$$\phi \int_0^{t_{cc}} v(t)dt + \frac{q_{co}}{q_{cc}+q_{co}} \int_{t_{cc}}^\infty v(t)dt - L_{co} \text{ and } (1-\phi) \int_0^{t_{cc}} v(t)dt + \frac{q_{cc}}{q_{cc}+q_{co}} \int_{t_{cc}}^\infty v(t)dt - L_{cc} \quad , \qquad (10)$$

respectively. In case the copyright owner reinstates the ID claim after the content creator disputes, the content creator will litigate when the benefit from the trial is more than the gain from inaction

$$\frac{(1-\phi)(q_{co}+q_{cc})}{b}(1-e^{-bt_{cc}}) + \frac{q_{cc}}{b} \cdot e^{-bt_{cc}} - L_{cc} > \frac{(1-\phi)(q_{co}+q_{cc})}{b} \qquad (11)$$

Therefore, the latest time that the content creator would dispute is $t_{cc,1} \equiv ln\left(\frac{bL_{cc}}{q_{cc}-(1-\phi)(q_{co}+q_{cc})}\right)^{-\frac{1}{b}}$, which is derived from (11). If t_{cc} goes beyond this threshold, the copyright owner believes that the content creator has no incentive to litigate because the new revenue gained past time $t_{cc,1}$ does not make up the litigating cost. Next, given that the litigation threat made by the content creator is credible, the copyright owner will accept the dispute only if the cost of going to court is more than the residual revenue (reallocated by the court) after time t_{cc}. That is,

$$L_{co} \geq \frac{q_{co}}{q_{cc}+q_{co}} \int_{t_{cc}}^{\infty} v(t)dt \quad (12)$$

Therefore, if the copyright owner knows that reinstating the ID claim will bring both to the court, the earliest dispute time that the copyright owner is willing to release the ID claim is $t_{cc,2} \equiv ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$, which is derived from (12). Figure 6 shows the significant difference between the original model and this extension. In our original model, both sides have the consensus that the credibility of a content creator's litigation threat is irrelevant to the dispute time, but too late dispute time can be useless in the extension. In the illustrated example shown in Figure 6, the content creator's best decision is to dispute at time $t_{cc} = 0$ because the copyright owner will always reinstate the ID claim at any time. It occurs because either the loss of giving up the left revenue stream is large for the copyright owner (that is, $t_{cc} < t_{cc,2}$) or the content creator's litigation threat is incredible (that is, $t_{cc} > t_{cc,1}$).

Figure 6. The feasible time frame for both copyright owner and content creator

Based on the relationship between $t_{cc,1}$ and $t_{cc,2}$, some important conditions for the interaction between both sides can be discovered. To begin, the content creator always gives up the right of dispute when the litigation is costly (that is, $\frac{q_{cc}-(1-\phi)(q_{co}+q_{cc})}{b} < L_{cc}$ derived from $t_{cc,1} < 0$). Thus, $t_{cc,1} \geq 0$ can imply that the content creator can find $t_{cc} \in [0, t_{cc,1}]$ such that the litigation threat is credible. If $t_{cc} \in [0, t_{cc,1}]$ where $t_{cc,1} \geq 0$ holds, the copyright owner always gives up the remaining revenue stream when $t_{cc,2} \leq 0$. Then, the condition that $\frac{q_{co}}{b} \leq L_{co}$, derived from $t_{cc,2} \leq 0$, can serve as an indicator of high litigation cost. If the copyright owner reinstates the ID claim when this condition is met, the content creator must litigate. Knowing that the litigation threat from the content creator is credible and the litigation cost L_{co} is high, the copyright owner will release the ID claim. However, if $L_{co} < \frac{q_{co}}{b}$, the content creator's decision rules is as follows. To simplify notations, we denote $X \equiv \left(1-\frac{bL_{co}}{q_{co}}\right)\frac{\phi(q_{co}+q_{cc})}{b} - \frac{q_{co}}{b}$, $\equiv \frac{L_{co}(q_{cc}-(1-\phi)(q_{co}+q_{cc}))}{q_{co}}$, and $Z \equiv \frac{q_{cc}-(1-\phi)(q_{co}+q_{cc})}{b}$.

Lemma 3.

(1) If $Z \leq L_{cc}$, the content creator always gives up the right of dispute. Formally, $t_{cc}^* = \infty$.

(2) If $L_{cc} < Z$ and $\frac{q_{co}}{b} \leq L_{co}$, the content creator chooses $t_{cc}^* = 0$.

(3) If $L_{cc} < Z$ and $L_{co} < \frac{q_{co}}{b}$, the content creator chooses $t_{cc}^* = 0$ when $Y < L_{cc}$.

(4) If $L_{cc} < Z$, $L_{co} < \frac{q_{co}}{b}$, and $0 < X \leq Y$, the content creator chooses $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ when $X \leq L_{cc} \leq Y$ and $t_{cc}^* = 0$ when $L_{cc} < X$.

(5) If $L_{cc} < Z$, $L_{co} < \frac{q_{co}}{b}$, and $X \leq 0 \leq Y$, the content creator chooses $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ when $L_{cc} \leq Y$.

Figure 7 demonstrates how the content creator's optimal dispute time depends on the litigation cost, which is segmented by X, Y, and Z. Obviously, the content creator will not dispute if the cost of going to court is too high (that is, $Z < L_{cc}$). On the other hand, if the litigation cost is not so high, then the best dispute time is $t_{cc} = 0$. Delaying the dispute time does not benefit the content creator because the more favorable revenue-sharing ratio via litigation starts from the dispute date. However, when the content creator's litigation cost is low (that is, $L_{cc} \leq Y$), there is a tradeoff between going to court by disputing on the first day or incentivizing the copyright owner to release the ID claim via the litigation threat at a proper dispute time t_{cc}.

The best strategy for the content creator is litigation if its cost is sufficiently low (that is, $L_{cc} < X$). When the litigation cost is not so low (that is, $X \le L_{cc} \le Y$), the content creator should choose a window $[0, t_{cc}]$ such that the copyright owner is indifferent between reinstating and releasing the ID claim. As the litigation cost is sufficiently high (that is, $Y < L_{cc} < Z$), the litigation threat (by choosing $t_{cc} = t_{cc,2}$) is not credible because the content creator's new revenue ratio will not be enough to compensate for the litigation cost. Therefore, the content creator cannot use windowing to convince the copyright owner to release the ID claim. As a result, in this area, the content creator still requests a dispute at $t_{cc} = 0$.

However, Lemma 3 is not sufficiently comprehensive to sort out the optimal dispute time in all scenarios for the content creator due to the option of using a window $[0, t_{cc}]$ to coordinate both sides could disappear if the content creator's ad revenue sharing ratio is too low. A further analysis based on Lemma 3 is needed to serve as a fundamental for depicting the complete picture that prescribes how both sides interact with each other.

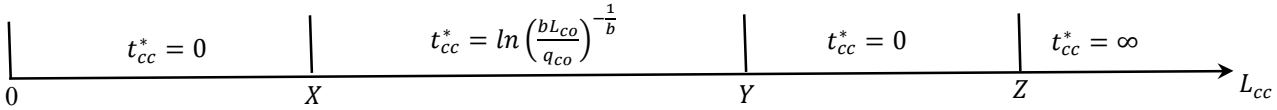

Figure 7. The content creator's optimal dispute time when $0 < X < Y < Z$

Lemma 4. If $L_{cc} < Z$ and $L_{co} < \frac{q_{co}}{b}$, then the content creator's optimal dispute time is as follows.

(Case 1) $\frac{q_{cc}q_{co}}{b(q_{co}+q_{cc})} \le L_{co}$: $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ when $0 < L_{cc} \le Y$ and $t_{cc}^* = 0$ when $Y < L_{cc} < Z$

(Case 2) $\frac{q_{cc}q_{co}}{b(q_{co}+2q_{cc})} \le L_{co} < \frac{q_{cc}q_{co}}{b(q_{co}+q_{cc})}$:

(i) $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ when

(i.1) $0 < L_{cc} \le Y$ and $\phi \in \left[1 - \frac{q_{cc}}{q_{co}+q_{cc}}, \frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}\right]$ or

(i.2) $X \le L_{cc} \le Y$ and $\phi \in \left[\frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}, 1\right]$

(ii) $t_{cc}^* = 0$ when $Y < L_{cc} < Z$

(Case 3) $L_{co} < \frac{q_{cc}q_{co}}{b(q_{co}+2q_{cc})}$:

(i) $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ when

(i.1) $0 < L_{cc} \le Y$ and $\phi \in \left[1 - \frac{q_{cc}}{q_{co}+q_{cc}}, \frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}\right]$ or

(i.2) $X \le L_{cc} \le Y$ and $\phi \in \left[\frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}, \frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}\right]$

(ii) $t_{cc}^* = 0$ when

(ii.1) $Y < L_{cc} < Z$ and $\in \left[1 - \frac{q_{cc}}{q_{co}+q_{cc}}, \frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}\right]$, or

(ii.2) $0 < L_{cc} < X$ and $\phi \in \left[\frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}, \frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}\right]$, or

(ii.3) $Y < L_{cc} < Z$ and $\in \left[\frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}, \frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}\right]$, or

(ii.4) $L_{cc} < Z$ and $\phi \in \left[\frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}, 1\right]$

Based on Lemma 4, if the ad revenue-sharing ratio ϕ is given, the interaction between the copyright owner and content creator is as follows.

Proposition 2. (The content creator's dispute time and the copyright owner's response)

(1) If $\leq L_{cc}$, there is no dispute from the content creator. Namely, $t_{cc}^{*} = \infty$.

(2) If $L_{cc} < Z$ and $\frac{q_{co}}{b} \leq L_{co}$, the content creator disputes at $t_{cc}^{*} = 0$. The copyright owner releases the ID claim after that.

(3) When $L_{cc} < Z$ and $L_{co} < \frac{q_{co}}{b}$, the content creator disputes at the time t_{cc} as prescribed in Lemma 4. In this case, if the content creator disputes at time $t_{cc}^{*} = 0$, the copyright owner reinstates the ID claim, and then the content creator must litigate. Moreover, the copyright owner releases the ID claim when the content creator disputes at time $t_{cc}^{*} = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$.

We use Figure 8 to show how Proposition 2 works and its implications. First, the horizontal and vertical axes are litigation costs L_{co} and L_{cc}. Second, the three vertical lines from left to right are $\frac{q_{cc}q_{co}}{b(q_{co}+2q_{cc})}$, $\frac{q_{cc}q_{co}}{b(q_{co}+q_{cc})}$, and $\frac{q_{co}}{b}$, respectively. Then, we draw *X*, *Y*, and *Z* based on the value of L_{co} and we compare their values with L_{cc} to suggest the content creator's dispute time and the copyright owner's response.

In Figure 8, the content creator gives up the dispute option when the litigation cost is too high (that is, $L_{cc} \geq Z$) and accepts the ad revenue-sharing ratio set by the copyright owner. On the other hand, when $L_{cc} < Z$ holds, the content creator can dispute at $t_{cc}^{*} = 0$ when the copyright owner's litigation cost is sufficiently high ($\frac{q_{co}}{b} \leq L_{co}$). In this extreme case, the copyright owner will release the ID claim due to high litigation costs. If $L_{co} < \frac{q_{co}}{b}$ holds, the content creator has to evaluate whether the late dispute time $t_{cc}^{*} = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ can convince the copyright owner to release the ID claim.

Since the litigation threat is not credible when the content creator's litigation cost is large (that is, $Y < L_{cc} < Z$), the content creator has to choose the litigation approach by disputing at $t_{cc}^{*} = 0$. If the content creator's litigation cost is not too high (for example, $X \leq 0 < L_{cc} \leq Y$ or $0 < X < L_{cc} \leq Y$), the late dispute time $t_{cc}^{*} = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ may be acceptable to the copyright owner. However, if the content creator's litigation cost is low enough, the litigation approach with $t_{cc}^{*} = 0$ can still be better when $0 < L_{cc} < X < Y$. Note that $Y \leq X$ when L_{co} is roughly less than 1.40 in this numerical example. In this case, the content creator receives less profit by disputing at time $t_{cc}^{*} = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$ because the waiting time is too long (due to low L_{co}) and the ad revenue decreases with time. When the copyright owner's litigation cost is low enough, this new setup will incur more lawsuits. On the contrary, our original model can help both sides to reach outcomes in which litigation concerns are not anticipated. Also, Lemma 4 and Proposition 2 show that the copyright owner's profit is not a continuous function (contingent on the ad-revenue sharing ratio ϕ) so that a numerical optimization approach can help investigate how the copyright owner decides on the ad revenue-sharing ratio according to the new policy in this extension.

Blocked Submissions

It is possible that the copyright owner avoids content co-production and blocks submissions. We here consider being blocked as a potential risk that discounts the payoff. If the probability of being blocked and the distribution of the content creator's contribution in the derivative work are independent, then our analysis remains largely unchanged. A better approach is to take the content creator's production decision into account so that the probability of being blocked will force high-risk content creators to choose other approaches instead (e.g., use royalty-free content or paying an upfront license fee).

Another factor to consider is how easily the base material can be "decoupled" from the co-production. When copyrighted content, such as background music, can be more easily "subbed out" for reproduction, it is easier to handle blockage and the content creator may be more inclined to use our approach. On the

other hand, when the base material (e.g., game clips for sports commentary shows) is more deeply embedded in the production, securing the license may be a preferred approach over revenue sharing. Better distribution of ad revenue, presumably, helps to reduce the need to replace blocked content.

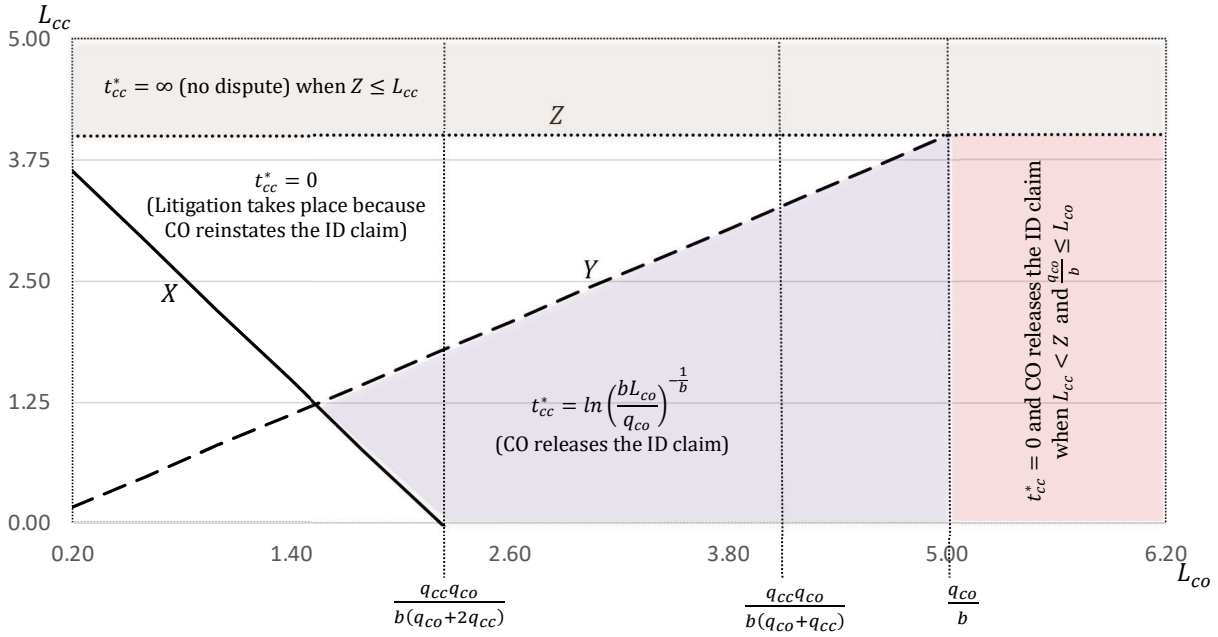

Figure 8. The equilibrium in the extension when ϕ is given, where $\equiv \left(1 - \frac{bL_{co}}{q_{co}}\right)\frac{\phi(q_{co}+q_{cc})}{b} - \frac{q_{co}}{b}$, $Y \equiv \frac{L_{co}(q_{cc}-(1-\phi)(q_{co}+q_{cc}))}{q_{co}}$, and $Z \equiv \frac{q_{cc}-(1-\phi)(q_{co}+q_{cc})}{b}$.

Litigation Uncertainty

The litigation cost should be a rough estimate of the real expense in a lawsuit. Therefore, we can define the litigation cost as $L_{cc} + \varepsilon_{cc}$ and $L_{co} + \varepsilon_{co}$, where ε_{cc} and ε_{co} are of normal distribution with zero mean. Both the content creator and copyright owner can figure out the value of L_{cc} and L_{co} through reviewing precedents or seeking expert opinion. The nature progression of the case affects the actual cost, and they are captured by the noise terms ε_{cc} and ε_{co}. In this research, its impact is limited because content creator and copyright owner are assumed risk-neutral. It would be worth exploring how a risk-averse content creator would change dispute time and co-production decisions if there are other available options such as free content.

Conclusion

To promote adoption and foster creativity, social media platforms have mechanisms to monetize derivative works and resolve disputes between copyright owners and content creators. In this study, we develop a content co-production mechanism such that the copyright owner can set a revenue-sharing split with other content creators, and a content creator can retain more ad revenue after some initial payouts. Our approach adds flexibility to the existing mechanism of predefined revenue-sharing ratio. To encourage high-quality uploads, social media platforms also need a more flexible ad revenue-sharing mechanism without relying on one-off negotiations on the license fee.

According to business reports, copyright claims are often the content creators' biggest concerns on social media platforms (Alexander, 2019). Fixed-fee licenses upfront could frustrate content creators due to high costs and some unreasonable terms and conditions. For instance, the license can only be used in a single video and for only two years (Whateley & Perelli, 2023). These inconvenient conditions could deter content creators from producing more high-quality derivative works. Moreover, based on our survey from

YouTube's official web pages,[6] its current policy appears to equally share the ad revenue between copyright owners and content creators. However, there is not an integrated approach to dynamically help copyright owners and content creators to reallocate their revenues. In the past, windowing was mainly used by media providers such as cinemas and cable TVs to share the benefit of titles. The purpose of our research is to apply this skill to facilitate the process of content creation. Therefore, our study recommends a window mechanism to help solve the dispute between content creators and copyright owners.

For potential extensions, other than demanding a fixed portion of ad revenue, copyright owners can also offer an upfront license fee.[7] The reason why some content creators prefer the upfront license over the revenue-sharing contract is the increase in surplus. However, the copyright owner cannot easily apply different pricing without a differentiated licensing policy on the scope of use, expiration date, and so on. As a result, the increased surplus of the content creator can imply a decreased payoff for the copyright owner. Moreover, both the copyright owner and content creator may have a bias in the value of going to court. Many prior studies have explored the impact of cognitive bias (e.g., overestimation or underestimation) on decision-makers. Expanding this point to our model can help link cognitive bias to key decision variables such as revenue-sharing ratio and window length. Finally, content creators may use multiple copyrighted materials to create their own derivative works. We plan to enhance our application to accommodate a more general case.

Limitations and Future Research

Some potential research questions based on our model remain to be solved. First, we adopt a simple function to define the value of the derivative work, but the adoption of a more general contribution function can make the implications behind this model more credible. Second, employing more complex mechanisms to license cannot be a profit booster if the scope of the license is the same. Adopting multiple mechanisms may be useful if the copyright owner can block some submissions. For instance, the copyright owner can offer a fixed fee contract to sell the license to "controversial" content creators and adopt our mechanism to share ad revenues with lower-risk content creators. This way, the copyright owner can dissuade certain categories of production by imposing a high fixed fee. Third, a content creator has to collect the required licenses from all copyright owners if this derivative work is based on multiple pre-existing content with copyrights. Therefore, a model supporting multiple copyright owners and multiple mechanisms is worth exploring as the future research.

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Appendix

Proof of Lemma 1.

It is trivial that no one can gain any benefit from the trial in court when the litigation costs of both sides are too high. WLOG, we assume that (5) holds, which means that neither sides will bear the loss in the trial. However,

$$(1-\phi)\int_0^\infty v(t)dt + \phi\int_0^\infty v(t)dt < \frac{q_{cc}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{cc} + \frac{q_{co}}{q_{cc}+q_{co}}\int_0^\infty v(t)dt - L_{co} \Rightarrow$$

$$\int_0^\infty v(t)dt < \int_0^\infty v(t)dt - L_{cc} - L_{co}, \text{ which is a contradiction.}$$

Proof of Lemma 2.

[6] https://support.google.com/youtube/answer/12657860?hl=en#examples&zippy=%2Cexamples-of-revenue-share-calculations

[7] YouTube's Creator Music lets creators use copyright protected music in videos while keeping revenue https://routenote.com/blog/youtube-use-music-in-video/

First, the indifferent time t_{cc} can imply $\int_0^{t_{cc}} v(t)dt = \frac{1}{\phi}\left(\frac{q_{co}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{co}\right)$. If the content creator disputes at the indifferent time t_{cc}, her expected payoff is

$$(1-\phi)\int_0^{t_{cc}} v(t)dt + \int_{t_{cc}}^{\infty} v(t)dt = \int_0^{\infty} v(t)dt - \phi\int_0^{t_{cc}} v(t)dt = \int_0^{\infty} v(t)dt - \left(\frac{q_{co}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{co}\right).$$

Moreover, if disputing at a time earlier than the indifferent time t_{cc}, the content creator's expected payoff is $\frac{q_{cc}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{cc}$. Therefore, the following inequalities complete the proof.

$$\int_0^{\infty} v(t)dt - \left(\frac{q_{co}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{co}\right) \geq \frac{q_{cc}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{cc}$$

$$\Leftrightarrow \int_0^{\infty} v(t)dt + L_{co} + L_{cc} \geq \left(\frac{q_{cc}+q_{co}}{q_{cc}+q_{co}}\right)\int_0^{\infty} v(t)dt$$

Proof of Proposition 1.

The point $\hat{x} \in [0,1]$ is the value such that a content creator with $q_{cc} = \hat{x}$ is indifferent between dispute and acceptance. Therefore solving $\frac{q_{cc}}{b} - L_{cc} = \frac{(1-\phi)(q_{co}+q_{cc})}{b}$ with respect to q_{cc} yields $\hat{x} = \frac{(1-\phi)q_{co}+b\ \ cc}{\phi}$. When $\hat{x} < q_{cc}$, the content creator with the value q_{cc} will dispute, and the decision of the copyright owner can be classified into Case I and II.

Case I. $\frac{q_{co}}{b} \leq L_{co}$:

When $\hat{x} < q_{cc}$, the content creator disputes at $t_{cc} = 0$ and the copyright owner releases the ID claim immediately. Therefore, the copyright owner's expected payoff is

$$\pi_{co} = \phi\int_0^{\hat{x}}\int_0^{\infty} v(t)dt\, dq_{cc} = \int_0^{\hat{x}} \frac{\phi(q_{co}+q_{cc})}{b} dq_{cc} = \frac{\phi}{b}\left(q_{co}\hat{x} + \frac{\hat{x}^2}{2}\right)$$

Moreover, $\frac{\partial \pi_{co}}{\partial \phi} = -\frac{(\phi^2+1)q_{co}^2+2bL_{cc}q_{co}+b^2L_{cc}^2}{2b\phi^2} < 0$. Therefore, solving $\hat{x} = 1$ yields ϕ^*, which is the largest value of ϕ such that $\hat{x} = 1$. If $\phi < \phi^*$, then $\hat{x} = 1$ still holds so that the content owner's payoff cannot be further improved but be worse off.

Case II. $\frac{q_{co}}{b} > L_{co}$:

When $\hat{x} < q_{cc}$, the copyright owner can gain a positive payoff from the litigation. Therefore, for enticing the copyright owner to release the ID claim, the content creator has to find out the optimal dispute time t_{cc} satisfying (7). In other words,

$$\phi\int_0^{t_{cc}} v(t)dt = \frac{q_{co}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{co} \Rightarrow t_{cc}^{\star} = ln\left(1 - \frac{q_{co} - bL_{co}}{\phi(q_{co}+q_{cc})}\right)^{-\frac{1}{b}}$$

Subsequently, the copyright owner's expected payoff is

$$\phi\int_0^{\hat{x}}\int_0^{\infty} v(t)dt\, dq_{cc} + \int_{\hat{x}}^{1}\left(\frac{q_{co}}{q_{cc}+q_{co}}\int_0^{\infty} v(t)dt - L_{co}\right)dq_{cc} = \frac{\phi}{b}\left(q_{co}\hat{x} + \frac{\hat{x}^2}{2}\right) + \left(\frac{q_{co}}{b} - L_{co}\right)\cdot(1-\hat{x})$$

Note that $\frac{\partial^2 \pi_{co}}{\partial \phi^2} = \frac{(q_{co}+bL_{cc})(bL_{cc}+2L_{co}b-q_{co})}{b\phi^3}$; therefore, solving $\frac{\partial \pi_{co}}{\partial \phi} = 0$ yields $\phi^* = \frac{\sqrt{(q_{co}+bL_{cc})(q_{co}-bL_{cc}-2bL_{co})}}{q_{co}}$, which is valid when $bL_{cc} + 2L_{co}b < q_{co}$ and $\hat{x} \leq 1$. Moreover, $\phi^* < 1$ holds forever because $(\phi^*)^2 - 1 = -\frac{b(bL_{cc}^2+2L_{co}q_{co}+2L_{co}bL_{cc})}{q_{co}^2} < 0$. When $\hat{x} = 1$, $\phi^* = \frac{\sqrt{(q_{co}+bL_{cc})(q_{co}-bL_{cc}-2bL_{co})}}{q_{co}} = \frac{q_{co}+bL_{cc}}{1+q_{co}}$. Therefore, when $bL_{cc} + 2bL_{co} < q_{co}$, $\phi^* = max\left\{\frac{\sqrt{(q_{co}+bL_{cc})(q_{co}-bL_{cc}-2bL_{co})}}{q_{co}}, \frac{q_{co}+bL_{cc}}{1+q_{co}}\right\}$. On the other hand, if $bL_{cc} + 2bL_{co} \geq q_{co}$, then $\frac{\partial \pi_{co}}{\partial \phi} = -\frac{(q_{co}+bL_{cc})(bL_{cc}+2bL_{co}-q_{co})+q_{co}^2\phi^2}{2\phi^2 b} \leq 0$. As a result, the optimal solution of the revenue-sharing ratio ϕ is the same as that in Case I.

Proof of Lemma 3.

First, if $Z < L_{cc}$, then the content creator knows that requesting a dispute is useless because the copyright owner (knowing that the content creator will not litigate due to high litigation cost L_{cc}) always reinstates the ID claim. Thus, $t_{cc}^* = \infty$. Subsequently, if $L_{cc} \le Z$ and $\frac{q_{co}}{b} \le L_{co}$, then the content creator chooses $t_{cc}^* = 0$ because the litigation threat is credible and the content creator knows that the copyright owner dislikes going to court due to high litigation cost L_{co}. Next, given that $L_{cc} \le Z$ and $L_{co} < \frac{q_{co}}{b}$, the condition that $t_{cc,2} < t_{cc,1}$ is required for convincing the copyright owner of releasing the ID claim via choosing $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$. Therefore, the content creator chooses $t_{cc}^* = 0$ when $< L_{cc}$, where Y is derived from solving $t_{cc,1} = t_{cc,2}$ with respect to L_{cc}. On the other hand, the content creator can choose in between when $L_{cc} \le Y$. The content creator receives $\frac{q_{cc}}{b} - L_{cc}$ if choosing $t_{cc}^* = 0$ and $\frac{(1-\phi)(q_{co}+q_{cc})}{b}\left(1 - \frac{bL_{co}}{q_{co}}\right) + \frac{(q_{co}+q_{cc})}{b}\frac{bL_{co}}{q_{co}}$ if choosing $t_{cc}^* = ln\left(\frac{bL_{co}}{q_{co}}\right)^{-\frac{1}{b}}$. Equaling both profits yields the value of X.

Proof of Lemma 4.

We only consider $\phi \in \left[1 - \frac{q_{cc}}{q_{co}+q_{cc}}, 1\right]$ because $Z < L_{cc}$ when $< 1 - \frac{q_{cc}}{q_{co}+q_{cc}}$. Note that $X = -L_{co} < Y = Z = 0$ when $= 1 - \frac{q_{cc}}{q_{co}+q_{cc}}$. Moreover, $\frac{\partial X}{\partial \phi} > 0$, $\frac{\partial Y}{\partial \phi} > 0$, $\frac{\partial Z}{\partial \phi} > 0$, $\frac{\partial X}{\partial \phi} - \frac{\partial Y}{\partial \phi} = \frac{(q_{co}+q_{cc})(q_{co}-2bL_{co})}{q_{co}b}$, $\frac{\partial Z}{\partial \phi} - \frac{\partial X}{\partial \phi} = \frac{L_{co}(q_{co}+q_{cc})}{q_{co}} > 0$, and $\frac{\partial Z}{\partial \phi} - \frac{\partial Y}{\partial \phi} = \frac{(q_{co}-bL_{co})(q_{co}+q_{cc})}{q_{co}b} > 0$. Therefore, we know that the segment between X and Y may disappear when the value of ϕ is large. First, if $L_{co} = \frac{q_{cc}q_{co}}{b(q_{co}+q_{cc})}$ holds, $X = 0$ when $\phi = 1$. Because $\frac{\partial X}{\partial L_{co}} < 0$ and $\frac{\partial Y}{\partial \phi} > 0$, $X \le 0 \le Y \le Z$ if $\frac{q_{cc}q_{co}}{b(q_{co}+q_{cc})} \le L_{co}$. Second, if $L_{co} = \frac{q_{cc}q_{co}}{b(q_{co}+2q_{cc})}$ holds, $X = Y$ when $\phi = 1$. Moreover, $X = 0$ when $\phi = \frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}$ holds. Therefore, if $\frac{q_{cc}q_{co}}{b(q_{co}+2q_{cc})} \le L_{co} \le \frac{q_{cc}q_{co}}{b(q_{co}+q_{cc})}$, $X \le 0 \le Y \le Z$ if $\phi \in \left[1 - \frac{q_{cc}}{q_{co}+q_{cc}}, \frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}\right]$ and $0 \le X \le Y \le Z$ if $\phi \in \left[\frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}, 1\right]$. Finally, if $L_{co} < \frac{q_{cc}q_{co}}{b(q_{co}+2q_{cc})}$, $X = Y$ when $\phi = \frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}$. Therefore, $X \le 0 \le Y \le Z$ if $\in \left[1 - \frac{q_{cc}}{q_{co}+q_{cc}}, \frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}\right]$, and $0 \le X \le Y \le Z$ if $\phi \in \left[\frac{q_{co}^2}{(q_{co}-bL_{co})(q_{co}+q_{cc})}, \frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}\right]$, and $0 \le Y \le X \le Z$ if $\phi \in \left[\frac{(q_{co}-bL_{co})q_{co}}{(q_{co}+q_{cc})(q_{co}-2bL_{co})}, 1\right]$.

Proof of Proposition 2.

This proof is based on Lemma 4 and the discussion in the extension.

References

Alexander, J. (2019). *YouTube CEO addresses top creator issues including copyright claims and trending section*. https://www.theverge.com/2019/4/30/18524426/youtube-ceo-creators-copyright-claims-infringement-trending-section-comments

Allison, J. R., & Lemley, M. A. (1998). Empirical evidence on the validity of litigated patents. *AIPLA QJ*, *26*, 185.

Amir, R., Encaoua, D., & Lefouili, Y. (2014). Optimal licensing of uncertain patents in the shadow of litigation. *Games and Economic Behavior*, *88*, 320-338. https://doi.org/https://doi.org/10.1016/j.geb.2014.09.009

Andritsos, D. A., & Tang, C. S. (2018). Incentive Programs for Reducing Readmissions when Patient Care is Co-Produced. *Production and Operations Management*, *27*(6), 999-1020. https://doi.org/https://doi.org/10.1111/poms.12847

Baldwin, A. (2020). Music Sampling and the De Minimis Defense: A Copyright Law Standard, 19 UIC REV. INTELL. PROP. L. 310 (2020). *UIC Review of Intellectual Property Law*, *19*(4), 2.

Barnes, M. (2022). *IP in Vietnam: One Little Pig and a Big Bad Lawsuit*. https://www.vietnam-briefing.com/news/intellectual-property-vietnam-lawsuit-wolfoo-peppa-pig.html/

Bhargava, H. K. (2022). The Creator Economy: Managing Ecosystem Supply, Revenue Sharing, and Platform Design. *Management Science*, *68*(7), 5233-5251. https://doi.org/10.1287/mnsc.2021.4126

Calzada, J., & Valletti, T. M. (2012). Intertemporal movie distribution: Versioning when customers can buy both versions. *Marketing Science*, *31*(4), 649-667.

Chen, Y.-n., & Png, I. (2003). Information Goods Pricing and Copyright Enforcement: Welfare Analysis. *Information Systems Research*, *14*(1), 107-123. https://doi.org/10.1287/isre.14.1.107.14762

Cheng, X., Liu, J., & Dale, C. (2013). Understanding the Characteristics of Internet Short Video Sharing: A YouTube-Based Measurement Study. *IEEE Transactions on Multimedia*, *15*(5), 1184-1194. https://doi.org/10.1109/TMM.2013.2265531

Chiang, I. R., & Jhang-Li, J.-H. (2020). Competition through Exclusivity in Digital Content Distribution. *Production and Operations Management*, *29*(5), 1270-1286. https://doi.org/https://doi.org/10.1111/poms.13156

Costa, L. s. A., & Dierickx, I. (2002). Licensing and bundling. *International Journal of Industrial Organization*, *20*(2), 251-267. https://doi.org/https://doi.org/10.1016/S0167-7187(00)00078-3

Dahl, K. (2017). *Legal Beat: Do You Need Permission To Upload A Cover Song To Youtube?* https://drummagazine.com/legal-beat-do-you-need-permission-to-upload-a-cover-song-to-youtube/

Geigner, T. (2021). *YouTube Copyright Transparency Report Shows The Absurd Volume Of Copyright Claims It Gets*. https://www.techdirt.com/2021/12/08/youtube-copyright-transparency-report-shows-absurd-volume-copyright-claims-it-gets/

Hollander, A. (1984). Market structure and performance in intellectual property: The case of copyright collectives. *International Journal of Industrial Organization*, *2*(3), 199-216. https://doi.org/https://doi.org/10.1016/0167-7187(84)90010-9

Jain, S., & Qian, K. (2021). Compensating Online Content Producers: A Theoretical Analysis. *Management Science*, *67*(11), 7075-7090. https://doi.org/10.1287/mnsc.2020.3862

Kumar, S., & Sethi, S. P. (2009). Dynamic pricing and advertising for web content providers. *European Journal of Operational Research*, *197*(3), 924-944. https://doi.org/https://doi.org/10.1016/j.ejor.2007.12.038

Lacerna, M. (2022). *Dragon Ball, One Piece Copyright Controversy Inspires New YouTube Rules*. https://www.cbr.com/dragon-ball-one-piece-copyright-toei-animation-youtube/

Lang, K. R., Shang, R. D., & Vragov, R. (2009). Designing markets for co-production of digital culture goods. *Decision Support Systems*, *48*(1), 33-45. https://doi.org/https://doi.org/10.1016/j.dss.2009.05.010

Lerner, J., & Tirole, J. (2004). Efficient Patent Pools. *The American Economic Review*, *94*(3), 691-711. http://www.jstor.org/stable/3592948

Li, Y., & Thorson, E. (2015). Increasing news content and diversity improves revenue. *Newspaper Research Journal*, *36*(4), 382-398. https://doi.org/10.1177/0739532915618408

Liu, Y., & Feng, J. (2021). Does Money Talk? The Impact of Monetary Incentives on User-Generated Content Contributions. *Information Systems Research*, *32*(2), 394-409. https://doi.org/10.1287/isre.2020.0971

Lorenzon, E. (2022). Zero-rating, content quality, and network capacity. *Information Economics and Policy*, *58*, 100965. https://doi.org/https://doi.org/10.1016/j.infoecopol.2022.100965

Mantena, R., Sankaranarayanan, R., & Viswanathan, S. (2010). Platform-based information goods: The economics of exclusivity. *Decision Support Systems*, *50*(1), 79-92.

Meniere, Y., & Parlane, S. (2010). Decentralized licensing of complementary patents: Comparing the royalty, fixed-fee and two-part tariff regimes. *Information Economics and Policy*, *22*(2), 178-191. https://doi.org/https://doi.org/10.1016/j.infoecopol.2009.10.003

Meurer, M. J. (1989). The Settlement of Patent Litigation. *The RAND Journal of Economics*, *20*(1), 77-91. https://doi.org/10.2307/2555652

Mukherjee, A., & Mukherjee, S. (2013). Technology licensing and innovation. *Economics Letters*, *120*(3), 499-502. https://doi.org/https://doi.org/10.1016/j.econlet.2013.05.015

Nalebuff, B. (1987). Credible Pretrial Negotiation. *The RAND Journal of Economics*, *18*(2), 198-210. https://doi.org/10.2307/2555547

Niu, S. (2017). Profit-sharing licensing. *Journal of Economics*, *121*(3), 267-278. https://doi.org/10.1007/s00712-017-0528-6

Rahmani, M., Roels, G., & Karmarkar, U. S. (2017). Collaborative Work Dynamics in Projects with Co-Production. *Production and Operations Management*, *26*(4), 686-703. https://doi.org/https://doi.org/10.1111/poms.12670

Reinganum, J. F., & Wilde, L. L. (1986). Settlement, Litigation, and the Allocation of Litigation Costs. *The RAND Journal of Economics*, *17*(4), 557-566. https://doi.org/10.2307/2555481

Sar, E. V. d. (2021). *YouTube Processes 4 Million Content ID Claims Per Day, Transparency Report Reveals*. https://torrentfreak.com/youtube-processes-4-million-content-id-claims-per-day-transparency-report-reveals-211207/

Sun, M., & Zhu, F. (2013). Ad Revenue and Content Commercialization: Evidence from Blogs. *Management Science*, *59*(10), 2314-2331. https://doi.org/10.1287/mnsc.1120.1704

Tang, Q., Gu, B., & Whinston, A. B. (2012). Content Contribution for Revenue Sharing and Reputation in Social Media: A Dynamic Structural Model. *Journal of Management Information Systems*, *29*(2), 41-76. https://doi.org/10.2753/MIS0742-1222290203

Wang, X. H. (1998). Fee versus royalty licensing in a Cournot duopoly model. *Economics Letters*, *60*(1), 55-62. https://doi.org/https://doi.org/10.1016/S0165-1765(98)00092-5

Wang, X. H. (2002). Fee versus royalty licensing in a differentiated Cournot duopoly. *Journal of Economics and Business*, *54*(2), 253-266. https://doi.org/http://dx.doi.org/10.1016/S0148-6195(01)00065-0

Whateley, D., & Perelli, A. (2023). *$18,000 for a song? YouTube creators testing its new music-licensing feature are feeling sticker shock*. https://www.businessinsider.com/youtube-creator-music-licensing-tool-prices-shock-influencers-2023-2

Yoon, K. (2002). The optimal level of copyright protection. *Information Economics and Policy*, *14*(3), 327-348. https://doi.org/https://doi.org/10.1016/S0167-6245(01)00062-2

Zhou, R., Khemmarat, S., Gao, L., Wan, J., & Zhang, J. (2016). How YouTube videos are discovered and its impact on video views. *Multimedia Tools and Applications*, *75*(10), 6035-6058. https://doi.org/10.1007/s11042-015-3206-0