Review of Economic Research on Copyright Issues, 2010, vol. 7(2), pp. 21-37

FAIR COPYRIGHT REMUNERATION: THE CASE OF MUSIC RADIO

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ABSTRACT. The issue of what price should be set for the music input to radio broadcasts has been hotly debated recently in several countries, including USA, Canada and New Zealand. Since music is subject to copyright, this is an issue that is of great importance to the economics of copyright. The central point is the fact that, because of the economic efficiency that is gained by collective management and blanket licencing, the copyright holders in music are represented by a single bargaining unit. The ensuing monopoly power is often seen to be detrimental to social efficiency, and so in exchange for allowing the collective to form and operate, the price at which it grants access to its repertory is regulated. The regulated price should be set at a fair and equitable level. In this paper, the Shapley methodology is used to attempt to provide such a tariff.

1. Introduction

The theory of copyright royalty contracts is not new. However, most of the theory has considered how the royalty would be set by an income maximising right holder, for the case of patents rather than copyright, and for the case of royalty payments on produced output or fixed fees (see, for example, Kamien and Tauman, 1986, Wang, 1998, Fosfuri and Roca, 2004, and Sen, 2005). There are also models in which the royalty contract is the outcome of a bargaining round between a copyright holder and a copyright user (see, for example, Alonso and Watt, 2003, and Michel, 2006). In essence, it can be seen that the copyright royalty that emerges from such models is nothing more than the price at which access to the copyright material is granted to the user.

The price of access to copyright material is an issue of great importance to the economic theory of copyright. Given that the grant of copyright confers monopoly power upon the copyright holder, it is often thought that the price that the right holder would like to set for access to his property is set too high for social efficiency. Above all, when copyright is negotiated collectively, there is a fear that the increased

The author is grateful to the hospitality of ICER in Turin (Italy), where he was visiting while this paper was written.The author is endebted to Ruth Towse, and an anonymous referee for very valuable comments and suggestions that have improved the paper. As always, the author remains the sole responsible for any remaining errors.

bargaining power that the strong monopoly position provides for the collective will lead to unfair price setting arrangements. This has led to some copyright tariffs being set by regulatory bodies, who search for a tariff that is "fair" or "equitable" to all parties to the transaction.[1] For example, the question of the tariff under which access to music for radio broadcasts has been set by regulatory bodies in many countries, and the rate that exists has recently come under debate in copyright tribunals in USA, Canada, Australia, New Zealand, among others.[2] This will be the setting upon which the present paper focuses.

Although economics is primarily concerned with efficiency, and has had problems in dealing with questions of fairness, there is a sizeable economic theory on the general topic of fairness (see Baumol 1987). This literature generally discusses the question of pie-splitting between two or more parties. The general outcome of that is that fairness is an envy-free allocation – no party prefers the final allocation of another party to his own. However, this theory has difficulty in incorporating initial points, and reservation outcomes, and so is not overly useful for the case of real economic transactions such as that between a copyright holder and a copyright user. It is also true that when the object being shared is simply money (as is likely the case for copyright transactions), envy-free allocations collapse directly onto allocations that split the pie equally.

Outside of the envy-free concept of fairness, we can also look to the outcome that would be generated by an auction process, a bargaining process, or some other market mechanism. For example, in a famous paper, Lloyd Shapley (1953) used game theory, and in particular a variant of bargaining theory, to define a fair allocation of a given pie. The Shapley value methodology as a solution concept has been widely endorsed and lauded by economists as providing a fair and equitable allocation rule.[3] Indeed, it has a strong claim to being the best and fairest solution concept for a cooperative game of the type that concerns us here. It has been used in a variety of real-world problems where fair sharing is of issue, among

[1]Baumol (2004) uses efficient component pricing to arrive at an access price that conforms to a "level playing field". As far as I know, in spite of its obvious relevance to the pricing of copyrights, I do not know of any cases in which it has actually been applied by regulatory bodies in the area of copyright pricing.

[2]When music is broadcast on the radio, there are typically two rights to consider. Firstly there are the rights of the composer/lyricists and of the performer(s), and secondly there is the right of the owner of the sound recording (usually a record label). In many countries, there are different collecting societies that represent these different groups of copyright holders. The rate that has most recently come before the courts is that corresponding to the owner of the recording.

[3]For example, according to Nobel Laurate Robert Aumann; "[B]ecause of its mathematical tractability, the [Shapley] value lends itself to a far greater range of applications than any other cooperative solution concept. And in terms of general theorems and characterizations for wide classes of games and economies, the value has greater range than any other solution concept bar none." (emphasis in original). See Aumann (2008).

which.(interestingly), the Shapley value methodology has been applied to revenue-sharing games of exactly the same basic type as that of radio stations and musical composition and sound recording copyright owners. For example, it has been used to successfully find a revenue sharing rule for a multi-museum pass programme (see Ginsburg and Zang, 2004), for the Eurasian natural gas market where Russian gas is cooperatively delivered to Western European countries using pipelines that run through Poland and other transit countries.(see Hubert and Ikonnikova, 2003), and for sharing of subscription payments to internet providers (see Ma et al., 2007). The Shapley methodology allows us to arrive at allocation rules for any number of copyright users and holders, and thus is applicable to the case of music radio, in which there typically would be several stations (or broadcasting companies) and several different copyright holders (record labels), even though the copyright holders may act through a collective. For the case of sharing of the surplus from music radio among the stakeholders, I shall take as "fair" the Shapley sharing rule.

2. Collective contracting - the case of music radio

It is now well known that due to transactions costs, it is efficient for copyright holders in music to join together and market licences to their music under a blanket licence.[4] This, for example, is what happens when music radio stations purchase the rights to broadcast copyright content. The broadcasters are forced to deal with a collective, acting as a single representative of many individual copyright holders. However, since the copyright holders have formed a collective, it is feared that they may weld too much monopoly power in any negotiation over the price at which the music would be made available to radio stations. The ensuing social inefficiency has prompted that the price at which music is made available to radio stations is heavily regulated in many countries. The objective of the regulator is to set the price at a "fair" level, that is, a price that both fairly compensates the copyright holders for the use that is made of their property, and yet that is not charged with monopoly rents.

The first work to look at the question of the pricing of music copyrights that are administered collectively was Peacock and Weir (1975), which considered the bilateral monopoly between the monopsony buyer (the BBC) and the monopoly seller, the PRS, in England. Although there is now competition in broadcasting, Peacock and Weir (1975) certainly sets the historical position of the problem. This work is interesting because it was concerned with the role of government regulation through copyright law rather than subsidy as the means of support for artists, a topic that has now become very important in cultural policy (Towse, 2001). Peacock and Weir (1975) also provided guidance to the PRS on setting the royalty rate charged to the

[4]See Handke and Towse (2007) for a good survey of the literature on copyright collectives.

BBC for the use of copyrighted music. The previously established formula for determining the rate had been based on the number of BBC licence holders, and was the equivalent of a specific tax. However, Peacock and Weir (1975) recommended an *ad valorem* formula based on the BBC's licence revenue, a format that appears to have been almost universally adopted. This case was eventually accepted by the Performing Right Tribunal, the body that regulates copyright disputes in the UK which had the job of resolving the 'bilateral monopolists' dispute over the revenue to be paid to PRS.[5]

Aside from Peacock and Weir (1975), the only other academic effort to date that attempts to find a fair and equitable price for the particular case of music broadcast on the radio is Audley and Boyer (2007), who consider the (hypothetical) price that would emerge should the market be competitive rather than a two-sided monopoly. While academically noteworthy in its objective, the Audley and Boyer methodology has met with little support from regulatory bodies,[6] who have turned to other rationales for guidance as to a fair tariff.

The principal issue is the perception that if negotiations between the copyright collective and the music radio broadcasters were unregulated, then the monopoly position of the music copyright collective gives it an unfair advantage against the radio stations. In essence, the problem that is envisaged is that the copyright collective supplies an essential input, and as such it may hold-up the radio broadcasters until a very high price is agreed upon. If this is true, then the tariff that would emerge from an unregulated bargaining round would likely be too high for social efficiency. Thus, the objective is to attempt to find a tariff that, while still offering fair recompense to the copyright holders, is also a fair measure of value of music to the radio broadcasters.

One way to envisage such a scenario is to imagine what would happen if (hypothetically of course, and in absence of transactions costs) the different copyright holders in music were to negotiate the rights to their own individual repertories with each of the radio stations. When considering this hypothetical scenario, we must impose certain restrictions. They are the following;

(1) We should assume that there are no transactions costs, or at least, the transactions costs are the same as those that actually exist under collective

[5]Aside from the analysis relating to the tariff setting problem, the book also undertook research into composers' earnings (from all sources, not just from royalties), and ways of compensating copyright holders for private home-taping (for which they recommended the introduction of a 'blank tape' levy). Peacock and Weir thus conducted a survey of composers' incomes, which was, I believe, the first such research into artists' labour markets, on which much subsequent work has been done by cultural economists, in addition to their analysis of the economics of copyright administration.

[6]The methodology was rejected for the tariff that was set in Canada, and a modified version of the Audley Boyer methodology was rejected by the Copyright Tribunal in New Zealand.

administration of the rights. This is simply because, due to the economic efficiency of the collective administration, the collective will not actually be disbanded, and in the end the efficiency benefits of the collective will be retained. All that is of issue is the price that the collective ends up charging.

(2) We should assume that when the individual contracting scenario is envisaged, we restrict the entire game to a single price, which is what will be in the end charged by the collective. That is, we do not allow the different copyright holders to charge different prices to different users.

(3) In the same way, we do not allow any copyright holder to refuse to trade with any given user, so long as the user is willing to pay the price. This is of course reasonable, as there is at least the threat of compulsory licensing should a refusal to license occur.

The easiest way to do this is to simply model the demand side of the market as a single unit, rather than as different individual radio stations. By doing this, although we notionally treat the copyright holders as different suppliers, and thereby we remove the threat of monopoly power on the supply side, we add (again notionally) monopsony power to the demand side. This can only lead to a final tariff that is less favourable to the suppliers, and more favourable to the demanders.

2.1. **The Shapley methodology.** A good way to model such a scenario is to use the Shapley model of allocation, which has long been accepted as providing a fair and equitable sharing rule. The Shapley model is fair in that it offers to each player a payoff that only reflects the average value of what they would offer to the business, for each possible cohort of players differentiated by order of arrival of players in the cohort. Thus, this model removes any artificial monopoly power that derives from a player holding out an essential input until the last.

The main problem in applying the Shapley model to the division of market surplus from the music radio business is in working out how much surplus would be created by each possible sub-cohort of players, as these are purely hypothetical outcomes.

2.1.1. *An example.* As an example, let's assume that there is only one broadcaster, who we denote by B, and two music suppliers, M_i where $1 = 1, 2$. The music suppliers hold the copyrights in mutually independent (i.e. totally different) sets of sound recordings. Player B would like to play the music from the repertories of each of the suppliers M_i. If the two music suppliers are united in a collective, then they will exert considerable market power over B, but if they must act independently, then they compete with one another for the broadcasting services of B.

Say the regulator finds that the collective bargaining outcome is unfair to the broadcaster, and attributes the unfairness to the monopoly power of the collective.[7] Then the regulator might envisage a notional (or hypothetical) bargaining situation in which the two music suppliers are made to act independently.

The Shapley model defines the value of the business under each of the following orderings of arrival of the three players, and at each point of arrival. For three players (B, M_1 and M_2), there are 6 (that is 3!) possible arrival orderings. They are:

(1) B, M_1, M_2
(2) B, M_2, M_1
(3) M_1, B, M_2
(4) M_1, M_2, B
(5) M_2, B, M_1
(6) M_2, M_1, B

Let us assume (for illustrative purposes only) the following:

a) a player alone generates \$0 regardless of who that player is;

b) regardless of order of arrival, music suppliers without a broadcaster generate \$0;

c) if B is present, he generates \$6 with M_1 alone and \$5 with M_2 alone;

d) if all three players are present, the business generates \$12.

The Shapley value of B is thus \$0 in ordering 1, \$0 in ordering 2, \$6 in ordering 3, \$12 in ordering 4, \$5 in ordering 5, and \$12 in ordering 6. The average of these values is 5.83, and this is taken to be the value of what B provides to the business. Similarly, the value of what M_1 provides is 3.33, and the value of what M_2 provides is 2.83. The sum of the three values of what each provides is, of course, 12, which is what the business generates with all three players present. Thus, a fair remuneration for B is a share of $\frac{5.83}{12}$ in the total surplus of 12, i.e. a payment of 5.83. Likewise, the two music suppliers would receive fair remunerations of 3.33 and 2.83 respectively. These remunerations are fair in the sense that they remove all options of being the last to the party, and thereby being able to command a very high recompense for holding the final key to the business.

Using this methodology, the regulator should decide that the collective of M_1 and M_2 are entitled, as a fair share of surplus, to the amount $3.33 + 2.83 = 6.16$,

[7]Of course, in the particular case envisaged here, it is actually not so easy to show that the collective welds greater monopoly power than the broadcaster, since we have assumed a perfect bilateral monopoly. Neither player gets anything without the presence of the other. The bilateral monopoly case set out here is only meant to be illustrative. In reality there is likely to be competition on the side of the broadcasters, in which case a clearer case for the collective having greater monopoly power can be made.

or 51.33% of total surplus. If we study the case of a single broadcaster and a single copyright holder, the Shapley model will give a strict 50-50 split of surplus.

One further difficulty is that, at least in the radio business, the payment to the copyright holders in sound recordings is set as a tax on radio revenues, not as a tax on radio profits (or surplus). However, given that we have the numbers, this is not really a problem. Say, for example, that the surplus of 12 is generated by a revenue of 50 and costs of 38. Then the appropriate revenue tax is found by dividing the payment due to the collective by the total revenue, in this case $\frac{6.16}{50} = 0.1232$, that is, a tax of 12.32% of revenue.

2.1.2. *The main problem with the Shapley approach.* The Shapley model provides a reasonable working solution for regulators to set tariffs for cases like that of radio broadcasting of copyright material. However, it does suffer from a particularly pressing problem – that of data availability. In principle, the values required in the calculation are the level of total surplus generated, the revenue that generated that surplus, and the hypothetical surplus that would be generated as players are added to the cohort in all possible ways. The first two are likely to be relatively easy to find, but the third, being hypothetical, is much harder to estimate reliably.

It is also true that as the number of participants in the model increase, the number of different orderings of arrival increase much faster. If there are three participants, we need to consider six arrival orders, but if there are six participants, then we need to consider $6! = 720$ different arrival orders. And each arrival order needs an assumption on the surplus that is generated at each step of the given arrival ordering. Since with six participants, there are 720 different arrival orderings, and 6 steps along each ordering, we need to know the surplus that would be produced in $720 \times 6 = 4320$ hypothetical scenarios. This is clearly a very difficult proposal. However, we shall now consider a possible way in which this can be done with a minimal effort.

3. A production function for music radio surplus

Let's stick with the assumption of a single radio broadcaster, but a number of music suppliers. Each music supplier controls a mutually exclusive repertory of music. Basically, what is of issue is how a radio broadcaster generates surplus from the input "music repertory". But in reality, all this is saying is that we should estimate the production function $S = S(m)$, where m represents the input "music", and S represents "surplus".

In order to estimate a production function, we firstly need to measure m in a logical manner, and for that I propose to measure this input as a fraction of the total repertory. Thus, if all input suppliers are present, then the entire repertory is on offer to the broadcaster, and so $m = 1$. This is of course the actual outcome if the music suppliers act under a collective that negotiates the entire repertory on their behalf. On the other hand, if no input suppliers are present, then $m = 0$, and if only some input suppliers are present then $0 < m < 1$, with the exact value of m in this case depending upon the proportion of the total repertory that is managed by the input suppliers that are present. Thus m represents the fraction of the total repertory that is available.

Now, the radio business works by program directors deciding (I assume optimally), exactly which song should be played at exactly which moment. Thus, for any given moment, there is (I assume) a rank ordering of all the songs in the entire repertory based upon their contribution to total surplus. Let's normalise our units and assume that, at any moment of time the most profitable song for that particular moment generates 1 unit of surplus, the next most profitable one generates s units of surplus (where $0 < s < 1$), the third most profitable one generates s^2 units of surplus, etc. Thus, in general, the song in ranking position i would generate surplus of s^{i-1}.

Now, assume that a fraction m of the total repertory is actually available. That means that there is only a probability of m of any randomly selected song actually being available. I shall assume that the total repertory contains n songs, where of course n is a very large number.[8] In this case, the expected surplus for any given moment of time can be found with the following analysis. With probability m the most favoured song is available and so surplus is equal to 1. With probability $1-m$ the most favoured song is not available, and so we need to search down the song list. Conditional upon the most favoured song not being available (a situation that occurs with probability $1 - m$), then with probability m the second most favoured song is available in which case the surplus is s, and with probability $1 - m$ the second most favoured song is not available and again we need to search further down the list. This process continues until either an available song is found, or we reach the end of the repertory.

Given that, the expected surplus for any given moment of time is

$$ES(m, s) = m + (1 - m)(ms + (1 - m)(ms^2 + (1 - m)(ms^3 + ...)))$$

Notice that, starting from the second term, each of the successive s^i values is premultiplied by $m(1 - m)^i$, and so the expected surplus can be written as

$$ES(m, s) = m + m(1-m)s + m(1-m)^2 s^2 + m(1-m)^3 s^3 + ... + m(1-m)^{n-1} s^{n-1}$$

[8] In fact, the true number of different songs in the repertory that is offered by collecting societies around the world is of the order of many millions.

Taking the common factor m, we have

$$\begin{aligned} ES(m,s) &= m\left[(1-m)^0 s^0 + (1-m)s + (1-m)^2 s^2 + ... + (1-m)^{n-1} s^{n-1}\right] \\ &= m \sum_{i=0}^{n-1} ((1-m)s)^i \end{aligned}$$

Finally, since $(1-m)s$ is smaller than 1, this is just m times an arithmetic sum of the type $\sum_{i=0}^{n-1} \alpha^i$. The arithmetic sum part is equal to $\frac{1-\alpha^n}{1-\alpha}$, and so using $\alpha = (1-m)s$, we can simplify the expected surplus to

$$ES(m,s) = \frac{m(1-((1-m)s)^n)}{1-(1-m)s}$$

Since n is a very large number, and $((1-m)s) < 1$, we shall approximate $((1-m)s)^n$ to 0, so that the most reasonable functional form for the expected surplus is

$$ES(m,s) = \frac{m}{1-(1-m)s}.$$

As should be expected for a production function, this is a strictly increasing and concave function with $ES(0,s) = 0$ (i.e. there are positive but decreasing returns for the input music, and no input implies no output). The normalisation that we have used is reflected in the endpoint value of the production function; $ES(1,s) = 1$.

However, I would add one additional aspect to the function. I would argue that a minimum fraction of repertory is required in order for any surplus to be generated at all. Let me denote the minimum repertory requirement by m_0. This assumption reflects the reality of the music broadcasting world. Typically, a radio station will play music for close to 75% of the minutes of the day.[9] That is, during about 1080 minutes daily, music is being broadcast. At about 3 minutes per song, this means that each day a station will play about 360 different songs. While there will certainly be some repetition of songs over different days (and maybe even during a given day), we do need to bear in mind that these are not 360 random songs, they are 360 carefully chosen songs, with perhaps very little substitutability between them. Typically, a music radio station will keep a "play list" of songs that may contain as many as 6,000 different (but quite specific) songs in order to survive without repeating songs too frequently, and to have certain specific titles on hand should a special need arise.[10] In a random selection of repertory, the station will need access to a much larger set of songs in order to have access to 6,000 different but quite

[9]See Audley and Boyer (2007).

[10]For example, the recent death of Michael Jackson lead to a much larger (and somewhat unexpected) need for songs from the Jackson repertory during several weeks. Station play-lists may be renewed, with some now unneeded songs replaced by new ones. This, for example would be the case of a "top 40" station playing only contemporary hits. On the other hand, a station playing only "golden oldies" will have a much more stable play-list over time.

paticular titles that will ensure its survival. The minimum number of songs that are required to be present in the repertory such that a minimally functional play list can be extracted is our parameter m_0.

Exactly how large is m_0 is a matter for empirical work. However, we can put forward some ideas about how it might be (relatively simply) measured. In essence, we have chosen our units such that the expected surplus of the station is valued between 0 and 1. The value is 0 when there are no songs available to be played, and the value is 1 when the entire repertory is available to choose from. The assumption, of course, is that when the entire repertory is available, the station will certainly decide to broadcast, that is, to function in the market. On the other hand, if no songs were available, the station would be forced to close down. In attempting to estimate m_0, what we are really looking for is the limit level of expected surplus such that the station is willing to continue in business. For example, say the station´s owners have an outside option for investing the equity that they currently hold in the radio station. Say, for example, that outside option is equal to 0.5 (recall that our units of measurement imply that to be relevant, the outside option must be valued between 0 and 1). Then, the station would close down if the number of songs in the repertory, m, were to satisfy

$$\frac{m}{1-(1-m)s} \leq \frac{1}{2}.$$

This simplifies to

$$m \leq \frac{1-s}{2-s}$$

The value $\frac{1-s}{2-s}$ is thus exactly what we need for our limit repertory size, m_0. For example, if $s = \frac{3}{4}$, we get a limit repertory availability of $m_0 = \frac{1}{5}$, or 20% of the total repertory. The greater is the outside investment option, and the smaller is s, the greater will be m_0.

More generally, then, if the outside option for investing the station's equity is r, then the limit repertory size m_0 satisfies

$$\frac{m_0}{1-(1-m_0)s} = r$$

This simplifies to

$$m_0(r,s) = \frac{r(1-s)}{1-rs}$$

Thus, the relevant production function to use for calculating the Shapley value is

$$ES(m,s) = \begin{cases} 0 & \text{if} \quad m \leq m_0(r,s) \\ \frac{m}{1-(1-m)s} & \text{if} \quad m > m_0(r,s) \end{cases}$$

For $r = 0.5$ and $s = 0.75$, this production function is represented in Figure 1:

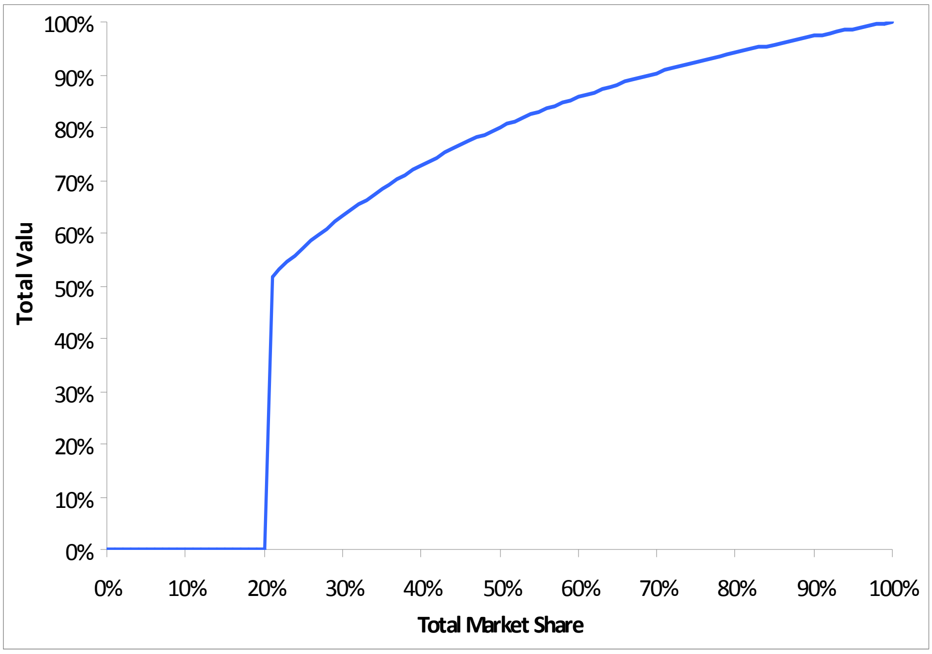


Figure 1. Production function for surplus in terms of percentage of repertory available

4. Calculation of the Shapley Value

Once we have the production function for surplus, we can now go ahead and perform the calculation of the Shapley value for any scenario that presents itself. When there are several players (music suppliers), the calculation will not be trivial, but it will always be possible. In order to perform the calculation, all we need is the production function and the share of the total repertory that is controlled by each of the music suppliers present. Let us perform some simple calculations based upon particularly simple repertory shares over music suppliers, and always assuming that there is only one radio broadcasting player (a consortium of stations). Recall that we are only performing here hypothetical, or notional, calculations, as if the music suppliers were to act as independent bargaining units rather than under the representation of a collective.

In the simplest case, there is also only one supplier of repertory. In this case, clearly the total surplus is equal to 0 when only one player (either the radio broadcaster or the music supplier) is present, and equal to 1 when both are present. Thus the only options here are $m = 0$ and $m = 1$, the two end-points of the expected surplus production function. The Shapley value of the music supplier is equal to the average of his marginal contributions over each of the two possible arrival orderings.

If the music supplier arrives first, he provides a value of 0 (there is no broadcaster), and if the music supplier arrives second, he provides a value of 1 (the broadcaster now has something to broadcast). The average is therefore $\frac{1}{2}$. The Shapley value for the broadcaster in this case is also $\frac{1}{2}$, and so the Shapley methodology would assign a one-half share of the total surplus to each of the two players. This particular special case also tells us that in an unregulated but voluntary bargaining environment, with one music supplier (in this case a collective management organisation) and one music broadcaster, with equal bargaining powers, the outcome would be a 50-50 profit share arrangement. This provides us with a baseline, or default scenario against which we can compare other options.

Secondly, suppose that there were two equally sized music suppliers, labeled M_1 and M_2. That is, each music supplier controls half of the total repertory. We denote the broadcaster by B. Let us assume that $m_0 \leq \frac{1}{2}$, so that even if only one music supplier is present, regardless of which one it is, the radio business earns enough surplus to cover the opportunity cost of staying in business.

Now, since the two music suppliers are equal, we really only need to calculate the Shapley value for one of them (the other one's Shapley value will be the same). The arrival orderings are (as was set out above) the following: (B, M_1, M_2), (B, M_2, M_1), (M_1, B, M_2), (M_1, M_2, B), (M_2, B, M_1), and (M_2, M_1, B), each of which is assumed to occur with equal probability, that is, with probability $\frac{1}{6}$.

Consider music supplier M_1. He provides a marginal value of 0 when he arrives first, or if he arrives second only to find that M_2 had arrived first. When he arrives second provided B has arrived first, he provides a marginal value of

$$\frac{0.5}{1-(1-0.5)s} = \frac{1}{2-s}$$

and when he arrives third, he provides a marginal value of

$$1 - \frac{1}{2-s} = \frac{1-s}{2-s}.$$

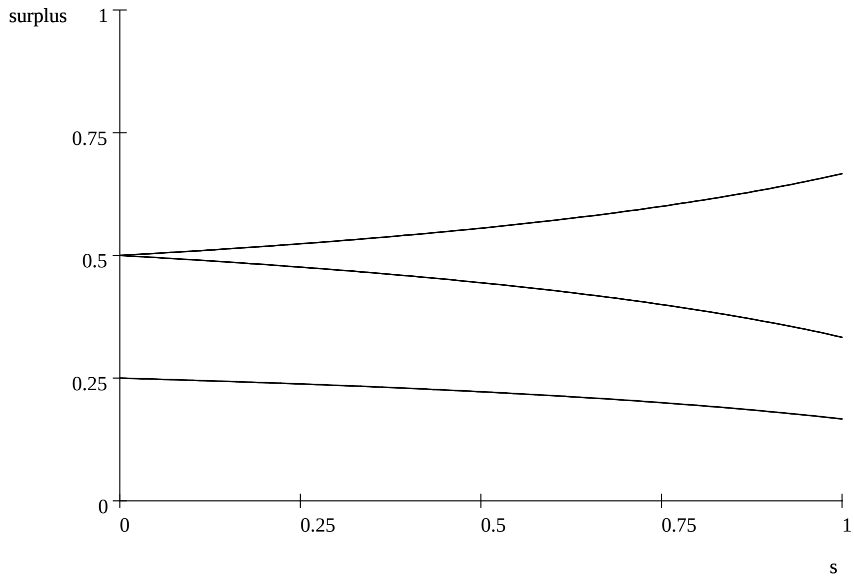
But since music supplier A arrives first in two of the six arrival orderings (i.e. a probability of $\frac{1}{3}$ of arriving first), he arrives second with M_2 arriving first in one of the six arrival orderings (probability $\frac{1}{6}$), second with B arriving first in one arrival ordering (probability $\frac{1}{6}$), and third in two arrival orderings (probability $\frac{1}{3}$), his average marginal contribution (his Shapley value) is

$$\frac{1}{3} \times 0 + \frac{1}{6}\left(0 + \frac{1}{2-s}\right) + \frac{1}{3}\left(\frac{1-s}{2-s}\right) = \frac{3-2s}{6(2-s)}$$

Since total surplus with all three present is 1, music supplier 1 is entitled to a payment of $\frac{3-2s}{6(2-s)}$. Music supplier 2 should also get this payment, while the broadcaster should get the rest of the surplus, i.e. a payment of

$$1 - 2\left(\frac{3-2s}{6(2-s)}\right) = \frac{3-s}{3(2-s)}$$

The total allocation over the three parties is 1. In Figure 2 the Shapley value of each music supplier individually in this example, together with the combined Shapley value of the two music suppliers, and the Shapley value of the broadcaster are given (all as functions of s).



Shapley values for music suppliers individually (lower-most curve), music suppliers combined (middle curve) and broadcaster (upper-most curve) with one broadcaster and 2 equally sized music suppliers

Notice that the Shapley value of the broadcaster is increasing in s, and always valued above $\frac{1}{2}$. On the other hand, the Shapley values of the music suppliers are decreasing in s and always valued below $\frac{1}{2}$ when aggregated. The interesting part of the graph for realistic purposes is where s is quite large. Taken to the limit, when $s = 1$, the broadcaster retains $\frac{2}{3}$ of the surplus and each music supplier gets $\frac{1}{6}$ of the surplus, for a combined share of $\frac{1}{3}$. Since in reality $s < 1$, together, the music suppliers should always get a proportion of total surplus that exceeds $\frac{1}{3}$. This can be compared to the situation (evaluated above) with only one music supplier, which took $\frac{1}{2}$ of the surplus. The two music suppliers combined in this second example can only take $\frac{1}{2}$ of the surplus when there is no surplus to share ($s = 0$), and it is much more likely that their total share in the surplus will be somewhat closer to $\frac{1}{3}$. Thus, by eliminating the market power that the two music suppliers would have should they act together, the Shapley methodology cuts their overall share in the surplus by anywhere between 0 and $\frac{1}{6}$, depending on the size of s.

Any other number of illustrative examples can be easily constructed. Exactly how each works out depends upon the values of the parameters involved, namely r, s, and the percentage of total repertory controlled by each music supplier. If, for example, we had 5 music suppliers, with market shares of 10%, 15%, 15%, 20% and 40%, and one broadcaster, then using the production function suggested (with parameters $r = 0.5$ and $s = 0.75$) the Shapley model would allocate 60.65% of total surplus to the broadcaster, and 39.35% to the music suppliers (i.e. to the copyright collective).[11]

Of course, if the regulator were interested not in the appropriate share of surplus, but rather in the share of revenue that should accrue to the music suppliers, it is very easy to work out the latter from the former. The Shapley methodology generates a surplus sharing rule for the participants in the market taken individually. Say the share of surplus that the Shapley methodology assigns to the i^{th} music supplier is α_i, and there are k individual music suppliers. Then the methodology assigns a combined share of surplus of $\alpha = \sum_{i=1}^{k} \alpha_i$ to the music suppliers as a group (i.e. to the collective representing the music suppliers, should one exist), and a share of surplus of $1-\alpha$ to the broadcaster. Since the broadcaster´s profit is just $\pi = R - C$, where R is the revenue generated and C represents the costs, the amount of money that ought to be paid to the music suppliers is $\alpha (R - C)$. Expressed as a percentage of revenue, this is just

$$\beta = \frac{\alpha (R - C)}{R}$$

The revenue sharing rule that the Shapley methodology provides is simply this β.

Of course, some adjustments to the profit might be in order, such that indeed one is sharing the true economic surplus of the business. For example, it may be that there exist certain externalities between radio airplay of music and sales of music. If radio airplay serves to increase sales of music (i.e. the externality is positive, known as a "promotions effect") then the music radio business generates a surplus that is actually greater than the monetary profits. Since the external effect is earned by the music suppliers (in the market for music sales), when taken into account the share of the radio industry profits that would be paid to the music suppliers would diminish compared to the case in which no externality exists. On the other hand, should radio airplay of music actually reduce the sales of music (i.e. the externality is negative, and suffered by the music suppliers), a case known as the "substitution effect", then the true shareable economic surplus is lower than

[11]Details on the exact calculation for this example are available from the author by request.

the monetary profits, and the music suppliers would be entitled to a larger share of monetary profits than when the externality does not exist.

Actually, it is not known if the effect of radio play upon music sales is positive or negative. Liebowitz (2004, 2007) argues (persuasively) for a negative effect – i.e. the substitution effect dominates the promotions effect – but others (in commissioned and unpublished work I note) have argued the opposite (see, for example, Dertousos 2008). In more recent work, using only digital music data, Bandookwala (2010) has shown that at least in New Zealand it is not true that radio play increases the sale of music. In the case brought before the New Zealand Copyright Tribunal in 2009, it was accepted that the external effect of radio play upon record sales should be valued at 0.

5. Conclusions

This paper has considered the way in which the surplus that is generated by the music radio industry can be shared, in a fair and equitable manner, between the broadcasters and the suppliers of music content. In searching for a truly fair and equitable sharing rule, the Shapley methodology has been suggested as a strong candidate. The Shapley value has long been lauded as providing fair and equitable sharing rules for cases in which a surplus is generated by more than one player, which is exactly the case of music radio. The use of the Shapley methodology allows us to remove any monopoly power that the music suppliers may otherwise hold, when (for reasons of economic efficiency with respect to transactions costs) they combine as a single bargaining unit under a copyright collective.

As with all models, in order to be of any realistic use, the model must be calibrated using real-world data. In this respect the Shapley methodology faces a particularly difficult problem. Since it requires that one know (or really, estimate) the marginal contribution of each participant in the model under all partial (hypothetical) groupings of the participants, it becomes practically impossible to find data to populate the model appropriately. In the present paper this problem has been addressed by a simple interpretation of what a partial repertory of songs actually means for music radio broadcasters. Given this new interpretation (of probability of the availability of a given song), it is possible to easily relate the production function for surplus generated by the music radio industry to any partial repertory size, and thus to remove the problem of having to assume what is otherwise a very large number of hypothetical values. Under this model of valuation, the only data points that need to be estimated are s and r, both of which should be calculable using industry experience. That compares to the several thousands of data points that would need to be estimated without the production function idea in place.

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