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Abstract

We analyze artistic markets considering three key distinctive features that have been overlooked by the standard analysis on intellectual property. These features are the dynamic link between the current number of young artists and future high-quality artistic creation, Rosen's *superstars* phenomenon, and the role played by promotion costs. Introducing them into an overlapping-generations model brings about a new perspective on the consequences for artistic creation of changes in the copyright term, progress in communication technologies favoring market concentration by stars, and the enlargement of markets. The conventional result that longer copyrights always stimulate artistic creation only holds as a particular case.

Keywords: superstars, copyrights, innate abilities, allocation of talent.

JEL Classification: J44, J62, L82, O34.

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1 Introduction

Individuals are born with different abilities. The process of sorting and developing the abilities of heterogenous individuals involve different mechanisms. In most cases, much of the process is carried out through the period of formal education. Education augments the skills of agents and helps sorting their capacities (Becker (1964), Arrow (1973), and Spence (1973)). However, some abilities cannot be ascertained without the actual job experience (Johnson (1978)). Some tasks where heterogeneous innate abilities are important and only become apparent after some working experience, involve occupations of large social impact. This seems to be the case for example for politicians, artists, and, to some extent, scientists. Clearly, a large endowment of talent or charisma is key in these activities, their output involve some public good traits that give them a large social impact, and the testing and development of abilities can hardly be achieved without the individual being actually performing the professional activity.[1]

These circumstances pose specific problems to the sorting and development of talent. Efficiency involves some optimal proportion between juniors (individuals whose talent has not been fully assessed yet) and senior professionals. The market may reach an efficient allocation by having juniors paying for the sorting and skill-development process in the form of commanding low or negative earnings at the beginning of their professional careers, and being subsequently compensated by very high earnings if they succeed. However, important market imperfections are likely to arise in this environment. Huge heterogeneity about innate abilities, which are uncertain to the individual as much as to the rest of agents, may imply great uncertainty about future earnings in professional careers requiring those abilities. Since this uncertainty is uninsurable due to the combination of high effort and skills needed to succeed, and since the individual may also be liquidity constrained (due to the impossibility to use highly uncertain human capital as collateral), the likely outcome in this setting is an inefficiently short supply

[1] Politicians grow in contact with the public, the media and the interaction with other politicians within their own party as well as from other parties. Actors, musicians, movie directors, etc. need to test their talent and charisma in contact with the public. Even in academics, the actual talent for conducting original research is not clearly assessed by tests used for admission in graduate studies but after having actually conducted some research.

of juniors. As noted, efficiency may also require negative prices for juniors' work that may be difficult to implement, and in some occupations (such as the political career) it is unclear how a market for the promotion of juniors may be implemented. Furthermore, senior professionals may be the ones responsible for the access of juniors to the profession but may find it in their own interest to restrict the number of juniors competing with them.

In this paper we concentrate on the particular case of artists and artistic markets. Artistic creation (in music, films, writing, performing arts, fine arts, etc.) is increasingly important as leisure time augments and societies become more affluent, and it is also connected to the ubiquitous good design. The need for a correct understanding of artistic markets is underscored by the public regulation of intellectual property (IP), which is a much debated topic in recent years as a result of the emergence of new communication and copying technologies, the globalization of culture, and the large differences in regulation across countries. In this respect, some creators and artistic producers are demanding tougher restrictions on the use of copying devices (including Internet, CD and DVD recording tools) and have been obtaining successive extensions of the copyright term in the US. Conversely, many people including some very reputable economists and Nobel laureates have suggested that the current IP protection is excessive in both the US and Europe (see Akerloff *et al.* (2002) and *The Economist*, Jun. 21st (2001), Nov. 11th (2004) and Jan. 6th (2005). See also Liebowitz and Margolis (2003) for a critical approach to this view, and surveys by Peitz and Waelbroeck (2004) and Varian (2005)).

In this paper we emphasize three distinctive features of artistic markets which have been overlooked by the standard analysis on IP regulation, and which we argue are crucial for a better understanding of most artistic markets. Granting these features an adequate role in the analysis brings about new and somewhat surprising insights on the optimal regulation of copyrights and on the consequences of progress in communication technologies and the globalization and enlargement of artistic markets.

The first of these three features is the positive link between the current number of young artists and future high-quality artistic creation. 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 be able to test themselves, to develop their abilities, and to show to the public and to promotion firms that they do have these characteristics (MacDonald (1988)). This gives rise to a positive dynamic relationship between the current number of junior artists and the future number of senior talented artists. The abundance of young artists (most of which do not succeed) is a precondition for a large number of high-quality artists in the future. Second, there is a huge gap between young artists' share of the market and earnings, and senior high-type artists'. The reason is that artistic markets are *superstar* markets. 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 usually present in artistic goods (such as scale economies arising from joint consumption), give rise to superstar markets: concentration of output on those few sellers who have the most talent, marked skewness in the associated distribution of income, and very large rewards at the top. In principle, superstars' large revenues seem to prompt potential young artists to attempt the artistic career. Yet, as we will argue, the very concentration of revenues by stars (combined with the high uncertainty about success and the impossibility of obtaining insurance against the likely event of failure) reduce the incentives to start an artistic career. 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 allocation of market shares between stars and young artists is largely affected by stars' hefty expenditures on marketing and promotion costs.

Copyright regulation has been analyzed within the general approach to optimal IP protection. According to this approach, optimal regulation involves seeking a compromise between the social costs of the monopoly created by the copyright and the incentives to creation. This conventional approach takes for granted that stronger and longer term copyrights always stimulates artistic creation.[3] In this paper we argue that this is not longer true when we take into account the interplay between junior and high-type senior artists (stars). The monotonically increasing relationship between

[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] See Grossman and Lai (2004) and Boldrin and Levine (2006) for a recent debate on the effects of the enlargement of markets for the optimal regulation of copyrights, within this conventional framework.

longer copyrights and the supply of artistic creation only holds as one of the possible cases in our model.

Our analysis is based on an ovelapping-generations model of artists. In this setting, the long run number of active high-type senior artists may be limited either by the revenues obtained by these high-type artists (which must be at least as large as their opportunity costs), or by the flow of talented young artists (which in turn depends on the life-long expected utility of initiating an artistic career and on the constraint that they must reach enough audience to be uncovered as talented artists in case they do have talent). Depending on which of the constraints is binding, the long run consequences for artistic creation of changes in the economic environment (such as length of the copyright term, communication technologies, size of market, etc.) are different. The case where high-type opportunity costs are the ones binding roughly corresponds to the analysis by the conventional approach.

We show that high-type senior artists' revenues tend to be the binding constraint for high-quality artistic creation when it involves very large opportunity costs both in absolute terms and relative to young artists' opportunity costs. When this is not the case, the binding constraint is the flow of talented young artists. There are two main factors determining the opportunity costs of high-type artistic creation. The first one is the degree of specialization of the natural ability required in the artistic activity. As pointed out by Murphy, Shleifer and Vishny (1991), there are different sorts of talent: on the one extreme, it 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 the particular artistic activity. Second, besides artists' time and talent, creation of artistic goods may require the use of general inputs (thus having an infinite price elastic supply from the point of view of the production of artistic goods).[4] The financial importance of these nonspecialized inputs widely varies from one artistic activity to the other. For example, nonspecialized inputs may have a large weight in the budget of a movie, whereas writing a novel may involve little

[4] By *creation of an artistic good* we mean the writing of a song or a novel, the making of a movie or a TV show, etc.; as opposed to process of making the good available to any number of consumers by means of copies or any other means, which involves a different sort of inputs.

more than the writer's time. When artistic creation is mostly the result of general inputs and general intellectual abilities, opportunity costs are high and therefore the constraint related to high-type artists' revenues will be the one binding. This case resembles very much the modern production of technological ideas, and the corresponding results in this paper on the effect of copyright's extension are coincident with the conventional analysis. By contrast, when specific natural talent tends to be the unique input of artistic creation, opportunity costs are low (this may be called the case of *pure artistic creation*). We will show that the flow of young artists is then the binding constraint. In this case, results substantially differ from the standard analysis of IP regulation. The conventional approach to optimal IP regulation has analyzed in a similar way the incentives to artistic ideas and to technological ideas since both share the character of public good. However, this conventional approach is inappropriate where artistic creation is mainly the result of innate specialized abilities rather than general inputs.

Our analysis concentrates on the determinants of artistic creation since most of the debate on copyrights has focused on this variable (artistic creation will be just proportional to the number of active artists in our model). Moreover, there is an open debate as to what extent advertising is informative or merely persuasive, and therefore welfare analysis becomes very controversial when advertising expenditures are involved. 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 just the assumption we make in the model.

The paper is organized as follows. In Section 2 we set out the general elements of our approach. In Section 3 we consider the case where the constraint limiting the flow of talented young artists is young artists' opportunities to reach enough audience (these opportunities play the role of the number of positions for junior professionals). This case allows us to start laying out the model in its simplest version while characterizing some relevant situations. In Section 4 we consider the more complex interplay between young artists' and high-type senior artists' opportunity costs. In both sections we analyze the consequences for artistic creation of changes in the copyright term and of progress in communication technologies favoring market concentration by stars. In Section 4 we also investigate how the copyright term that maximizes artistic creation in the long run changes in face of increases in market size and technological progress. In Section 5 we draw some final comments.

2 General Setting

Our approach relies on a overlapping generations model of artists who live for two periods, and who may or may not have talent. Each period every artist creates a single artistic work (such as a song, novel, movie, TV show, etc.) which can be made available to any number of consumers at a constant marginal cost c. MacDonald (1988) has analyzed in this type of setting how artists with heterogeneous and uncertain talent are sorted by the market through an information accumulation process. Assuming that future performance is correlated with past performance (possibly because of innate talent) he shows that individuals will enter the artistic career only when young, and stay only if they receive a good review of their performance in this first period of life. 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 have become stars whose earnings are more than proportional to their uncovered talent).

Our setting is similar to MacDonald's model, though we will not go trough all the details of the information updating process in order to concentrate on a different set of issues. We assume there is free entry into the low-type market of artists with uncertain talent. Following McDonald's results we go on to assume that individuals entering the artistic profession do so in their first period of life and call them *young* artists. Only a fraction ρ of young artists are *talented*, but neither them nor artistic firms or the public can observe this innate characteristic but after the artist has completed her first life period and has been able to reach a minimum audience (e.g., number of readers, record sales, public attending her performances, etc.). Only young artists that reveal themselves as talented in their first period may find it profitable to continue their career in their second life-period and become *high-type artists*. Non-talented young artists drop out.

Incentives and Opportunity Costs to Artistic Creation

As already pointed out in the Introduction, the long run number of active high-type artists may be limited by: (i) the size of revenues accruing to high-type artists which must be at least as large as their opportunity costs; (ii) the flow of young artists that are revealed as talented. This flow, in turn, depends on the life-long expected utility for a young artist of entering the artistic market, which must be at least as high as her expected utility outside the artistic career; and on how many young artists can reach the minimum audience (sales of books, records, etc.) to be able to be sorted as a talented artist in case they do are talented.[5] We normalize units by taking this minimum audience to be equal to one. Formally, we have the following three constraints where expression (1) corresponds to (i), and expressions (2) and (3) correspond to the double constraint (ii):

$$\pi_t^h \geq F^h; \tag{1}$$

$$\frac{1}{1-\sigma}\left[\pi_t^y\right]^{1-\sigma} + \frac{n_{t+1}}{m_t}\frac{\theta}{1-\sigma}\left[\pi_{t+1}^h\right]^{1-\sigma} + \left(1 - \frac{n_{t+1}}{m_t}\right)\frac{\theta}{1-\sigma}\left[F^y\right]^{1-\sigma} \geq \frac{1+\theta}{1-\sigma}\left[F^y\right]^{1-\sigma}; \tag{2}$$

$$y_t \frac{1}{m_t} \geq 1. \tag{3}$$

Where π^h is (per capita) high-type artists' revenues, π^y is young artists' revenues, F^h is high-type artists' opportunity cost, F^y is young artists' opportunity cost, m_t is the number of young artists at time t, n_{t+1} is the number of high-type artists one period later, $\sigma > 0$ is the coefficient of relative risk-aversion, $\theta < 1$ is the subjective intertemporal discount factor, and y_t is total sales in the low-type market of young artists.

As we already noted, which of these constraints will likely be the one binding depends on the absolute and relative levels of young and high-type artists' opportunity costs. We will show that the case where (1) is the binding constraint corresponds to a situation where high-type artistic creation involves very large opportunity costs relative to young artists' opportunity costs (and talent can easily be uncovered in a short period of time). In this case, constraint (2) and (3) are not binding which means that there is not shortage of young artists trying the artistic career and showing up

[5] We assume young artists cannot obtain insurance for the eventuality that they do not become stars. This seems to be very plausible empirically and may be the consequence of moral hazard and adverse selection problems. Becoming a star usually requires a significant (nonabsorbable by third parties) personal effort during the young-artist period, even for those who have talent and charisma.

as talented. The case where (2) is the binding constraint is somewhat the opposite situation: young artists' opportunity costs are similar to high-type artists'. Even if high-type artists' revenues are above their opportunity cost, this does not bring about a large supply of young artists due to the large uncertainty of success. Finally, if both high-type as well as young artists have small opportunity costs but high-type artists concentrate most of the artistic market, the binding constraint will be (3). In this situation, economic incentives are not limiting the number of artists. The situation will be that of a large amount of young individuals willing to become artists but being unable to reach enough audience (even when commanding a zero revenue for their work).

Entry and the Flow of Young Artists

Free entry as a young artist implies that young artists' expected utility in the artistic career cannot be above their opportunity costs. Therefore constraint (2) must be satisfied with equality:

$$[\pi_t^y]^{1-\sigma} + \theta \frac{n_{t+1}}{m_t} \left(\left[\pi_{t+1}^h \right]^{1-\sigma} - [F^y]^{1-\sigma} \right) = [F^y]^{1-\sigma} . \tag{2'}$$

High-type artists may obtain revenues above their opportunity costs however, since their number is limited by the number of successful young artists.

As already stated, a fraction ρ of young artists have talent. Yet not necessarily all young artists that have come out with talent (and that have reached enough audience) get promoted as high-type artists in their second life-period. It may occur that $n_t < \rho m_{t-1}$. This may happen if high-type artists' opportunity cost (1) is binding so that additional active high-type artists would bring their earnings below their opportunity costs. On the other hand, if high-type artists are strictly above their opportunity cost, all young artists that come up as talented will become high-type artists in their second life-period. According to these arguments the number of high-type artists will be given by:

$$\begin{aligned} n_t &\leq \rho m_{t-1}; \\ \left(\pi_t^h - F^h \right) (n_t - \rho m_{t-1}) &= 0. \end{aligned} \tag{4}$$

Demand and Competition

Every period, consumers spend the same amount of money S in artistic goods (we will refer to S as the size of the market). High-type artists enjoy promotion and marketing costs that are provided by a competitive industry of artistic-promotion firms.[6] The assumption that promotion firms only find profitable to invest in promoting high-type artists 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 steak with artists whose talent and charisma has already been established. High-type artists' share of the market is an endogenous parameter depending on total high-type artists' expenditures on promotion, and is denoted by a $(0 < a < 1)$.

The setting may 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 locality, the public buys both the output of their local artists as well as the output of international artists (local artists' work may thought to be more influenced by the cultural peculiarities and experiences of their geographic area or ethnic group). Local artists' main mechanism to get known is word-of-mouth, whereas international artists rely on expensive marketing and promotion. The fraction of income spent in either type of artist in every locality 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.

Formally, we assume a representative consumer that solves the following maximization problem:[7]

$$\begin{aligned} MaxU &= a \ln x + (1-a) \ln y, \\ s.t.\ \ & p_x x + p_y y = S \end{aligned} \tag{5}$$

where x and y are, respectively, total consumption of stars' and young

[6] We ignore the possible bargaining problem between artists and promotion firms and just focus on the forces explaining the profits of the integrated structure. The potential conflicts of interest between these two parties have been analyzed in Gayer and Shy (2006). Similarly, we also leave aside the possibility that the market of promotion firms is not competitive.

[7] In the spatial interpretation, the model may be reformulated as with ℓ symmetric local markets each one with size $(1-a)S$, and one international market with size $\ell{\cdot}a{\cdot}S$.

artists' work,[8] p_x and p_y are the corresponding prices, and the market share a is determined according to the following expression:

$$a = \alpha - \beta e^{-\gamma A/S},\ A = \sum_{i}^{n} A_i, A_i \geq 0,\ i = 1, 2, .., n\ . \tag{6}$$

In this expression, α, β and γ are exogenous parameters, $1 > \alpha > \beta > 0$, $\gamma > 1$, A_i is advertising and promotion cost by artist i, and n ($n \geq 2$) is the number of high-type artists. This formulation implies that the amount of promotion costs needed to obtain a given share of the market is proportional to the size S of the market.[9] High-type artists' market share would be α for $A = \infty$, and $\alpha - \beta$ for zero promotion expenditures. The parameter γ determines how productive promotion costs are in gaining market share.

Competition takes place according to the following multistage game:

- Stage 1: Each high-type artist chooses simultaneously, and independently, its level of A_i.
- Stage 2: Each young artist decides whether or not to enter the artistic market.
- Stage 3: Agents compete à la Cournot.

[8] Two-stage budgeting and the Cobb-Douglas formulation greatly simplify calculations. Should we use a more general CES utility function, results would only change but continuously as a function of the elasticity of substitution. Thus, all the results would be maintained within this more general setting for at least some range of the elasticity of substitution. On the other hand, it may be more interesting to reinterpret this formulation as coming from a continuum of consumers of size S each consuming a unit of money in artistic goods, and such that the share of consumers buying either from stars or from young artists depends on total promotion expenditures.

[9] A firm's advertising tends to increase both the demand for the firm's specific 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 firms, ignoring the competitive effects of advertising within high-type firms and focussing on the aggregate interactions between the low and the high-type sub-markets. We also leave aside the existence of horizontal differentiation among artists belonging to the same sub-market. Preferences for diversity could be easily introduced, however, by assuming that variables x and y are aggregates of the type assumed by Spence (1976) and Dixit and Stiglitz (1977), which tend to produce results equivalent to models of homogeneous products (Yarrow, 1985).

Note that the parameters α and γ depend on technological progress. Rosen (1981) pointed out the importance that radio and phonograph records had for the market of superstars and wondered about the changes that will be brought by cable, video cassettes, and home computers. The path of technological changes in this industry does not seem to have slowed down in recent years when 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 technical improvements (such as recording, radio, TV, etc.), the increasing availability of electronic devices rising quality and decreasing price, and the opening of frontiers to foreign cultural influences which has been spectacular in recent years for many countries. Changes in parameters α and γ may capture the effect of changes on the potential market that stars might reach and the effectiveness of the techniques aimed at increasing stars' market shares (such as marketing and promotion techniques).

3 Artistic Markets with Low Opportunity Costs

In this section we assume that the constraint (3) is the one binding. This corresponds to a situation where young artists' career is constrained by the opportunities to reach enough audience. Since constraints (1) and (2) are not binding and there is free entry, there will be a excess supply of young artists who will be pushing the price of their services to a zero level.[10] Clearly, for this to happen expected returns in case of success must be very high, so that young artists' life-long expected revenues are above their opportunity costs even for $\pi^y = 0$.[11] Economic incentives are not constraining artistic careers in any way; the problem is having some room in the market to show up.[12] This might be considered a rather extreme case, but it will allow to start

[10] We exclude the possibility that young musicians, writers, actors, film directors, etc., pay to have some audience consuming their work (i.e., we exclude negative prices for their work).

[11] See Appendix B which builds on the analysis in the next section for the conditions as to (1) and (2) not to be binding. Low opportunity costs are more likely to occur when young artists are able to participate in the low-type artistic market while obtaining revenues from a simultaneous non-artistic job (which often seems the case for prospective writers and pop musicians).

[12] An additional element that we have not been introduced in our model which would lead to a similar constraint on young artists' audience is a limit on the number of artistic

laying out the model in its simplest version and characterizing some relevant situations. At any rate, the analysis in the next section is independent of the results in this section.

3.1 The Short Run Number of Young Artists

We now solve for every period (short run) equilibrium taking the number of high-type artists as exogenous. This 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 group of stars keep changing with lower frequency than the group of young artists.

Let us consider the Cournot-Nash equilibrium at Stage 3. Standard calculations show that the demand functions for each good are given by $p_x = aS/x$; and $p_y = (1-a)S/y$. Thus, the profit function of each high-type (artistic) firm 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 the production of firm i and c is the constant marginal cost, assumed identical for all firms. The first order conditions of a Cournot equilibrium yield the equations

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

By solving the previous system we get the Cournot equilibrium levels of price, output per firm and profits:

$$p_x = \frac{n}{n-1}c; \quad x_i = \frac{n-1}{n^2}\frac{aS}{c}; \quad \pi_i^h = \frac{aS}{n^2} - A_i. \tag{7}$$

Now, let us solve for the first stage to obtain the subgame perfect Nash equilibrium of the game. We can write the profit function of each high-type firm as

$$\pi_i^h(A_i, A) = \frac{(\alpha - \beta e^{-\gamma A/S})S}{n^2} - A_i, \ i = 1, 2, ..., n. \tag{8}$$

goods (movies, concerts, books, etc.) consumers may consume per unit of time. Even if young artists' supply their work for free, consumers may limit their consumption of young artists' work and may want to spend a large share of their scarce leisure time enjoying only high-type artists' work.

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

$$\frac{\beta e^{-\gamma A/S}}{n^2} - (1/\gamma) = 0 \;\rightarrow\; a(n) = \alpha - n^2/\gamma. \tag{9}$$

The inequality $n^2 < \beta\gamma$ is a necessary and sufficient condition to have $A_i > 0$. Throughout the paper we always assume γ is always high enough to guaranty this condition. It is easy to see that under this condition, high-type artists always obtain positive net revenues. Now, assuming constraint (3) is binding and $p_y = c$ (since the excess supply of potential young artists imply they supply their services at zero price), we have:

$$m_t = \frac{1 - a(n)}{c} S = \frac{1 - \alpha + n_t^2/\gamma}{c} S \tag{10}$$

As noted by Rosen, the development of some modern recording and communication technologies may amplify the scale economies of joint consumption associated to artistic goods and may tend to further concentrate market shares and earnings on top talented artists. As we argued at the end of the last section, some of the impact of improvements in communication technologies and the dismantlement of cultural frontiers helping top artists reach larger audiences may be captured by rises in γ and α. According to equations (9) and (10), a rise in γ or in α would increase market concentration by stars $a(n)$ and reduce the number m of young artists.

3.2 The Long Run Dynamics

Since constraint (1) is not binding, (4) implies:

$$n_{t+1} = \rho m_t.$$

Using this to substitute in (10) we obtain the following difference equation:

$$n_t = \left(1 - \alpha + n_{t-1}^2/\gamma\right) \frac{S}{c} \rho. \tag{11}$$

Solving $n_t = n_{t-1}$ it is easy to see that this system has two positive steady state solutions for $\gamma \left[c/\rho S\right]^2 \geq 4\left(1 - \alpha\right)$ (i.e., for γ and c sufficiently large, or ρS sufficiently small). The smallest n solving the system is the stable one and is denoted by n^* (see Figure 1). In the previous subsection we noted that the development of better communication and promotion technologies may favor the concentration of market shares and earnings by top artists thereby reducing the number of young artists. The next proposition points out that, in the long run, rising market concentration is also negative for high-quality artistic creation.

Proposition 1 *When potential young artists are constrained by the opportunities to reach enough audience (i.e., for parameters such that constraint (3) is binding), economic changes favoring market concentration by high-type artists (such as improvements in marketing and communication technologies and the globalization of artistic markets as captured by increases in* γ *and* α*), reduce the long run number of young as well as of high-type artists.*

To see this note that an increase in γ or α rises $a(n)$ (equation (9)) and shifts $\left(1-\alpha+n_{t-1}^2/\gamma\right) S\rho/c$ downwards in Figure 1, thereby lowering n^*. The reason for the reduction in n^* is that low-type (or local) artistic markets help testing, sorting and developing future high-type artists. Larger market concentration by high-type artists reduces the number of active young (local) artists in the short run, which in turn reduces high-type artistic creation in the long run.

3.3 The Length of the Copyright Term

In this subsection we extend the model to analyze the consequences of changing the length of the copyright term. We now assume that high-type artistic goods are also consumed after the creator' death. Utility provided by old creations diminishes as the date of creation becomes more distant according to a discount factor $\eta, 0 < \eta < 1$ (old artistic goods become less adapted to current tastes). However, artistic work by unsuccessful young artists is lost for good as the artist drops out from the market at the end of her first life-period. High-type artists are able to capture the present discounted value of the net earnings from future sales by selling their copyrights when they are still alive.

To keep things simple, it is now more convenient to assume that consumers live for only one period and that their holdings of copies of artistic goods cannot be resold (or are useless) to other consumers after their death.

The new consumer's problem at any given period t is:

$$MaxU = (1-\eta)\sum_{\tau=0}^{\infty} a_\tau \eta^\tau \ln x_\tau + \left[1-(1-\eta)\sum_{\tau=0}^{\infty} a_\tau \eta^\tau\right] \ln y, \quad (12)$$

$$s.t. \;\; p_{x_\tau}\sum_{\tau=0}^{T-1} x_\tau + c\sum_{\tau=T}^{\infty} x_\tau + p_y y = S.$$

Where $T \geq 1$ is the length of the copyright term, x_τ is the current consumption of high-type artistic goods created τ periods ago, p_{x_τ} is their price, c is the already defined marginal cost which determines the competitive price at which copies are sold when copyright expires, $a_\tau = \alpha - \beta e^{-(\gamma/S)A_\tau}$, and A_τ are promotion costs on high-type artistic goods created τ periods ago (which were spent at the time the good release, i.e., τ periods ago).[13]

The analysis of high-type artist decisions remains almost unchanged after this extension. As in the previous subsection, first consider the Cournot-Nash equilibrium at Stage 3. Demand functions for each type of good are given by $p_{x_\tau} = a_\tau(1-\eta)\eta^\tau S/x_\tau$. Hence denoting by $x_{\tau i}$ firm i's output at time t which sells an artistic good that was created at period τ, the Cournot 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 (and whose works are available at time t). Now, let us solve for the first stage to obtain the subgame perfect Nash equilibrium of the game. We directly go on to solve for a symmetric steady state equilibrium: $n_\tau = n^* = \rho m_t = \rho m^*, A_\tau = A, a_\tau = a^*$. The following expression corresponds to a high-type firm's present discounted value of profits at the time of deciding about promotion costs A_i:

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

[13] Our restriction that $T \geq 1$ is equivalent to assuming that the minimum copyright protection is given by the length of the young artistic period. Note that the current copyright term in the US is the life of the artist plus 70 years.

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

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

Now, 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 it is bounded from above by 1: we would have $w = 1$ for $T = \infty$ and $R = 1$). We will 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 be implicitly taking T as a continuous variable). Since (10) holds the same and (4) is binding, we obtain the following equation for the steady state:

$$n = \left(1 - \alpha + \frac{n^2}{\gamma} \frac{1}{w(T)}\right) \frac{S}{c} \rho. \tag{11b}$$

This expression is very similar to system (11). For $\gamma \left[w(T)c/\rho S\right]^2 \geq 4(1-\alpha)$, it has two positive solutions of which the smallest n^* is the stable one. Thus, for γ, T and c sufficiently large, or ρS sufficiently small have:

$$n^* = \frac{w(T)\gamma c/\rho S - \sqrt{\left[w(T)\gamma c/\rho S\right]^2 - 4(1-\alpha)\gamma}}{2} > 0; \tag{15}$$

where we are picking the stable solution. It is easy to see that for conditions leading to a positive solution $n^* \geq 0$ we have $dn^*/dT < 0$. Graphically, an increase in T raises $w(T)$ and therefore shifts downwards the $\left(1 - \alpha + n^2/w(T)\gamma\right) S\rho/c$ schedule in Figure 1. Therefore, extending the length of copyright protection reduces low- as well as high-type artistic creation in the long run.

Proposition 2 *When potential young artists are constrained by the opportunities to reach enough audience (i.e., for parameters such that constraint (3) is binding), extending the length of the copyright term reduces the long run number of both young and high-type artists.*[14]

[14] In Appendix B we set out to the conditions for constraint (3) to be binding while (1) and (2) are not.

Longer copyrights raise stars' revenues, but this does not help increase the number of artists since in this case (i.e., when constraint (3) is binding) young potential artists as well as high-type artists expected revenues are already above their opportunity costs. The problem is that young artists' share of the audience is too small and this is limiting the possibility to discover new talents. The increase in high-type artists' revenues (due to longer copyrights) raises the incentives to invest in the promotion of high-type artists and worsens the problem: young artists' market share is reduced. Eventually, this will reduce high-type artistic creation because it chokes the flow of future high-type artists. This negative effect is independent of the monopolistic distortions implied by copyrights.

4 Artistic Markets with Binding Opportunity Costs

We now consider the case where constraints (1) and (2) may be binding. High-type artists' opportunity cost F^h may be larger than young artists': $F^h \geq F^y$. As already discussed in the Introduction, this higher opportunity cost may reflect two facts: first, once individual's talent has been revealed as high she may have better working alternatives (since artistic talent may be positively correlated with valuable abilities at other activities); and second, it may be optimal to combine talented work with some other general inputs to create high-type artistic goods (those general inputs to be included in the opportunity cost of high-type artistic creation F^h).[15]

We go on directly to analyze symmetric steady state equilibria ($a_\tau = a$). The analysis of high-type artists' optimal decisions from the previous section remains unchanged. Hence from (13) and (14) we have (per capita) high-type artists' revenues:

$$\pi^h(T,n) = S\left[\frac{\alpha w(T)}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln\left(\frac{\beta\gamma w(T)}{n^2}\right)\right]. \tag{16}$$

Using this expression, let us consider the combinations of the copyright term T and the number of high-type artists n satisfying constraint (1) with equality; i.e., the set of pairs (T, n) giving rise to high-type artists' revenues

[15] Talented artistic work and other inputs may be complements in the production of movies, music, etc. We do not carry out an explicit analysis on this possibility, however, since this would add little new to the model but some additional tedious algebra.

equal to their opportunity costs. We denote this locus by $H(T,n)$:

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

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 2:

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

It will be useful to define the function $h : R \to R$ as the set of pairs (T,n) satisfying $H(T,n)$. Thus, a pair (T,n) satisfies constraint (1) if and only if $n \leq h(T)$.

Now, let us analyze young artists' decisions and market. From (12), demand for young artists' output is given by $p_y = \left[1 - \sum_\tau^\infty a_\tau (1-\eta)\eta^\tau\right] S/y$, and each active young artist's net revenues by:

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

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

$$\pi_i^y = \frac{(1-a)S}{m^2}. \quad (18)$$

Substituting into (2'), we have a new version of young artists' opportunity-cost and free-entry constraint:

$$\left[\frac{(1-a)}{m^2}S\right]^{1-\sigma} + \theta\frac{n}{m}\left(\left[\pi^h\right]^{1-\sigma} - [F^y]^{1-\sigma}\right) = [F^y]^{1-\sigma}. \quad (19)$$

Now, consider the combinations of T and n that give rise to young (low-type) artists' revenues equal to their opportunity costs when $n = \rho m$. We denote this locus by $L(T,n)$. Substituting with (16) into (19), we have:

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

Differentiation with respect to w and n gives:

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

where K is defined as

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

Given the rest of parameters, for $\rho^{2\sigma-1}\theta$ small enough (i.e., for low probability of becoming a star–with $\sigma > \frac{1}{2}$– or large discount rate due, for instance, to a long period to have the opportunity to develop and show up as a talented artist), the derivative $dn/dw(T)$ is negative. Therefore the $L(T,n)$ locus would have a negative slope as in Figure 2.[16] It is convenient to define the function $l : R \to R$ as the set of pairs (T,n) satisfying $L(T,n)$.

4.1 The Length of the Copyright Term

The following Lemma describes how the long run number of high-type artists n^* is determined as a function of the length of the copyright term T.

Lemma 3 *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 2 indicate the binding segments of $l(T)$ and $h(T)$ that determine n^*. Now, note that we may have any relative position of $H(T,n)$ with respect to $L(T,n)$ along the feasible range of the copyright term $T \in [1, \infty)$. In particular, we can have any of the three possible cases: (i) $H(T,n)$ is always above $L(T,n)$; (ii) $H(T,n)$ is always below $L(T,n)$;

[16] Note that the denominator of the expression for K is given by:

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

where the inequality holds from profit maximization with respect to advertising (recall $(\alpha - \beta)\,wS/n^2$ 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.

and (*iii*) $L(T,n)$ and $H(T,n)$ cross each other (which is the case depicted in Figure 2). Clearly, the consequences on artistic creation of changing the copyright term depend on which is the case better describing a particular artistic market. This in turn 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 4 *If $\rho^{2\sigma-1}\theta$ is small enough (i.e., for low probability and/or long career to become a star, with relative risk aversion $\sigma > 1/2$), the following properties hold:*

i) If high-type artists' opportunity cost F^h are similar to young artists' opportunity cost F^y then the long run artistic creation is decreasing in T for $T \in [1, \infty)$.

ii) If high-type artists have a very high opportunity cost relative to young artists' opportunity the long run artistic creation is increasing in T for $T \in [1, \infty)$.

iii) For intermediate cases (i.e., for 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 this number is increasing (decreasing) in T if and only if $T < T^0$ ($T > T^0$).

Moreover, these cases can be further be characterized as follows: The long run artistic creation is decreasing in the copyright term if high-type artists obtain economic rents, and decreasing otherwise.

Proof. See Appendix A ■

Total earnings in the artistic market increase as a result of longer copyrights, but only high-type artists benefit from this increase. In fact, there is also a shift of earnings from the life-period as a young artist to the uncertain second-period event of succeeding as a star (since the raise in stars' revenues increase their incentives to invest in promotion). This is always positive for the current generation of stars, but can hardly be positive for the expected discounted utility of starting an artistic career (due to the large uncertainty and intertemporal discount).

Extending the copyright term shrinks the market for young artists and tends to lower their number, thereby hindering the process of developing and uncovering young talented artists. This process reduces the number of high-type artists in the long run in case (i) and in case (iii) for $T > T^0$, since young artists' expected utility is the binding constraint on the long number of high-type artists in all these cases. The result is then the same that the one in the previous section. In the opposite case *(ii)*, or in case (iii) as long as $T < T^0$, the binding constraint on the long run number of high-type artists is revenues accruing to them (as compared with their opportunity costs). In these cases, extending copyrights is positive for artistic creation in the short and in the long run. This last situation is comparable to the setting assumed by the conventional approach to optimal IP protection. Note that in these cases we have a corner solution where $n^*/m^* < \rho$ and longer copyrights always increase artistic creation. Intuitively, the proportion of talented young artists is too big given the very large opportunity costs of creating high-type artistic goods, so that there is no room for promoting all talented young artists into the stars' market.

As stated in the proposition, which case holds depends on the relative size of high-type artists' opportunity costs with respect to young artists' opportunity costs, which in turn depends on how specialized is talent and other inputs used in high-type artistic creation, as argued in Section 2.

4.2 The Long Run Effect of Changes in the Environment

In this subsection we consider the long run consequences on artistic creation of changes in the environment, for any given copyright term T. In the next subsection we analyze the normative issue of how the length of the copyright should be changed as the environment changes, if artistic creation is to be maximized. Thus, we will be considering the case $T = T^0$.

How do structural changes in the relevant environment (communication technologies, cultural frontiers, market size, etc.) affect artistic creation in the long run? The answer happens to depend on which of the $H(T, n)$ and $L(T, n)$ locuses is the relevant constraint for artistic careers. In any case, the long run consequences on artistic creation are an indirect effect of the short run changes in market concentration by stars. When α or γ increase, the $L(T, n)$ schedule shifts downwards in Figure 3 and the $H(T, n)$ schedule shifts upwards. For $T < T^0$ only the shift in $H(T, n)$ is relevant, whereas for $T > T^0$ only the shift in $L(T, n)$ is relevant. Furthermore, when market size S increases, both schedules shift upwards. This leads to the following results:

Proposition 5 *An increase in market size always increases the long run number of artists. However, the impact of technological progress and economic changes favoring artistic-market concentration, as captured by increases in parameters γ and α, depend on which of the constraints on artistic careers is binding. The following properties hold for $\rho^{2\sigma-1}\theta$ small enough (i.e., for low probability and/or long period to become a star, with relative risk aversion $\sigma > 1/2$). An increase in parameter γ or α:*

(i) reduces the long run number of both young artists and stars when high-type artists' opportunity cost F^h is similar to young artists' opportunity cost F^y or $T > T^0$;

(ii) increases the long run number of both young artists and stars when high-type artists' opportunity cost is high enough relative to young artists' opportunity cost or $T < T^0$.

Proof. See Appendix A. ■

As in Proposition 3, case (i) is characterized by high-type artists obtaining economic rents, whereas case (ii) is characterized by high-type artists' earnings being equal to their opportunity costs. And again, case (i) will be the most likely case whenever artistic creation is the result of using specialized inputs. Hence when artistic creation is mostly the result of artistic talent, technological changes favoring market concentration by superstars will be negative for artistic creation in the long run.

4.3 The Copyright Term Maximizing Artistic Creation

As stated in Proposition 4, for intermediate values of $F^h/F_l > 1$ there exists a finite copyright term $T^0 > 1$ that maximizes artistic creation in the long run. In what follows we refer to T^0 as the creation-maximizing T. This creation-maximizing copyright length is given by the intercept between schedules $H(T,n)$ and $L(T,n)$. Hence shifts in these schedules would indicate how the copyright term should be changed as a result of changes in the environment, in order to maximize artistic creation.

Graphically, the effect of changes in α and γ were 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 creation-maximizing copyright term increases when γ or α rise. On the other hand the effect of an increase in market size S is represented in Figure 4, where both $H(T, n)$ and $L(T, n)$ shift upwards after an increase in S. Under our assumption that ρ is small enough and $\sigma > \frac{1}{2}$, the upwards shift of $H(T, n)$ is larger than the shift of $L(T, n)$ so that T^0 decreases with S. These results can be summarized in the following

Proposition 6 *Assume $\rho^{2\sigma-1}\theta$ is small enough (i.e., assume becoming a star has very low probability –with relative risk aversion $\sigma > 1/2$– or requires a long period as a young artist). If the goal is to maximize the number of artists in the long run, the copyright term should be reduced:*

i) when communication technologies favoring market concentration by stars improve, as captured by increases in γ and α;

ii) when market size S increases.

Proof. See Appendix A. ■

Interestingly, our conclusion in part (ii) of this proposition is similar to the result by Boldrin and Levine (2006) suggesting that copyrights should be shortened as market size increases. However, in contrast with this previous contribution, in our model the amount of artistic creation would increase, while in Boldrin and Levine the lower IP protection involves lower innovative activity.

The adjustments of copyrights suggested by the proposition may be not, however, the most likely consequence of the political economy of copyright regulation. The reason is that the rise in stars' expected future revenues also increases the incentives to lobbying aimed at extending the term of copyrights, in a similar way as it increases the incentives to spend in stars' promotion costs.

5 Final Comments

Artistic careers are a prominent case of occupations where innate abilities are important but cannot be ascertained without the actual job experience. In these occupations, the number and average talent of senior professionals is dependent on the number of juniors trying the career, many of whom may abandon the career after updating their priors about their abilities. As a result of this dynamic link, even if price for senior professionals' services increases well above their current opportunity costs, their long run supply may register little increase. The reason is that incentives for young individuals to enter the professional career may not increase in the same proportion. This will happen if individuals are risk averse and uncertainty about the actual abilities is high. *Superstar markets* forcefully pushes up this uncertainty since earnings concentrate in a very narrow group of successful seniors. In this situation, any redistribution of earnings from the period as a junior professional to the senior period contingent on success, reduces expected utility by potential entrants in the profession thereby reducing the number of talented senior professionals in the long run.

In this paper we have analyzed several factors that tend to shift market shares (and revenues) in favor of stars. Whenever technological progress favors market concentration by stars it may have a negative effect on artistic creation in the long run. Extensions of the copyright term can have similar consequences. We have characterized the situations when this will be the case. Furthermore, changes in the economic and political environment are now facilitating the globalization of culture, which favors further concentration of artistic markets and higher revenues accruing to superstars. In turn, these larger revenues increase the incentives to lobby for extensions of the copyright term. However, our analysis shows that under plausible circumstances there is a length of the copyright term that maximizes the long run number of high-type artists, and that this length is decreasing in the size of the market (as well as in the parameters capturing technological progress favoring higher concentration in artistic markets).

Our analysis is dotted with numerous simplifications. The emphasis is not on generality but on incorporating some relevant factors that are omitted in the standard analysis of IP, and on discussing the likely circumstances that may make these factors to prevail over the ones considered by the standard analysis. We have argued that the standard analysis on IP protection is better suited for creative activities using mostly inputs that have a high general value (non-specialized inputs). In contrast, the standard approach may be misleading when specific innate abilities are important for artistic creation, and these abilities are very uncertain and only recognized after a period of actual working as a junior artist.

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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 constraint (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 combinations (T, n, m) satisfying (19) with $n < \rho m$ must lay below the $L(T, n)$ locus; i.e., $n < l(T)$.

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: $n < h(T) \leq l(T) = n$. Therefore we conclude that for T such that $l(T) \leq h(T)$, we have $n^* = h(T)$.

Proof of Proposition 4: We have the following possibilities on $F^h/F^y \geq$ 1:

i) If F^h/F^y is small enough, then $h(T) > l(T)$ for any $T \geq 1$. Therefore, according to Lemma 3 $l(T)$ determines n^* and the statement in the proposition follows.

To see the inequality $h(T) > l(T)$ note that (20) is equivalent to

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

So that assuming that $\pi^y < \pi^h$ (a high-type artist would always fare better than a young artist), the above expression implies $F^y < \pi^h$. Thus, for $F^h = F^y$ we have $F^h < \pi^h$ and therefore (17) is not binding. Hence $h(T) >$ $l(T)$.By continuity, the same property holds if F^h is larger but sufficiently close to F^y.

ii) At the other extreme, if F^h/F^y is large enough we have $h(T) < l(T)$ for any $T \geq 1$. Therefore, according to Lemma 3 $h(T)$ determines n^*.

To see this, note that the $H(T,n)$ schedule moves to the right as F^h increases, but does not affect the $L(T,n)$ schedule. Since $h(T)$ is strictly increasing and $l(T)$ strictly decreasing, $h(T) < l(T)$ for any $T \geq 1$ if and only if $h(T) < l(T)$ as $T \to \infty$. This follows from noticing that $w(T) \to \frac{1-\eta}{1-\eta R}$ as $T \to \infty$, and that according to (19) $h(T)$ approaches zero as F^h goes to infinity; whereas $\lim_{T\to\infty} l(T) > 0$. Hence given F^y, for F^h large enough we have $h(T) < l(T)$ for any $T \geq 1$.

iii) For intermediate values of F^h/F^y, the $H(T,n)$ and $L(T,n)$ schedules intersect at some strictly positive point (T^0, n^0). The statement in the proposition follows from Lemma 3 by noticing that $h(T) < l(T)$ if and only if $T < T^0$, while $h(T) > l(T)$ if and only if $T > T^0$. Furthermore, the artistic-creation maximizing policy is $T = T^0$.

Finally, $l(T)$ is the single binding constraint if and only if we are below $h(T)$; which implies $F^h < \pi^h$. Hence we have a negative relationship between the copyright term and long run high-type artistic creation if and only if high-type artists obtain positive rents. Otherwise, the positive relationship given by $h(T)$ holds.

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 in Figure 3; 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 $L(T,n)$. From (20) we obtain the following derivatives, for any given copyright term T:

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

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

$$\frac{dn^l}{dS} = \frac{\left(1 - \alpha + \frac{n^2}{\gamma w}\right)\left[\rho^{2\sigma}\left(\frac{1-\alpha}{n^2} + \frac{1}{\gamma w}\right) + \rho^{2\sigma-1}\theta\left(\frac{\alpha w}{n^2} - \frac{1}{\gamma} - \frac{1}{n\gamma}\ln(\frac{\beta\gamma w}{n^2})\right)\right]}{S\left[2(1-\alpha) + \frac{2}{\gamma}\rho^{2\sigma-1}K^\sigma\theta(1 - \frac{\alpha\gamma w}{n} + \frac{1}{2}\ln\left(\frac{\gamma\beta w}{n^2}\right)\right]}.$$

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, using (16), 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 follows from observing that

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

Let us denote by n^h the level of n associated to $H(T,n)$. From (16), (17) and our previous results we have:

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

Therefore schedule $H(T,n)$ shifts upwards when α or γ or S increase.

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 the market S. Since both (17) and (20) hold, the above results on $\frac{dn^h}{d\alpha}$, $\frac{dn^h}{d\gamma}$, and $\frac{dn^h}{dS}$ (see proof of Proposition 5) can now be used to substitute into the expression for the total differentiation of (20). Hence assuming $\rho^{2\sigma-1}K^{\sigma}\theta$ is small enough, we obtain:

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

Where the last derivative is negative if and only if the following inequality holds:

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

which is satisfied for ρ small enough, provided that $\sigma > 1/2$.

Appendix B: Low Opportunity Costs and the Young Artists' Minimum Audience Constraint

In Section 3 we analyzed the case when constraint (3) is the one binding; that is, when young artists' career is constrained by the opportunities to reach the minimum audience to be uncovered as talented. Under which conditions will this minimum audience constraint be binding instead of constraints (1) or (2')? In Section 3 we informally suggested that this may be the relevant constraint for low opportunity costs. We now show this analytically.

Following inequality (3) through the analysis in Section 3 up to equation (15) we obtain the following expression for this constraint:

$$n \leq \frac{w(T)\gamma c/\rho S - \sqrt{[w(T)\gamma c/\rho S]^2 - 4(1-\alpha)\gamma}}{2} \equiv M(T). \tag{B.1}$$

According to the analysis in Section 3, this constraint has a negative slope: $\partial M/\partial T < 0$. Now we want to show that depending on parameters, this constraint may be below or above the $H(T,n)$ and $L(T,n)$ schedules.

Consider a set of parameters such that $\gamma\,[w(T)c/\rho S]^2 = 4(1-\alpha)$. Then, from (B.1) we have $n \leq w(T)\gamma c/2\rho S$. Now, recall that the intersection of $L(T,n)$ and $H(T,n)$ denoted (T^0, n^0), solves (using (17) and (20)):

$$\left[\left(\frac{1-\alpha}{(n^0)^2} + \frac{1}{\gamma w(T^0)}\right)\rho^2 S\right]^{1-\sigma} = (1+\theta\rho)\,[F^y]^{1-\sigma} - \theta\rho\left[F^h\right]^{1-\sigma}.$$

Hence,

$$\begin{aligned}(n^0)^2 &= (1-\alpha)\frac{\rho^2 S\gamma w(T^0)}{\Phi(F^y,.)\gamma w(T^0) - 1}, \\ \text{where}\quad \Phi(F^y,.) &= \left((1+\theta\rho)\,[F^y]^{1-\sigma} - \theta\rho\left[F^h\right]^{1-\sigma}\right)^{1/(1-\sigma)}.\end{aligned}$$

Thus, for F^y high enough, we have $n^o < w(T)\gamma c/\rho S$, and therefore (B.1) is not binding. Whereas for low F^y the constraint (B.1) is binding (in particular, as $\Phi(F^y,.)$ approaches $1/\gamma w(T^0)$). See Figure 5 where n_2^0 is now the maximum possible long run number of artists, which is obtained for a copyright length $T = T_2^0$ (solid lines are again the binding segments of the constraints).

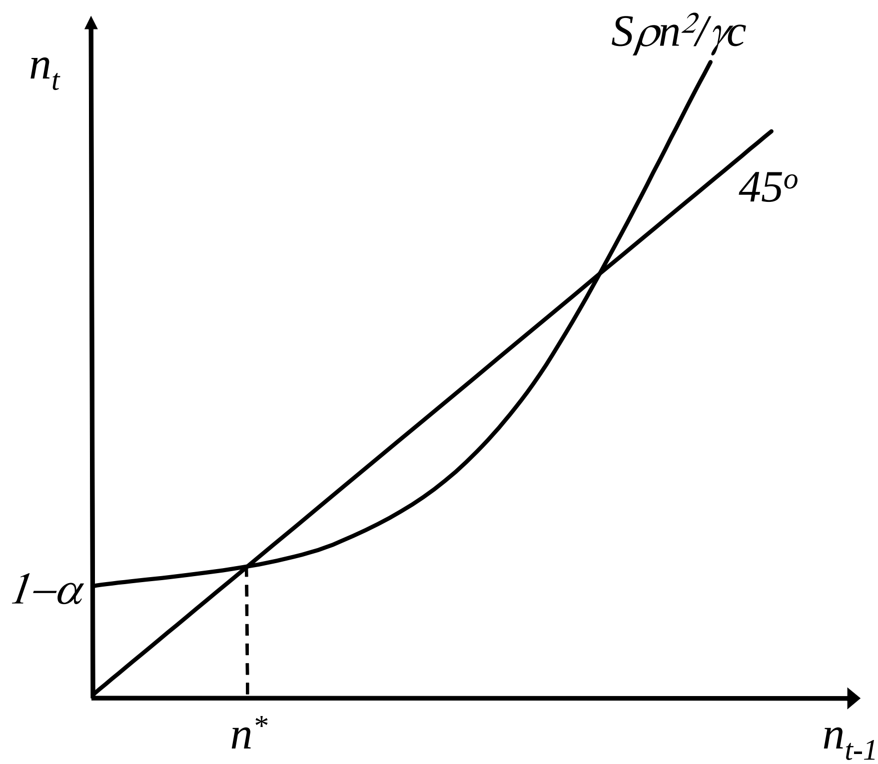

Figure 1:

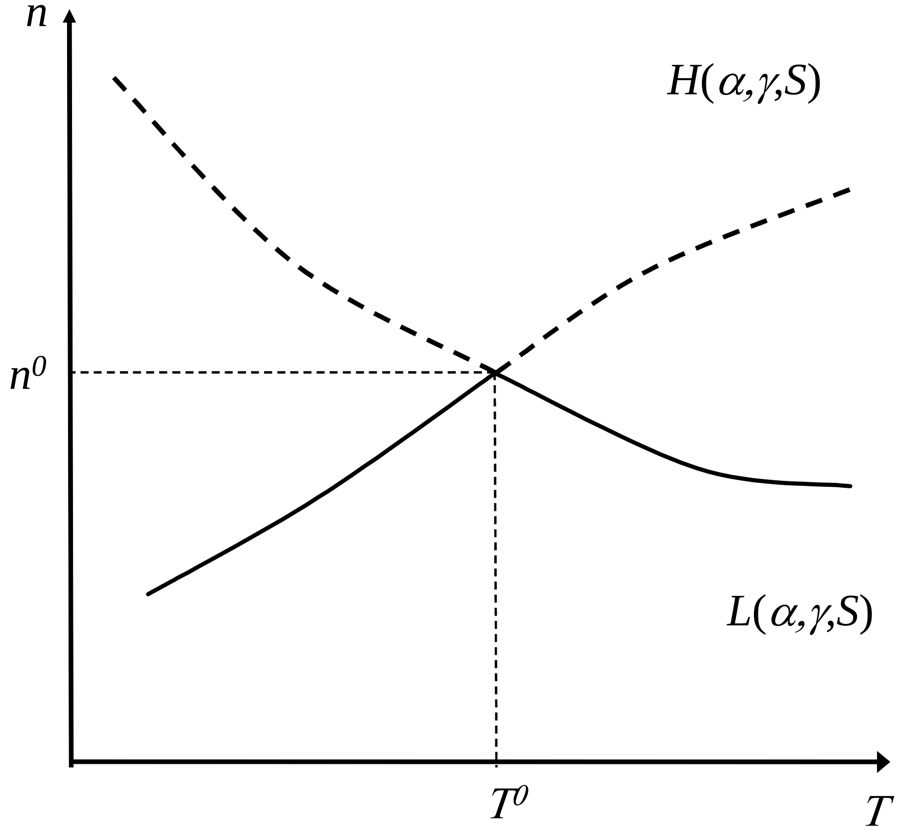

Figure 2:

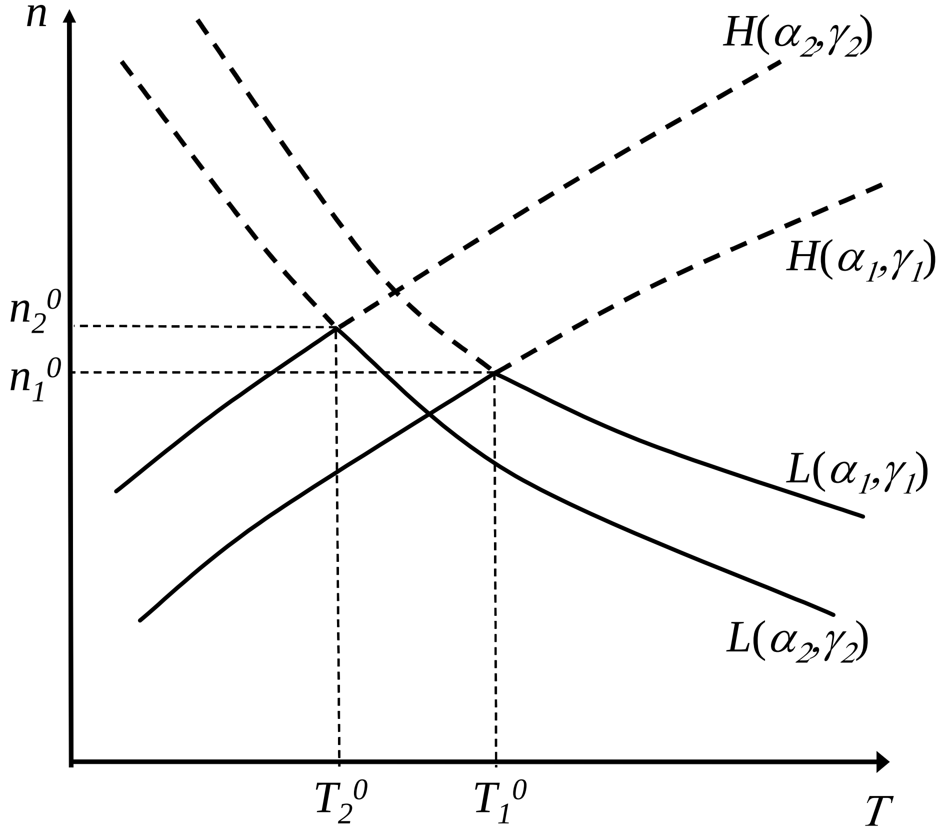

Figure 3:

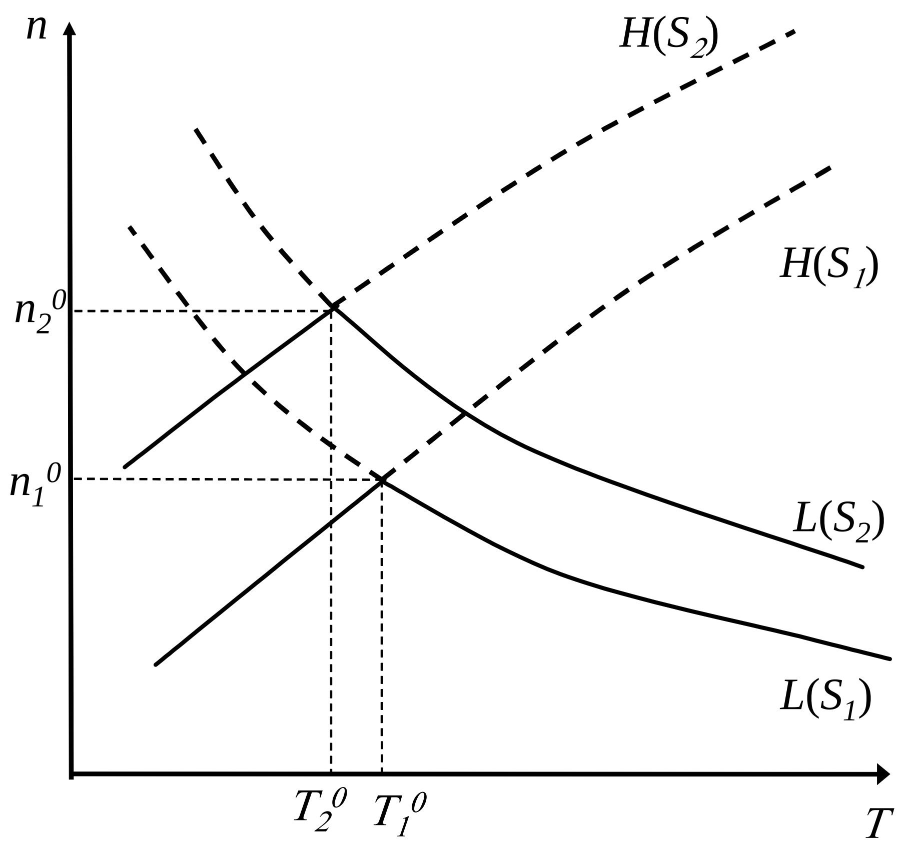

Figure 4:

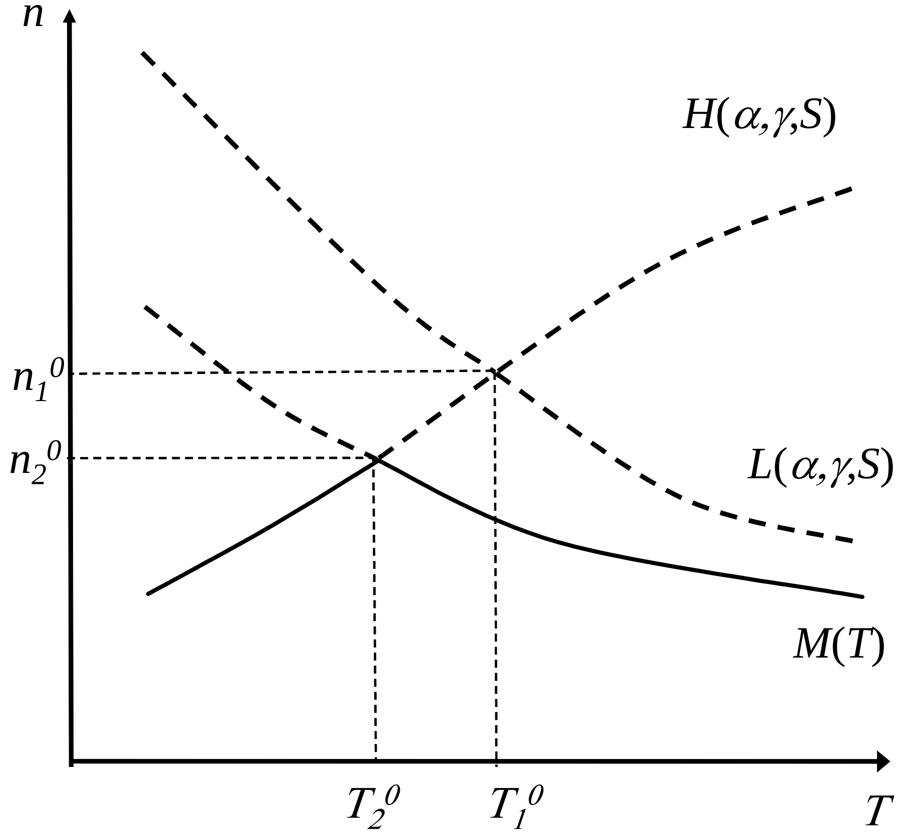

Figure 5: