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ABSTRACT

There is a puzzle arising from empirical analyses of the impact of music piracy that this has caused declines in music revenue without a consequential decline, and perhaps even an increase, in the entry of artists and the supply of high quality music. There have been numerous explanations posited and this paper adds a novel one: that artists are time inconsistent and hence, tend to underweight fame over fortune when making future choices; i.e., the degree to which they will 'sell out.' Regardless of whether selling out is anticipated or not, the puzzle is resolved. When selling out is not anticipated, future expectations of piracy are not a concern as these impact on monetary awards that are not driving entry. When selling out is anticipated, piracy actually constrains the degree to which artists sell out, and assured of that, raises entry returns. Implications and the role of publisher contracts are also explored.

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"I hate to sound like an old man now, but I am, and you mark my words, in a generation from now people are going to say: 'What happened?' Steve Jobs is personally responsible for killing the music business."

Jon Bon Jovi

1 Introduction

Digitisation of music has brought with it new challenges for copyright owners, publishers and, in particular, artists to monetise their creative work. In particular, unauthorised copying – or in the popular parlance, piracy – means that it is increasingly easy for consumers to own music without paying for it. A host of recent empirical research[1] has reached the overall conclusion that revenue from music sold has declined as result of digital technologies – such as Napster and its later followers – although there has been an increase in units consumed[2] and a documented increase in concert sales.[3] However, as Waldfogel (2013) shows, this decline in revenue may be associated with a decline in costs as well as a diminished role for publishers. Consequently, the relevant welfare issue is whether there has been a reduction in the supply of quality music or the entry of artists. To this end, Waldfogel (2011, 2012) provides a careful empirical analysis that suggests that quality and entry have not diminished in the 'post-Napster era' and, indeed, in some categories, these have increased.

The precise mechanism whereby music revenues can decline while the incentives to enter the music industry, at least on the part of artists, increase is not clear. It is a puzzle from the perspective of usual economic analyses precisely because it is usually predicted that, unless supply is perfectly elastic, a reduction in the reward from an activity will lead to a reduction in quantity supplied – in this case, of artistic inputs.

There are several candidate explanations for this puzzle that have been suggested thusfar. One is that piracy can allow sampling and better music discovery[4] although this should have a positive impact on revenues. Another is that artists can make up revenue on things other than music sales (Mortimer, Nosko and Sorenson, 2012) although losing a

[1] See Rob and Waldfogel (2006), Zentner (2006) and Leibowitz (2006) for prominent examples.
[2] See Oberholzer-Gee and Strumpf (2007); Handke (2006, 2010).
[3] See Mortimer, Nosko and Sorenson (2012).
[4] See Takeyama (1994) and Peitz and Waelbroeck (2006). Zhang (2013) provides an empirical analysis. See King and Lampe (2003) for a critique.

revenue source is a constraint. Finally, there is a notion that the incidence of piracy (and digitisation) falls more on incumbent publishers than artists (Waldfogel, 2013).

The purpose of this paper is not to suggest the primacy of one of these mechanisms over the other but to suggest a novel one that can be placed alongside them and may be of relevance for those empirical researchers exploring the mechanisms that drive creative artist entry. It is motivated by the puzzle and also by an additional set of anecdotes that successful artists (particularly those of a now older generation) have lamented the impact of piracy on music revenues. Bon Jovi quoted above illustrates some frustration but his colleague Richie Sambora singled out piracy as a cause for the music industry's troubles.[5] Meanwhile, former KISS guitarist, Gene Simmons has been very vocal against piracy and is actively engaged in legal action to prevent it (Lasar, 2010). This suggests that, once artists become successful, no matter what their prior beliefs were regarding making money from music, they become very concerned about it. In the impression of some, they 'sell out.'

This potential story motivates me to explicitly consider (a) artists' choices regarding selling out or not – in particular a trade-off between emphasising fame over fortune and (b) that they may have time inconsistent preferences regarding this trade-off. In particular, using a model of hyperbolic discounting standard in behavioural economics, I demonstrate how artists may change as they become successful from a trade-off that emphasises fame (and hence, low prices to increase their fan base) to one that emphasises fortune (raising prices when they are older). Consequently, when they are starting out, time inconsistent artists, when choosing whether to enter or not, do not place weight on the notion that, in the future, they might sell out and so, in the face of expected piracy, are not concerned about the loss of music revenues that might result. Time consistent agents, on the other hand, forecast correctly these attitudes but also can commit to the trade-off they desire ex ante. For them, a reduction in music revenue constrains them and reduces their returns to entry. Thus, I demonstrate here that the existence of time inconsistent artists may provide an explanation for the combination of a loss in music revenues and no or even higher artist entry in the face of piracy. Moreover, this model is consistent with a view that older artists may strongly lament a loss in music revenue even when their

[5] See the 2014 interview here: https://www.youtube.com/watch?v=brxyw2dTN5s.

younger selves professed not to care about the money. The use of behavioural economics to consider the incentives of creative agents is a novel contribution of this paper.

The paper proceeds as follows. In the next section, I develop a baseline model of fame and fortune and show how piracy can simultaneously cause a decline in observed music revenue and an increase in the entry incentives of time inconsistent artists. Section 3 then considers how robust this result is to the addition of publisher contracts. It confirms that the attrition of publisher rents is another explanation for the high elasticity of music artist supply but also does not alter the forces that cause time inconsistent artists to receive benefits at the point of entry if there is increased piracy. A final section concludes.

2 Baseline Model of Fame and Fortune

This section presents a model of artist incentives that offers them a return for successful creative works comprised of two components: *fortune* and *fame*. To access both requires the artist to be successful. Suppose that new artists considering entering the music industry have an outside option with (net present) utility, u. If they forgo this, they enter into a lottery. With probability s, they are successful and can sell music in the future. With probability, 1-s, they fail, sell no music and they return to their outside option in the future; receiving neither fortune nor fame.

The fortune component is comprised of the sales of music. Music sales have demand, $N(p)$, where p is price and N is the number of fans; $N(.)$ satisfies the usual properties of a demand function.[6] It is assumed that, to be a fan, you need to purchase the music.[7] Thus, in one period, music sales are made which earns revenue pN while, in the next, there is a body of fans available who have experienced the music.

The fame component comes from having fans (N) and, as already assumed, fans can only come from the set of people who have experienced the music. The marginal utility of fame is γ per fan. While the utility from fame can be considered as purely

[6] Specifically, $N(p)$ is concave or log concave so that all objective functions that follow are concave.
[7] Conceptually, fans may also arise without consumption of music. My own observation of current teenage music suggests that this would explain a lot. This may change the conclusions below but it is not something I will investigate in this paper.

intrinsic it could also have extrinsic components; for instance, being able to play and profit from larger concerts or being able access other trappings that come from high status in society.

This structure captures a natural trade-off between fame and fortune with respect to price (p). The price, p^m, that maximises music sales is characterised by $N'(p^m) = -N(p^m)/p^m < 0$ (assuming, as is standard these days, that there are no costs of distributing music). This clearly involves a higher price than would maximise fame $\gamma N(p)$; i.e., $p = 0$. While here one might consider price as strictly the unit price of music, it could also represent other choices – such as style – that may maximise sales but not generate long-lasting fame. Thus, a choice to place weight on setting a higher price can be interpreted (with some judgment intended) as the degree of "selling out" by the artist.

At this point, it is instructive to consider the impact of piracy and why it presents a puzzle with respect to the empirical findings to date on artist entry. Suppose that the fame and fortune components above represent the entire lifetime utility of a successful artist. Then the artist will enter if and only if:

$$\max_p s(p+\gamma)N(p) + (1-s)u \geq u \tag{1}$$

A conventional way to model piracy is to imagine that there is a cap, $\overline{p}$, on the price that can be charged for music; that is, the price that can be charged is limited by the transaction (or moral) costs faced by consumers obtaining the music for free. If p^* solves the left hand side of (1), then if $p^* \leq \overline{p}$, piracy has not impact on the choices of the artist and hence, no impact on entry. However, if $p^* > \overline{p}$, then the artist's chosen earnings from music revenue would be reduced although this would be somewhat mitigated by additional utility from fame. Nonetheless, as the artist is constrained, the reduction in their expected utility implies that piracy would be expected to deter entry.

2.1 Dynamic Structure

To rationalise the puzzle of how piracy could simultaneously impact adversely on music sales yet at the same time at least not harm entry, a more dynamic model is considered. This model embeds three broad assumptions. First, the fame and fortune rewards for an artist are delayed (specifically, they occur one period after entry). This is

not an unreasonable assumption for any creative endeavour but it is the case that artists often receive advances on music publishing contracts which suggests that some rewards may be earlier. However, the purpose of those advances is, generally, to cover the costs of the production of the creative work and, importantly for the purposes of this exercise, involves little discretion from the artist in manipulating the variables that determine the mix of fame and fortune (namely, price).[8] Consequently, it is simply assumed that the artist receives no utility immediately although the key assumption is that the artist cannot control their own fate until later.

Second, it is assumed that fortune comes before fame. Importantly, it is not possible to 'sell out' in the future unless there is an opportunity at a decision point to choose between current fortune and future fame. This is a substantive assumption that will drive the results below. However, it naturally follows from the notion that fans have to experience music *before* becoming the fan-base that confers the benefits of fame on the artist. The idea is that the artist has initial commercial success that generates monetary income and that, while some components of fame may be associated with that success, fame itself is a longer-lived good and, for that reason, may be discounted as a future reward. Again, having fame being utility mostly derived in the future provides the opportunity to 'sell out.'

Fourth, consistent with the behavioural economics literature, it is assumed that, given this dynamic structure, the expected utility from becoming an artist at the time of the entry decision is:

$$V(p,\beta) \equiv s\beta\delta\left(pN(p)+\delta\gamma N(p)\right)-\left(1-(1-s)\beta\delta\right)u \qquad (2)$$

where $\beta,\delta \in (0,1]$. The structure here is to allow for the possibility that artists may be time inconsistent or hyperbolic discounters (O'Donoghue and Rabin, 1999) here with the (β,δ) parameterisation (Phelps & Pollak, 1968; DellaVigna & Malmendier, 2004). Suppose that $\hat{\beta}$ is an artist's perception of the value of β at time 0 (the date they decide to enter). If $\beta = \hat{\beta} = 1$, the artist is *time consistent*. If $\beta < \hat{\beta} = 1$, the artist is time

[8] See Connolly and Krueger (2006) for a description of such contracts and outcomes.

inconsistent and *naïve* about it. If $\beta = \hat{\beta} < 1$, the artist is time inconsistent but *sophisticated* about it.

Finally, it is assumed that the artist cannot commit to p until after their success/failure uncertainty has been resolved. Given this structure, the expected utility after success but at the time the artist makes a decision on price (or the fame-fortune trade-off) is given by:

$$pN + \beta\delta\gamma N \tag{3}$$

Note that the hyperbolic discount factor, β, enters the time inconsistent artist's decision calculus at this point. Thus, at this time, the artist will set price according to:

$$N(p) + pN'(p) + \gamma\beta\delta N'(p) = 0 \Rightarrow p^*(\beta) = -\tfrac{N(p)+\gamma\beta\delta N'(p)}{N'(p)} = -\tfrac{N(p)}{N'(p)} - \gamma\beta\delta \tag{4}$$

So the chosen price is decreasing in β; that is, a time inconsistent artist will set a higher price than a time consistent one. Importantly, time consistent artists will internalise the impact of the degree of selling out they do when they are successful, naïve artists will eventually sell out more than they expect while sophisticated artists will anticipate that they will eventually sell out more than they originally would have wanted to.

From this, it is easy to see that the threshold u for entry for a time consistent artist and a naïve one will be based on the same expected future fame and fortune. Naïve artists will enter less as they discount the value of that utility more than time consistent artists. In contrast, sophisticated artists will anticipate that they will have greater fortune than fame in the future but their utility will be lower as a result. Thus, they will have the highest threshold for entry.

2.2 Impact of piracy

Piracy will have a different set of impacts on time consistent, naïve and sophisticated artists not only because of the different prices potentially set in the absence of piracy but also because of differing expectations of what those prices would be. The following proposition summarises the different impacts:

Proposition 1. *Let* $\hat{p} \in \left\{ \min p \middle| V(p,\beta) \geq V(p^*(\beta),\beta) \right\}$. *For* $\overline{p} \geq p^*(\beta)$, *piracy has no impact on entry decisions. For* $\overline{p} < \hat{p}$, *piracy reduces the expected returns from entry for all artists. For* $\overline{p} \in \left(\hat{p}, p^*(1)\right)$, *piracy reduces the expected entry returns for time*

consistent and naïve artists. For $\overline{p} \in \left(p^*(1), p^*(\beta)\right)$*, piracy has no impact on the expected entry returns of time consistent and naïve artists. For* $\overline{p} \geq \hat{p}$*, piracy increases the expected entry returns of sophisticated artists.*

The proof is relatively straightforward. Note, first, that time consistent and naïve artists have precisely the same expected future utility from successful entry and thus, the impact of piracy on their decisions will be identical. Piracy will, therefore, only constrain their expected choice of p if $\overline{p} < p^*(1)$ in which case it reduces the return from entry. Otherwise, it has no impact.

For sophisticated artists, the impact of piracy is more complicated. Note that such artists would want to commit to a price of $p^*(1)$ but anticipate setting a higher price of $p^*(\beta)$. As their utility (i.e., $V(p,\beta)$) is concave in price, reducing price below $p^*(\beta)$ has a positive impact on their utility until a certain point defined by $\hat{p} < p^*(1)$ where it reduces it. Thus, for $\overline{p} \geq \hat{p}$, sophisticated but time inconsistent artists actually benefit from anticipated piracy. Hence, for them, more entry would be associated with piracy because is the equivalent of a binding commitment to fame over fortune.

Recall that the puzzle this paper was examining was the association of a decline in music revenues as a result of piracy with no negative impact on new music creation or artist entry. Proposition 1 demonstrates that this puzzle is rationalised if artists are time inconsistent. This is obvious for sophisticated artists for whom not only do music revenues decline with piracy but entry returns rise. For naïve artists, there exists a range (i.e., $\overline{p} \in \left(p^*(1), p^*(\beta)\right)$) whereby observed music revenue declines but they do not anticipate them to decline; that is, ex ante, naïve artists believe that they will be unconstrained by piracy and place more weight on fame. But, in actuality, in the future, they want to price higher and would have if there had not been piracy. Thus, from an empirical standpoint music revenue declines are associated with no reduction in the returns to entry; providing a behavioural explanation for the puzzle.

3 Incorporating Publisher Contracts

Thusfar, the model here has treated the artist as independent. Of course, artists sign with publishers prior to their success. The question is: what types of contracts will they agree to? Specifically, publishers want to maximise revenues and place no weighting on fame. However, the issue is will publisher control change the impact of piracy analysed thus far?

Importantly, publisher contracts may be able to provide various commitment mechanisms that change how time inconsistent artists behave. To capture this, it is assumed that publishers are not time inconsistent and have a discount factor of δ. Moreover, it is assumed that contract negotiations occur prior to an artist making an initial entry decision.

Publisher contracts generally consist of three elements (a) an upfront payment to artists; (b) a share of revenues (royalty) to the artist, α; and (c) decision rights as to who gets to set price, p (see Caves, 2000 and also Curien and Moreau, 2009). There may also be other conditions related to the promotion of artist's work but, in what follows, I will assume this is contractible and hence, optimised to whatever other decisions are taken and so set it aside as a background issue.[9]

As mentioned earlier, upfront payments are normally made to cover artist start-up costs and fill any gap in liquidity that may prevent them from investing resources and time to produce music. In what follows, as it is assumed that there are no such immediate costs, such upfront payments are not considered explicitly. It is readily apparent that they would not substantively change the qualitative results below.

3.1 Publisher controls price

Consider first the case where the publisher not only sets but commits to p upfront. In this case, suppose also that the publisher makes a take-it-or-leave-it offer to the artist. Thus, for a given p, the royalty rate, α, will be set to satisfy the artist's participation constraint. For a time consistent artist this is:

[9] Specifically, I have given the publisher no economic role other than being a long-term time consistent agent. A publisher may have a role in determining the success of an artist but this has been moved to the background as it does not appear to be a first order issue regarding the impact of piracy in this context.

$$\alpha^* = \frac{u\left(1-(1-s)\delta\right)}{s\delta pN(p)} - \frac{\gamma\delta}{p} \tag{5}$$

so that publisher profits are:

$$(p+\delta\gamma)s\delta N(p) - u\left(1-(1-s)\delta\right) \tag{6}$$

Thus, the publisher would commit to a surplus maximising price so as to reduce royalty rate. By contrast, for time inconsistent artists this is:

$$\alpha^* = \frac{u\left(1-(1-s)\beta\delta\right)}{s\beta\delta pN(p)} - \frac{\gamma\delta}{p} \tag{7}$$

so that publisher profits are:

$$(p+\delta\gamma)s\beta\delta N(p) - u\left(1-(1-s)\beta\delta\right) \tag{8}$$

Note that, in either case, the publisher would find it optimal to commit ex ante to $p^*(1)$ as both (6) and (8) represent total surplus in each case. Intuitively, the publisher prefers to minimise the royalty rate paid to the artist and will trade-off a lower price against providing the artist with more fame.

What is the impact of piracy? If $\overline{p} \geq p^*(1)$, there is no impact as the publisher's pricing choice is not constrained. However, if $\overline{p} < p^*(1)$, then the publisher will be constrained and, moreover, will be forced to raise the royalty rate to artists in order to encourage entry. However, this insulates the returns on artists only for $\overline{p}$ relatively close to $p^*(1)$; although it does prevent their returns falling for a larger price decrease than the independent artist case. When $\overline{p}$ falls by a large amount, even a royalty rate such that all surplus accrues to the artist will not provide a return to entry.

When the publisher can set *p* ex ante, regardless of their type, piracy can be associated with a decline in total music revenue but no change in the observed entry decision by artists. Here the publisher plays a role of *insulating* the artist against those changes but it should be noted that, in this model, the seeming welfare accruing to the artist in the face of piracy is a 'difference' effect as the publisher role means that, prior to any piracy, they receive lower returns overall above the cost of entry.

Given this, it is instructive to examine what happens when the publisher's ability to commit or set *p* is weaker. For instance, suppose that the publisher cannot commit to *p*

ex ante even if they can commit to the royalty rate. In this case, it will set price, regardless of the royalty level, to its monopoly level; that is, $p^m = -\frac{N(p)}{N'(p)}$. This will coincide with the artist's choice only if $\beta = 0$ or $\gamma = 0$.

In this situation, as p will be in excess of the price that maximises total surplus, the royalty rate offered to the artist, regardless of type, will be higher. In this case, however, for $\overline{p} \in (p^*(1), p^m)$, piracy will lead to a fall in the royalty rate, no change in the artist return and an increase in publisher returns; regardless of the type of artist. For a lower price, $\overline{p} < p^*(1)$, the same impact as describe above for the ex ante commitment to p case will arise. Thus, even where the publisher cannot commit to a price, there is a range of prices where the impact of piracy results in a decline in music revenues but no change in the observed entry from artists due, again, to the insulation that the publisher provides.

3.2 Publisher does not control price

Of course, what this demonstrates is that when the publisher controls price directly, the publisher themselves will absorb the impact of piracy up to a point and, in the process, provide a rationalisation for the puzzle motivating this paper. Moreover, there is no specific additional role to having time inconsistent agents.

To explore this further, consider a case where the publisher has no direct control over price but indirect control through the royalty rate. This means that royalties only have relevance if it is the artist who sets price or, as is perhaps a more palatable interpretation, takes ex post, non-contractible actions that determine their fortune versus fame. Hence, here we focus on how the royalty rate impacts on that trade-off.

While a general examination is complex, insight can be gained by choosing a specific functional form for $N(p)$.

Proposition 2. *Let $N(p) = 1 - p$. Then the optimal royalty rate is non-decreasing in $\overline{p}$. There exists (a) $\overline{p} < \overline{p}_{soph}$, such that piracy reduces the returns to all artist types; (b) $\overline{p}_{soph} \leq \overline{p} < \overline{p}_{naive}$, such that piracy reduces the returns to time consistent and naïve artists but increases the returns to sophisticated artists and (c) $\overline{p}_{naive} \leq \overline{p}$, such that piracy reduces the returns to time consistent artists but increases the returns to time inconsistent artists.*

The proof is in the appendix. Intuitively, note first that the artist will set price according to:

$$\alpha N(p^*(\beta,\alpha))+\left(\alpha p^*(\beta,\alpha)-\gamma\beta\delta\right)N'(p^*(\beta,\alpha))=0 \quad (9)$$

First, as the artist generally wants to set price below the revenue maximising price, the price will reside on the inelastic portion of the demand curve. This implies that the chosen price will by non-decreasing in α. Second, note that a time consistent artist will, ceteris paribus, set price lower than a time inconsistent one; as per our earlier observation. Finally, the publisher will set the royalty rate with regard to its expected price. Thus, for a time consistent artist, this would be based on $p^*(1,\alpha)$ while for a time inconsistent artist – regardless of whether they are sophisticated or naïve, this will be based on $p^*(\beta,\alpha)$. Setting a higher royalty rate takes away from publisher profits but this is the 'price' for achieving higher music revenue overall. Thus, the royalty rate for time consistent artists will be set above those for time inconsistent ones. Nonetheless, because the time inconsistent artist's ex post interests are more aligned with the publisher, it is the case that, in equilibrium, the price and hence, music revenue will be higher when dealing with time inconsistent artists than with time consistent ones. Consequently, the cap imposed by piracy is likely to constrain the outcome when there are time inconsistent artists for a wider parameter range than it would for time consistent ones. In all cases, when the cap constrains price, it will reduce the publisher's choice of α, which can be lower and still ensure the artist chooses a price at the piracy cap.

This discussion assumes that the royalty rate does not bind the artist's participation constraint. If it were to do so, then the outcomes would be the same as those described under piracy when the artists did not control price. As the royalty rate to time consistent artists is higher (in addition to their higher utility upon success), it is less likely to bind for them. For time inconsistent artists, the likelihood that the participation constraint binds depends upon whether they are sophisticated or naïve. For sophisticated artists, they anticipate the same price the publisher does and correspondingly anticipate a lower utility from success than naïve ones facing the same royalty rate. Thus, the sophisticated artist participation rate will bind for a larger range of parameters than for a naïve artist.

What this implies is that, for naïve artists, there is a range whereby piracy actually binds the price chosen but, because they do not anticipate being constrained by it, they receive a lower royalty rate that causes them to perceive that they will be worse off. Hence, for them, entry returns are reduced. By contrast, as has been the case throughout this paper, piracy caps benefit the sophisticated artists by preventing their own undesired trade-off of fortune for fame. While the royalty rate is lower as a result of piracy (indeed, the desire to price at the cap determines the royalty rate), because there are rents accruing to the artist in that case, the entry return will be higher for relatively high piracy caps.

4 Conclusion

This paper has provided a distinct explanation for the seeming neutrality of piracy on music artist entry despite observed decreases in music revenue. It is based on an assumption that music artists are time inconsistent and, as a consequence, either (i) overly discount how much they will care about piracy on their future utility and choices (for naïve artists) or (ii) see piracy as constraining poor choices their future selves might make (for sophisticated artists). Either way, and including when publishers mediate those choices to some degree, the prediction of this model is that piracy will, up to a point, not harm the entry and supply of quality music and hence, will not have the welfare costs commonly associated with it.

It should be emphasised that this is just a theory. There is no independent verification here that music artists are time inconsistent but an exploration of what the implications of their being that way would be. Nonetheless, it is demonstrated that time inconsistency matters in resolving the empirical puzzles in the piracy literature to date. Moreover, even if artists are time inconsistent, as emphasised earlier, there is no verification that their future selves behave in the way they do here. That behaviour relies on fortune preceding fame to a degree, which may not be an appropriate description of what occurs in reality. All that I claim is that there is some plausibility to it and that together time inconsistency along with these dynamic assumptions gives rise to a coherent mechanism for the observed phenomenon.

Most applications of behavioural economics have involved consumer-level studies – purchasers, savers etc – and hence, predictions regarding the determinants of demand. This paper here posits what happens when behavioural agents supply goods and services. Creative arts is certainly an attractive place to explore such consequences because supply is likely determined by a mix of monetary and non-monetary components. However, it could be imagined that this avenue could be a fruitful avenue for exploration in other fields including, for example, the study of academics who are motivated by science but influenced or perhaps 'sell out' to commercial interests.

5 Appendix: Proof of Proposition 2

In the absence of piracy, note that $p^*(\beta,\alpha)=\frac{1}{2}-\frac{\beta\delta\gamma}{2\alpha}<\frac{1}{2}$. Note that $p^*(1,\alpha)<p^*(\beta,\alpha)$. Given this, the publisher's optimal choice of royalty rate is:

$$\alpha^*(\beta)=-\frac{\left(-9\beta^2\gamma^2\delta^2+\sqrt{3}\sqrt{\beta^4\gamma^4\delta^4\left(27+\beta^2\gamma^2\delta^2\right)}\right)^{1/3}}{3^{2/3}}+\frac{\beta^2\gamma^2\delta^2}{\left(-27\beta^2\gamma^2\delta^2+3\sqrt{3}\sqrt{\beta^4\gamma^4\delta^4\left(27+\beta^2\gamma^2\delta^2\right)}\right)^{1/3}} \tag{10}$$

It is straightforward to demonstrate that $\alpha^*(1)>\alpha^*(\beta)$ Note that for a time consistent artist, this implies that their payoff from entering is:

$$V_{tc}\equiv s\delta\left(\alpha^*(1)p^*(1,\alpha^*(1))+\delta\gamma\right)\left(1-p^*(1,\alpha^*(1))\right)-\left(1-(1-s)\delta\right)u \tag{11}$$

whereas for a sophisticated time inconsistent artist and naïve time inconsistent artist they are:

$$V_{soph}\equiv s\beta\delta\left(\alpha^*(\beta)p^*(\beta,\alpha^*(\beta))+\delta\gamma\right)\left(1-p^*(\beta,\alpha^*(\beta))\right)-\left(1-(1-s)\beta\delta\right)u \tag{12}$$

$$V_{naive}\equiv s\beta\delta\left(\alpha^*(\beta)p^*(1,\alpha^*(\beta))+\delta\gamma\right)\left(1-p^*(1,\alpha^*(\beta))\right)-\left(1-(1-s)\beta\delta\right)u \tag{13}$$

Note that: $p^*(1,\alpha^*(\beta))<p^*(1,\alpha^*(1))<p^*(\beta,\alpha^*(\beta))$. Thus, $V_{naive}>V_{soph}$ although ex post they end up being equal.

Under piracy, the publisher will choose α so that the artist will choose the cap price. That is,

$$\alpha^*(\overline{p},\beta)=\begin{cases}\alpha^*(\beta) & \text{if} \quad \overline{p}>p^*(\beta,\alpha^*(\beta))\\ \frac{\beta\delta\gamma}{1-2\overline{p}} & \overline{p}\le p^*(\beta,\alpha^*(\beta))\end{cases} \tag{14}$$

This is the minimum royalty rate that will ensure pricing to the cap and it is decreasing in $\overline{p}$. In this case, note that, if the cap binds,

$$V_{tc}(\overline{p})=s\delta\frac{(1-\overline{p})^2\gamma\delta}{1-2\overline{p}}-\left(1-(1-s)\delta\right)u \tag{15}$$

As, if it binds, it must be that $\overline{p}<\frac{1}{2}$, note that this is increasing in $\overline{p}$. Thus, piracy reduces the returns to the time consistent artist.

For time inconsistent artists, note first that:

$$V_{naive}(\overline{p})=s\beta\delta\frac{(1-2\overline{p}+\beta)^2\gamma\delta}{4(1-2\overline{p})\beta}-\left(1-(1-s)\beta\delta\right)u \tag{16}$$

This is because $\overline{p}=p^*(\beta,\alpha^*(\overline{p},\beta))\ge p^*(1,\alpha^*(\overline{p},\beta))$ and so the naïve artist always believes their price choice will be unconstrained ex ante. Note that the derivative of (16) with respect to $\overline{p}$ is: $s\gamma\delta^2\frac{4(1-\overline{p})\overline{p}+\beta^2-1}{2(1-2\overline{p})^2}$. There exists a threshold $\overline{p}_{naive}$ such that for $\overline{p}>\overline{p}_{naive}$, the returns to naïve artists are increasing in $\overline{p}$.

By contrast, for sophisticated artists:

$$V_{soph}(\overline{p}) = s\beta\delta\frac{(1-\overline{p})(1-\overline{p}(2-\beta))\gamma\delta}{1-2\overline{p}} - \left(1-(1-s)\beta\delta\right)u \qquad (17)$$

Taking the derivative with respect to $\overline{p}$ gives: $s\beta\delta^2\gamma\frac{2(1-\overline{p})\overline{p}(2-\beta)+\beta-1}{(1-2\overline{p})^2}$. There exists a threshold $\overline{p}_{soph}$ such that for $\overline{p} > \overline{p}_{soph}$, the returns to naïve artists are increasing in $\overline{p}$. It is easy to show that $\overline{p}_{soph} < \overline{p}_{naive}$.

6 References

Caves, R.E. (2000), *Creative Industries: Contracts Between Art and Commerce*, Harvard University Press: Cambridge (MA).

Caves, R.E. (2003), "Contracts Between Art and Commerce," *Journal of Economic Perspectives*, 17 (2), pp. 73-84.

Connolly, M. and A.B. Krueger (2006), "Rockonomics: The Economics of Popular Music," *Handbook of the Economics of Art and Culture*, Elsevier.

Curien, N. and F. Moreau, (2009), "The Music Industry in the Digital Era: Toward New Contracts," *Journal of Media Economics*, 22 (2), pp.102–113.

DellaVigna, S. and U. Malmendier (2004), "Contract Design and Self-Control: Theory and Evidence," Quarterly Journal of Economics, 119 (2), pp.353-402.

Handke, C. (2006), "Plain destruction or creative destruction? Copyright erosion and the evolution of the record industry," *Review of Economic Research on Copyright Issues* 3(2), pp.29–51.

Handke, C. (2010), "Digital copying and the supply of sound recordings," *mimeo*.

King, S.P. and R. Lampe (2003), "Network externalities, price discrimination and profitable piracy," *Information Economics and Policy*, 15 (3), pp.271-290.

Lasar, M. (2010), "KISS frontman on P2P: 'Sue everybody. Take their homes, their cars," ArsTechnica, Oct 5, 2010, (http://arstechnica.com/tech-policy/2010/10/kiss-frontman-we-should-have-sued-them-all/).

Liebowitz, S.J. (2006), "File Sharing: Creative Destruction or Just Plain Destruction?" Journal of Law and Economics, 49 (1), pp.1-28.

Mortimer, J.H., C. Nosko, and A. Sorenson (2012), "Supply Responses to Digital Distribution: Recorded Music and Live Performances," Information Economics and Policy, 24 (1), pp.3-14.

Oberholzer-Gee, F. and K. Strumpf (2007), "The Effect of File Sharing on Record Sales: An Empirical Analysis*." Journal of Political Economy*, 115 (1), pp.1–42.

O'Donoghue, T.D. and Matthew Rabin (1999), "Doing It Now or Later," *American Economic Review* 89, pp.103-124.

Peitz, M. and P. Waelbroeck (2006), "Why the Music Industry may gain from Free Downloading – The Role of Sampling," *International Journal of Industrial Organization*, 24, 907-913.

Phelps, E.S. and R.A. Pollak (1968), "On Second-Best National Saving and Game-Equilibrium Growth," *Review of Economic Studies*, 40, pp.391-401.

Rob, R. and J. Waldfogel (2006), "Piracy on the High C's: Music Downloading, Sales Displacement, and Social Welfare in a Sample of College Students," *Journal of Law & Economics*, 49 (1), pp.29-62.

Takeyama, L. (1994), "The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Network Externalities," *Journal of Industrial Economics*, 42, pp.155-166.

Waldfogel, J. (2011), "Bye, Bye Miss American Pie? The Supply of New Recorded Music Since Napster," NBER *Working Paper* No. 16882.

Waldfogel, J. (2012), "Copyright Protection, Technological Change, and the Quality of New Products: Evidence from Recorded Music since Napster," *Journal of Law and Economics* (forthcoming).

Waldfogel, J. (2013), "Digitization and the Quality of New Media Products: The Case of Music," *Economics of Digitization*, A. Goldfarb, S. Greenstein and C. Tucker (eds), NBER.

Zentner, A. (2006), "Measuring the effect of file sharing on music purchases," *Journal of Law and Economics*, 49, pp.63-90.

Zhang, L. (2013), "Intellectual Property Strategy and the Long Tail: Evidence from the Recorded Music Industry," *mimeo*., Toronto.