Equilibrium Licensing of Public Performance Rights

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Abstract

In a closing statement of the review of the ASCAP and the BMI consent decrees, the US Department of Justice noted that the decrees require ASCAP and BMI to grant licensees full rights to use their repertories, rather than a fractional right that would require the licensee to license fractional rights from multiple organizations. This paper investigates the effect of the proposed switch from fractional to full-work licensing on licensing equilibrium. A theoretical condition is established, under which total licensing revenues would decrease after the regime switch. Some assessment on the plausibility of the condition is provided.
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1 Introduction

A public performance license is an agreement between the owner of a copyrighted musical composition (e.g., lyrics, melody, arrangement) and a user (e.g., radio stations, restaurants, shops and live music venues) that grants permission to perform the musical composition in public. Due to the high transaction costs associated with licensing performance rights from individual copyright owners, the performance rights are collectively managed by the so-called Performing Rights Organizations (PROs), which collect publishing royalties from licensees and distribute the revenues to the songwriters and publishers.[1]

PROs monitor music users for public performance of their members' compositions (repertories), which can be very difficult to do for individual songwriters or publishers. However, by issuing a 'blanket license' to provide users access to millions of songs in their repertories, PROs have long raised antitrust concerns; and in fact they have been subject to consent decrees since the United States brought lawsuits in 1941 alleging that PROs had unlawfully exercised market power acquired through the aggregation of public performance rights in violation of Section 1 of the Sherman Act (Department of Justice, 2016).

This paper investigates a certain aspect of the PRO's licensing and its antitrust implications in light of the Department of Justice (DoJ)'s recent review of the PRO consent decrees. We do so by explicitly taking into account the fact that there are more than one PRO in the United States (and similarly in a number of other countries). Specifically, in the US, the American Society of Composers, Authors, and Publishers (ASCAP) represents over 16 million musical works; and Broadcast Music, Inc. (BMI) represents over 18 million musical works. Combined, the two PROs represent 90 percent of American songs (ASCAP, 2017).[2]

The literature on collective management of copyrights has often neglected the fact that there

[1]Performance royalties are only owed to songwriters and their publishers and not for recording artists or labels, who own master rights to a particular recording of the musical composition. In addition to selling vinyl and CDs, recording artists/labels in the US can earn revenues from digital or satellite radios as well as streaming and download services such as Spotify, Amazon, and Apple.

[2]There are more, smaller PROs in the US. For example, another PRO, the Society of European Stage Authors and Composers (SESAC), represents over 1 million songs; Global Music Rights (GMR) started in 2013 and remains small. For tractability, we only assume two PROs to show the main implications of equilibrium licensing, but the analysis would be generalizable to more than two PROs.

are multiple PROs, from which songwriters can choose to represent their works. In particular, this can matter because songwriters can only choose one PRO, and songs can be co-written and co-owned by members of different PROs. Hence, it is unclear how much competition there is between the two PROs in terms of licensing the performance rights. This is further complicated by the fact that a user may obtain licenses from both PROs instead of just one, and each PRO must consider this fact when they make a licensing offer to the music user.

Therefore, to better understand the pricing incentives and resultant licensing revenues, we first derive the equilibrium licensing with two PROs under the current 'fractional' licensing regime. The fractional licensing regime means that each PRO only possesses rights to fractional shares of the musical works that are owned by members of the respective PRO. This implies that a user needs to obtain licenses from both PROs in order to perform the musical works that are jointly owned by members of the two PROs. With a license from a single PRO, the user can only play works that are written by and thus wholly owned by members of that PRO.

In contrast, in a recent review of the ASCAP and BMI consent decrees, the Department of Justice interpreted that the decrees require so-called 'full-work' licensing, which would mean that a PRO should license all works in its repertory including those that are jointly owned with the members of other PROs. Hence, a user would be able to perform works without infringement that are co-written by members of the two PROs with a performance license from either PRO. Although federal courts have subsequently disagreed with the DoJ's statement, the fractional versus full-work licensing remains to be an important foundational issue (Delrahim, 2021).

What we find in our analysis is that revenue-maximizing PROs set license fees in such a way that the user obtains licenses from both PROs. However, there are two types of equilibria, depending on whether a single license serves as an effective alternative to obtaining both licenses. If it does, then the licensing fees will be depressed and the user who obtains both licenses will receive a positive surplus. If it does not, then the two PROs can jointly extract the entire surplus from the user.

How would the change from fractional to full-work licensing regime affect the licensing equilibrium? While the answer is in general ambiguous, we provide a sufficient condition under which

full-work licensing would change the type of licensing equilibria mentioned above, depending on whether the user's utility from accessing all (separately or jointly owned) repertories is greater or less than the sum of utilities from accessing only those works that are wholly owned by the respective PRO.

While the theoretical condition under which the PROs' royalty revenues would decrease after the licensing regime change depends on the shape of the user's utility function, the condition is more likely to be satisfied, holding everything else constant, if the quantity and/or quality of the jointly-owned repertories were larger. We look at some data on recent song titles that would be popular to the public and find that a significant share of the popular titles are in fact co-owned by one of the two major PROs (i.e., ASCAP and BMI) rather than wholly owned by them.

There is a growing literature on Collective Management Organizations (CMOs). For instance, Towse (2012) examines a case of a government-proposed, digital clearing house for copyright licenses and whether it can encourage competition between CMOs. Watt (2015) analyzes a model of a CMO that signs licensing contracts with users and distributes royalty payments to its members, and finds that there are efficiency gains from the members' risk-sharing as well as the PROs' blanket license. Handke (2016) compares individual and joint copyrights management and argues that new retail-focused, for-profit intermediaries in the digital market for copyrighted music may substitute for traditional CMOs.

Earlier related works includes Hollander (1984), who investigates the effect of royalty rates on the number of copyrighted works produced and the circulation of these works. Besen et al. (1992) analyze a monopoly CMO with closed or open membership, where the CMO exercises its market power by setting its blanket license fee at the total value to the licensee of the CMO's repertory; they also consider competition among CMOs, where an incumbent may use limit pricing to deter entry, and argue that countervailing power by users can discourage the formation of competing CMOs. However, they do not consider the jointly owned works, hence, the issue of fractional versus full-work licensing.

Our paper is also related to Kleit (2000), where competition between profit-maximizing

PROs takes place in a horizontally differentiated product space and the PROs can sell either a blanket or a per-use license that allows for picking and playing a particular song ex post. Kleit's finding is that blanket licenses generate higher profits for the PROs than per-use licenses, which explains why PROs are reluctant to offer per-use licenses in the real world. We consider in our model blanket licenses, which the aforementioned literature found is optimal in many use cases, and focus on the effect of the licensing regime.

2 Model

There are two Performing Rights Organizations (PROs), labeled as A and B, which license the performance rights of its members' musical works to music venues, media broadcasters, and streaming services (henceforth, users/licensees). With slight abuse of notation, we also denote the set of musical works (i.e., a repertory) whose ownership rights are entirely (100%) represented by the respective PRO as A and B. Additionally, there is a set of musical compositions co-written, hence jointly owned, by members of each PRO, which we denote as C. Therefore, the three sets represent a mutually exclusive partition of a universe of musical compositions X.[3]

Under the current, fractional licensing, a user who exclusively obtains the performance license from PRO A (or B) has only access to the repertory that is 100% owned by PRO A (or B), while a use who obtains both licenses from PRO A and PRO B has access to the jointly-owned repertory C as well as A and B. Under the proposed, full-work licensing, the change is that a user who exclusively obtains a license from PRO A (or B) has access to the repertory C and A (or B), while a user who obtains both licenses under full-work licensing has access to all three repertorys (A, B, and C) just like a user does under fractional licensing.

A user's preference is represented by a utility function $U : \Omega^X \to R$, where Ω^X is the power set of the universe of musical works X; and R is the real line. For now, we impose the following

[3]Here, we take the universe of musical works as given. The universe includes all historically created stock of compositions including derivative works and new arrangements of, e.g., the works in the public domain. Hence, most of once-copyrighted musical works are still protected. On the other hand, new musical works are created; however, the qualitative results of our analysis would remain the same as long as the additions to the universe of musical works are relatively small.

monotonicity condition on preference: for any $X_1, X_2 \in X$, $U(X_1) < U(X_2)$ if and only if $X_1 \subset X_2$. This means that the user always prefers a repertory more than any subset of the repertory. This is a weaker condition, hence more general, than the monotonicity condition that can be similarly constructed based on the cardinality of the repertory sets, namely, for any $X_1, X_2 \in X$, $U(X_1) < U(X_2)$ if and only if $|X_1| < |X_2|$.[4]

We assume that the two PROs simultaneously make a take-it-or-leave-it offer to the user, specifically, offering a blanket license to perform any work in their repertory at a fixed fee, P_A and P_B, consistent with a given (fractional or full-work) licensing regime. Then the user chooses whether to obtain a license from PRO A, B, or both.[5] We normalize the outside option of obtaining neither to zero and assume that the user's utility is quasi-linear in price and each PRO, A and B, wants to maximize its licensing fee for any given user. The solution concept is the subgame perfect Nash equilibrium.

3 Analysis

First, let us consider the fractional licensing regime. As usual, we start from the second stage of the game where a user decides which license(s) to obtain given an arbitrary pair of license fees offered by the two PROs. Note that the net utility from only obtaining a license from PRO A is $U(A) - P_A$; similarly, it is $U(B) - P_B$ from PRO B. On the other hand, the net utility from obtaining both licenses is $U(A \cup B \cup C) - P_A - P_B$. Given the monotonicity of the user's preference, we know $U(A \cup B \cup C) > U(A)$ and $U(A \cup B \cup C) > U(B)$; however, we do not generally know whether $U(A) \geq U(B)$ or $U(A) \leq U(B)$.

Thus, without loss of generality, we assume $U(A) \leq U(B)$. Given the licensing fees, P_A and P_B, the user's choice is optimal if it is incentive compatible and individually rational. For instance, the user would only obtain a license from PRO A when it is preferred to obtaining a

[4]Notice that the monotonicity condition does not imply that the user only cares about the size of the repertory (or the cardinality of the set) because, for instance, even if $|X_1| < |X_2|$, it does not necessarily follow that $U(X_1) < U(X_2)$ if $X_1 \not\subset X_2$.

[5]We do not consider the case in which a user wants to directly obtain performance licenses from individual copyright owners, because the costs of searching for and negotiating with a large number of individual owners is too high for many use cases.

license from B or from both A and B, which implies $U(A) - P_A \geq U(B) - P_B$ and $U(A) - P_A \geq U(A \cup B \cup C) - P_A - P_B$. In addition, the net utility from only obtaining a license from A should be nonnegative for it to be an optimal choice, which implies $U(A) - P_A \geq 0$. Applying the same logic to the other alternatives and rearranging yield the following lemma.

Lemma 1. Under fractional licensing, the following holds true:
i) A user only obtains a license from A if

$$\begin{aligned} P_B &\geq U(B) - U(A) + P_A \\ P_B &\geq U(A \cup B \cup C) - U(A) \\ P_A &\leq U(A) \end{aligned} \tag{1}$$

ii) A user only obtains a license from B if

$$\begin{aligned} P_B &\leq U(B) - U(A) + P_A \\ P_A &\geq U(A \cup B \cup C) - U(B) \\ P_B &\leq U(B) \end{aligned} \tag{2}$$

iii) A user obtains both licenses from A and B if

$$\begin{aligned} P_B &\leq U(A \cup B \cup C) - U(A) \\ P_A &\leq U(A \cup B \cup C) - U(B) \\ P_B &\leq U(A \cup B \cup C) - P_A \end{aligned} \tag{3}$$

Lemma 1 yields two types of user's license choice depending on whether $U(A \cup B \cup C) \gtreqless U(B)+U(A)$. Let us first consider the case of $U(A \cup B \cup C) \leq U(B)+U(A)$. Figure 1 shows the user's optimal choice as a function of the two PROs' licensing fees, P_A and P_B. Specifically, it shows a parameterization where obtaining a license from PRO A or PRO B serves as competing alternatives for the user, because the areas of license price pairs (P_A, P_B) that lead the user to

only obtain a license from A or B are adjacent to each other. Hence, when the license fees are neither too small or too large, the user chooses whichever PRO's license that provides a higher net utility.

On the other hand, if both licensing prices, P_A and P_B, are sufficiently small, then the user chooses to obtain both PROs' licenses because the utility gain from adding a second license would outweigh the additional cost. This area is represented by the square in the bottom-left corner of Figure 1. The 45-degree line from the y-intercept, $U(B)-U(A)$, comprises the pairs of prices at which the user is indifferent between obtaining either of the two PROs' licenses. Note that, whenever the two PROs' licenses compete with each other, the positive y-intercept allows PRO B to charge a higher license fee than PRO A by the difference in utilities from standalone licensing.

Knowing the user's optimal choice, the two PROs choose license fees in a price competition. Without the alternative of obtaining both licenses from PRO A and B, the equilibrium would be standard: PROs will bid down their prices until PRO A's price becomes zero and PRO B sells its license at a price of $U(B) - U(A) \geq 0$. With the possibility of obtaining both licenses, however, the price competition only drives down the prices to $P_A = U(A \cup B \cup C) - U(B)$ and $P_B = U(A \cup B \cup C) - U(A)$, the incremental utilities, at which point the PROs have no incentive to decrease their licensing fees further because the user would obtain both licenses.

It turns out that the user obtains both PROs' licenses and receives a positive surplus in equilibrium. In Figure 1, a price pair that would extract the full surplus from the user would lie on the dashed line with a slope of -1 and a y-intercept of $U(A \cup B \cup C)$; however, the equilibrium pair of prices (indicated with a dot) is below this line. In fact, the user's surplus is $U(A \cup B \cup C) - P_A - P_B = U(A) + U(B) - U(A \cup B \cup C) \geq 0$, so the benefit from PROs' licensing competition would be greater for a user who values more the standalone licenses, $U(A)$ and $U(B)$, holding constant the utility from obtaining both licenses, $U(A \cup B \cup C)$.

Proposition 1. Given a partition of X, suppose $U(A \cup B \cup C) \leq U(A) + U(B)$ holds true. There is a unique equilibrium, in which PROs set their licensing fees as $P_A^* = U(A \cup B \cup C) - U(B)$

and $P_B^* = U(A \cup B \cup C) - U(A)$; and the user accepts both licensing offers.

In this case, the option of purchasing only one of the two PROs' licenses exerts a competitive pressure on pricing to the extent that single sourcing from PRO A or PRO B remains as viable alternatives to each other. Given the parameterization, the competitive force drives down the license fees, so the two PROs cannot extract the full surplus from the licensee. Therefore, the sum of the two PROs' licensing revenues is lower than the full surplus extraction, which a monopoly PRO could achieve (if there were only one PRO) or two PROs may nonetheless be able to achieve under some conditions (as we show below).

Next, consider the case where $U(A \cup B \cup C) \geq U(B) + U(A)$, so the benefit to the user from obtaining only one of the two PROs' licenses is sufficiently small. The user's optimal choice under this parameterization is illustrated in Figure 2. Recall that the 45-degree line from the y-intercept is the line where the user is indifferent between obtaining either of the two PROs' licenses. Figure 2 shows that this line does not define the two areas in which the user chooses to only obtain a license from PRO A or PRO B, respectively. That is, the 45-degree line is slack when it is optimal for the user to obtain a single license.

Hence, in this parameterization, there is no direct competition among PROs to win over the user. The option to get a license from a single PRO is not a viable alternative to obtaining licenses from both PROs unless the price of one license is sufficiently low and the price of the other sufficiently high. Given this choice behavior, the equilibrium occurs at price pairs where the user obtains both licenses and the two PROs together extract the user's full surplus. On the other hand, the utility from obtaining both licenses, $U(A \cup B \cup C)$, must be divided between the two PROs, which yields a multiplicity of equilibria.

Proposition 2. Given a partition of X, suppose $U(A \cup B \cup C) \geq U(A) + U(B)$ holds true. There is a continuum of equilibria, in which PROs set their licensing fees so that $P_A^* + P_B^* = U(A \cup B \cup C)$, $P_A^* \geq U(A)$, and $P_B^* \geq U(B)$; and the user accepts both licensing offers.

The full surplus extraction is the same as that of the monopoly PRO, even though there are two PROs offering their respective licenses in a non-cooperative, one-shot price-setting game. Thus, the equilibrium outcome is collusive even without any communication to collude. For this to hold, note that $U(A \cup B \cup C)$ must be greater than $U(A) + U(B)$; hence, given a partition of the universe X, the repertory C that is jointly created and owned by members of the respective PRO plays an important role. If the set C contains a larger number of songs the user values highly, then the condition is more likely to be satisfied.

4 Regime Switch

We now consider what happens when the licensing regime changes from fractional to full-work licensing. In the latter, the user can access the repertory C, jointly owned by the two PROs, even when the user only obtains a license from one PRO. That is, as long as PROs issue blanket licenses and the jointly owned works are in each PRO's repertory, either PRO's license gives the licensee the right to perform all works contained in the PRO's repertory.

Therefore, the change in terms of the user's preference is that the utility from only obtaining PRO A's license changes from $U(A)$ to $U(A \cup C)$; and that from obtaining PRO B's license changes from $U(B)$ to $U(B \cup C)$. Accordingly, Lemma 1 changes, whereby $U(A \cup C)$ and $U(B \cup C)$ substitute for $U(A)$ and $U(B)$, respectively. Note that the utility from obtaining both licenses, $U(A \cup B \cup C)$, remains unchanged under the full-work licensing.

Given the monotonicity assumption, it follows that $U(A) < U(A \cup C)$ and $U(B) < U(B \cup C)$; thus, the effect of the regime switch can be illustrated by using Figure 1 and Figure 2: If the licensing equilibrium prior to the switch is of the type shown in Figure 1, where the equilibrium licensing fees are $P_A^* = U(A \cup B \cup C) - U(B)$ and $P_B^* = U(A \cup B \cup C) - U(A)$, then both fees will decrease after the switch because $U(A) < U(A \cup C)$ and $U(B) < U(B \cup C)$, while $U(A \cup B \cup C)$ remains unchanged.

On the other hand, if the licensing equilibrium prior to the switch is of the type shown in Figure 2, then there is a range of equilibrium licensing fees, P_A^* and P_B^*, that fully extract the

user's surplus from obtaining both licenses. When the utility terms $U(A)$ and $U(B)$ change to $U(A \cup C)$ and $U(B \cup C)$, respectively, under full-work licensing, one possibility is that the range of equilibrium licensing fees shrinks, but the combined fees still extract the full surplus from the user, $U(A \cup B \cup C)$.

Another possibility is that Figure 2 no longer characterizes the equilibrium after the regime switch; instead, Figure 1 does. In this case, full-work licensing means that the two PROs can no longer fully extract the user's surplus from accessing all three repertories, decreasing the two PROs' combined royalty revenues. Therefore, the full-work licensing can change the licensing equilibrium from monopolistic to competitive type, but this change is not guaranteed. Below, we identify a condition under which this change occurs.

Proposition 3. Suppose the utility function is strictly subadditive; that is, $U(X_1 \cup X_2) < U(X_1) + U(X_2)$ for any $X_1, X_2 \in X$. If $P_A^* + P_B^* = U(A \cup B \cup C)$ under fractional licensing, then $P_A^* + P_B^* < U(A \cup B \cup C)$ under full-work licensing.

A strict subadditivity means that a user values more the sum of the utilities from accessing a repertory X_1 and a repertory X_2 than the utility from accessing both repertories at the same time. We think that this assumption is plausible in many cases; for instance, most people value listening to a song, and while they are likely to value more listening to two songs, the incremental utility from an additional song may be lower than the first one. Thus, the utility from two songs is not twice as high as the utility from accessing a song.[6]

If we accept the subadditivity of the utility function, then what is important for the change in the type of licensing equilibrium is that the two PROs fully extract the user's surplus before the regime switch; that is, $U(A \cup B \cup C) \geq U(A) + U(B)$ holds under fractional licensing (from Proposition 2). Then Proposition 3 tells us that the two PROs' combined royalty revenues,

[6]This logic applies to a bundle of songs. Note, however, that subadditivity is a weaker condition than concavity, because here the utility is a set function which does not require musical works in the sets of repertories A, B, and C to be fungible, so only the quantity matters. For instance, $|X_1| \geq |X_2|$ does not imply $U(X_1) \geq U(X_2)$.

P_A^* and P_B^*, would decrease under full-work licensing, while the user's net surplus (or indirect utility) increase from zero to a positive figure in new equilibrium.

We can attempt to assess whether $U(A \cup B \cup C) \geq U(A) + U(B)$ is likely to hold in the real world by comparing the sizes of repertories A, B, and C while holding constant the quality of the repertories. Specifically, we consider recent, popular songs in the ASCAP's, the BMI's and their jointly-owned repertories as those that represent the theoretical counterparts A, B, and C, respectively. The reason for focusing on popular songs is because firstly it is infeasible to collect copyright ownership data for all historically created songs and secondly popular songs would affect the utility value more than the long tail of music does.

We thus collect data on the copyright ownership of musical compositions (writers and publishers) of the songs that entered the Billboard Hot 100 chart between January 2014 and December 2018. The Billboard Hot 100 is the music industry standard for songs, published weekly, and it is based on sales, radio play, and online streaming in the US, so we think that the songs that make up the charts are those that are most sought after or valued by the average music users. Although there are classic titles of the decades which are still played, we think that a look at the recent titles can provide a useful indication for the plausibility of the theoretical condition.

There are 2258 unique song titles that entered Hot 100 charts during the sample period, and we manually searched the copyright ownership information on the ASCAP repertory (https://www.ascap.co and the BMI repertory (https://repertoire.bmi.com/) websites. A tabulation of the data is provided in Table 1, where songs are classified into four groups—100% owned by ASCAP, 100% owned by BMI, Co-owned by ASCAP and/or BMI, and not found in ASCAP/BMI repertories. The last category represents those songs that are owned by smaller PROs such as SESAC, and comprises 3.5% of the titles in the sample. Hence, our focus is on the first three categories.

Table 1 shows that the size of the fractionally-owned repertories among the Billboard Hot 100 songs is significantly larger (74.9%) than those 100% owned by either ASCAP (10.4%) or BMI (11.2%). This is more or less the same if we count the number of title-weeks instead of unique titles. Thus, in terms of quantity, $U(A \cup B \cup C) \geq U(A) + U(B)$ is a plausible condition, given the sheer size of the set C, even after considering the fact that the utility function is

subadditive.

Table 1 also shows the title-level averages of chart duration, peak rank, and mean rank by the same categorization, so they represent some measures of quality. Our assessment based on the quantity may need to be adjusted if the quality among the groups were considerable different. However, the differences in the mean among the first three groups are statistically insignificant, so the three groups are relatively homogeneous in terms of quality, hence, comparable in terms of quantity.

Specifically, one-way analysis of variance tells us that the null hypothesis that the three groups' means are the same cannot be rejected at the 5% level in the case of average chart duration and peak rank. The null is rejected at the 5% level in the case of average mean rank, but pairwise comparisons indicate that this significance is due to the difference between group A (ASCAP) and group B (BMI) rather than due to group C (Co-owned). Hence, group C is not really different from the other two in terms of quality, so the above assessment stands.

5 Discussion

We have analyzed a simple model of public performance licensing in the presence of two PROs. In equilibrium, the user ends up licensing from both PROs; however, the type of equilibrium may differ by the fractional or full-work licensing regime. Under the condition where the user's utility is subadditive and the co-owned repertory adds a significant marginal value to the user, we have shown that the switch to the full-work licensing regime may lead to lower licensing revenues for the PROs and a higher surplus for the user.

From the social standpoint, there are trade-offs if the PROs' combined revenues were to decrease under full-work licensing. On the one hand, lower licensing revenues may lead to a lower remuneration to the songwriters, so it may discourage the entry of new writers and/or encourage the exiting of existing writers. On the other hand, a higher surplus for the licensees can entice the entry of new users and/or enable R & D activities of existing users. Thus, the net welfare implication would be difficult to predict in our model.

Appendix

Proof of Proposition 1. The Nash equilibrium of the pricing game is a pair of prices (P_A, P_B) such that each price is a best response to the other.

First, suppose $P_B > U(B)$. Then PRO A's best response is to set $P_A = U(A)$ because the user would accept A's licensing offer. In turn, PRO B can win over the user by setting $P_B = U(B) - \epsilon$, where ϵ is the smallest monetary unit. Thus, $P_B > U(B)$ is not an equilibrium. Similarly, it can be shown that $P_A > U(A)$ is not an equilibrium.

Second, suppose $P_B \leq U(B)$ and $P_B > U(A \cup B \cup C) - U(A)$. Then PRO A's best response is to set $P_A = P_B - U(B) + U(A) - \epsilon$ because the user would accept A's licensing offer. In turn, PRO B can win over the user by setting $P_B - 2\epsilon$ and so forth. Thus, $P_B > U(A \cup B \cup C) - U(A)$ is not an equilibrium. Similarly, it can be shown that $P_A > U(A \cup B \cup C) - U(B)$ is not an equilibrium.

Third, suppose $P_B = U(A \cup B \cup C) - U(A)$. Then the user would accept PRO B's licensing offer regardless of PRO A's licensing fee. Thus, A's best response is to set its licensing fee at the highest price that the user would accept, which is $P_A = U(A \cup B \cup C) - U(B)$. Given this, B's best response is to set $P_B = U(A \cup B \cup C) - U(A)$ for the analogous reason.

Fourth, suppose $P_B < U(A \cup B \cup C) - U(A)$. Then the user would accept PRO B's licensing offer regardless of PRO A's licensing fee. Thus, A's best response is to set $P_A = U(A \cup B \cup C) - U(B)$. Given this, B's best response is to set $P_B = U(A \cup B \cup C) - U(A)$. Therefore, $P_B < U(A \cup B \cup C) - U(A)$ is not an equilibrium. Similarly, it can be shown that $P_A < U(A \cup B \cup C) - U(B)$ is not an equilibrium. □

Proof of Proposition 2. The proof proceeds in a similar manner to the Proof of Proposition 1.

First, suppose $P_B > U(A \cup B \cup C) - U(A)$. Then PRO A's best response is to set $P_A = U(A)$ because the user would accept A's licensing offer. In turn, PRO B would set $P_B = U(A \cup B \cup C) - U(A)$ because it is the highest price at which the user would additionally obtain a license from PRO B. Hence, $P_B > U(A \cup B \cup C) - U(A)$ is not an equilibrium. Similarly,

$P_A > U(A \cup B \cup C) - U(B)$ is not an equilibrium.

Second, suppose $P_B \leq U(A \cup B \cup C) - U(A)$ and $P_B \geq U(B)$. Then PRO A's best response is to set $P_A = U(A \cup B \cup C) - P_B$ because it is the highest price at which the user would additionally obtain a license from PRO A. In turn, PRO B has no incentive to decrease its initial price P_B because doing so would only decrease its licensing revenue. It has no incentive to increase its initial price either because the user would not obtain a license from either PRO.

Third, suppose $P_B < U(B)$. Then PRO A's best response is to set $P_A = U(A \cup B \cup C) - U(B)$ because it is the highest price at which the user would additionally obtain a license from PRO A. In turn, PRO B would set $P_B = U(B)$ because it is the highest price at which the user would obtain a license from PRO B. Hence, $P_B < U(B)$ is not an equilibrium. Similarly, $P_A < U(A)$ is not an equilibrium. □

Proof of Proposition 3. From the subadditivity, for a given partition of musical works A, B, and C, it follows that $U(A \cup B \cup C) < U(A \cup C) + U(B)$. If $P_A^* + P_B^* = U(A \cup B \cup C)$, then $U(A \cup B \cup C) \geq U(A) + U(B)$ from Proposition 2. Thus, it follows that $U(A \cup C) + U(B) \leq U(A \cup C) + U(A \cup B \cup C) - U(A)$. By the subadditivity, $U(A \cup B \cup C) < U(A) + U(B \cup C)$. By substituting in for $U(A \cup B \cup C)$, it follows that $U(A \cup C) + U(A \cup B \cup C) - U(A) < U(A \cup C) + U(A) + U(B \cup C) - U(A) = U(A \cup C) + U(B \cup C)$. Thus, $U(A \cup B \cup C) < U(A \cup C) + U(B \cup C)$; and Lemma 1 and Proposition 1 imply that $P_A^* + P_B^* < U(A \cup B \cup C)$. □

Table 1: Billboard Hot 100 Entries, 2014-2018

	ASCAP	BMI	Co-owned	Others
No. of unique titles	235	253	1691	79
%	(10.4%)	(11.2%)	(74.9%)	(3.5%)
No. of title-weeks	2769	2788	19403	454
%	(10.9%)	(11.0%)	(76.4%)	(1.8%)
Avg. weeks on chart	11.78	11.02	11.47	5.75
SD	(11.57)	(11.57)	(11.31)	(8.94)
Avg. peak rank	49.69	55.35	51.11	63.89
SD	(30.20)	(28.56)	(29.33)	(27.38)
Avg. mean rank	63.34	68.55	65.60	72.24
SD	(24.15)	(21.24)	(22.84)	(22.73)

The sample comprises all titles that have entered Billboard Hot 100 chart during calendar years 2014-2018, matched to the weekly charts until March 2019. ASCAP (BMI) means 100% owned by ASCAP (BMI); Co-owned means either ASCAP or BMI has a fractional ownership; Others means neither ASCAP now BMI has a fractional ownership. SD is standard deviation.

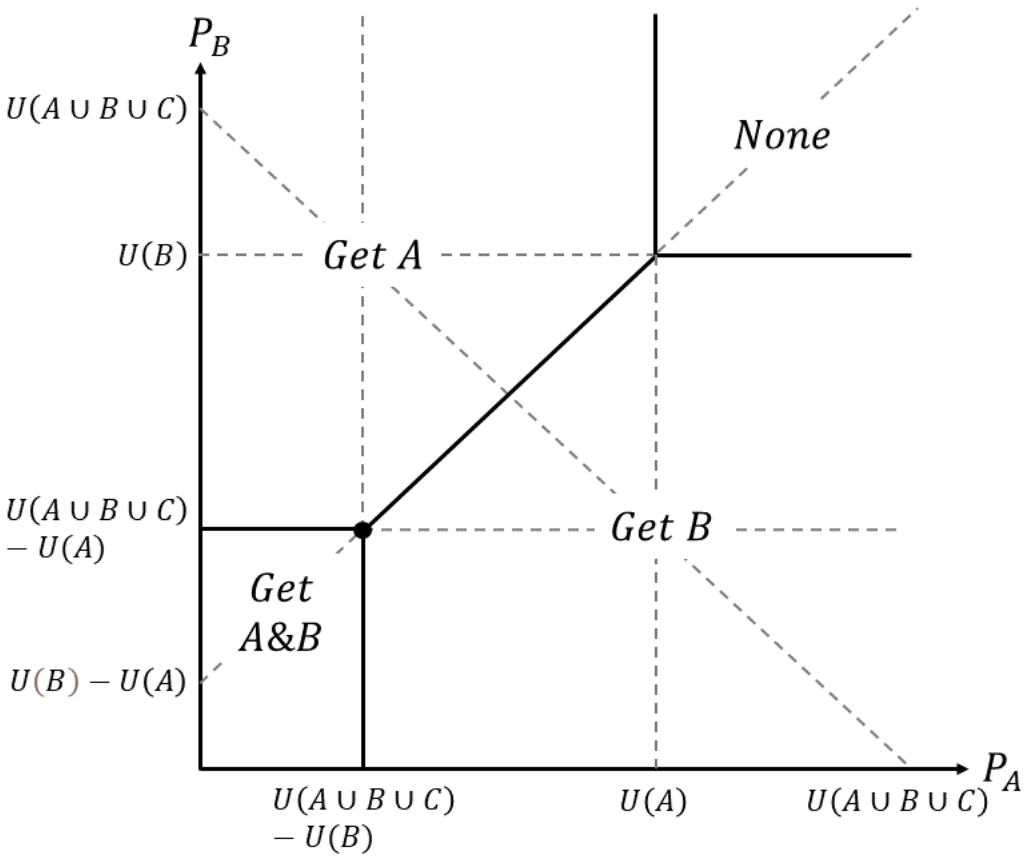

Figure 1: Equilibrium Configuration (Case 1)

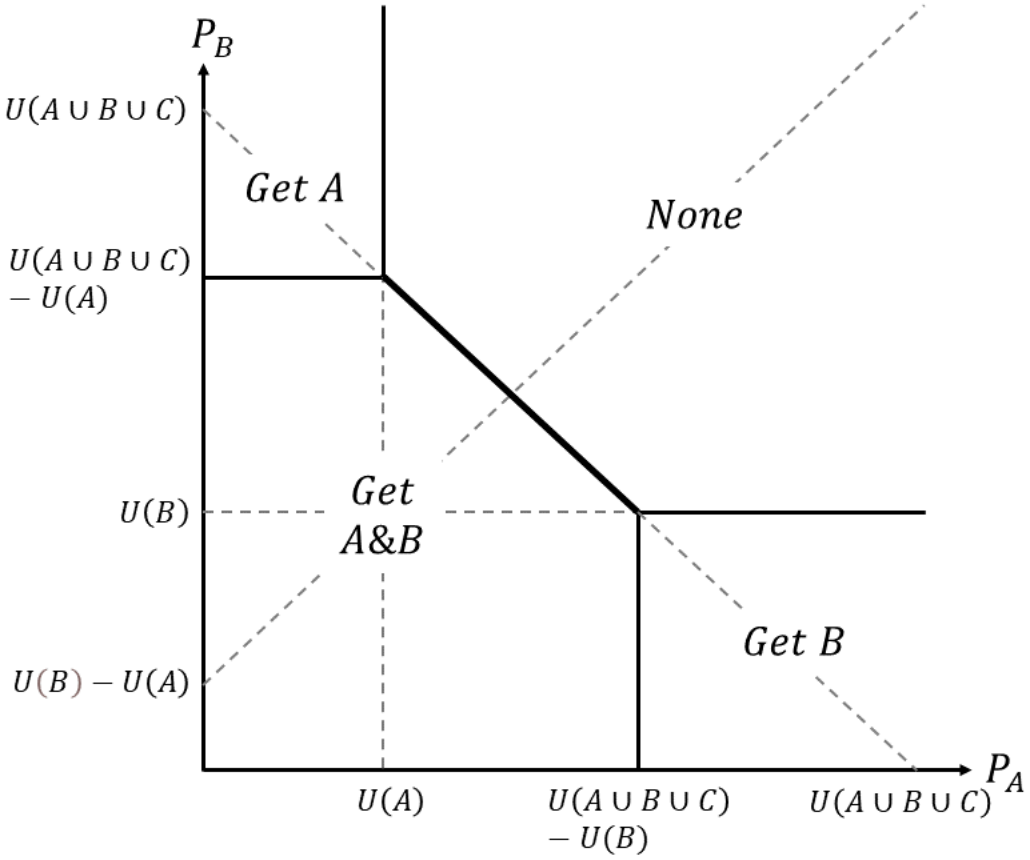

Figure 2: Equilibrium Configuration (Case 2)

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