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Abstract

Promoting high-quality artistic creation requires sorting the most talented people of each generation and developing their skills. This paper takes a professional-career perspective in analyzing the determinants of artistic creation. The paper builds an overlapping-generations model of artists with three features: (*i*) the number of highly talented artists in a given period is positively linked to the number of young artists starting the career in the previous period; (*ii*) artistic markets are *superstar* markets; *iii*) promotion expenditures play an important role in determining market shares. In this framework, the paper analyzes the consequences for high-quality artistic creation of changes in the length of the copyright term, increases in market size, and progress in some communication technologies. It is shown that increasing superstars' returns do not always increase the expected return to starting an artistic career. As a result, in the long run, longer copyrights do not always stimulate artistic creation.

Keywords: copyrights, superstars, allocation of talent, globalization.

JEL Classification: J44, L82, O34.

"Quality is the offspring of quantity" (old Spanish saying)

1 Introduction

Artistic creations such as songs, movies, and novels are non-rival goods whose production may be very sensitive to market size and communication technologies. These two factors have undergone profound changes in recent years as a result of market globalization and new information and communication technologies. In turn, these changes have prompted an intense debate over how copyrights should be adapted to the new environment.[1] This paper investigates these issues from a significantly different perspective than the standard analysis. Standard economic analysis considers artistic creation as a particular case of development of new ideas. This paper argues that artistic creation and artistic markets have very distinctive features. These features are related to the fact that high-quality artistic creation requires innate specific abilities that can only be developed and recognized after individuals have actually started the professional activity. This calls for a professional-career perspective in analyzing the determinants of artistic creation. The paper shows in a simple setting that a professional-career approach brings about a substantially different view on how copyrights affect artistic creation and how they should be adapted to changes in market size and communication technologies.

Our analysis emphasizes three distinctive features of artistic markets. The first is a positive link between high-quality artistic creation at a given moment in time and the number of young artists that were able to initiate an artistic career in previous periods. Individuals are born with different abilities. Much of the process of sorting and developing those abilities is carried out through the period of formal education. However, some

[1] See Akerloff et al. (2002) and Liebowitz and Margolis (2003) for different positions on the optimality of the recent extension of the copyright term in the US; Kretschmer et al. (2008) for the discussion of the proposed extension in the European Union; Grossman and Lai (2004) and Boldrin and Levine (2006) on the debate on how that length should be changed as the market increases; Peitz and Waelbroeck (2003) and Varian (2005) for surveys; and The Economist October 11th 2007, for some account of the ongoing public debates.

abilities cannot be ascertained without the individual actually performing the professional activity (Johnson 1978 and Terviö 2009). This is the case of artists. Innate talent is central to artistic creation, but talent and charisma are rare and not easily detected. Young artists need time and some share of the market to test themselves and to develop their abilities. Similarly, the market (promotion firms and consumers) needs time to test and sort real talent (MacDonald 1988). This gives rise to a positive dynamic relationship between the current number of young artists and the future number of talented artists. In other words, the abundance of young artists (most of which will not succeed) is a precondition for a large amount of high-quality artistic creation in the future.

The second feature of artistic markets emphasized in our analysis is the huge difference between young artists' market share and earnings, and those of senior high-type artists or *superstars*. In a celebrated article, Sherwin Rosen (1981) showed that goods that are intensive in an innate input such as talent, combined with some characteristics that are usually present in artistic goods (such as scale economies arising from joint consumption), give rise to *superstar markets*; i.e., markets with a strong concentration of output and revenues on those few sellers who have the most talent. This has important consequences for artistic careers. Since the probability of becoming a star is very low, lifelong expected returns for a prospective young artist are extremely uncertain. Finally, the third feature of artistic markets emphasized in this paper is the important role played by promotion costs in shaping demand.[2] In particular, the distribution of market shares between stars and young artists is largely affected by stars' hefty expenditures on marketing and promotion costs. In turn, the economic incentives to invest in these expenditures depend on copyright regulation, communication technologies, and the size of the market.

Our analysis is framed into an ovelapping-generations model of artists.[3] Artists start

[2] For example, according to several sources cited by Peitz and Waelbroeck (2004), marketing and promotion are often the main cost of making and selling a CD.

[3] In the context of technological innovation Chou and Shy (1993) consider an overlapping generations model where a long patent duration reduces the rate of new product development in the economy. However the mechanism in their model is very different to ours and is based on the dynamic allocation of savings in an overlapping-generation framework

their careers as *young artists* whose talent is uncertain. Only those that show talent after their first life period become *high-type artists* (*stars*) in their second (and last) life period. The analysis focus on the long run determinants of high-type artistic creation.[4] In our model, high-type artistic creation is proportional to the number of active high-type artists. We show that, in the long run, the number of high-type artists may be limited by two constraints: (1) high-type artists' income must be at least as large as their opportunity costs, and (2) their number is bound by the inflow of new talented young artists (which in turn depends on the lifelong expected utility of initiating an artistic career). Depending on which of these two constraints is binding, the long run consequences for artistic creation of changes in the legal and economic environment (copyright regulation, communication technologies, and market size) may be very different.

In this respect, it is usually taken for granted that shocks increasing superstars' returns (such as extensions in the copyright term) always increase the expected return to starting an artistic career. Therefore, these shocks would always increase the inflow of new young artists. This paper shows that this is not necessarily the case. Longer copyrights tend to only benefit artists that succeed as superstars since earnings from copyrights are very unequally distributed and only the most successful work survives in the market after some time.[5] Moreover, longer copyrights increase superstars' incentives to invest in capturing a larger share of the artistic market. Note that in this respect any shift in consumers' expenditure from young artists' output to superstars' output (as a result of higher superstars'

[4] By *creation* or *production* of an artistic good we mean writing a novel, writing or recording a song, making a movie, etc., as opposed to the process of making the good available to any number of consumers by means of copies.

[5] Although data about earnings from copyrights are not easily accessible (they are privately held by collecting societies), there is some solid evidence on their extremely skewed distribution across artists. For example, Kretschmer and Hardwick (2007) report data on the distribution of payments in 1994 by the UK Performing Right Society. This society distributed ₤20,350,000 among 15,500 writers for the public performance and broadcasting of their works. The top 9.3% of writers earned 81.07% of the total. The Gini coefficient of the distribution of these earnings was 0.88. Ten composers earned more than ₤100,000, whereas 53.1% of the composers earned less than ₤100. These authors' estimations for the period 2004-5 show similar results.

promotion) reduces the expected value of initiating an artistic career due to time and high risk discounting of future earnings. Thus, the long run impact of changes in copyrights and other shocks on artistic creation requires an artists' lifelong expected discounted returns perspective, which does not coincide with incumbent superstars' perspective.

Which of the above two constraints (high-type artists' income or the inflow of new talented young artists) is more likely to be binding? What are the different consequences of either constraint being the binding constraint? When high-type artistic creation involves very large opportunity costs (with respect to young artists' opportunity costs), high-type artists' revenues are more likely to be the binding constraint. If this is the case, our results are similar to those obtained by the conventional approach to intellectual property. Contrarily, when high-type artists' opportunity costs are similar or only moderately higher than young artists', the constraint most likely be limiting long run high-quality artistic creation is the inflow of new talented young artists. In this second case, high-type artists obtain economic rents[6] and the results are different from those of the conventional analysis. In particular, the monotonically positive relationship between the copyright term and long run artistic creation does not hold.[7] Hence, this second case is the one leading to the most novel results in the paper. Furthermore, it can be argued that this case is very likely to hold. As pointed out by Murphy, Shleifer and Vishny (1991), there are different sorts of talent: on one extreme, talent may be highly correlated with generally valuable traits such as intelligence, energy, social charisma, or leadership; on the other, it may consist of a greatly specialized ability with no connection with traits that are valuable outside a particular activity. Artistic creation tends to be linked to this second sort of specialized talent whose potential alternative occupations outside the artistic market are very limited. To the contrary, human capital and other inputs used in R+D usually have close potential alternative occupations where they could obtain similar returns. Thus,

[6] See Chisholm (2004) for empirical work providing strong support to the hypothesis that stars obtain substantial economic rents in the motion picture industry.

[7] In the conventional approach to IP, longer copyright terms always stimulate artistic creation. The regulation problem in that setting is to find an optimal compromise between the positive effect on artistic creation of longer copyrights and the larger monopoly costs.

relatively low opportunity costs as well as economic rents (which characterize this second case) are likely to arise in artistic markets and create a key difference with respect to the environment in which new technological ideas are developed. See Table 1 for a simplified scheme of these two cases whose additional conditions and details will be explained along the paper.

The paper is organized as follows. In Section 2 we present the general setting of our analysis. In Section 3 we consider a simplified version of the model and analyze the long run consequences for artistic creation of changes in the copyright term and progress in communication technologies. In Section 4 we extend our analysis to a more general setting to investigate whether the copyright term that maximizes artistic creation is increasing or decreasing in market size and in the efficiency of communication technologies. In Section 5 we summarize and make some final comments.

2 General Setting

We consider an economy with overlapping generations of potential artists who live for two periods. Every period, each potential artist may decide to be active as an artist, in which case she creates a single artistic good (such as a song, a novel, or a movie). Alternatively, she may stay out of the artistic market, in which case she earns an income F. Artistic goods are made available to consumers by means of copies, which are produced at a constant marginal cost c.[8] Talent is heterogeneous and unknown to the public as well as to the artists themselves before they start the artistic career. In this environment, MacDonald (1988) has analyzed how artists are sorted by the market through an information accumulation process. Assuming that future performance is correlated with past performance, MacDonald shows that individuals will enter the artistic career only when young (i.e., the first life period), and remain in the artistic market for the second period only if they receive a good review of their performance in the first period. If this happens,

[8] In this paper all copies are assumed to be produced and sold by the owner of the copyright, in case the copyright has not expired yet. For an analysis of the consequences of piracy and file sharing in a similar setting to the one in this paper see Alcalá and González-Maestre (2009).

their performances in the second life-period are attended by a larger number of consumers who pay higher prices (i.e., they become stars). In this paper we take advantage of these results to simplify some aspects of the model and concentrate on the consequences of the legal and economic environment for the long run dynamics of artistic creation.

Following McDonald's results, we go on to assume that individuals entering the artistic profession do so in their first period of life. They are called *young* artists and create an artistic good in case of entering the artistic market. Only a fraction ρ of young artists are *talented*, but neither them nor artistic firms or the public can observe this innate characteristic until after the artist has completed her first life period. At the end of this first period, the fraction ρ of talented young artists reveal their talent and decide whether to continue the artistic career in the second life-period. In equilibrium, the fraction $1-\rho$ of young artists that realize that they do not have talent never find it profitable to remain in the artistic market. Talented artists that continue the artistic career in the second period are called *high-type artists* or *stars* and are the only ones to benefit from costly promotion expenditures.[9] These artists create a *high-quality artistic good* in their second life period. There is free entry to the artistic market as a young artist.

Our analysis focuses on the long run determinants of artistic creation and, in particular, of high-quality artistic creation. Since every artist creates one artistic good every period, per period high-quality artistic creation is equal to the number of active high-type artists.

2.1 The Artistic Career: Expected Utility and Constraints

Potential artists maximize expected utility with constant relative risk aversion $\sigma > 0$ and subjective intertemporal discount factor $\theta < 1$, which is assumed to be equal to the interest rate. That is, they maximize $U(c_1, c_2) = \frac{1}{1-\sigma} {c_1}^{1-\sigma} + \frac{\theta}{1-\sigma} E\left[{c_2}^{1-\sigma}\right]$; where c_1 and c_2 are consumption at each life period. F^y is the per-period income earned by any individual outside the artistic market. Thus, lifelong expected utility in the case of not starting an

[9] This assumption may be motivated by the complementarity between promotion and talent, and by fixed costs. Given the low probability of success, small fixed costs would lead promoting firms to stick with artists whose talent and charisma has already been established.

artistic career is:

$$\frac{1+\theta}{1-\sigma}\left[F^{y}\right]^{1-\sigma}.$$

Alternatively, expected utility of starting an artistic career is:[10]

$$\frac{1}{1-\sigma}\left[\pi_t^{y}\right]^{1-\sigma}+\frac{n_{t+1}}{m_t}\frac{\theta}{1-\sigma}\left[\pi_{t+1}^{h}\right]^{1-\sigma}+\left(1-\frac{n_{t+1}}{m_t}\right)\frac{\theta}{1-\sigma}\left[F^{y}\right]^{1-\sigma};$$

where π_t^y is earnings of a young artist at time t, π_t^h is earnings of a high-type artist, m_t is the number of young artists at time t, and n_{t+1} is the number of high-type artists one period later ($n_{t+1} \leq m_t$). Note that since the probability of having talent is the same for all potential young artists at the moment of deciding whether to start an artistic career, the probability that any of them becomes a high-type artist is the same for all of them and equal to the ratio n_{t+1}/m_t. Young artists not becoming stars after the first period drop out from the artistic market in the second period and earn F^y. Free entry to the artistic career implies that the expected utility of starting an artistic career must be equal to its opportunity cost:

$$\left[\pi_t^{y}\right]^{1-\sigma}+\theta\frac{n_{t+1}}{m_t}\left(\left[\pi_{t+1}^{h}\right]^{1-\sigma}-\left[F^{y}\right]^{1-\sigma}\right)=\left[F^{y}\right]^{1-\sigma}. \quad (1)$$

It is interesting to consider the possibility that high-type artists have an opportunity cost in the second period F^h that is larger than F^y. This higher opportunity cost of high-type artists may be the consequence of two circumstances. First, once an individual's talent has been revealed as high in her period as a young artist, she may have better outside options in the second life-period (since artistic talent may be positively correlated with other skills that are valuable in non-artistic occupations). And second, in order to create high-type artistic goods, it may be optimal to combine talented work with some additional costly inputs (with respect to the possible inputs used in young-artist artistic creation). These additional inputs have to be included in the opportunity cost F^h of

[10] In line with the analysis in Terviö (2009), we assume young artists cannot obtain insurance for the eventuality that they do not become stars and cannot borrow against future expected income. This seems to be very plausible empirically and may be the consequence of moral hazard problems. Becoming a star usually requires a significant (non-observable by third parties) personal effort during the young-artist period, even for those who have talent and charisma.

high-type artistic creation.[11] In any case, high-type artistic creation requires high-type artists' revenues to be at least as large as their specific opportunity costs:

$$\pi_t^h \geq F^h; \tag{2}$$

where $F^h \geq F^y$.

Note that it is possible that high-type artists' revenues are strictly above their opportunity costs in equilibrium (i.e., constraint (2) may be not binding). The reason is that the number of high-type artists is limited by the number of successful young artists; i.e., $n_t \leq \rho m_{t-1}$. Still, having talent is a necessary but not a sufficient condition for becoming high-type artists in their second life-period. That is, it may happen that young artists that show talent in their first life-period do not become high-type artists in their second life-period: $n_t < \rho m_{t-1}$. This may occur if high-type artists' opportunity cost is binding. If this is the case, additional active high-type artists would bring their earnings below their opportunity costs. On the other hand, if high-type artists' earnings are strictly above their opportunity costs, all young artists that show talent will want to stay in the artistic market in their second life-period as high-type artists. These arguments are summarized in the following constraint:

$$\begin{aligned} n_t &\leq \rho m_{t-1}; \\ \left(\pi_t^h - F^h\right)(n_t - \rho m_{t-1}) &= 0. \end{aligned} \tag{3}$$

If constraint (3) is binding, the number of high-type artists will be determined by substituting with $n_{t+1}/m_t = \rho$ in expression (1). Alternatively, if (3) is not binding, then constraint (2) is binding. In this case, $\pi_t^h = F^h$ will be the key expression determining high-type artistic creation.

[11] The financial importance of these inputs may widely vary across artistic activities. For example, they may have a large weight in the cost of producing a high-quality movie, whereas writing a novel may involve little more than the writer's time. Our arguments below may then justify longer copyrights for movies than for novels, as it is often the case. Still, we do not carry out an explicit analysis on the possible complementarities between talented artistic work and other inputs since this would add little new to the analysis but some tedious algebra. For our purposes it is enough to consider the possibility that $F^h > F^y$.

Summarizing, the long run number of active high-type artists is limited by either the revenue that these artists obtain (which must be at least as large as their opportunity costs), or by the inflow of talented young artists (which in turn depends on the life-long expected utility of initiating an artistic career). In the sections below, we show that the long run consequences for artistic creation of changes in copyright regulation, communication technologies, and market size depend on which of these two constraints is binding. As we will see below, the case where (2) is the binding constraint is more likely to occur when high-type artistic creation involves very large opportunity costs relative to young artists' opportunity costs. The case where (3) is the binding constraint is somewhat the opposite situation: the flow of new generations of young artists is the limiting factor of high-type artistic creation. Even if high-type artists' revenues are above their opportunity cost, this does not bring about a large supply of young artists. This can be the case because future earnings in the artistic career are highly discounted due to the high uncertainty of success.

2.2 Demand and Competition in Artistic Markets

We assume that every period, consumers spend an amount S of money in artistic goods. We refer to S as the size of the market. The representative consumer solves the following maximization problem:

$$\begin{aligned} &\text{Max } U = a \ln x + (1-a) \ln y, \qquad (4) \\ &s.t. \;\; p_x x + p_y y = S. \end{aligned}$$

where x (respectively, y) is purchased copies of stars' artistic goods (resp. young artists' goods), p_x (resp. p_y) is their price, and a is the relative preference for stars' artistic goods, which is also equal to the stars' market share.[12] High-type artists' market share a is endogenous and depends on total high-type artists' expenditures on advertising and

[12] This setting could be easily framed into a two-stage budgeting model with a general consumption good in addition to artistic goods. Agents would maximize $U = c^{1-\lambda} \left[a \ln x + (1-a) \ln y\right]^{\lambda}$, where c is consumption of the general good and λ is the share of income spent in artistic goods (which is assumed to be small). This more explicit setting would just make the model somewhat more cumbersome without

promotion.[13] Artist i's advertising and promotion expenditures are denoted by A_i. Then, high-type artists' market share a is determined by the following expression:

$$a = \alpha - \beta e^{-\gamma A/S}, \; A = \sum_{i}^{n} A_i, A_i \geq 0, \; i = 1, 2, .., n \; ; \tag{5}$$

where n ($n \geq 2$) is the number of high-type artists, and α, β and γ are exogenous parameters, $1 > \alpha > \beta > 0, \gamma > 1$. Parameter α is the maximum market share stars can reach. Parameter γ determines how productive promotion costs are in gaining market share. Stars' market share would be α for $A = \infty$ or $\gamma = \infty$, and $\alpha - \beta$ for zero promotion expenditures. Promotion costs needed to obtain a given market share are proportional to market size S.[14]

Note that parameters α and γ depend on the efficiency of information and communication technologies. For example, in the XIX century, the maximum audience that an opera superstar could reach was limited by the size of theatres. Now, a single singer can

adding any further insight. Our formulation also abstracts from horizontal differentiation among artists belonging to the same sub-market. The setting can be interpreted as one with a measure-one set of consumers, where each consumer has income S and buys one copy of the work of x high-type artists and of y young artists, and where consumers' purchases are uniformly and independently distributed within each group of artists (x and y being smaller than the number of artistic goods in each group). Alternatively, the setting could be interpreted as one with a measure-S set of consumers, each with income equal to one and buying one copy of the work of x/S high-type artists and of y/S young artists.

[13] Promotion expenditures are sometimes financed by artistic promotion firms. In this model, promotion firms may implicitly be thought to be perfectly competitive. Thus, we ignore the possible bargaining problems and potential conflicts of interest between artists and promotion firms, which have been analyzed in Gayer and Shy (2006).

[14] A firm's advertising tends to increase both the demand for that firm's good and the overall demand for the type of good being advertised. As a result, advertising increases the share of this type of good in consumers' expenditure (Sutton, 1991). In our formulation we model advertising as a public good for high-type agents, ignoring the competitive effects of advertising within high-type agents and focussing on the aggregate interactions between the low-type (young artists) and the high-type sub-markets. There is also an open debate as to what extent advertising is informative or merely persuasive. We do not make any assumption in this respect. As pointed out by Sutton (1991, sections 3.1 and 14.3), the only well-established empirical observation about advertising is that it is effective in stimulating demand, which is the assumption we make.

potentially reach a worldwide audience at any time. Rosen (1981) pointed out the importance that radio and phonograph records had for the market of superstars and wondered about the changes that would be brought by cable, video cassettes, home computers, etc. The path of technical progress affecting artistic markets does not seem to have slowed down in recent years as new devices and quality improvements have been introduced. The possibility that top artists are able to reach millions of consumers across the world is the consequence of the availability of an increasing number of electronic devices with rising quality and decreasing price. The opening of frontiers to foreign cultural influences after the end of the cold world has also been spectacular. Parameters α and γ will allow us to analyze the long run consequences for artistic creation of changes in the potential market that stars can reach and the effectiveness of the techniques aimed at increasing stars' market shares (such as marketing and promotion techniques).

Within each period, we assume the following timing:

- Stage 1: Given the number of high-type artists that results from the previous period, each high-type artist chooses simultaneously and independently her advertisement expenditure A_i.

- Stage 2: Potential young artists decide whether or not to enter the artistic market.

- Stage 3: Each artist (young artists as well as stars) creates an artistic good and competes à la Cournot in the number of copies brought to the market.

The general setting just laid out could also be interpreted in a spatial way. Young artists may be thought to be *local artists*, whereas high-type artists correspond to *international artists*. In every place, consumers buy local artists' output as well as international artists' (local artists' work may be thought to be more tied to the cultural peculiarities of a geographic area or ethnic group). Local artists become known by means of word-of-mouth, whereas international artists rely on expensive marketing and promotion. The fraction of income spent on either type of artist depends on international artists' promotion expenditures. Dynamically, a fraction of local artists reveal themselves as having *universal talent* and are periodically drafted by promotion firms to the international high-type market. In this spatial interpretation, the model could be reformulated as with ℓ symmetric local markets each one with size $(1-a)S/\ell$, and one international market with size $a{\cdot}S$.

3 A Simple Case with Stars Obtaining Rents

In this section, we consider the case where high-type artists obtain economic rents. Thus, we assume that constraint (2) is not binding. Therefore, according to (3), the number of high-type artists each period is limited by the inflow of new talents; i.e., $n_t = \rho m_{t-1}$. Moreover, we consider the particular case where the subjective time discount factor θ is zero. Under this extreme assumption, the analysis delivers the basic insights of the model in the simplest possible way. In the next section, we will consider the general case $\theta > 0$ together with the possibility that high-type artists do not obtain rents.

3.1 The Short Run Number of Young Artists

Let us solve the equilibrium at a given period taking the number of high-type artists n as exogenous. This short run equilibrium serves as a first step to the dynamic analysis in the next subsection. The exogeneity of the number of high-type artists in the short run reflects the idea that the set of stars changes with lower frequency than the set of young artists.

Consider the Cournot-Nash equilibrium at Stage 3. Standard calculations show that inverse demand functions are given by $p_x = aS/x$ and $p_y = (1-a)S/y$. Thus, each high-type artist's profit function is given by

$$\pi_i^h(x_i, x) = \frac{aSx_i}{x} - cx_i - A_i,\ i = 1, 2, ..., n.$$

where x_i is artist i 's sales of copies of her creation and c is the constant marginal cost of making a copy. First order conditions in a Cournot setting yield

$$\frac{aS}{x} - c - \frac{aSx_i}{x^2} = 0,\ i = 1, 2, ..., n.$$

From this system we get high-type artists' equilibrium price, output per artist, and profits as a function of advertisement and the endogenous market share:

$$p_x = \frac{n}{n-1}c;\quad x_i = \frac{n-1}{n^2}\frac{aS}{c};\quad \pi_i^h = \frac{aS}{n^2} - A_i. \tag{6}$$

Then, we can solve for the first stage of the game when advertisement is chosen. High-type firms' profit function can be written as

$$\pi_i^h(A_i, A) = \frac{(\alpha - \beta e^{-\gamma A/S})S}{n^2} - A_i,\ i = 1, 2, ..., n. \tag{7}$$

The first order conditions for the subgame perfect Nash equilibrium (SPNE) of the game yield the equilibrium level for high-type artists' market share $a(n)$:

$$\frac{\beta e^{-\gamma A/S}}{n^2} - (1/\gamma) = 0 \ \rightarrow\ a(n) = \alpha - n^2/\gamma. \tag{8}$$

Note that $n^2 < \beta\gamma$ is a necessary and sufficient condition for $A_i > 0$ (which in turn guarantees $\pi_i^h > 0$). This conditions can always be met for γ large enough. Hence throughout the paper it is assumed that the effectiveness of promotion expenditures is high enough (γ is large enough) for high-type artist to be willing to spend a positive amount of money on promotion.

In turn, young artist i's profits selling y_i copies of her creation are given by:

$$\pi_i^y(y_i, y) = \frac{(1-a)Sy_i}{y} - cy_i\ ;\ i = 1, 2, ..., m.$$

Cournot equilibrium in the low-type market gives rise to the following price and output per artist:

$$p_y = \frac{m}{m-1}c,\quad y_i = \frac{(m-1)}{(m)^2}\frac{(1-a)S}{c}.$$

The SPNE number of young artists m^* is determined by the free entry condition (1). Assuming $\theta = 0$, we have:

$$\pi_i^y = \frac{(1-a)S}{m^2} = F^y = 0;\ i = 1, 2, ..., m.$$

Hence,

$$m^* = \left[\left(1 - \alpha + n^2/\gamma\right)\frac{S}{F^y}\right]^{\frac{1}{2}}. \tag{9}$$

3.2 Long Run Dynamics

As already noted, since constraint (2) is not binding, we have $n_{t+1} = \rho m_t$. Using this to substitute in (9) we obtain the following difference equation:

$$n_t^2 = \left(1 - \alpha + n_{t-1}^2/\gamma\right)\frac{S}{F^y}\rho^2. \tag{10}$$

Hence the steady state number of high-type artists is given by:

$$n^* = \left[\frac{(1-\alpha)\frac{S}{F^y}\rho^2}{1 - \frac{S}{F^y}\rho^2/\gamma}\right]^{1/2}. \tag{11}$$

As already noted, the development of recording, communication, and other technologies amplified the scale economies of joint consumption of artistic goods and helped concentrate market shares and earnings in top talented artists. The next proposition points out that technical improvements that benefit incumbent high-type artists and increase their market share, may reduce high-quality artistic creation in the long run.

Proposition 1 *If stars obtain economic rents, innovations favoring market concentration by high-type artists (such as improvements in information and communication technologies as captured by increases in γ and α) reduce artistic creation in the long run (i.e., they reduce the number of both young and high-type artists).*

The mathematics of the proposition are straightforward since only the positive solution for n^* makes economic sense.[15] Intuitively, larger high-type artists' market share leaves little audience for young artists, thereby reducing its number. As a result, fewer new

[15] It may also be noted that for γ large enough, the denominator in the expression is positive. It can then be shown that the positive root solving (11) is also an stable equilibrium.

talents are uncovered, which in turn reduces the number of high-type artists in the long run (and therefore high-quality artistic creation).

Proposition 1 does not imply that technical progress always reduces the number of artists. First, technical progress can also work against superstars' earnings and market share. This is what seems to happen with the Internet (which can help young artists to get promoted) and the technologies of file sharing (which may reduce superstars' earnings). Assessing the impact of these technologies on artistic creation is beyond the scope of this paper.[16] Second, if technical progress increases consumers' income and this raises expenditure on artistic goods, technical progress has a positive effect on artistic creation (see Proposition 5 below). Third, if copyrights' length is reduced to compensate for the increase in superstars' returns, the negative long run effect on artistic creation does not necessarily follow. This is the point to be made next.

3.3 The Length of the Copyright Term

In this subsection we extend the model to analyze the impact of different lengths of the copyright term. In general, young artists' work does not last in the market, whereas superstars' records, movies, and books may yield important returns for a long period after their production, although sales are likely to be diminishing.[17] We now assume that high-type artistic goods can provide positive utility for an infinite number of periods after their creation, although at a decreasing rate. Specifically, we assume that the utility they provide diminishes according to a discount factor η, $0 < \eta < 1$. High-type artists are assumed to be able to capture the present discounted value of the net yields from future sales of their work (e.g., by selling their copyrights when they are still alive). In the case of young artists' work, it is assumed to be lost for good after the period of creation.

[16] See Alcalá and González-Maestre (2009) for an analysis of the consequences of piracy within the approach of this paper.

[17] Liebowitz (2007) provides some illustrative numbers on the decay of record sales in the UK by date of production. The percentage of albums sales in 2004 by year of production was: 60.90% albums of the 2000s, 12.30% albums of the 1990s, 11.00% albums of the 1980s, 9.50% albums of the 1970s, 4.80% albums of the 1960s, and 1.30% albums of the 1950s.

To keep things simple, assume that the demand at any period t comes from a representative consumer that lives for only one period,[18] and that any copy of an artistic good produced in a given period is worn out due to its use by the end of the period. The new consumer's problem at time t is:

$$\max U = (1-\eta)\sum_{\tau=0}^{\infty} a_\tau \eta^\tau \ln x_\tau + \left[1-(1-\eta)\sum_{\tau=0}^{\infty} a_\tau \eta^\tau\right] \ln y, \tag{12}$$
$$s.t.\ \ p_{x_\tau}\sum_{\tau=0}^{T-1} x_\tau + c\sum_{\tau=T}^{\infty} x_\tau + p_y y = S.$$

Where $T \geq 1$ is the length of the copyright term, x_τ is current consumption of high-type artistic goods created τ periods ago, p_{x_τ} is their price, c is the marginal cost of a copy which is also the competitive price at which copies are sold when copyrights expire, $a_\tau = \alpha - \beta e^{-A_\tau \gamma/S}$, and A_τ are promotion costs spent on high-type artistic goods created τ periods ago (which were spent at the time of the good release, i.e., τ periods ago). We assume $(\alpha-\beta)(1-\eta) \geq 1/2$ to insure that high-type artists always fare better than young artists, which should be the consequence of their higher expected talent.

The analysis of high-type artist decisions remains almost unchanged after this extension. As in the previous subsection, first consider the Cournot equilibrium at Stage 3. Current inverse demand for a high-type artistic good created τ periods ago is $p_{x_\tau} = a_\tau(1-\eta)\eta^\tau S/x_\tau$. Let $x_{\tau i}$ be the number of copies of a representative artistic good created at period τ that are sold at time t. Equilibrium prices and output are:

$$p_{x_\tau} = \frac{n_\tau}{n_\tau - 1}c; \quad x_{\tau i} = \frac{n_\tau - 1}{n_\tau^2}\frac{a_\tau(1-\eta)\eta^\tau S}{c};$$

where n_τ is the number of high-type artists that were active τ periods ago. Then, let us solve directly for a symmetric steady state equilibrium: $n_\tau = n^* = \rho m_t = \rho m^*, A_\tau = A, a_\tau = a^*$. High-type artists's discounted value of revenues at the time of deciding about

[18]The model could be easily extended to consider consumers that live for two periods and include among their savings assets representing the value of copyrights. This extension would be straightforward, provided that the artistic market is assumed to be small enough not to affect the overall general equilibrium of the economy (in particular, the interest rate).

promotion costs A_i are given by:

$$\begin{aligned} \pi_i^h(A_i, A) &= \frac{\alpha - \beta e^{-(\gamma/S)A}}{n^2} S(1-\eta) \sum_{\tau=0}^{T-1} (\eta R)^{\tau} - A_i, \\ A &= \sum_i A_i;\ i = 1, 2, ..., n; \end{aligned} \tag{13}$$

where R is the intertemporal discount factor. The first order conditions for the SPNE of the game determine the equilibrium value of a:

$$\frac{\beta e^{-(\gamma/S)A}}{n^2} w(T) - (1/\gamma) = 0 \ \rightarrow a(n) = \alpha - \frac{n^2}{\gamma} \frac{1}{w(T)}; \tag{14}$$

where

$$w(T) = (1-\eta) \sum_{\tau=0}^{T-1} (\eta R)^{\tau} = (1-\eta) \frac{1-(\eta R)^T}{1-\eta R}.$$

The necessary and sufficient condition for $A_i > 0$ is $n^2 < \beta\gamma w(T)$. Clearly, $w(T)$ is strictly increasing in T (and is bounded from above by 1: we would have $w = 1$ only in the limit $T \rightarrow \infty$ and for $R = 1$). Below we sometimes simplify notation by interpreting an exogenous change in w as originated by a change in T of the same sign (and with some abuse of notation we will take T as a continuous variable with $T \geq 1$).

From (12), the inverse demand for young artists' output is given by $p_y = \left[1 - \sum_{\tau}^{\infty} a_{\tau} (1-\eta) \eta^{\tau}\right] S/y$. Thus, each active young artist's net revenues are:

$$\pi_i^y(y_i, y) = \frac{(1-a)Sy_i}{y} - cy_i\ ;\ i = 1, 2, ..., m.$$

Where y_i are young artist i's sales. Cournot equilibrium in the low-type market gives rise to the following price and output per artist:

$$p_y = \frac{m}{m-1}c, \quad y_i = \frac{(m-1)(1-a)S}{m^2 c}.$$

Therefore, (per capita) young artists' revenues are

$$\pi_i^y = \frac{(1-a)S}{m^2}. \tag{15}$$

Since (10) holds the same as in the previous subsection and (3) is binding, using (14) we obtain the following equation for the steady state:

$$n^2 = \left(1 - \alpha + \frac{n^2}{\gamma}\frac{1}{w(T)}\right)\frac{S}{F}\rho^2. \tag{16}$$

This expression is very similar to equation (11). The steady state number of high-type artists is now given by:

$$n^* = \left[\frac{(1-\alpha)\frac{S}{F}\rho^2}{1 - \frac{S}{F}\rho^2/(\gamma w(T))}\right]^{1/2}$$

Therefore, we have the following

Proposition 2 *If stars obtain positive rents and young artists' intertemporal discount factor is very small ($\theta = 0$) extending the length of the copyright term reduces artistic creation in the long run.*

Longer copyrights raise stars' revenues, but this does not help increase the number of artists. The reason is that when constraint (3) is binding, the problem limiting the number of high-type artists is that young artists' share of the audience is too small and thus reduces the possibility to discover new talents. The increase in high-type artists' revenues as a result of longer copyrights raises the incentives to invest in the promotion of high-type artists and worsens the problem: young artists' market share is reduced. This further chokes the flow of future high-type artists. Note that this negative effect is independent of the monopolistic distortions implied by copyrights, which is the usual criticism of long copyrights.

The corollary of Propositions 1 and 2 is that if superstars obtain rents, the impact of economic and technological innovations that increase superstars' market share and returns should be compensated by reducing the length of the copyright term. Otherwise, artistic creation will be reduced in the next periods.

4 The General Model

We now consider the more general case where either constraint (2) or (3) is binding and the intertemporal discount factor is positive: $\theta > 0$. Still, the analysis of high-type artists' optimal decisions from the previous section remains unchanged. We go on to directly consider the symmetric steady state equilibria of the model.

4.1 A Graphical Exposition

The $H(T,n)$ locus Per capita high-type artists' revenues are given by (13) using (14):

$$\pi^h(T,n) = S\left[\frac{\alpha w(T)}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left(\frac{\beta\gamma w(T)}{n^2}\right)\right]. \tag{17}$$

Using this expression, consider the combinations of the copyright term T and the number of high-type artists n satisfying constraint (2) with equality; i.e., the set of pairs (T,n) giving rise to high-type artists' revenues equal to their opportunity costs. We denote this locus by $H(T,n)$:

$$H(T,n) =: \left\{(T,n) : \left[\frac{\alpha w(T)}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left(\frac{\beta\gamma w(T)}{n^2}\right)\right]S = F^h\right\}. \tag{18}$$

Note that $a(n) = \alpha - \frac{n^2}{\gamma w} > 0$ implies $0 > 1 - \frac{\alpha\gamma w}{n^2} > 1 - \frac{\alpha\gamma w}{n^2} + \frac{1}{2}\ln(\frac{\beta\gamma w}{n^2}) - (n-1)\frac{\alpha\gamma w}{n^2} = 1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln(\frac{\beta\gamma w}{n^2})$. Therefore, $H(n,T)$ has a positive slope in Figure 1:

$$\frac{dn}{dw(T)} = \frac{\alpha\gamma - \frac{n}{w}}{2\frac{\alpha\gamma w}{n} - 2 - \ln\left(\frac{\beta\gamma w}{n^2}\right)} > 0.$$

It is useful to define a function from $H(T,n)$. Define $h: R \to R$ as the function yielding the value of n that satisfies (18) for each T. Note that a pair (T,n) satisfies constraint (2) if and only if $n \le h(T)$.

The $L(T,n)$ locus Using (13)-(15) to substitute into young artists' free-entry condition (1) we have:

$$\left[\frac{(1-a)}{m^2}S\right]^{1-\sigma} + \theta\frac{n}{m}\left(\left[\left(\frac{\alpha w(T)}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left[\frac{\beta\gamma w(T)}{n^2}\right]\right)S\right]^{1-\sigma} - [F^y]^{1-\sigma}\right) = [F^y]^{1-\sigma}. \tag{19}$$

Now, consider the combinations of T and n satisfying constraint (3) with equality; i.e., pairs (T,n) that give rise to young artists' revenues equal to their opportunity costs when $n = \rho m$. We denote this locus by $L(T, n)$:

$$L(T,n) =: \ \{(T,n) : (1+\theta\rho)\left[F^{y}\right]^{1-\sigma} = \left[\left(\frac{1-\alpha}{n^2} + \frac{1}{\gamma w(T)}\right)\rho^2 S\right]^{1-\sigma}$$
$$+\theta\rho\left[\left(\frac{\alpha w(T)}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left[\frac{\beta\gamma w(T)}{n^2}\right]\right) S\right]^{1-\sigma}\}. \tag{20}$$

Differentiation with respect to w and n yields:

$$\frac{dn}{dw(T)} = -\frac{n^3 + \rho^{2\sigma-1}K^{\sigma}\theta\left[n - \alpha\gamma w\right]wn}{2\gamma(1-\alpha)w^2 + \rho^{2\sigma-1}K^{\sigma}\theta\left[2\alpha\gamma w - 2n - n\ln(\frac{\beta\gamma w}{n^2})\right]w^2};$$

where K is defined as

$$K \equiv \frac{1-\alpha+\frac{n^2}{\gamma w}}{\alpha w - \frac{n^2}{\gamma} - \frac{n}{\gamma}\ln\left(\frac{\beta\gamma w}{n^2}\right)}.$$

Given the rest of parameters, the derivative $dn/dw(T)$ is negative for $\rho^{2\sigma-1}\theta$ small enough.[19] The condition on $\rho^{2\sigma-1}\theta$ requires either a low probability of becoming a star (with relative risk aversion $\sigma > \frac{1}{2}$) or a large discount rate (which may be due to a long period of having the opportunity to grow and emerge as a talented artist), or a combination of both. The high uncertainty of success is precisely one of the characteristics of artistic markets, as emphasized in the introduction to this paper. This motivates the following:

Assumption 1 *The probability ρ of success is low enough (with relative risk aversion $\sigma > 1/2$) or the career to become a star is long enough (low θ) as to insure $dn/dw(T) < 0$.*

Under this assumption, the $L(T, n)$ locus has a negative slope in Figure 1.[20] It is now useful to define $l : R \to R$ using $L(T, n)$, as the function yielding the value of n that satisfies (20) for each T.

[19] Using (17), we know that the denominator of the expression for K satisfies

$$n^2\pi^h/S = \alpha w - n^2/\gamma - n/\gamma\ln\left(\beta\gamma w/n^2\right) > (\alpha-\beta)\,w > 0;$$

where the inequality holds from profit maximization with respect to advertising (recall that $(\alpha-\beta)\,wS/n^2$ is stars' discounted profits for zero advertising; see equation (13)). Thus, the denominator of K is bounded away from zero. On the other hand, K is also bounded from above by a number independent of both ρ and θ.

[20] The reason for drawing the $H(T, n)$ and $L(T, n)$ locuses in Figure 1 part as solid lines and part as dashed lines will become apparent in the following.

4.2 The Length of the Copyright Term

Pairs (T, n) on or below the locus $H(T, n)$ in Figure 1 satisfy constraint (2), whereas pairs on or below $L(T, n)$ satisfy (1) and constraint (3). Using $h(T)$ and $l(T)$ we can determine the long run number of high-type artists n^* as a function of the length of the copyright term T.

Lemma 3 *Given the length of the copyright term T, the long run number of high-type artists n^* is given by $n^* = \min[l(T), h(T)]$.*

Proof. See Appendix A. ■

Solid lines in Figure 1 indicate the segments of $l(T)$ and $h(T)$ that determine n^*. Since the case where $l(T)$ is the relevant schedule is characterized by high-type artists' obtaining revenues above their opportunity costs and since Assumption 1 ensures this schedule has a negative slope, the following proposition is immediate:

Proposition 4 *Let Assumption 1 hold. If high-type artists' obtain economic rents, then extending the copyright length reduces artistic creation in the long run. Otherwise, it increases artistic creation.*

The intuition for this result is similar to that in the previous section. Total earnings in the artistic market increase as a result of longer copyrights, but only high-type artists benefit from this increase. The reason is that there is also a shift in consumer expenditure from young artists' work to stars' work since a copyright extension raises stars' investment in promotion. Hence, the extension of copyrights is very profitable for the current generation of stars but, overall, may be negative for the expected discounted utility of starting an artistic career. Key to the lower expected discounted utility of an artistic career is the large uncertainty of success (or the large intertemporal discount) involved in Assumption 1.[21]

[21] This is consistent with the empirical analysis of Kretschmer and Hardwick (2007) who, after comparing the different sources of writers' income in Germany and the UK and the skewness of copyright earnings, conclude that current copyright law may exacerbate risk.

Thus, extending the copyright term reduces consumer expenditure on young artists' work and may lower their number, thereby hindering the long run process of developing and uncovering young talented artists. Eventually, this process reduces the number of high-type artists if the flow of new generations of talented young artists is the long run binding constraint. To the contrary, extending the copyright term helps long run high-type artistic creation if the binding constraint on the long run number of high-type artists is revenues accruing to them (which is the implicit assumption in the conventional approach to optimal IP protection).

Clearly, the probability that the copyright term falls either within the segment where $L(T,n)$ is the relevant schedule or within the $H(T,n)$ segment, depends on the relative position of these two schedules. In turn, this relative position depends on the value of high-type artists' opportunity cost F^h with respect to young artists' opportunity cost F^y. The more similar these opportunity costs are, the larger is the segment where the $L(T,n)$ schedule is the relevant one; and, therefore, the more likely it is that superstars obtain rents and that the copyright term is too long from the point of view of maximizing artistic creation. This case is more likely to occur if artistic talent is a very specialized ability, as noted in the Introduction. See Appendix B for a formal analysis of this issue.

4.3 The Long Run Impact of Changes in the Environment

How do structural changes in the relevant environment (increases in market size and improvements in communication and marketing technologies) affect artistic creation in the long run, given a constant copyright term? The answer may depend on whether the relevant constraint for artistic careers is the $H(T,n)$ or he $L(T,n)$ locus. An increase in market size S shifts both schedules upwards (see Figure 2, where $S_2 > S_1$). In turn, an increase in α or γ shifts the $L(T,n)$ schedule downwards and the $H(T,n)$ schedule upwards (see Figure 3, where $\gamma_2 > \gamma_1$ and $\alpha_2 > \alpha_1$). This leads to the following results:

Proposition 5 *An increase in market size always increases the long run number of artists, whatever the length of the copyright term. Furthermore, under Assumption 1,* *improvements in communication and marketing technologies favoring market concentration by stars (i.e., increases in γ or α) reduce the long run number of both young and high-type artists if high-type artists' obtain economic rents, and increases artistic creation otherwise.*

Proof. See Appendix A. ■

4.4 Adapting Copyrights to an Expanding Market and Technological Changes

Should the length of the copyright be changed as the economic environment changes if artistic creation is to be maximized? It is clear from Figure 1 that as long as the $H(T, n)$ and $L(T, n)$ schedules cross for some feasible value of T (T_0 in the figure), this value maximizes long run artistic creation. Hence shifts in these schedules will indicate how the maximizing copyright term changes as a result of changes in the environment.

Graphically, the effect of changes in α or γ is illustrated in Figure 3. Schedule $H(T, n)$ shifts upwards as γ or α increase, whereas schedule $L(T, n)$ shifts downwards. As a result, the maximizing copyright term always decreases when γ or α rise. On the other hand, the effect of an increase in market size is represented in Figure 2, where both $H(T, n)$ and $L(T, n)$ shift upwards after an increase in S. Under Assumption 1, the upwards shift of $H(T, n)$ is larger than the shift of $L(T, n)$ so that T^0 also decreases with S. These results are summarized in the following

Proposition 6 *Improvements in communication technologies favoring market concentration by stars (i.e., increases in γ or α) reduce the length of the copyright term that maximizes the long run number of high-type and young artists. Similarly, if Assumption 1 holds, an increase in the size of the market for artistic goods reduces the length of the copyright term that maximizes the long run number of artists.*

Proof. See Appendix A. ■

Our second result in this proposition is similar to the one in Boldrin and Levine (2006). Yet, in contrast with our model, shorter copyrights involve lower innovative activity in

Boldrin and Levine (their argument for a shorter copyright term relies on its monopoly distortions).

It may also be that larger markets not only increase superstars' incentives to spend on promotion but also their incentives to lobby for the extension of the copyright term. This may pose political economy difficulties in pursuing an optimal copyright policy.

5 Concluding Comments

Artistic talent and charisma cannot be easily appraised before the individual enters the artistic career. As a result, the sorting and forging of talented artists requires many young artists of unknown talent trying the career and dropping out after priors about their abilities are updated. In a superstar market, a large uncertainty about young artists' abilities translates into an enormous uncertainty about future earnings. Thus, earnings in the case of success are heavily discounted in computing the expected value of a young artist's career. This implies that changes in superstars' revenues have little direct impact on young artist's career expected value. In the long run, increasing young artists' opportunities to gain an audience and succeed may be more effective in promoting artistic creation than increasing returns only in case of success (i.e., increasing only superstars' returns).

Even more, increasing the returns in the case of success may be counter productive for helping new artistic careers. Most artistic markets operate in the framework of an overwhelming machinery of promotion and advertising. Incentives to invest in the promotion of the superstars rise as the prospects of superstars' revenues improve (as caused by modifications in the regulation of copyrights or the size of global markets). In this environment, the expected discounted return of a young artist' career may be reduced as a result of a positive shock to superstars' revenues. As a consequence, larger high-type artists' revenues may result in the long run in fewer numbers of artists, and therefore, less high-quality artistic creation. The model characterizes the circumstances that will lead to this result. This will occur if high-type artists obtain economic rents so that the factor limiting high-quality artistic creation in the long run is not high-type artists' income but the flow of young artists entering the artistic career. This is more likely to be the case when artistic talent is a very specialized ability.

Copyrights should be adapted to changes in the technological and economic environment. For more than a century, technological changes have favored market concentration by superstars. As long as superstars obtain rents, this paper shows that copyrights should have been shortened. This makes room for more young artists in the market and promotes high-quality artistic creation in the long run. Instead, most countries have kept extending copyrights. More recent technological, economic, and cultural changes are having mixed consequences on superstars' market share. New communication technologies such as the Internet and new copying devices are working against concentration; whereas changes in the economic and political environment have facilitated the globalization of culture and the enlargement of markets, which favor superstars. This paper analyzed this second type of shocks and has shown that, under plausible circumstances, the length of the copyright term that maximizes the long run number of high-type artists is decreasing in the size of the market. This paper's framework can also be extended to analyze the optimal response of intellectual property regulation to new communication and copying technologies, which facilitate the promotion of young artists as well as piracy thereby reducing superstars' market concentration (see the companion paper Alcalá and González-Maestre, 2009).

Our analysis makes substantial simplifications in many respects. However, it introduces important features of artistic markets that the standard analysis of intellectual property has ignored. Moreover, it points out the circumstances under which the standard approach holds. The standard analysis is better suited for creative activities using mostly non-specialized inputs. This is likely to be the case in the development of technological ideas. In contrast, the standard approach may be misleading when innate and very specific abilities are important, when these abilities are not easily observable but can only be fully recognized after starting the professional career, and when the professional career takes place in a superstars' market. These circumstances seem to be the usual case in the production of artistic ideas.

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Appendix A: Proof of Propositions

Proof of Lemma 3: First note that a necessary condition for a combination (T, n, m) to satisfy (19) is $n \leq l(T)$. In particular, if $n = \rho m$ we must have $n = l(T)$ (since plugging $n/m = \rho$ into (19) brings about the $L(T, n)$ locus); whereas if $n < \rho m$, we then must have $n < l(T)$.

Consider first the case $l(T) \leq h(T)$. Hence we must have $n \leq l(T)$. But equilibrium cannot be strictly below $L(T, n)$ either. To see this, assume $n < l(T)$. Satisfying (19) would then require $n < \rho m$. But then, (4) implies $\pi^h = F^h$; which in turn implies the point lies on the high-type opportunity cost locus $H(T, n)$ (i.e., $n = h(T)$). Hence we have a contradiction: $n < l(T) \leq h(T) = n$. We therefore conclude that for T such that $l(T) \leq h(T)$, we have $n^* = l(T)$.

Now, consider copyright terms T such that $l(T) > h(T)$. Equilibria cannot lie above any of the $L(T, n)$ and $H(T, n)$ locuses, hence we must have $n \leq h(T)$. But they cannot be strictly below $H(T, n)$ either. To see this, assume $n < h(T)$. But then (4) implies $n = \rho m$; which in turn implies the point lies on the $L(T, n)$ locus (i.e., $l(T) = n$). Hence we have a contradiction: $n < h(T) \leq l(T) = n$. Hence we conclude that for T such that $l(T) \leq h(T)$, we have $n^* = h(T)$. ■

Proof of Proposition 5: We have to show that when α or γ increase, the $L(T, n)$ schedule shifts downwards, whereas the $H(T, n)$ schedule shifts upwards. And that when S increases, both schedules shift upwards. The direction of the shifts can be obtained by taking the appropriate derivatives along the schedules $L(T, n)$ and $H(T, n)$ given the copyright term T.

Let us denote by n^l the level of n associated to $L(T, n)$. For any given copyright term

T, we obtain, from (20) the following derivatives:

$$
\begin{aligned}
\frac{dn^l}{d\alpha} &= -\frac{n-\rho^{2\sigma-1}K^\sigma\theta n w(T)}{2(1-\alpha)+\rho^{2\sigma-1}K^\sigma\theta\left[2\alpha\gamma w(T)-2n-n\ln(\frac{\beta\gamma w(T)}{n^2})\right]/\gamma};\\
\frac{dn^l}{d\gamma} &= -\frac{n^3-\rho^{2\sigma-1}K^\sigma\theta\left[n-1+\ln\left(\frac{\gamma\beta w(T)}{n^2}\right)\right]w(T)n^2}{2\gamma^2(1-\alpha)w(T)+\rho^{2\sigma-1}K^\sigma\theta\left[2\alpha\gamma w(T)-2n-n\ln(\frac{\beta\gamma w(T)}{n^2})\right]w(T)\gamma};\\
\frac{dn^l}{dS} &= \frac{\left(1-\alpha+\frac{n^2}{\gamma w}\right)\left[\rho^{2\sigma}\left(\frac{1-\alpha}{n^2}+\frac{1}{\gamma w}\right)+\rho^{2\sigma-1}\theta\left(\frac{\alpha w}{n^2}-\frac{1}{\gamma}-\frac{1}{n\gamma}\ln(\frac{\beta\gamma w}{n^2})\right)\right]}{S\left[2(1-\alpha)+\frac{2}{\gamma}\rho^{2\sigma-1}K^\sigma\theta(1-\frac{\alpha\gamma w}{n}+\frac{1}{2}\ln\left(\frac{\gamma\beta w}{n^2}\right)\right]}.
\end{aligned}
$$

If $\rho^{2\sigma-1}K^\sigma\theta$ is small enough, then $dn^l/d\alpha$ and $dn^l/d\gamma$ are negative, whereas dn^l/dS is positive. On the other hand, from (17) the effects of α, γ, S and n on high-type artists' revenues are given by:

$$
\begin{aligned}
\frac{\partial\pi_i^h}{\partial\alpha} &= S\frac{w}{n^2}>0;\\
\frac{\partial\pi_i^h}{\partial\gamma} &= S\frac{1}{\gamma^2}\left[1-\frac{1}{n}+\frac{1}{n}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]>0;\\
\frac{\partial\pi_i^h}{\partial S} &= \left[\frac{\alpha w}{n^2}-\frac{1}{\gamma}-\frac{1}{\gamma n}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]>0;\\
\frac{\partial\pi_i^h}{\partial n} &= \frac{2S}{n^2\gamma}\left[1-\frac{\alpha\gamma w}{n}+\frac{1}{2}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]<0.
\end{aligned}
$$

Where the sign of the last derivative comes from observing that

$$
\begin{aligned}
a(n) &= \alpha-\frac{n^2}{\gamma w}>0\\
&\Rightarrow\; 0>1-\frac{\alpha\gamma w}{n^2}>1-\frac{\alpha\gamma w}{n^2}+\frac{1}{2}\ln(\frac{\beta\gamma w}{n^2})-(n-1)\frac{\alpha\gamma w}{n^2}\\
&= 1-\frac{\alpha\gamma w}{n}+\frac{1}{2}\ln(\frac{\beta\gamma w}{n^2}).
\end{aligned}
$$

Therefore schedule $H(T,n)$ shifts upwards when α or γ or S increase. Let us denote as n^h the level of n associated to $H(T,n)$. According to our previous analysis and taking into account (17) and (18), we have:

$$\begin{aligned}
\frac{dn^h}{d\alpha} &= -\left(\frac{\partial \pi_i^h}{\partial \alpha} / \frac{\partial \pi_i^h}{\partial n}\right) > 0; \\
\frac{dn^h}{d\gamma} &= -\left(\frac{\partial \pi_i^h}{\partial \gamma} / \frac{\partial \pi_i^h}{\partial n}\right) > 0; \\
\frac{dn^h}{dS} &= -\left(\frac{\partial \pi_i^h}{\partial S} / \frac{\partial \pi_i^h}{\partial n}\right) = \frac{\alpha w \gamma - n^2 - n \ln\left(\frac{\beta\gamma w}{n^2}\right)}{2S\left[1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]} > 0. \blacksquare
\end{aligned}$$

Proof of Proposition 6: We need to show how the artistic-creation maximizing copyright term T^0 varies as a function of technological parameters α and γ, and of the size of the market S. By total differentiation in (18) and (20), and assuming $\rho^{2\sigma-1}K^\sigma\theta$ is small enough, we obtain, taking into account our previous analysis:

$$\begin{aligned}
\frac{dT^0}{d\alpha} &= \frac{-\left(\frac{\partial \pi_i^h}{\partial n}\frac{\partial n^l}{\partial \alpha} + \frac{\partial \pi_i^h}{\partial \alpha}\right)}{\left(\frac{\partial \pi_i^h}{\partial n}\frac{\partial n^l}{\partial w} + \frac{\partial \pi_i^h}{\partial w}\right)\frac{\partial w}{\partial T}} < 0; \\
\frac{dT^0}{d\gamma} &= \frac{-\left(\frac{\partial \pi_i^h}{\partial n}\frac{dn^l}{d\gamma} + \frac{\partial \pi_i^h}{\partial \gamma}\right)}{\left(\frac{\partial \pi_i^h}{\partial n}\frac{dn^l}{dw} + \frac{\partial \pi_i^h}{\partial w}\right)\frac{\partial w}{\partial T}} < 0; \\
\frac{dT^0}{dS} &= \frac{-\left(\frac{\partial \pi_i^h}{\partial n}\frac{dn^l}{dS} + \frac{\partial \pi_i^h}{\partial S}\right)}{\left(\frac{\partial \pi_i^h}{\partial n}\frac{dn^l}{dw} + \frac{\partial \pi_i^h}{\partial w}\right)\frac{\partial w}{\partial T}} = \frac{-\frac{\partial \pi_i^h}{\partial n}\left(\frac{dn^l}{dS} - \frac{dn^h}{dS}\right)}{\left(\frac{\partial \pi_i^h}{\partial n}\frac{dn^l}{dw} + \frac{\partial \pi_i^h}{\partial w}\right)\frac{\partial w}{\partial T}}
\end{aligned}$$

Where the last derivative is negative if and only if

$$\begin{aligned}
\frac{dn^l}{dS} / \frac{dn^h}{dS} &= \left(\frac{\left(1 - \alpha + \frac{n^2}{\gamma w}\right)\left[\rho^{2\sigma}\left(\frac{1-\alpha}{n^2} + \frac{1}{\gamma w}\right) + \rho^{2\sigma-1}\theta\left(\frac{\alpha w}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right)\right]}{S\left[2(1-\alpha) + \frac{2}{\gamma}\rho^{2\sigma-1}K^\sigma\theta\left(1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln\left(\frac{\gamma\beta w}{n^2}\right)\right]}\right) \\
&\quad \div \left(\frac{\alpha w \gamma - n^2 - n\ln\left(\frac{\beta\gamma w}{n^2}\right)}{2S\left[1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]}\right) \\
&= \frac{\left(1 - \alpha + \frac{n^2}{\gamma w}\right)\left[\rho^{2\sigma}\left(\frac{1-\alpha}{n^2} + \frac{1}{\gamma w}\right) + \rho^{2\sigma-1}\theta\left(\frac{\alpha w}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right)\right]}{\left[1 - \alpha + \rho^{2\sigma-1}\frac{\theta}{\gamma}K^\theta\left(1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right)\right]} \\
&\quad \times \frac{\left[1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]}{\left[\gamma\alpha w - n^2 - n\ln\left(\frac{\beta\gamma w}{n^2}\right)\right]} < 1;
\end{aligned}$$

which is satisfied for ρ small enough, provided that $\sigma > \frac{1}{2}$. $\blacksquare$

6 Appendix B: Opportunity costs and superstars' rents

There can be different relative positions of $H(T, n)$ with respect to $L(T, n)$ along the feasible range of the copyright term $T \in [1, \infty)$. In fact, there are three possible cases: (i) $H(T, n)$ is always above $L(T, n)$; (ii) $H(T, n)$ is always below $L(T, n)$; and (iii) $L(T, n)$ and $H(T, n)$ cross each other (which is the case depicted in Figure 1). Which case is most likely to hold depends on the importance of high-type artists' opportunity cost F^h relative to young artists' opportunity cost F^y, as summarized in the following proposition.

Proposition 7 *(i) If high-type artists' opportunity cost F^h is similar enough to young artists' opportunity cost F^y, high-type artists will obtain economic rents. Therefore, extending the copyright length would reduce artistic creation in the long run.*

(ii) If high-type artists' opportunity cost is large enough relative to young artists', high-type artists will not obtain economic rents. Therefore, extending the copyright length would raise high-quality artistic creation in the long run.

(iii) For intermediate cases (i.e., high-type artists' opportunity cost moderately larger than young artists' opportunity cost) there exists a finite copyright term $T^0 \in (1, \infty)$ that maximizes the long run number of artists, so that any change in the copyright term away from this length reduces artistic creation in the long run.

Proof Condition (1) evaluated at the steady state becomes:

$$\left[\frac{\pi^y}{\pi^h}\right]^{1-\sigma} + \frac{n}{m}\theta = \left(1 + \frac{n}{m}\theta\right)\left[\frac{F^y}{\pi^h}\right]^{1-\sigma}. \tag{A.1}$$

Given that $F^h/F^y \geq 1$, we have the following possibilities on F^h/F^y:

i) If F^h/F^y is small enough (i.e., close to 1) and since $\pi^y < \pi^h$ (a high-type artist always fares better even with zero promotion costs since $(\alpha - \beta)(1 - \eta) \geq 1/2$), then $F^h < \pi^h$; and, consequently, (2) is not binding. To see this, note that equation (A.1) implies $F^y < \pi^h$ and the result holds for $F^h = F^y$. Hence, by continuity, the same property holds if F^h is larger but sufficiently close to F^y. Therefore, in this case (3) must be binding, as well as (20), which implies that n^* is decreasing in T, according to the properties of $l(T)$.

ii) At the other extreme, if F^h/F^y is large enough the binding constraint is (2), which implies zero rents for the stars. To show this, note the following: If F^h (and consequently π^h) tends to infinity, given F^y, then, according to (A.1), it must be the case that $\frac{n}{m}$ approaches to zero and $\frac{n}{m} < \rho$. But this implies that (3) cannot be binding and, in turn, (20) cannot be binding either. Therefore, in this case the binding condition is (2) as well as (18). Hence n^* is increasing in T, given the properties of $h(T)$.

iii) For intermediate values of F^h/F^y the $H(T, n)$ and $L(T, n)$ schedules intersect at some strictly positive pair (T^0, n^0); see Figure 1. Given that $h(T)$ is strictly increasing and $l(T)$ is strictly decreasing, it follows that $H(T, n)$ is binding if and only if $T < T^0$;whereas $L(T, n)$ is binding if and only if $T > T^0$. Therefore, the copyright term that maximizes the number of artists is T^0. ■

Table 1: The Long Run Dynamics of Artistic Creation: Two Cases Depending on Which Constraint Is Binding

Alternative Binding Constraints	Factors Increasing the Likelihood that This Constraint is Binding	Characterization and Consequences
Superstars' income must be at least as large as their opportunity costs.	Artistic talent is highly correlated with abilities that are highly valuable in other occupations. And/or high-quality artistic creation requires an important amount of other valuable inputs.	Superstars do not obtain rents. Increasing the length of copyrights' term would enhance high-quality artistic creation.
The expected utility of an artistic career must be at least as large as the expected lifelong utility in alternative occupations.	Artistic talent is a very specialized ability that is uncorrelated with valuable skill outside the artistic market. Moreover, high-quality artistic creation almost does not require other inputs but artistic talent.	Superstars obtain rents. Increasing the length of the copyright term would reduce both high- and low-quality artistic creation in the long run. Moreover, the copyright term should be reduced as the artistic goods market grows.

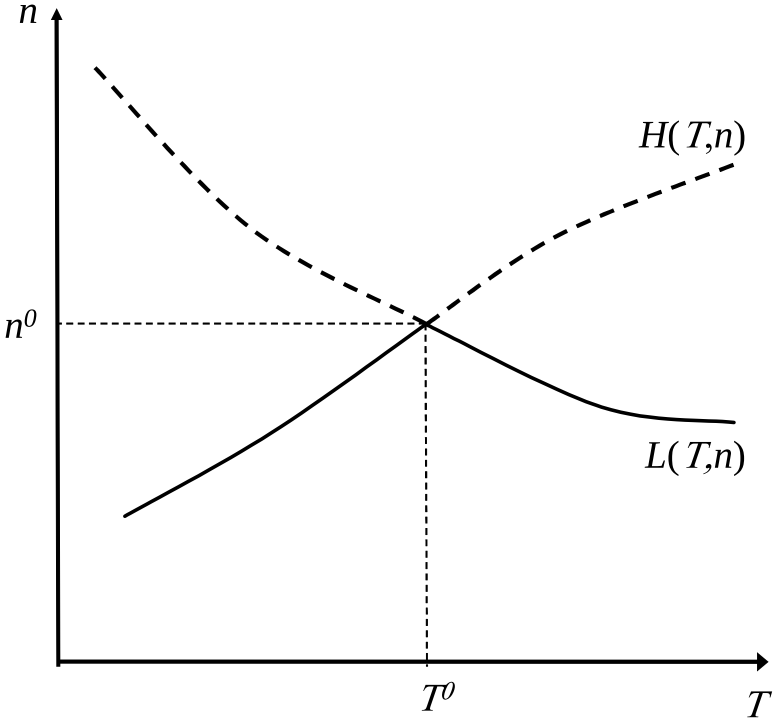

Figure 1:

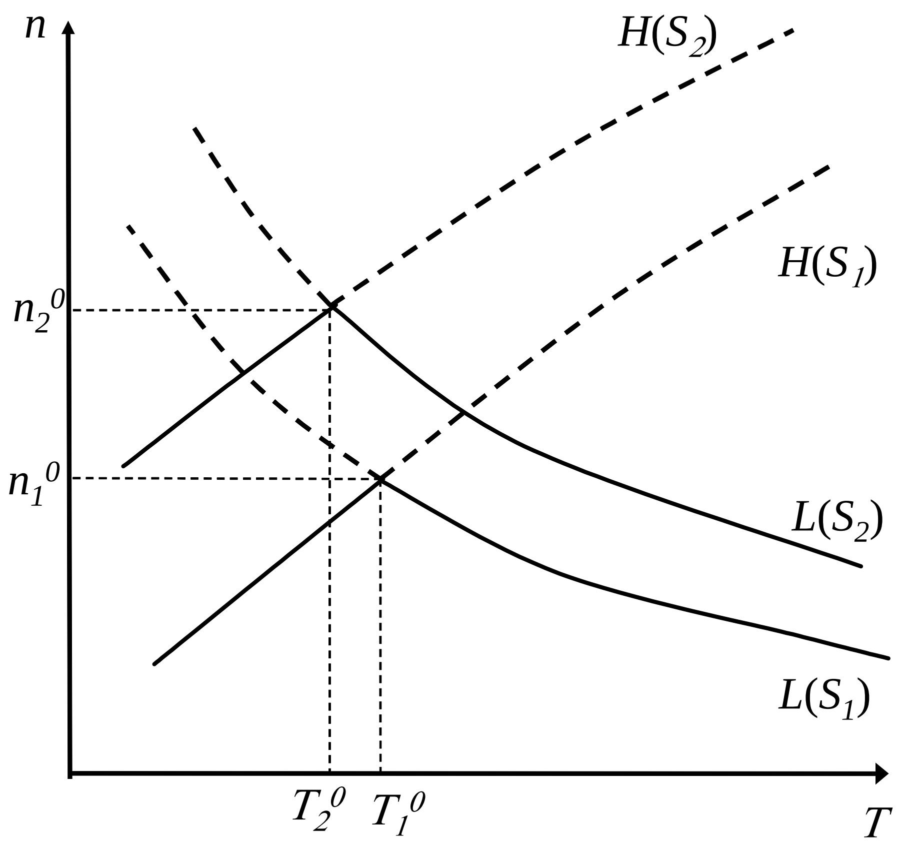

Figure 2:

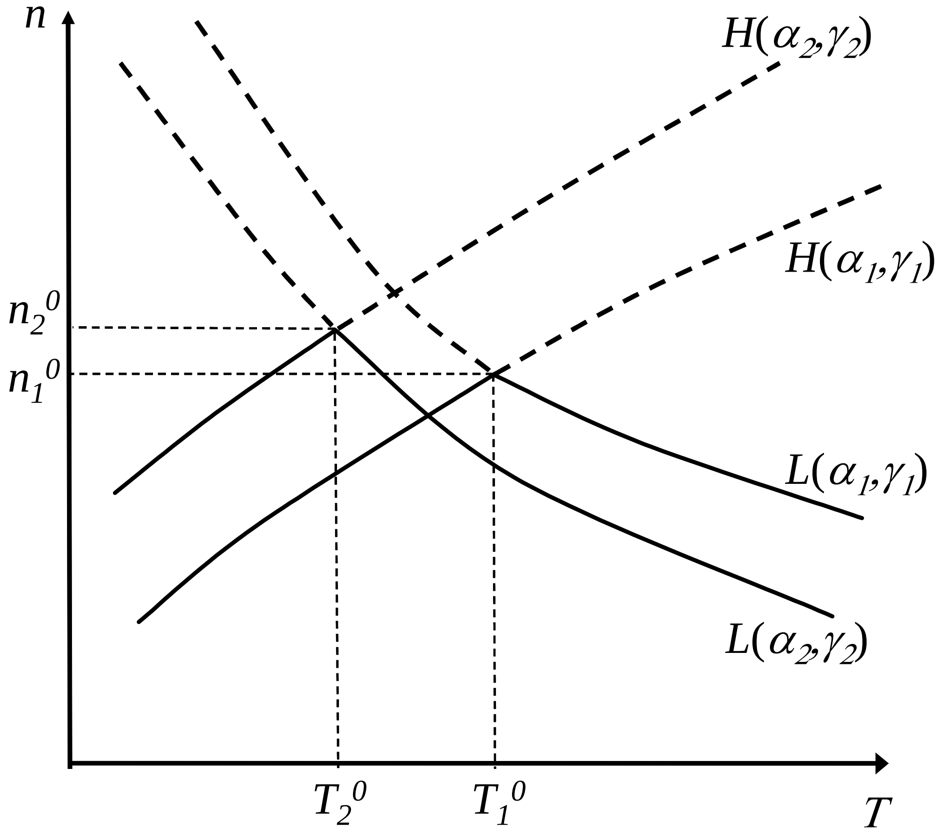

Figure 3:

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