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Abstract

Reaching high levels of artistic creation in a society requires institutions that facilitate the sorting of the most talented individuals of each generation and the development of their skills across artistic careers. This working paper takes a professional career approach to analyzing how copyright regulation affects artistic creation. It builds an overlapping-generations model of artists in which the number and average talent of senior artists in each period is linked to the number of young artists in previous periods. Long copyrights increase superstar market concentration and can reduce the number of young artists who are able to pursue artistic careers. As a result, in the long run, excessively long copyrights can reduce artistic creation, the average talent of artists, and social welfare.

Resumen

El mantenimiento de elevados niveles de creación artística en una sociedad requiere de un marco institucional que facilite el descubrimiento de los mejores talentos de cada generación y el desarrollo de sus cualidades a lo largo de carreras artísticas. Este documento de trabajo examina la influencia que tiene la regulación de los derechos de propiedad sobre la creación artística en cuanto a cómo esa regulación afecta a las carreras artísticas. Se construye un modelo de generaciones solapadas de artistas en el que el número y talento de los artistas consagrados recogidos en cada período está ligado al número de artistas jóvenes en los períodos previos. Los derechos de autor en vigencia durante un tiempo más prolongado aumentan la concentración del mercado en favor de las grandes estrellas y pueden reducir el número de jóvenes artistas que son capaces de iniciar y desarrollar una carrera artística. Como consecuencia de ello, en el largo plazo, los derechos de autor excesivamente largos pueden reducir la creación artística, el talento medio de los artistas consagrados y el bienestar social.

Key words

Copyrights, superstars, sorting of talent, artistic markets.

Palabras clave

Derechos de autor, estrellas, descubrimiento de talento, mercados artísticos.

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1. Introduction

NEW technologies as well as market globalization are profoundly affecting artistic markets. Partly as a result of this, intellectual property regulation is undergoing important changes in many countries. For instance, the copyright term has been extended in the US from 50 to 70 years after the death of the creator, while the European Commission is considering an extension of the copyright term from 50 to 90 years. These changes are taking place amid an intense popular and academic debate about how intellectual property should be adapted to changes in the economic and technological environment to better serve the public[1].

This paper provides a new approach to the analysis of the long-run link between intellectual property and artistic creation. The approach is based on a professional-career perspective of the determinants of artistic creation. Artistic creation is intensive in a unique input, talent, which is rare and can only be recognized and developed after the potentially talented artist has actually started the professional activity. Reaching high levels of artistic creation requires testing many artists every generation so as to sort the most talented. In the long run, artistic creation depends on how attractive to potential young artists this highly uncertain professional career is. Within this perspective, this paper builds an overlapping-generations model of artists with three features: (i) the number and average talent of senior artists in a given period is linked to the number of young artists starting the career in previous periods; (ii) artistic markets are *superstar* markets; iii) promotion and marketing expenditures play an important role in determining market shares. This approach provides new important insights on the long-run link between copyrights and artistic creation. Specifically, it shows that excessively long copyrights can boost superstars' market share at the expense of the opportunities for young artists to start an artistic career. This in turn reduces artistic creation and the average talent of senior artists in the long run.

[1] For example, the proposed extension of the copyright term in the European Union has been labeled as "a redistribution of income from living to dead artists" (Kretschmer et al. 2009). See Akerloff et al. (2002) and Liebowitz and Margolis (2003) for different positions on the optimality of the last extension of the copyright term in the US; Kretschmer et al. (2008) for 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 market size increases; Peitz and Waelbroeck (2005) and Varian (2005) for surveys; and *The Economist* October 11th 2007 and April 9th 2010 for some account of the ongoing debate.

As indicated, the first feature emphasized by our analysis is the positive link between high-quality artistic creation by senior artists at a given moment in time and the number of young artists that were able to initiate an artistic career in previous periods. Much of the process of sorting and developing innate individual abilities is carried out through the period of formal education. However, some abilities cannot be ascertained without the individual actually performing the professional activity (Johnson, 1978). This is the case of artists. Young artists need time and some share of the market to test themselves and to develop their skills. Similarly, the market (promotion firms and consumers) needs time to test and sort real talent (MacDonald 1988). This gives rise to a positive dynamic link between the current abundance of young artists (most of whom will not succeed) and the future number and average talent of senior artists[2].

The second characteristic of artistic markets featured in our analysis is the huge difference in market share and earnings between a small number of superstars and remaining artists. In a celebrated article, Sherwin Rosen (1981) showed that goods that are intensive in an innate input such as talent, combined with some characteristics 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. Several papers provide evidence of the strong (and increasing) concentration of sales in some artistic markets (see Rothenbuhler and Dimmick 1982, Crain and Tollison 2002, and Krueger 2005, among others). For example, in the case of rock and roll, Krueger (2005) reports that the top 1% of artists obtained 26% of concert revenue in 1982. In 2003, this proportion rose to 56%. Similarly, the top 5% of revenue generators took in 62% of concert revenue in 1982 and 84% in 2003. There is also some solid evidence on the extremely skewed distribution of copyright yields across artists although data about earnings from copyrights are not easily accessible. For example, Kretschmer and Hardwick (2007) report data on the distribution of payments in 1994 by the UK Performing Rights 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

[2] The need for a professional-career perspective in the analysis of the allocation of human resources is also important in some other markets. For example, having a large supply of good politicians and large-firm managers not only depends on paying them large sums at the peak of their careers but on developing the appropriate institutions and environment such that new potential talents can be tested, sorted, trained and promoted. Market failure arises as a consequence of the impossibility of insuring against the uncertainties of the professional career when talent is difficult to recognize ex ante. See Terviö (2009).

writers earned 81.07% of the total. Ten composers earned more than £100,000, whereas 53.1% of composers earned less than £100[3]. The superstar character of artistic markets generates extraordinary uncertainty on young artists' future revenues and has important consequences for the optimal regulation of copyrights.

The third feature of artistic markets emphasized in this paper is the important role played by promotion and marketing expenditures[4]. In particular, the distribution of market shares between stars and young artists is largely affected by stars' hefty expenditures on marketing their work, which in turn are affected by copyright regulations.

The finding that copyright extensions could in the long run reduce artistic creation is in sharp contrast with some implications of the standard analysis of intellectual property. Note that, according to the standard analysis, the copyright regulation problem is to find an optimal compromise between the positive effect that stronger copyrights have on artistic creation and their negative underutilization effect (see Hirshleifer and Riley [1979], Novos and Waldman [1984], and the references therein). An exception is Landes and Posner (1989), who point out that excessively strong intellectual property rights may in fact hinder the development of new ideas that are based on previous ones. However, in spite of the thoroughness of this work, it also neglects the dynamic effects of copyright regulation on the expected value of artistic careers and does not account for the cited three characteristics of artistic markets that are central to our analysis.

Our analysis is framed into an ovelapping-generations model of artists. Firstly, we consider a model with only two types of artists (talented and not-talented), which borrows important features from MacDonald (1988): artists start their careers as young artists whose talent is uncertain; only those that show talent after their first life-period continue the artistic career and become *stars* in their second (and last) life-period. Secondly, we generalize the results in a model with a continuum of talents. Although the mechanisms involved in these two models may seem different, the key condition for the main results is the same: the super-

3 The data for the Spanish artistic market show an even higher degree of concentration: the top 1.5% of beneficiaries of the main collecting society in the country (SGAE) obtain 75% of total revenues (see AEVAL 2008). See also Chisholm (2004) for empirical work providing strong support to the hypothesis that stars obtain substantial economic rents in the motion picture industry.

4 According to several sources cited by Peitz and Waelbroeck (2004), marketing and promotion are often the main cost of making and selling a CD.

star effect must be important; i.e., a substantial share of market revenues accrues to a small fraction of superstars that obtain large rents. When this occurs, reinforcing copyrights may be negative for artistic creation and social welfare in the long run.

The paper is organized as follows. In section 2 we present the general setting of the analysis. In section 3 we consider a model with two types of artists in terms of talent. We analyze the long-run consequences for artistic creation and social welfare of changes in the copyright term and progress in communication technologies favoring market concentration. In section 4, we build a model with a continuum of artist types. In addition to generalizing previous results, this model provides new insights on how, in the long run, copyright regulation influences the average talent of senior artists. We summarize and conclude in section 5. Sections 6 and 7 provide some further generalizations and analytical details.

2. General Setting

CONSIDER an economy with overlapping generations of potential artists who live for two periods. In each 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). If she decides to stay out of the artistic market, she earns an income F^Y. Artistic goods are made available to consumers by means of copies, which are produced at a constant marginal cost c[5]. Talent is heterogeneous and unknown to the public as well as to the artists themselves before they start the artistic career. There is free entry to the artistic market as an unknown artist.

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

[5] In this paper all copies are assumed to be produced and sold by the owner of the copyright in cases where the copyright has not expired yet. Thus, we do not consider issues related to piracy and file sharing. On these issues see Alcalá and González-Maestre (2010) who explore the consequences of unauthorized copying and levies on copy equipment in a model in which artistic firms use limit pricing strategies. That model simplifies on a number of issues with respect to this one but introduces heterogeneous consumers in terms of their preferences for irregular copies and originals.

the first period. If this happens, their performances in their second life-period are attended by a larger number of consumers who pay higher prices (i.e., they become superstars). 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 MacDonald's (1988) results, we go on to assume that individuals entering the artistic profession do so in their first period of life. In case of entering the artistic market, they become *young* artists and create an artistic good. Only a fraction ρ of young artists are *talented*, but neither they 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 reveals their talent and decide whether to continue the artistic career in the second life-period. In turn, the fraction $1-\rho$ of young artists that reveal to be non-talented do not find it profitable to remain in the artistic market. Talented artists that continue the artistic career in the second period are called *senior artists* or *superstars* and are the only ones to benefit from costly marketing expenditures[6]. Each of these senior artists creates a *high-quality artistic good* in her second life period. Since every artist creates one artistic good every period, per period (high-quality) artistic creation is equal to the number of active (senior) artists.

2.1. The artistic career: expected utility and constraints

Potential young artists maximize lifelong expected utility $U(c_1,c_2)=\frac{1}{1-\sigma}c_1^{1-\sigma}+\frac{\theta}{1-\sigma}E\left[c_2^{1-\sigma}\right]$; where c_1 and c_2 are consumption at each life period, $\sigma>0$ is the constant relative risk aversion coefficient, and $\theta<1$ is the intertemporal discount factor, which is assumed to be equal to the interest rate. They compare the expected utility of starting and not starting an artistic career. As already indicated, we denote by F^Y the per-period income earned by any individual outside the artistic market. Thus, the ex-

[6] This assumption can be motivated by fixed costs. Given the low probability of success, small fixed costs would lead promoting firms to stick with artists whose talent and charisma have already been established.

pected utility in the case of not starting an artistic career is $\frac{1+\theta}{1-\sigma}\left[F^{Y}\right]^{1-\sigma}$. Alternatively, expected utility of starting an artistic career is[7]:

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

where π_t^Y is the earnings of a young artist at time *t*, π_t^S is earnings of a senior artist, m_t is the number of young artists at time *t*, and n_{t+1} is the number of stars one period later $\left(n_{t+1} \le m_t\right)$. 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 of becoming a senior artist is the same for all of them and equal to the ratio n_{t+1}/m_t. Young artists that do not become stars after the first period drop out from the artistic market and earn F^Y in the second period. Free entry to the artistic career implies that the expected utility of starting an artistic career must be equal to its opportunity cost:

$$\left[\pi_t^{Y}\right]^{1-\sigma}+\theta\frac{n_{t+1}}{m_t}\left(\left[\pi_{t+1}^{S}\right]^{1-\sigma}-\left[F^{Y}\right]^{1-\sigma}\right)=\left[F^{Y}\right]^{1-\sigma} \qquad (1)$$

We will assume $F^S \ge F^Y$. In fact, stars could have higher opportunity costs as a result of two circumstances. First, an individual that reveals to have talent in her fist period 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-quality artistic goods it may be optimal to combine talented work with some other inputs that are more costly than those that are optimal to use by young-artist when creating their art. These additional inputs can be thought of being included in the opportunity cost F^S of stars' artistic creations[8].

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[7] 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.

[8] The financial importance of these inputs may greatly vary across artistic activities. For example, they may have a large weight in the cost of producing high-quality movies, whereas writing novels

High-type artistic creation requires the stars' revenues to be at least as large as their opportunity costs: $\pi_t^S \geq F^S$. In equilibrium, this constraint may be slack; that is, superstars may obtain economic rents. The reason is that there is not free entry in the artistic market as a superstar but the number of superstars in a given period is limited by the number of talented young artists that entered the artistic market in the previous period. In fact, according to the evidence cited in the Introduction, stars seem to obtain large rents. Hence, we assume throughout sections 2 and 3 that $\pi_t^S > F^S$. Then, all the young artists that show talent in a given period become stars the next period:

$$n_t = \rho m_{t-1} \tag{2}$$

In section 6 (appendix A) we also consider and discuss the case in which $\pi_t^S \geq F^S$ is binding, in which case we could have $n_t = \rho m_{t-1}$.

2.2. Demand and competition in artistic markets

There is a continuum of consumers Z each one buying a copy of an artistic work each period. A fraction a of consumers buys copies from superstars whereas the remaining fraction $(1-a)$ buys from new young artists. The fraction a is endogenously determined as a function of the superstars' advertising and marketing expenditures. Specifically, we assume $a = a(A)$, where $A \equiv \sum_{i=1}^{n} A_i$ and $A_i \geq 0$ is star i's advertising and marketing expenditures. Horizontal differentiation within each sub-market is modeled following Salop (1979). That is, consumers are uniformly distributed in each sub-market along a circular space of preferences that has length one. Artists competing in each sub-market are located symmetrically around that circle. The consumer located at distance z from her closest artist obtains utility

$$U(Q_i; P_i; z) = Q_i - p_i - \lambda z \tag{3}$$

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may involve little more than the writers' time. Still, we do not carry out an explicit analysis on the possible complementarities between talented artistic work and other more expensive inputs because this would add little to the analysis but some tedious algebra. Note however that our arguments below could justify longer copyrights for those types of artistic creations that need more costly inputs.

where Q_i is the quality of artist *i*'s creation, p_i is its price, and λ is the consumer *unit transport cost*, which can be interpreted as the disutility associated with departing from her optimal consumption location. As in Salop (1979) we assume that Q_i is the same for all the artists in the same sub-market. However, we allow for the possibility that young artists' creation is of lower average quality than superstars' work; i.e., we assume $Q^S \geq Q^Y$, where Q^S and Q^Y are respectively the expected quality of stars' and young artists' work[9]. To simplify the analysis we also assume that Q^S and Q^Y are large enough to ensure that in equilibrium all the consumers buy one copy of an artistic good.

There is an open debate as to whether advertising is informative of merely persuasive. However, our results do not depend on the point of view in this respect. For instance, an interpretation of the model assigning a strong informative role to advertising is the following. Assume Q^S is not only strictly higher than Q^Y but the difference is sufficiently large so that any consumer would prefer to buy a star work instead of a low type (independently of their location in the circular space of characteristics) if she could recognize who are the stars. Star advertising and marketing is the mechanism informing who the talented artists are. Then, the fraction of consumers that is reached by stars' advertising and marketing is given by *a*. Thus, this is the fraction buying stars' work. An opposite interpretation of the model is to consider that stars do not really have more talent than the rest of artists; i.e., $Q^S = Q^Y$ [10]. In such a case, star advertising is not informative but persuasive and pushes a fraction *a* of consumers to buy star creations even if they are sold at significantly higher prices. Our qualitative results do not depend on whether we assume $Q^S > Q^Y$ or $Q^S = Q^Y$. The key point in the argument is not whether superstars are or not talented but whether they obtain rents[11].

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[9] We can take $Q^Y = \rho Q^S + (1-\rho)\underline{Q}$, where $\underline{Q}$ is the quality provided by a non-talented artist $\left(\underline{Q} \leq Q^S\right)$.

[10] There is some controversy about whether it is necessary to be more talented in order to become a superstar. See Adler (1985) for some theory and Hamlen (1991) as well as Spierdijk and Voorneveld (2009) for empirical tests and references to additional analyses.

[11] Our setting can also be interpreted in a spatial way. Young artists may be thought to be *local artists*, whereas stars are *international artists*. In each place, consumers buy the local artists' output as well as the international artists' (the 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 the international artists' marketing expenditures. Every

The stars' market share depends on their total marketing expenditures according to the following expression[12]:

$$a = 1-\beta e^{-\gamma nA/Z} \tag{4}$$

where *n* is the number of senior artists $(n \geq 2)$, and β and γ are exogenous parameters $(1 > \beta > 0,\ \gamma > 1)$. Thus, the stars' market share would be equal to 1 if $A = \infty$ and equal to $(1 - \beta)$ if $(A = 0)$. Note that the marketing expenditures that are necessary to obtain a given market share are proportional to market size Z[13]. Parameter γ determines how productive marketing expenditures are in gaining market share. This parameter may be thought to depend on the state of information, communication and reproduction technologies, as well as on the barriers to the globalization of culture[14]. For example, when Alfred Marshall was calling attention on the superstar phenomenon for the first time, the maximum audience that an opera superstar could reach was limited by the size of theatres. Now, a singer can 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

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period, a fraction of local artists reveals to have *universal talent* and is drafted by promotion firms to the international market. In this spatial interpretation, the model could be reformulated as with ℓ symmetric local sub-markets each one with size $(1-a)Z/\ell$. The international sub-market would still have size $a \cdot Z$.

[12] Advertising and marketing of artistic goods are usually financed by artistic promotion firms. In this paper we consider each artist and her possible promotion firm as a single unit. Thus, we ignore the potential bargaining problems and conflicts of interest between artists and promotion firms, which have been analyzed elsewhere (see for example Gayer and Shy 2006).

[13] 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 stars, ignoring the competitive effects of advertising within stars and focussing on the aggregate interactions between young artist and star sub-markets. Taking into account the competitive effects of advertising within stars would likely lead to more advertising by stars and to an even smaller market share for young artists.

[14] See the previous footnote for the interpretation of stars as international artists. A given expenditure in artistic promotion leads to larger stars' international sales (and lower local artists' sales) as economic and political barriers to the international diffusion of culture are reduced. Lower barriers are captured by a higher γ.

that would be brought by new devices such as cable, video cassettes, and home computers. The path of technical progress affecting artistic markets does not seem to have slowed down in recent years thereby enhancing the ability to reach millions of consumers at lower costs and with increasing quality. The opening of frontiers to foreign cultural influences after the end of the cold world has also been spectacular. Comparative statics with respect to parameter γ will allow us to analyze the consequences for artistic creation of changes in the potential market that stars can reach and in the effectiveness of marketing techniques aimed at increasing stars' market share[15].

Within each period, we assume the following timing:

- Stage 1: Each young artist that revealed to be talented in the previous period decides whether to continue in the artistic market as a star.
- Stage 2: Each star chooses simultaneously and independently her marketing expenditure A_i.
- Stage 3: Potential new young artists decide whether or not to enter the artistic market.
- Stage 4: Each artist (young artists as well as stars) creates an artistic good and competes in prices with the rest of the artists in the same sub-market. At the end of this stage, young artists' talent is revealed.

3. The Model with Two Artist Types

IN this section we consider the simple case in which there are only two types of artists in terms of talent: talented and non-talented. This assumption helps to develop our arguments in a simple setting that incorporates the superstars feature: talent heterogeneity leads to a very high concentration of market share and revenues in a small fraction of artists. Moreover, we

[15] Note that we are implicitly assuming that stars marketing expenditures *A* does not affect the total number of sales of artistic goods, *Z*. However, it could be argued that they tend to have a positive effect on *Z*. Thus, the increase in the stars' sales would come in part as a result of a shift of demand from young-artists' work to stars' work and in part as a result of an in increase in consumer expenditure on artistic goods. However, there is no reason to expect that an increase in the stars' marketing expenditures would increase young artists' sales, which is the important assumption in the model.

assume that the time discount factor θ is zero. Under this strong assumption, the analysis delivers the main insights of the paper in the simplest possible way. In the last subsection we discuss the generalization of this analysis to the case $\theta > 0$. The mathematics of this generalization is brought to section 6 (appendix A).

3.1. Equilibrium with short-lived artistic creations

Before we introduce perdurable artistic creations and copyrights, the dynamics of the model are more easily presented by considering artistic creations that stay in the market for only one period.

3.1.1. The short-run number of young artists

Let us solve the equilibrium in a given period taking the number of stars *n* as exogenous. Consider the Nash equilibrium (NE) at Stage 4. Following Salop's (1979) standard calculations, the price and output per artist in the stars' symmetric NE are $p^S = \lambda/n + c$ and $x^S = aZ/n$. Then, we can solve for stage 2 [16]. Stars' profit function can be written as

$$\pi_i^S\left(A_i, A_{-i}\right) = \frac{\left(1-\beta e^{-\gamma nA/Z}\right)Z\lambda}{n^2} - A_i, i = 1,2,\ldots,n \tag{5}$$

The first-order conditions for the Nash equilibrium of this second-stage stage game yield the equilibrium market share of stars *a(n)*:

$$\frac{\beta e^{-\gamma nA/Z}}{n} - 1/\left(\gamma\lambda\right) = 0 \rightarrow a\left(n\right) = 1 - n/\left(\gamma\lambda\right) \tag{6}$$

[16] Consider the two artist *i*'s marginal consumers, z_i, each on each side of the artist's location, who are indifferent between buying from firm *i* or from each of its closest neighbors. They satisfy the following condition $p_i + \lambda z_i = p^S + \lambda\left(1/n - z_i\right)$, where p^S is the common price set by the rest of the artist at the symmetric NE of the price game. Thus, the demand function of artist *i* is given by $x_i\left(p_i, p^S\right) = aZ/2\lambda\left(p^S - p_i + \lambda/n\right)$ and artist *i*'s first-order condition of profit maximization yields, after using the symmetry condition $p_i = p^S$, the expressions $p^S = \lambda/n + c$ and $x^S = aZ/n$.

Note that $n < \beta\gamma\lambda$ is a necessary and sufficient condition for $A_i > 0$ (which in turn guarantees $\pi_i^S > 0$. 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 (i.e., γ is large enough) for stars to be willing to spend a positive amount of money on promotion.

In turn, the Nash equilibrium in the young sub-market yields the following price and output per artist: $p^Y = \lambda/m + c$ and $x^Y = (1-a)Z/m$. The equilibrium number of young artists $m(n)$ is then determined by the free entry condition (1), where we plug in $n_{t+1}/m_t = \rho$ (from (2)). Thus, assuming $\theta = 0$, we have $\pi^Y = (1-a)Z\lambda/m^2 = F^Y; i = 1,...,m$. Hence,

$$m = \left(\frac{nZ}{\gamma F^Y}\right)^{\frac{1}{2}} \tag{7}$$

3.1.2. The long run number of artists

Using (2) in the steady state to substitute in (7) yields the long-run equilibrium number of stars:

$$n^* = \frac{\rho^2}{\gamma}\frac{Z}{F^Y} \tag{8}$$

Recall that changes in the parameter γ can be seen as capturing positive effects on the stars' capacity to gain market share due to technological innovations, marketing improvements and reductions in cultural and political barriers. Historically, these changes have worked in favor of superstars. For example, theatre and live concerts in cities and small villages yielded their way to movies, TV shows, and recorded music in which superstars would thrive. More recent innovations such as the Internet could work in favor of the promotion and the diffusion of young artists work. Expression (8) shows that increases in γ (which raise stars' market share: see (6)) reduce the long-run number of stars n^*. Moreover, a reduction in n^* also implies a reduction in the long-run number of young artists because $n^* = \rho m^*$. Hence we have the following proposition.

Proposition (1). If stars obtain economic rents, then technological and social innovations that favor market concentration (as those captured by increases in γ) reduce artistic creation in the long run.

Intuitively, increases in stars' market share leaves little audience for young artists, thereby reducing its number. As a result, fewer new talents are discovered, which in turn reduces the number of talented artists and high-quality artistic creation in the long run.

3.2. Long-lived creations and copyrights

We now explicitly introduce copyrights in the model. Young artists' work does not usually last for long in the market, whereas superstars' records, movies, and books find buyers for a long period after creation even if sales decrease over time[17]. We will assume that young artists' works are sold only during the period in which they are created, whereas stars' works maintain positive market shares after the period of creation. These market shares decrease over time according to a discount factor $\eta, 0<\eta<1$. Stars are assumed to be able to capture the present discounted value of the net yields from future sales by selling the copyrights when they are still alive.

As before, there is a continuum of consumers *Z* each buying one copy of an artistic good in each period. A fraction $a_\tau(1-\eta)$ prefers to buy contemporaneous artistic creations, whereas a fraction $a_\tau(1-\eta)\eta$ prefers creations from the last period and, in general, a fraction $a_\tau(1-\eta)\eta^\tau$ prefers creations from τ periods ago, $\tau=0,\ldots\infty$. Thus, $1-(1-\eta)\sum_{\tau=0}^{\infty} a_\tau \eta^\tau$ is the fraction of consumers that buy young artists' work in the current period. Furthermore, we have $a_\tau = 1-\beta e^{-\gamma n A\tau/Z}$, where A_τ is the amount spent in the promotion of senior artistic goods created τ periods ago (which was invested at the time of

[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: 60.9% albums of the 2000s, 12.3% albums from the 1990s, 11% from the 1980s, 9.5% from the 1970s, 4.8% from the 1960s, and 1.3% from the 1950s. Moreover, Kretschmer et al. (2008) provide evidence on the concentration of revenues from copyrights in a small percentage of successful artists.

the good release, i.e., τ periods ago). We assume that $(1-\beta)(1-\eta)\geq 1/2$ to insure that stars always fare better than young artists.

Consumers buying work from each vintage as well as those buying from young ar-tists are distributed around a horizontal-differentiation circle of length one. Thus, the computation of prices and sales of stars' work from each vintage is analogous to the one in the previous subsec-tions. The current period NE price and sales per artist of work created τ periods ago are $p_\tau^S = \frac{\lambda}{n_\tau}+c$ and $x_\tau^S = \frac{a_\tau(1-\eta)\eta^\tau Z}{n_\tau}$; where n_τ is the number of stars that were active τ periods ago. Then, we can solve directly for the symmetric steady state equilibrium in which $n_\tau = n^* = \rho m_t = \rho m^*,\ A_\tau = A,\ a_\tau = a^*$. Each star's present discounted value of future reve-nues at the time in which she was active and decided about promotion expenditures A_i is:

$$\pi_i^S(A_i, A_{-i}) = \frac{1-\beta e^{-\gamma nA/Z}}{n^2} Z\lambda(1-\eta) \sum_{\tau=0}^{T-1}(\eta R)^\tau - A_i \tag{9}$$

where $T\geq 1$ is the length of the copyright term and $R<1$ is the intertemporal discount factor. Maximizing with respect to marketing expenditures and using symmetry yields the equilibrium values of *A* and *a*:

$$A = \frac{Z}{\gamma n}\ln\left(\frac{\beta\gamma\lambda\omega}{n}\right),\ a(n) = 1-\frac{n}{\gamma\lambda}\frac{1}{\omega(T)} \tag{10}$$

where $\omega(T) = (1-\eta)\sum_{\tau=0}^{T-1}(\eta R)^\tau = (1-\eta)\frac{1-(\eta R)^T}{1-\eta R}$. Below we give conditions guaran-teeing $n<\beta\gamma\lambda\omega(T)$ in equilibrium, so that $A_i>0$. Clearly, $\omega(T)$ is strictly increasing in *T* and *R*, and is bounded by 1 $\left(\lim_{T\to\infty}\omega = 1 \text{ if } R=1\right)$. With some abuse, below we consider $\omega(T)$ as a continuously differentiable function of *T*. Moreover, to simplify notation we use ω and refer to it as the length of the copyright term. Substituting with (10) in (9) yields profits in equilibrium:

$$\pi^S(\omega,n)=Z\left[\frac{\lambda\omega}{n^2}-\frac{1}{\gamma n}-\frac{1}{\gamma n^2}\ln\left(\frac{\beta\gamma\lambda\omega}{n}\right)\right] \tag{11}$$

In turn, the fraction of consumers buying young artists' work in the steady state is $1-\sum_{\tau=0}^{\infty}a_\tau(1-\eta)\eta^\tau=1-a$. The NE in the young sub-market yields the same price and output per artist as in the previous subsections: $p^Y=\lambda/m+c,\ x^Y=(1-a)\lambda Z/m$. Hence, per capita young artists' revenues are again:

$$\pi^Y=(1-a)Z\lambda/m^2 \tag{12}$$

Therefore, using (1) and (2), which hold the same as in the previous subsection, as well as (10), yields the steady state number of senior and young artists:

$$n^*=\rho m^*=\frac{1}{\omega\gamma}\frac{Z}{F^Y}\rho^2 \tag{13}$$

We thus have the following result:

Proposition (2). If stars obtain rents then extending the length of the copyright term reduces the long run number of artists.

Longer copyrights raise stars' revenues, but this does not help increase the number of artists. The reason is that the constraint limiting the number of talented artists is that young artists' market share is too small. This reduces the possibility to discover new talents. Extensions of the copyright term increase stars' marketing expenditures and reduce young artists' market share even more. This chokes the emergence of future talented artists. Note that this negative effect is in addition to the monopolistic distortions implied by copyrights, which lead to the underutilization problem. The result is conditional on stars obtaining rents. The references in the Introduction provide evidence in favor of this case. Analytically, it is shown in section 6 (appendix A) that if talent is sufficiently scarce in relative terms (i.e., if ρ is sufficiently small), then stars always obtain rents.

3.3. Social welfare

We have shown that longer copyrights may lead to fewer artists and less creation. Do fewer artists imply lower social welfare? Not necessarily. In fact, it is well-known that free entry may lead to an excessive number of firms in monopolistic competition markets (e.g., Salop 1979). If the benefits of wider product diversity are small relative to the fixed costs of having additional products, social welfare is maximized for a number of firms that is smaller than the number brought by monopolistic competition with free entry. A similar result holds in the model in this paper. However, if artistic variety has a sufficiently large value for consumers or if talent is sufficiently scarce, then increasing the number of artists leads to higher social welfare. As a consequence, extensions of the copyright term that reduce the number of artists would be negative for social welfare.

To see this, define the per-period social welfare generated by the artistic market *(W)* as:

$$W=\left[Q^{S}aZ+(1-a)Q^{Y}Z\right]-\left[aZ\frac{\lambda}{4n}+(1-a)Z\frac{\lambda}{4m}\right]-A-cZ-nF^{S}-mF^{Y} \tag{14}$$

where the first term in square brackets is the consumers' gross utility obtained from buying artistic goods, the second term is the costs (or disutility) of distance between the artists' and the consumers' locations, and the remaining terms are advertising, production and artists' opportunity costs, respectively. We have the following result:

Proposition (3). Assume that stars obtain rents and that the value of artistic diversity is sufficiently high (i.e., λ large) or talent is sufficiently scarce (i.e., low ρ). Then, extending the length of the copyright term reduces social welfare in the long run.

To explain this result, note that there are four welfare effects associated to a longer copyright. First, the gross utility of consumers increases as a greater stars' marketing expenditure raises the fraction of people consuming stars' output. This positive effect is conditional on stars' output being of higher quality than the other artists' output (i.e., $Q^{S}>Q^{Y}$). Second, distance costs increase (or equivalently, utility stemming from artistic variety decreases). This negative effects arises from the reduction in the number of both types of artists. Third, marketing costs *A* increase. And fourth, total opportunity costs $nF^{S}+mF^{Y}$ are reduced as the number of artists decreases. If the value λ of artistic variety is sufficiently high or the fraction ρ of talented artist is sufficiently small, the second and third effects outweigh the first and forth effects (see section 7 (appendix B) for the formal proof).

Note that the key novel mechanism in our analysis of the link between copyrights and welfare is the negative impact that excessively strong copyrights can have on the long-run number of artists, which was the result in the previous subsection. If the variety of high-quality artistic creation is small and sufficiently valuable, then the number of artists and social welfare move in the same direction: the negative effect of longer copyrights on the number of artists outweighs, from the point of view of social welfare, the positive effect of greater informative advertising and lower total opportunity costs.

There is another potential mechanism that increases the costs of excessively strong copyrights. This additional mechanism is the *underutilization effect*, which is the key effect limiting the optimal length of copyrights according to the standard analysis. It is due to the reduction in the use of already existing artistic goods that occurs if copyrights are extended. In our model, this effect is ignored because sales of artistic goods, *Z*, are constant and therefore inelastic to prices. However, longer copyrights imply higher prices and it is reasonable to think that sales would decrease with prices. Taking into account this underutilization effect would reinforce the potential negative impact of long copyrights on social welfare.

3.4. Generalizations

The analysis can be generalized to consider the case in which time discount factor θ is strictly positive. In this subsection, we only state and discuss the results. The mathematics are worked out in section 6 (appendix A).

Stronger copyrights raise stars' potential revenues and the incentives to invest in marketing their output, which in turn shifts consumer expenditure from the young artists' work to the stars'. Thus, longer copyrights have two effects on the expected utility of starting the artistic career: a positive effect on future earnings in case of succeeding and becoming a star, and a negative effect on current actual returns as a young artist. If success has low probability and is coupled with risk aversion (specifically, if ρ is sufficiently small and relative risk aversion $\sigma > 1/2$) or if future potential earnings as a star are heavily time-discounted (i.e., if θ is sufficiently small), then the negative effect of copyright extensions will dominate and reduce the discounted expected utility of starting the artistic career[18,19]. Thus, if stars obtain rents (so that there is no shortage of revenues constraining their creativity), copyright extensions would reduce artistic creation in the long run by hindering the process of developing and uncovering young talented artists. See proposition (8) in section 6 (appendix A), which generalizes proposition (2) to the case of strictly positive discount factors.

How do structural changes in the relevant environment such as improvements in communication and marketing technologies (or reductions in the barriers to the globalization of culture) affect artistic creation in the long run? Results in proposition (1) are also extended in section 6 (appendix A). It is shown that if stars obtain rents and the probability of success as a star is sufficiently low (with $\sigma > 1/2$) or the time discount factor is sufficiently small, improvements in communication and marketing technologies favoring market concentration by stars (as captured by increases in γ) reduce artistic creation in the long run. Moreover, the optimal copyright term from the point of view of maximizing artistic creation decreases with the effectiveness γ of communication and marketing technologies (see propositions (9) and (10)).

4. A Continuum of Artist Types

IN this section, we generalize the results in the previous section to a model with a continuum of artist types in terms of their talent. Furthermore, we also show that longer copyrights tend to lower the average talent of senior artists. Thus, in the long run, excessively long copyrights may reduce the total number of artists, their average talent and social welfare. The key condition for this to occur is that the *superstar effect* is sufficiently strong. In the model, this requires talent to be unevenly distributed across artists, so that there is a small fraction of artists with very high talent and that talent falls sharply as we consider additional artists from

[18] 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.

[19] It may be argued that potential young artists are prompted to start the artistic career by the non-pecuniary returns associated to the possibility of becoming a celebrity rather than by the discounted expected value of the artistic career. However, if these non-pecuniary returns are the key incentives for artistic creation, then the arguments in favor of long copyrights are weakened.

a given pool. In other words, what is needed is a distribution of talent that somewhat approaches the previous case of a two-type distribution of talent.

4.1. The setting

As in the previous sections, a fraction ρ of the most talented young artists of each generation continue active as stars in their second life-period. However, ρ is now endogenous. Let q denote an artist talent and let q^M be the talent of the *marginal senior artist*; i.e., the talent of the least talented active senior artist. We assume that the distribution of talents is the same every generation of young artists (though the number of young artists may vary) and that the young artists that continue their careers as senior artists are the most talented of their generation. Therefore, the talent of the marginal senior artist is a decreasing function of the fraction of young artists continuing their careers. Denote this function as $q^M(\rho)$. We assume the specific functional form $q^M(\rho) = (1+k)e^{-k\rho}$, where $k > 0$. The parameter k provides sufficient flexibility to discuss different configurations of the market: $k = 0$ would correspond to the case of homogeneous talent, whereas the larger k is, the more skewed the distribution is and the larger the difference of talent between superstars and modest artists. We refer to a larger k as a *stronger superstar configuration* of the market. Hence, the average talent of senior artists in the steady state is $E\left[q^S\right] = \frac{1}{\rho}\left(\frac{1+k}{k} - \frac{q^M}{k}\right) = \frac{1}{\rho}\frac{1+k}{k}\left(1-e^{-k\rho}\right)$.

To simplify and fit the new continuous distribution of talent within the Salop (1979) framework, we assume that artistic talent translates into being quantitatively more creative. That is, an artist with talent q creates q artistic goods per period. The number of senior artistic goods created each period is denoted by N. Thus, $N = n \cdot E\left[q^S\right]$. Moreover, we assume each artist locates and sells her artistic creations as if each one had been created by a different artist. That is, each artistic creation is symmetrically located around the corresponding circle of characteristics (i.e., either around the stars' circle or around the young artists' circle) regardless of the author. This allows us to maintain the same symmetric monopolistic competition framework with very few changes: the exogenous ρ is now substituted with the condition that the marginal senior artist obtains no rents, whereas the relevant number determining prices in the senior sub-market is not the number of senior artists *n* but the number of senior creations *N*.

We directly go on to analyze the steady state. Thus, all the propositions below refer to the long run. In equilibrium, the fraction of young artists that continue active in the second period as senior artists is such that the marginal senior artist obtains no rents:

$$q^M \cdot \pi^S(\omega, N) = F^S \tag{15}$$

where $\pi^S(\omega, N)$ is now interpreted as the discounted revenues per senior artistic good. Discounted revenues per senior artistic good are determined by the same expression (11) above except that *N* substitutes for *n*. Therefore, we have:

$$q^M = \gamma N^2 \frac{1}{\lambda\gamma\omega - N - \ln(\lambda\beta\gamma\omega/N)} \frac{F^S}{Z} \tag{16}$$

This continuous and increasing relationship between q^M and *N* over the interval $[0, N_2 \equiv \lambda\beta\gamma\omega]$ is represented in figure 1 as $M(N, q^M)$. In turn, the new free entry condition as a young artist is[20]:

$$\pi^Y(\omega, n) = \frac{1 - a(N)}{m^2}\lambda Z = \frac{Z\rho^2}{\gamma\omega N}\left(E\left(q^S\right)\right)^2 = F^Y .$$

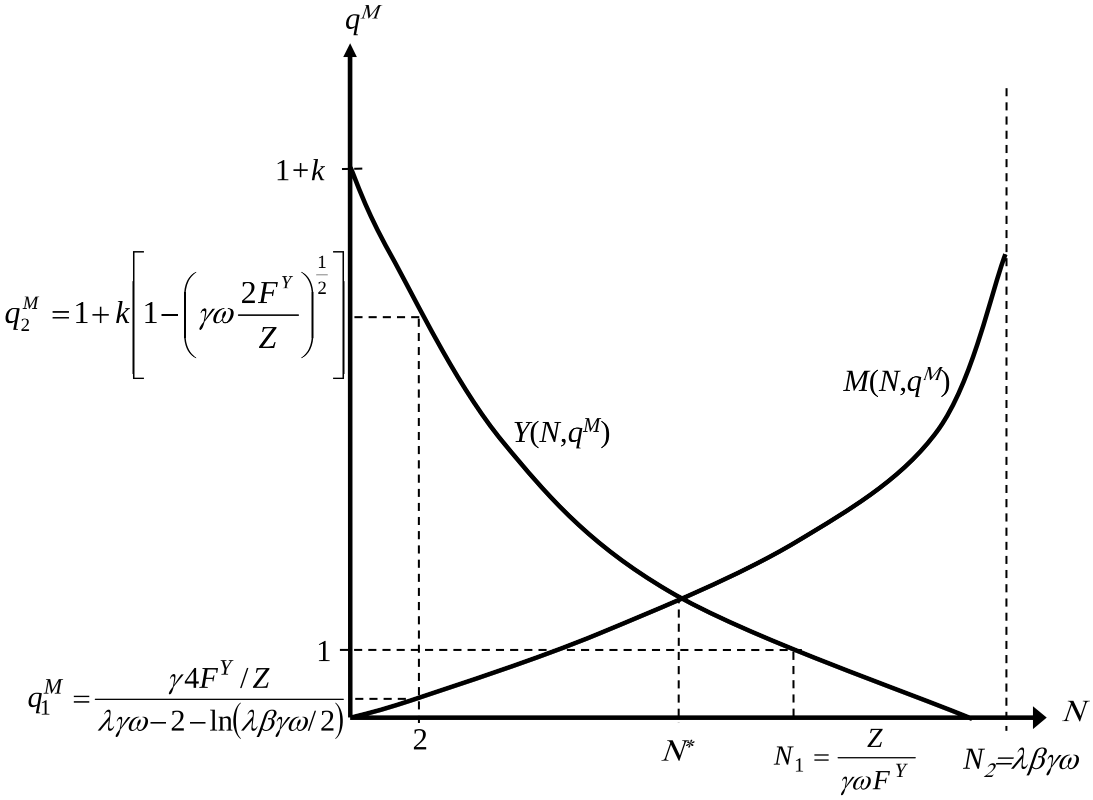
[20] We are assuming that each young artist creates one artistic good. Instead, we could assume that talent differences lead to differeces in output already when artists are young. Returns during the period as a young artist would then be uncertain. Moreover, $m \cdot E\left[q^Y\right] = m \cdot \left(1 - e^{-k}\right)$ would be the number of young-artist works in the market every period, which would determine their prices and revenues. The main consequence of this setting would be that uncertainty during the period as a young artist is larger, which in turn reduces the expected value of starting the artistic career. This is equivalent to considering an increase in F^Y. This setting would make the notation and exposition somewhat heavier without providing any additional insight.

Therefore,

$$q^M = 1 + k\left[1 - \left(\gamma\omega N \frac{F^Y}{Z}\right)^{1/2}\right] \tag{17}$$

This continuous and decreasing relationship between q^M and N over the interval $[0,\infty)$ is represented in figure 1 as $Y\left(N, q^M\right)$. Note that for $N = N_1 \equiv Z/\left(F^Y\gamma\omega\right)$ then $Y\left(N, q^M\right)$ implies $q^M = 1$ whereas $M\left(N, q^M\right)$ implies $q^M > 1$.

FIGURE 1: **Equilibrium in the model with a continuum of talents**



Note: Extending the copyright term ω shifts downwards both the *M(N; q^M)* and the *Y (N; q^M)* schedules. This reduces the marginal artist's talent q^M. Furthermore, if the artistic market has a strong superstar configuration (large *k*), the shift in *Y (N; q^M)* dominates and reduces artistic creation in the long run *(N*)*.

4.2. Copyrights and artistic creation

The existence of long run equilibria with some degree of artistic diversity requires a positive market share for young artists $(\beta < 1)$, some minimum copyright protection ω, some minimum market size Z with respect to the size of the fixed opportunity costs F^Y, and some minimum consumer preference for artistic diversity λ. If k is sufficiently large, then the following assumption is sufficient for the existence of an equilibrium with $N^* \geq 2$ (and therefore, with $\pi^S > F^S$). This can be checked using figure 1[21].

Assumption (1): $\lambda\beta/2 > Z/2F^Y > \gamma\omega > 1 > \beta$

Note that conditions in assumption (1) will continue to be met when we consider arbitrarily large values of λ, as we do in the next propositions. Expressions (16) and (17) determine the equilibrium number of senior-artist creations:

$$N^* = \frac{1}{\gamma\omega}\frac{Z}{F^Y}\left(1 - \frac{1}{k}\frac{F^S}{\pi^S(N,\omega)}\right)^2 \tag{18}$$

We then have the following results (see the proofs in section 7 [appendix B]).

Proposition (4). If the artistic market has a sufficiently strong superstar configuration (i.e., if k is sufficiently large), then there exists a finite copyright term T^N (i.e., there exists a $\omega^N < 1$) that maximizes artistic creation. Extending the length of the copyright term beyond that point reduces the number of young artists starting the artistic career and reduces artistic creation in the long run by both young and senior artists. Moreover, the stronger the superstar configuration of the market, the shorter the copyright term that maximizes artistic creation.

[21] Consider figure 1. Assumption (1) and k suffciently large insure $N_1 > 2, M\left(N, q^M\right) > 1$ for $N = N_1$, and $q_2^M > q_1^M > 0$. Hence $M\left(N, q^M\right)$ and $Y\left(N, q^M\right)$ cross at N^* such that $2 < N^* < N_1$ (also note that $N^* < N_1 < N_2 \equiv \lambda\beta\gamma\omega$ also implies $A > 0$).

Proposition (5). Extending the length of the copyright term increases the fraction of young artists that become senior artists, which involves a reduction in the average talent of senior artists.

When copyrights are extended, young artists that were slightly short of having enough talent to break even as senior artists are then able to cover opportunity costs F^S. However, the absolute number of young artists as well as senior creation may be reduced in the long run as a result of copyright extensions even if a larger fraction of young artists succeed. The intuition is as follows: if the copyright term is extended, senior artists invest more in marketing. This reduces the size of the young artists sub-market and therefore the number of young artists that are able to start the artistic career. As a result, the new generation of young artists provides a smaller pool of talent for the next generation of senior artists. The shortage of new highly-talented senior artists is partially compensated by a higher fraction of young artists continuing their careers as senior artists. This can also be seen as increasing the fraction of mediocre senior artists. In any case, senior artistic creation is reduced.

Graphically, an increase in ω shifts downwards both the $Y\left(N,q^M\right)$ and the $M\left(N,q^M\right)$ schedules in figure 1 (recall assumption (1) implies $\omega > 1/\lambda\gamma$). Given ω, if *k* is large then the shift in $Y\left(N,q^M\right)$ tends dominate, thereby reducing *N**. Then, given *k*, if ω is sufficiently small then the downward shift of $M\left(N,q^M\right)$ dominates and implies a new equilibrium with larger *N**. In between those copyright terms, there is a value ω^N, $0 < \omega^N < 1$, that maximizes *N** (see section 7 [appendix B] for the proof).

To see the implication on the number of young artists, note that $N = n \cdot E[q^S] = m \cdot (1 - e^{-k\rho})$. Hence a lower *N* and a larger ρ imply a lower *m*. Thus, if talent is sufficiently heterogeneous, the number of young artists that start the artistic career decreases with copyrights, even if a larger fraction of them are able to continue in the market as senior artists. The combination of a smaller entry of young artists and a larger fraction of them continuing as senior artist could result in larger artistic creation if talent were evenly distributed among artists (i.e., if *k* were low)[22]. However, the larger the parameter *k* is, the

[22] More specifically, $\frac{dN}{d\omega}\frac{\omega}{N}$ is always positive if artistic talent is homogeneous or if the effectiveness

lower the creativity of the marginal senior artist. As a consequence, if k is sufficiently large, the negative effect that greater copyrights have on artistic creation due to a lower entry of young artists outweighs the positive effect due to a higher fraction of young artists continuing as senior artists[23].

The mechanism can also be viewed from the perspective of how additional revenues in the artistic industry are allocated across artists. As k tends to 0, the difference in talent between the most talented artists and the marginal artist goes to zero. Therefore, superstar rents would also tend to zero. If this is the case, the additional revenues accruing to the artistic industry as a result of an extension of copyrights go to help more young artists to continue their career as senior artists: the talent cutoff determining the marginal senior artist decreases, thereby inducing young artists that were to drop out from the artistic market to continue their careers. The flatter is the distribution of talent, the larger would be the number of these additional senior artists[24]. In contrast, if talent is very unevenly distributed, most additional revenues accruing to the artistic industry that result from a reinforcement of copyrights go to increase the superstars' rents. This does not help artistic creation.

Proposition (5) implies that an excessive concentration of revenues in the artistic market can harm artistic creation in the long run, even if one of the causes of this concentration were an exogenously large heterogeneity of talent. If this is the case, shortening the co-pyright term can reduce the concentration of sales and revenues, help discover new

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of promotion expenditures is very low; i.e., if k or γ is equal to 0 (see expression (25) in section 7 [appendix B]). Note if k and γ tend to zero, then all the three key features of the model disappear: all artists within a given generation are alike, there is no difference between young and senior artists either (everybody has the same expected talent), and marketing expenditures do not play any informative or persuasive role. This makes clear that all the three distinctive features of our model emphasized in the Introduction are necessary to produce $\frac{dN}{d\omega}\frac{\omega}{N} < 0$.

[23] If the second-period expected returns of young artists are taken into account, then increases in superstar rents have a less negative impact on young artist's decissions to start the artistic career. But again, if uncertainty and risk aversion are sufficiently large or if the discount factor is sufficiently low, the same qualitative results hold as shown in section 6 (appendix A) for the model with two artist types.

[24] The derivative $\frac{dN}{d\omega}\omega$ is decreasing in k, as can be seen using expressions (25) and (26) in section (appendix B).

talents, and raise creation in the long run. Finally, note that the two-type model in the previous section with small ρ can be viewed as a limit case of this continuum of types model with large *k*.

4.3. Social welfare

What are the potential welfare consequences of extending the copyright term in this setting? How does the optimal copyright term depend on the structure of the market? Welfare is given by the same expression (14) above. Results are then similar to those found in the framework of the two-type model (see the proof in section 7 [appendix B]).

> ***Proposition (6).*** If artistic diversity is sufficiently valuable to consumers (i.e., if λ is sufficiently large) and artistic markets have a sufficiently strong superstar configuration (i.e., if *k* is sufficiently large), then there is an optimal copyright term ω^W that maximizes long run social welfare. Extending copyrights beyond that term reduces social welfare due to a negative impact on artistic creation. Moreover, the stronger the superstar configuration of the market, the shorter optimal copyrights are.

Conceptually, the derivative in the model with a continuum of types has the same four components than in the two-type model, and the intuition for the results in the proposition is analogous. First, a larger copyright raises the gross utility of consumers as the fraction of people consuming stars' output increases. Again, this positive effect is conditional on stars' output being of higher quality than the other artists' output. Second, utility stemming from artistic variety decreases. Third, marketing costs increase. And fourth, total opportunity costs are reduced as the number of artists decreases. If artistic diversity λ is sufficiently valuable, the second and third effects eventually outweigh the first and forth effects. Moreover, the more valuable artistic diversity, the closer ω^W is to ω^N (i.e., the closer the copyright term that maximizes welfare is to the one that maximizes artistic creation). This seems intuitive because as λ becomes large then only the second effect tends to matter.

The empirical counterpart of a high *k* is a high concentration of sales and revenues by a group of superstars. Thus, if artistic diversity is indeed highly valuable, the last proposition in combination with the evidence indicating that concentration of sales and revenues in artistic markets is high and increasing would suggest that the length of the copyright term should have been shortened in the last decades. Nonetheless, the length of the copyright term has been increased periodically over time. Does this involve a contradiction between the analysis in this paper and the facts? To explain the trend towards longer copyrights it is more appropriate to refer to the political economy of copyright regulation than to refer to the normative economics of optimal copyrights. In this respect, note that the value of an extension of the copyright term for a copyright holder increases as communication and marketing technologies improve and as the market for artistic goods expands and becomes more global (note that the stars' revenues increase with λ and Z). Even more, copyright extensions for artistic goods that were created in the past are even more lucrative for copyright holders because the main costs or creating and promoting the good were already paid[25]. Hence, over time, we can expect increasing lobbying by copyright holders in favor of copyright extensions.

5. Concluding Comments

ARTISTIC talent and charisma are unequally distributed across individuals and are difficult to assess. Talent is sorted and developed by having potentially talented artists start artistic careers that most often end in failure. Understanding the long run consequences of copyright regulation for artistic creation requires understanding how this regulation affects young artists' incentives to start the artistic career. The contribution of this paper is to provide a professional-career perspective to the analysis of optimal copyright regulation that accounts for the superstar character of artistic markets. Such a perspective provides new insights that complement the existing analyses. The paper shows that, in the long run, excessively long copyrights can lead to a really bad situation in terms of creativity and talent: they can reduce young and senior artistic creation while increasing the proportion of mediocrities within the group of senior artists. If artistic diversity is sufficiently valuable to consumers and the artistic market has a strong superstar configuration, those effects reduce social welfare.

There are several mechanisms at work in our results. Increases in superstar revenues can have no impact on the expected value of young artists' careers or can even have

[25] It has been suggested that the main beneficiaries from the proposed extension of the copyright term in the European Union would be the «shareholders of four major multinational companies that control the valuable recordings of the 1960s (Universal, Warner, Sony and EMI)». See Kretschmer et al. (2009).

a negative one. Most artistic markets operate in the framework of an overwhelming machinery of promotion and advertising. Raising the superstars' potential for revenues (as by extending the copyright's term) increases the profitability of marketing their work. This reduces young artists' market share and may reduce their absolute number even if total revenues accruing to the industry rise. Hence, stronger copyrights may result in an increase in superstar earnings but in fewer young artists starting the artistic career, which leads to lower average talent and less artistic creation in the long run.

The optimal length of the copyright term decreases with the degree of market concentration by superstars. The stronger the superstar configuration of artistic markets, the more uncertain artistic careers are, the larger the share of additional revenues created by extensions of the copyright term that will accrue to superstars, and the more likely that these extensions will reduce young artists' economic opportunities to start the artistic career. Co-pyright regulation cannot affect the uneven distribution of talents, which is the underlying reason for the superstar character of artistic markets. But it can affect how the distribution of talents translates into a distribution of revenues. Increasing the allocation of financial resources towards superstar rents, which are highly discounted by time and risk as components of the expected value of an artistic career, may be wasteful and even counterproductive as a way to promote artistic creation. Policies directly aiming at increasing young artists' opportunities to have an audience and to test their skills may be more effective in promoting talent and artistic creation than increasing superstar revenues.

The analysis has a number of implications for other related issues. Copyrights should be adapted to changes in the technological and economic environment. For more than a century, technological and institutional changes have favored market concentration by super-stars. This paper suggests that copyrights should have been shortened in that scenario. Instead, most countries kept extending copyrights, which could be explained in terms of the greater incentives for lobbying in favor of copyright extensions that larger superstar rents create. More recent technological, political, and cultural changes are having mixed consequences on superstars' market share. New copying and communication technologies such as the Internet seem to be working against concentration, whereas changes in the economic and political environment have facilitated the globalization of culture, which tends to favor superstars. Information about how concentration in artistic markets is changing should be an important key in determining the direction in which copyright regulation should be adjusted.

6. Appendix A: The Model with Positive Discount Factor

IN this appendix, we generalize the analysis to a positive intertemporal discount factor (i.e., $\theta > 0$) and consider the possible implications of stars' constraint $\pi_t^S \geq F^S$. The analysis of senior artists' optimal decisions carried out in section 3 remains unchanged. To save notation, in this section we assume $\lambda = 1$. We go on to directly to consider the symmetric steady state equilibrium of the model.

6.1. A graphical exposition

If stars' opportunity cost is binding, additional active stars would bring their earnings below their opportunity costs. Hence, it may happen that young artists that reveal their talent in their first life-period do not become stars in their second life-period. To the contrary, if superstars' 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 senior artists. These arguments are summarized in the following constraint:

$$n_t \leq \rho m_{t-1}; \qquad (19)$$

$$\left(\pi_t^S - F^S\right)\left(n_t - \rho m_{t-1}\right) = 0$$

Depending on whether or not the constraint $n_t \leq \rho m_{t-1}$ is binding, we use $n_{t+1}/m_t = \rho$ or $\pi_t^S = F^S$ to substitute in expression (1) to determine the equilibrium.

In sum, the number of superstars 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 new talented young artists (which in turn depends on the life-long expected utility of starting the artistic career). The long run consequences for artistic creation of changes in copyright regulation and marketing technologies depend on which of these two constraints is limiting the number of active senior artists.

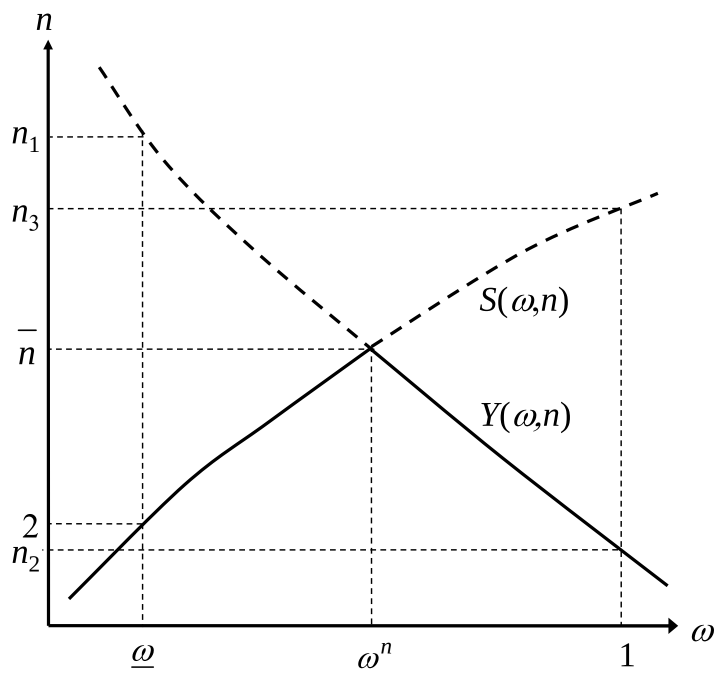
The $S(\omega,n)$ locus

Consider the pairs of ω and n that satisfy constraint $\pi_t^S \geq F^S$ with equality; i.e., the combinations of copyrights and number of stars leading to a stars' income level equal to their opportunity costs. We denote this locus by $S(\omega,n)$:

$$S(\omega,n) =: \{(\omega,n) : \pi^S(\omega,n) = F^S\} \tag{20}$$

where $\pi^S(\omega,n)$ is given by (11). Hence, differentiating $S(\omega,n)$ with respect to n and ω yields $dn/d\omega = \dfrac{\gamma - 1/\omega}{2F^S\gamma n/Z + 1 - 1/n} > 0$ (note that $a(n) = 1 - n/\gamma\omega > 0$). Therefore $S(\omega,n)$ has a positive slope as shown in figure 2. Intuitively, a longer copyright term increases stars' revenues thereby allowing stars to cover their opportunity costs even if the number of stars is larger (i.e., even if there is more competition and prices of artistic goods are lower). It is useful to define $s: R \rightarrow R$ as the function that for each ω yields the value of n that satisfies (20). Note that a pair (ω,n) satisfies constraint $\pi_t^S \geq F^S$ if and only if $n \geq s(\omega)$.

FIGURE 2: The long-run number of talented senior artists (stars) (n) and the copyright term (ω)



Note: Stars' income is equal (or higher) than their opportunity costs for points in (or below) $S(n,\omega)$. Young artists' expected discounted returns of starting the artistic career are equal (or higher) than their opportunity costs for points in (or below) $Y(n,\omega)$. This schedule has a negative slope as long as the probability of succeeding as a star is low or the career to become a star is long. The solid line shows the long-run number of stars as a function of the length of the copyright term. The copyright term ω^n !n maximizes the number of stars.

The $Y(\omega,n)$ locus

Substituting (12) into young artists' free-entry condition (1) yields:

$$\left[\frac{(1-a)}{m^2}Z\right]^{1-\sigma}+\theta\frac{n}{m}\left(\left[\pi^S(\omega,n)\right]^{1-\sigma}-\left[F^Y\right]^{1-\sigma}\right)=\left[F^Y\right]^{1-\sigma} \tag{21}$$

Now, consider the combinations of ω and n satisfying this expression and constraint (19) with equality; i.e., the combinations of ω and n providing an expected discounted revenue of starting the artistic career equal to opportunity costs when all talented young artists will be willing to continue their career as stars. We denote this locus by $Y(\omega,n)$, which after using (10) is given by:

$$Y(\omega,n)=:\left\{(\omega,n):(1+\theta\rho)\left[\frac{\rho^2}{F^Y}\right]^{\sigma-1}=\left(\frac{\gamma n\omega}{Z}\right)^{\sigma-1}+\theta\rho^{2\sigma-1}\left[\pi^S(\omega,n)\right]^{1-\sigma}\right\} \tag{22}$$

Differentiation with respect to ω and n yields:

$$\frac{dn}{d\omega}\frac{\omega}{n}=\frac{g-\theta\rho^{2\sigma-1}\left(n\cdot\pi^S\right)^{1-\sigma}\dfrac{\partial\pi^S}{\partial\omega}\dfrac{\omega}{\pi^S}}{g-\theta\rho^{2\sigma-1}\left(n\cdot\pi^S\right)^{1-\sigma}\dfrac{\partial\pi^S}{\partial n}\dfrac{n}{\pi^S}} \tag{23}$$

where $g=(\gamma\omega/Z)^{\sigma-1}$. Note that the product $n\cdot\pi^S$ as well as $\frac{\partial\pi^S}{\partial\omega}$, and $\frac{\partial\pi^S}{\partial n}$ are bounded from above by Z. Hence, if there is a sufficiently small probability ρ of becoming a star (assuming $\sigma>1/2$) or if the time needed to grow and emerge as a talented artist is sufficiently long (which implies a small discount factor θ), then $dn/d\omega$ is negative. Both circumstances seem to characterize artistic markets as argued in the Introduction, which motivates assumption (2) below. Under this assumption, the $Y(\omega,n)$ locus has a negative slope as shown in figure 2. Intuitively, longer copyrights increase stars' revenues, marketing, and market share. As a consequence, they reduce the number of young artists that can cover their opportunity costs of starting the artistic career. Moreover, if (19) is binding, then n is determined by the number of young artists that start the career and have talent (i.e., a fraction ρ). Therefore, n is decreasing in ω. It is useful to define $y: R \to R$ using $Y(\omega,n)$, as the function that for each ω yields the value of n that satisfies (22). Note that a pair (ω,n) satisfies constraint (19) if and only if $n \le y(\omega)$.

Now, define $\underline{\omega}$ as the copyright satisfying $\pi^S(\underline{\omega},2) = F^S$ and n_1 as the number of senior artists satisfying $Y(\underline{\omega},n_1)$. Note that if γ is sufficiently large, then $0 < \underline{\omega} < 1$ (also $n < \beta\gamma\omega$, which guarantees $A > 0$), and that if Z is sufficiently large then $n_1 > 2$. See figure 2. In turn, define n_2 as the n satisfying $Y(1,n_2)$, and define n_3 as the n satisfying $S(1,n_3)$. Note that we always have $n_3 > 2$ and that for ρ sufficiently low, we also have $n_2 < 2$. Hence for ρ sufficiently low, we have $n_3 > n_2$. These circumstances together would guarantee that $Y(\omega,n)$ and $S(\omega,n)$ cross each other for some $\omega^n \in (\underline{\omega},1)$. Hence we have the following:

Proposition (7). If the probability of success as a star ρ is sufficiently small and relative risk aversion σ is larger than $1/2$, and if marketing efficiency γ and market size Z are sufficiently large, then the long-run equilibrium number of senior artists n^* satisfies $n^* > 2$. Moreover, it is given as a function of the length of the copyright term by $n^* = \min\left[y(\omega), s(\omega)\right]$ and there exists $\omega^n \in (\underline{\omega},1)$ that maximizes n^*.

Proof. Pairs (ω,n) on or below the locus $S(\omega,n)$ in figure 2 satisfy constraint $\pi_t^S \ge F^S$, whereas pairs on or below $Y(\omega,n)$ satisfy (1) and constraint (19). Thus, using $s(\omega)$ and $y(\omega)$ we can determine the long-run equilibrium number of senior artists n^* as $n^* = \min\left[y(\omega), s(\omega)\right]$. Then, recall that if the probability of success as a star ρ is sufficiently small and if $\sigma > 1/2$, then we have $dn/d\omega < 0$ in schedule $Y(\omega,n)$ and that $n_3 > n_2$. And, also, that if γ is sufficiently large, then $\underline{\omega} < 1$, whereas if market size Z is sufficiently large, then we have $n_1 > 2$. This implies that for some $\omega^n \in (\underline{\omega},1)$, $Y(\omega,n)$ and $S(\omega,n)$ cross each other. Then, the positive slope of $S(\omega,n)$ and the negative slope of $Y(\omega,n)$ within the interval $[\underline{\omega},1]$ imply that the long number of senior artists is maximized for this copyright term ω^n.

The assumption with the most important conceptual content in this proposition is that ρ has to be sufficiently small. Our results crucially depend on this assumption implying that revenues in artistic markets are very uncertain and unevenly distributed. This is analogous to the assumption in the continuous-type model requiring that markets have a *superstar configuration* that is sufficiently strong. If earnings were homogeneous across artists, longer copyrights would always stimulate artistic creation according to this model. The other assumptions have a more technical nature. Marketing expenditures must be sufficiently effective for them to be non-negative. This requires γ being sufficiently large. Then, the fact that artists have some fixed opportunity cost implies that market size *Z* has to be sufficiently large for the number of artists to be at least 2.

Solid lines in figure 2 indicate the segments of $y(\omega)$ and $s(\omega)$ that determine *n**. Note that if senior artists obtain revenues above their opportunity costs then $y(\omega)$ is the relevant schedule determining *n**. The following corollary is then immediate:

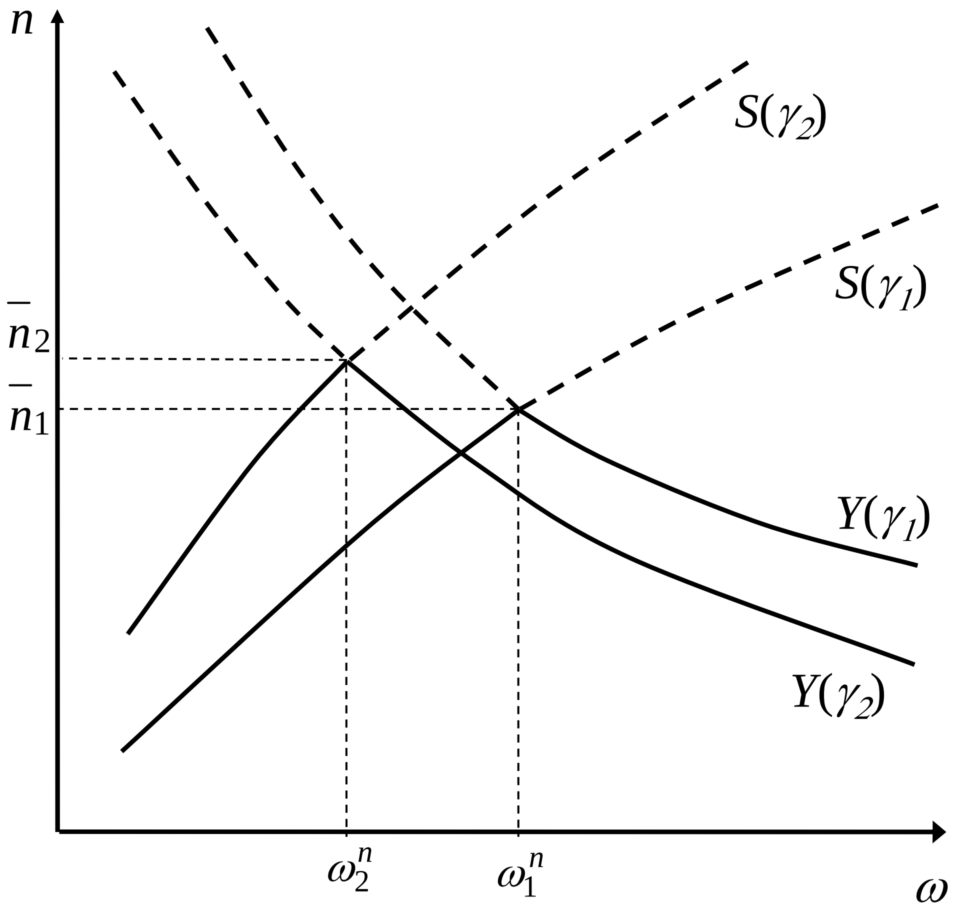
> ***Corollary (8).*** Let assumption (2) hold. If stars obtain rents, then extending the copyright length reduces artistic creation in the long run. Otherwise, it increases artistic creation.

6.2. Technological innovations and market expansions

Now we consider how structural changes in the relevant environment affect artistic creation in the long run. The effect depends on whether the relevant constraint for artistic careers is the $S(\omega,n)$ locus or the $Y(\omega,n)$ one. An increase in market size *Z* shifts both schedules upwards, so that *n* increases regardless of ω. In turn, an increase in γ shifts the $Y(\omega,n)$ schedule downwards and the $S(\omega,n)$ schedule upwards (see figure 3, where $\gamma_2 > \gamma_1$). Therefore, the impact of γ on *n* depends on ω. If ω is to the right of ω_1^n (i.e., if stars obtain rents), then an increase of γ leads to a reduction of *n*. These results are summarized in the following proposition.

> ***Proposition (9).*** Increases in market size always increase artistic creation in the long run, regardless of the copyright term. In turn, under assumption (2) and if stars obtain rents, improvements in communication and marketing technologies favoring market concentration by stars (i.e., increases in γ) reduce artistic creation in the long run.

FIGURE 3: The long-run number of stars (n) and the copyright term (ω)



Note: Improvements in communication and marketing technologies as well as reductions in the barriers to the globalization of culture are captured by increases in γ. They shift upwards the $S(n,\omega)$ schedule and downwards the $Y(n,\omega)$ schedule. The solid lines show the long-run number of stars *n* as a function of the copyright term ω. Increases in γ reduce the copyright term ω^n that maximizes the number of stars (the talented senior artists).

Proof. We have to show that when γ increases the $S(\omega,n)$ schedule shifts upwards whereas the $Y(\omega,n)$ schedule shifts downwards; and that when *Z* increases, both schedules shift upwards. The directions of the shifts can be obtained by differentiating *n* with respect to γ and *Z* in $Y(\omega,n)$ and $S(\omega,n)$, while taking ω as a constant. To analyze the effects of γ and *Z* on $S(\omega,n)$, note first that:

$$\frac{\partial \pi^S}{\partial Z} = \pi^S / Z > 0;$$
$$\frac{\partial \pi^S}{\partial \gamma} = Z\frac{1}{\gamma n^2}\left[1-\frac{1}{n}+\frac{1}{n}\ln\left(\frac{\beta\gamma\omega}{n}\right)\right] > 0;$$
$$\frac{\partial \pi^S}{\partial n} = -\frac{Z}{n}\left[\frac{2\pi^S}{Z}-\frac{1}{\gamma n}\left(1-\frac{1}{n}\right)\right] < 0.$$

Let n^S be the level of n implied by $S(\omega,n)$. Differentiating $S(\omega,n)$ with respect to n and Z, and with respect to n and γ yields, respectively:

$$\frac{dn^S}{dZ} = -\left(\frac{\partial \pi^S}{\partial Z}\Big/\frac{\partial \pi^S}{\partial n}\right) > 0; \frac{dn^S}{d\gamma} = -\left(\frac{\partial \pi^S}{\partial \gamma}\Big/\frac{\partial \pi^S}{\partial n}\right) > 0$$

Therefore, the schedule $S(\omega,n)$ shifts upwards when Z or γ increase. Now, let n^Y be the level of n implied by $Y(\omega,n)$. Differentiating $Y(\omega,n)$ yields:

$$\frac{dn^Y}{dZ}\frac{Z}{n^Y} = \frac{g-\theta\rho^{2\sigma-1}\left(n\cdot\pi^S\right)^{1-\sigma}\frac{\partial \pi^S}{\partial Z}\frac{Z}{\pi^S}}{g-\theta\rho^{2\sigma-1}\left(n\cdot\pi^S\right)^{1-\sigma}\frac{\partial \pi^S}{\partial n}\frac{n}{\pi^S}} > 0;$$
$$\frac{dn^Y}{d\gamma}\frac{\gamma}{n^Y} = \frac{g-\theta\rho^{2\sigma-1}\left(n\cdot\pi^S\right)^{1-\sigma}\frac{\partial \pi^S}{\partial \gamma}\frac{\gamma}{\pi^S}}{g-\theta\rho^{2\sigma-1}\left(n\cdot\pi^S\right)^{1-\sigma}\frac{\partial \pi^S}{\partial n}\frac{n}{\pi^S}} < 0.$$

Note that we always have $n \geq 2$, that the product $n\cdot\pi^S$ as well as $\frac{\partial \pi^S}{\partial Z}$, $\frac{\partial \pi^S}{\partial n}$, and $\frac{\partial \pi^S}{\partial \gamma}$ are bounded from above by Z, and that π^S is bounded from below by F^S. Hence, assuming $\sigma > 1/2$, if ρ or θ is sufficiently small, then dn^Y/dZ is positive whereas $dn^Y/d\gamma$ is negative. Therefore, if Z (respectively, γ) increases, then the schedule $Y(\omega,n)$ shifts upwards (resp., downwards). Finally, note that an increase in Z raises n regardless of

ω, whereas the impact of γ depends on ω. If ω is to the right of ω_1^n (i.e., if stars obtain rents), then an increase of γ leads to a reduction of *n*. See figure 3.

How should the copyright term be changed as the economic environment changes? It is clear from figure 2 that if the $S(\omega,n)$ and $Y(\omega,n)$ schedules cross for some copyright term $\omega^n > 0$, this is the term maximizing long-run artistic creation. We can thus use this graphical analysis to investigate how the maximizing copyright term changes as a result of changes in the economy. It is easy to check using figure 3 that an increase in γ always leads to a shorter optimal term ω^n.

> ***Proposition (10).*** Improvements in communication and marketing technologies as well as reductions in the barriers to the globalization of culture (as captured by increases in γ) shorten the length of the copyright term that maximizes long-run artistic creation.

7. Appendix B

7.1. Proof of Proposition (3)

Consider the derivative of (14) with respect to ω. Recalling that $\frac{dn}{d\omega}\frac{\omega}{n} = -1$ and that $\frac{da}{d\omega} = 2\frac{1-a}{\omega} > 0$, yields:

$$\begin{aligned}\frac{dW}{d\omega}\frac{1}{Z} &= \left(Q^S - Q^Y\right)\frac{da}{d\omega} + \frac{\lambda}{4n}\left[\left((1-a)\frac{\rho}{\omega} + \frac{a}{\omega}\right)\frac{dn}{d\omega}\frac{\omega}{n} - (1-\rho)\frac{da}{d\omega}\right] - \frac{dA}{d\omega}\frac{1}{Z} - \left(\frac{F^S}{Z} - \frac{F^Y}{Z\rho}\right)\frac{dn}{d\omega} \\ &= \left(Q^S - Q^Y\right)\frac{\rho^2}{\gamma^2}\frac{2Z}{\omega^3\lambda F^Y} - \frac{1}{4}\left(\lambda\frac{\gamma}{\rho^2}\frac{F^Y}{Z} + \frac{1-\rho}{\gamma\omega^2}\right) - \frac{dA}{d\omega}\frac{1}{Z} + \frac{\rho}{\gamma}\frac{1}{\omega^2}\left(\rho\frac{F^S}{F^Y} + 1\right)\end{aligned} \quad [24]$$

where $\frac{dA}{d\omega} = \left[2 + \ln\left(\frac{\beta\gamma^2\lambda\omega^2F^Y}{Z\rho^2}\right)\right]\frac{F^Y}{\rho^2} > 0$. This derivative is negative if λ is sufficiently large or ρ is sufficiently small. ■

7.2. Proof of Proposition (4)

Differentiating expression (18) yields:

$$\varepsilon_{N\omega} \equiv \frac{dN}{d\omega}\frac{\omega}{N} = -\frac{k\cdot\pi^S\big/F^S - 1 - 2\dfrac{\partial\pi^S}{\partial\omega}\dfrac{\omega}{\pi^S}}{k\cdot\pi^S\big/F^S - 1 - 2\dfrac{\partial\pi^S}{\partial N}\dfrac{N}{\pi^S}} \tag{25}$$

If *k* is sufficiently large, then this derivative is positive for short copyrights and negative for long ones, which implies the potential negative effect of the extension of copyrights on artistic creation stated in proposition (4). Note that if assumption (1) holds, in equilibrium we have $\pi^S > 0$ as well as $\frac{\partial\pi^S}{\partial N}\frac{N}{\pi^S} < 0$ and $\frac{\partial\pi^S}{\partial\omega}\frac{\omega}{\pi^S} > 0$. Substitute with $N = 0$ in (15) and (17), and define $\underline{\omega}$ as the copyright solving $k\cdot\pi^S\left(\underline{\omega},0\right) = F^S$. This is a lower bound for the copyright term: below this level, no senior artist would be able to pay for her opportunity costs F^S. As ω approaches $\underline{\omega}$ from above, (15)-(17) yield that *N* tends to $0, k\cdot\pi^S\big/F^S$ tends to 1, and therefore the derivative in (25) is positive.

In turn, for any $\omega, \underline{\omega} < \omega \le 1$, if *k* is sufficiently large then expression (25) is negative. To see this note that *N** is bounded from above by $Z\big/\gamma\omega F^Y$ and from below by 2 (see figure 1). Hence, (11) and assumption (1) imply that π^S is bounded from below above zero and that $\partial\pi^S\big/\partial\omega$ is bounded from above. Therefore, for *k* sufficiently large, there is a copyright term $\omega^N, \underline{\omega} < \omega^N < 1$, such that $\frac{dN}{d\omega}\frac{\omega}{N} = 0$ and *N** is maximized.

Now, to show that $\frac{d\omega^N}{dk} < 0$, note first that in a neighborhood of the maximizer ω^N we have $d^2N/d\omega^2 < 0$. Then, we have to show that $\frac{d^2N}{d\omega dk} < 0$ (or, equivalently, that $\frac{d\varepsilon_{N\omega}}{dk} < 0$) in that neighborhood. Using (25) note that the sign of $\varepsilon_{N\omega}$ in a small neighborhood of ω^N is given by the sign of $H = -k\frac{\pi^S}{F^S} + 1 + 2\frac{\partial\pi^S}{\partial\omega}\frac{\omega}{\pi^S}$. The derivative with respect to k yields $\frac{dH}{dk}=-\frac{\pi^S}{F^S}-\left[\frac{\partial\pi^S}{\partial N}\frac{N}{\pi^S}-2\frac{d\left(\frac{\partial\pi^S}{\partial\omega}\frac{\omega}{\pi^S}\right)}{dN}\frac{N}{k}\right]\frac{dN}{dk}\frac{k}{N}$. In turn, implicit differentiation of (18) yields $\frac{dN}{dk}\frac{k}{N}=2\Big/\left(k\frac{\pi^S}{F^S}-1-2\frac{\partial\pi^S}{\partial N}\frac{N}{\pi^S}\right)$. Recall that π^S is bounded from below above zero whereas $\frac{\partial\pi^S}{\partial N}\frac{N}{\pi^S}$ is bounded from above. Hence $\lim_{k\to\infty}\frac{dN}{dk}\frac{k}{N}=0$. Moreover, for k sufficiently large we have $\frac{dH}{dk}<0$. Therefore, $\frac{d\varepsilon_{N\omega}}{dk}<0$ in a neighborhood of ω^N. ■

7.3. Proof of Proposition (5)

Note from (25) that we always have $\varepsilon_{N\omega}>-1$. Then, taking into account that $q^M=ke^{-k\rho}$ and differentiating (17) with respect to ω yields the result in proposition (5):

$$\frac{d\rho}{d\omega}\omega=\frac{1}{2}\frac{e^{k\rho}-1}{k}\left(1+\varepsilon_{N\omega}\right)>0 \tag{26}$$

■

7.4. Proof of Proposition (6)

Welfare is:

$$\begin{aligned} W &= \left[Q^S aZ+(1-a)Q^Y Z\right]-\left[aZ\frac{\lambda}{4N}+(1-a)Z\frac{\lambda}{4m}\right]-A-cZ-nF^S-mF^Y \\ &= Z\left[Q^S-\frac{Q^S-Q^Y}{\gamma\lambda}\frac{N}{\omega}+\left(\frac{1}{\gamma}-\lambda\left(\frac{N}{\omega}\right)^{-1}\right)\frac{1}{4\omega}-\left(\frac{1}{16}\frac{F^Y}{\gamma Z}\right)^{1/2}\left(\frac{N}{\omega}\right)^{1/2}\right]-A-cZ \\ &\quad -\rho\left(\frac{N}{\omega}\right)^{1/2}\left(\frac{F^Y}{Z}\gamma\right)^{-1/2}\left(F^S+F^Y/\rho\right) \end{aligned} \tag{27}$$

Taking derivatives yields:

$$\frac{dW}{d\omega}\frac{\omega}{Z}\frac{1}{\lambda}=\frac{Q^S-Q^Y}{\gamma\lambda^2}\frac{N}{\omega}(1-\varepsilon_{N\omega})+\frac{1}{4}\left[\frac{1}{N}\varepsilon_{N\omega}-\frac{1}{\lambda\gamma\omega}\right]-\frac{1}{\lambda}\frac{dA}{d\omega}\frac{\omega}{Z}$$

$$+\frac{1}{2\lambda}\left(N\frac{F^Y}{\gamma\omega Z}\right)^{1/2}\left[\left(\frac{5}{4}+\rho\frac{F^S}{F^Y}\right)(1-\varepsilon_{N\omega})-\frac{1+\varepsilon_{N\omega}}{\left[\left(\frac{Z}{\gamma\omega NF^Y}\right)^{1/2}-1\right]k}\frac{F^S}{F^Y}\right] \quad [28]$$

where $\varepsilon_{N\omega}\equiv\frac{dN}{d\omega}\frac{\omega}{N}$ (which is negative for k sufficiently large: Proposition (5) and $\frac{1}{\lambda}\frac{dA}{d\omega}\frac{\omega}{Z}=\frac{1}{\lambda\gamma N}\left(1-[1+\ln(\beta\gamma\lambda\omega/N]\varepsilon_{N\omega}\frac{1}{Z}\right)$. Note first that for ω sufficiently close to zero the above expression would be positive (as long as assumption (1) still holds). However, given a copyright term $0<\omega<1$, for λ and k sufficiently large this derivative becomes negative. To see this recall that $\varepsilon_{N\omega}>-1$, N is bounded $\left(N<Z/F^Y\gamma\omega<\lambda\beta\gamma\omega\right)$ as well as $\rho\left(\rho\le 1\right)$, and that $\lim_{k\to\infty}\varepsilon_{N\omega}=-1$ (see (25)) and $\frac{dA}{d\omega}\frac{\omega}{Z}>0$. Hence there is a copyright term $\omega^W, 0<\omega^N<1$, that maximizes social welfare.

Now, as the value of artistic diversity λ increases, the copyright that maximizes social welfare ω^W becomes arbitrarily close to the one that maximizes senior artistic creation ω^N. Formally, using expression () we have $\lim_{\lambda\to\infty}\frac{dW}{d\omega}\frac{\omega}{Z}\frac{1}{\lambda}=\frac{1}{4}\frac{1}{N}\varepsilon_{N\omega}$. Hence $\frac{dW}{d\omega}=0$ at ω^N, which is the copyright such that $\varepsilon_{N\omega}=0$. Thus, we have the following cross-derivative evaluated at ω^N:

$$\frac{dW}{d\omega dk}\frac{\omega}{Z}\frac{1}{\lambda}=\frac{1}{4N}\left[\frac{d\varepsilon_{N\omega}}{dk}-\varepsilon_{N\omega}\frac{dN}{dk}\frac{1}{N}\right]=\frac{1}{4N}\frac{d\varepsilon_{N\omega}}{dk}<0$$

Therefore we conclude that the optimal copyright term is shorter in markets where k is larger. ■

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