Art and Internet: Blessing the Curse?*

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"Beauty, however, in its general aspect, is the inseparable characteristic of the idea when it has become known. In other words, everything is beautiful in which an idea is revealed; for to be beautiful means no more than clearly to express an idea." – Schopenhauer (2004-eBook edition)

"In the last analysis, the artist may shout from all the rooftops that he is a genius: he will have to wait for the verdict of the spectator in order that his declarations take a social value and that, finally, posterity includes him in the primers of Artist History." – Marcel Duchamp (1966)

1. Introduction

At the time photography was invented, the technology was expensive, difficult to use and required specialized skills and craftsmanship. Because many painters at the time were doing portraits, they saw the danger of the new technology for their activity. The folk history credits the painter Paul Delaroche to have said after seeing the Daguerreotype "from today, painting is dead".[1] Other artists embraced the opportunity to use the new medium and indeed, a movement developed quickly that defined photography as art.

*Many thanks to Victor Ginsburgh for his patient editorial work and for convincing me that economists should be interested in arts. I benefited from comments by William Baumol and Andrew Newman.

[1]Some historians of photography like Robert Leggat (1999) claim that in fact Delaroche was a supporter of photography. He had been commissioned by the French government to present a report

When George Eastman invented the "clic-clac Kodak" in 1868, photography became widely accessible; while there were some issues of craftsmanship, the act of taking a picture became trivial enough that it took effort by photographic artists to preserve their identity. Some have argued that the *pictorial movement* emerged in response to this democratization of the access to the technology. The recent emergence of digital photography has made the marginal cost of taking and viewing pictures rather trivial; despite this democratization of the technology, photography as an art form is still alive, present in large museums and taught in art departments in prestigious universities.

Before the Gutemberg press, the church had a monopoly on the stock of original writings and monks were the main artisans for reproducing these works, often by using techniques and crafts that required years of training. The Gutemberg press rendered this craftsmanship unnecessary for copying or for production of new books.[2]

The emergence of new technologies is therefore both a blessing and a curse for art. The blessing is that more opportunities for artistic creation are available. The curse is that more people have access to it. It is a curse because issues of craftsmanship tend to be less important, and a work of art may now have to be distinguished from its look alike by another dimension than craftsmanship. That aesthetics or craftsmanship is not a necessary characteristic of a work of art is well espoused by philosophers and artists.[3] Duchamp's Readymades are an extreme illustration of this since common objects like a urinal, a bicycle wheel or a snow shovel can become works of art. When art is not necessarily linked to aesthetics, the definition of art becomes somewhat of a challenge.

While economists are ill equipped to philosophize on art, they and scientists in general are also in the business of creating ideas, and transmitting these ideas to peers and the public at large. In a modest, or probably immodest way, this activity is sometimes

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on the Daguerreotype where he wrote "Daguerre's process completely satisfies all the demands of art, carrying essential principles of art to such perfection that it must become a subject of observation and study even to the most accomplished painters."

[2] See chapter 19 by Benhamou and Ginsburgh on copying.

[3] I refer the reader to chapter 6 by Roger McCain in this Handbook and to Danto (1986).

compared to that of artists. As producers, most of us recognize the difficulties to come up with truly original ideas, to write these ideas in a way that will be transparent and convincing to our readers. As consumers we sit through seminars, read working papers or published papers and we hope that these activities will give us some insights into the message that the author wants to convey. Sometimes, we enjoy a speaker's charisma, sometimes we enjoy the writing of a paper, but eventually we are interested in the underlying idea. We train students for many years hoping that one day they will be able to read and understand our papers or that they will themselves be able to contribute to the production of ideas. In the process, we try to make a living and get credit for our contributions to the field.

Scientists are different from artists however, both on the demand side and the supply side for their creations. On the demand side their "natural" markets differ: new working papers are in general consumed by scientists and researchers in the field, but new paintings are bought and appreciated by non-painters. On the supply side, there is an intentionality behind scientific production: scientists try to communicate precise ideas, results and they follow well established methodologies for doing so; there is not necessarily intentionality for artistic creation. As Duchamp (1959) notes

> "In the creative act, the artist goes from intention to realization through a chain of totally subjective reactions. His struggle toward the realization is a series of efforts, pains, satisfaction, refusals, decisions, which also cannot and must not be fully self-conscious, at least on the esthetic plane.".

Hence, while both scientific and artistic communications are imperfect and require interpretation, in art this interpretation is complicated by the heterogeneity of the potential consumers and the sometimes fuzzy knowledge that the artist has about his or her motives for creation. Danto (1986) views this as the main hurdle in defining art:

> There are two sorts of mistakes the concept of art gives rise to, one of which is philosophical and the other merely critical. The first is to interpret

> something which is not in candidacy for art, and the second consists in giving the wrong interpretation of the right sort of thing.

Artists and philosophers refer to a "missing dimension" – the "idea" in Schopenhauer's opening quote – to explain the imperfect communication between the artist and the difficulty for outsiders to interpret artistic creation. Duchamp (1986) has even defined an "art coefficient" to capture the level of imperfection in artistic communication

> "The result of this struggle is a difference between the intention and its realization, a difference which the artist is not aware of. Consequently, in the chain of reactions accompanying the creative act, a link is missing. This gap, representing the inability of the artist to express fully his intention, this difference between what he intended to realize and did realize, is the personal' art coefficient' contained in the work. In other words, the personal' art coefficient' is like an arithmetical relation between the unexpressed but intended and the unintentionally expressed."

Because interpretation becomes so important, some have argued that they are themselves works of art (Danto 1986); we should not be surprised since common parlance refers to singers or pianists as *interpreters*![4] Achieving the interpretation of a work of art requires knowledge, appreciation of the historical context in which the work was created. And here the Internet's curse that more people use the same technology as the artists can be also a blessing because Internet may facilitate the diffusion of the knowledge needed for interpretation.

Hence, markets in which ideas are valued, either directly, like in research, because they contribute to the stock of knowledge and facilitate the production of new ideas, or indirectly, like in art, because they change our perception of the world, have two characteristics that distinguish them from other markets:[5]

[4] There is a famous quote on the pianist Glenn Gould : at the end of a dispute with a fellow pianist about a piece by Bach, Gould is credited to have said "Ok you will do it your way, I will do it *his* way."

[5] See also the chapter of Roger McCain on "Defining cultural goods" and the chapter of Tony Bryant

H. the consumer values the work of art, that is the physical or digital good by which the "idea" is embodied, both for its aesthetics and for the message it brings about the idea;

I. the transmission of the idea from the creator to the consumer is not immediate, is subject to noise both during the process of creation and during the process of interpretation; furthermore interpretation requires in general effort on the part of the consumer.

There are other characteristics that are not specific to art markets. Many of them are covered in this Handbook: the rise of superstars (chapters 5 and 14), the use of auctions as allocation mechanisms (chapter 15), the two-sided nature of the market and the gatekeeper role of intermediaries (chapters 20 and 22), the difficulty to specify complete contracts (chapter 20). The internet and the possibility of digitalization of works of art have magnified some of these aspects, in particular the possibility to distribute at a rapid pace digital works, to reproduce or even modify existing works, and for artists to bypass current gatekeepers.

This chapter is by necessity incomplete. As George Stigler had noted for the theory of regulation in the 70s, the proper time to survey a literature is after the subject is developed and a consensus is reached in the field. The theory of regulation did not achieve this in the 70s. We are far from this goal for art and internet; the Internet is in its teens, and research on its economic and cultural effects is still in its infancy.[6] I take the view here that it is because the Internet makes entry easier for artists and

and David Throsby on "Creativity, the economy and the behaviour of artists". Properties HI are actually reasonable assumptions for most processes of communication; language is inherently ambiguous and skilled speakers use rhetoric to present facts or events in a new light. Despite the importance of information in today's economic analysis, most of it continues to assume that communication is a frictionless process, not subject to interpretation, interference or noise. Recent exceptions are Legros and Newman (1999, 2002), Dewatripont and Tirole (2003).

[6] See however Brynjolfsson (2002), Kahin and Varian (2000), Peitz and Waelbroeck (2003b), Quah (2002b, 2003) for recent collective works or recent surveys of the literature.

consumers that economists should be interested in its effects. I will therefore focus on the tradeoffs between the blessing (a larger market and more possibilities for creating works of art) and the curse (more competition) of the Internet for art.

Most of the discussion in the media and in the academic literature on this topic has been about the *appropriability* by artists and intermediaries of the revenues generated from creative ideas. The curse of the Internet and the new technologies is the ease with which some digital works can be replicated and distributed. Many like the monks a long time ago or the painters more recently fear that this will eliminate incentives for creation or distribution of art. The leading example has been copyright infringements for digital music and software. I review this case in section 2. Music is obviously only used as an example of art form making use of the Internet; digital painting, poetry, photography, video are other prominent examples of works of art being distributed or created on the Internet. The issues of copyright protection, incentives for creation, the tradeoff between market expansion versus competition effects are common to all these works of art. In section 3, I will then take a more abstract approach and use a model based on Boldrin and Levine (2002) and Quah (2002a) to argue that preferences of different participants in the market for strong copyright may have little to do with social efficiency, including incentive provision for new creative ideas. I continue in Section 4 with a faster tour on other issues linked to the market expansion effect of the Internet and a conclusion.

2. The Example of MP3s and Software

Traditional gatekeepers, the music majors, are fighting for strict copyright laws, by which consumers are not allowed to replicate, distribute, and much less modify a work, unless it is for "fair use". This fight takes the form of legal battles, like against NAPSTER and other peer-to-peer networks where individuals exchange freely MP3s or videos. The software and music industries claim large loses from copyright infringement – or piracy as it is called in the media.[7] Some economists question the magnitude

[7]Most of the empirical work is preliminary and the magnitude of the measured effect of piracy sometimes contradictory. Peitz and Waelbroeck (2003) find a decrease of 1.76% in CD sales worldwide

of these losses arguing that if copyright laws were perfectly enforced, many users would decide not to consume (Gayer and Shi 2001), or that downturns in CD sales correspond to normal cycles or substitution to other types of entertainment (Liebowitz 2002).[8]

The legal battle is on-going. For instance, the maker of iMesh file-sharing software agreed to pay $4.1 million to the recording industry for copyright infringement. On August 20, 2004, a U.S. federal appeals court ruled that makers of two leading file-sharing programs (Grokster and StreamCast) are not legally liable for copyright infringement by the users of their software. This may force the music industry to fight directly against the users. And they have some successes on this front; for instance, on August 26, 2004, the FBI seized for the first time software and computers of users of a P2P network in Texas. According to an article of August 25, 2004 in the Financial Times, record companies have also launched legal actions against karaoke bars in big Chinese cities, demanding damages for the infringement of their licensing rights.[9] But many see this legal fight as hopeless.[10]

The industry is also fighting in more intrusive forms. For instance, by uploading bad quality MP3s on peer-to-peer networks in order to decrease the benefits of using these networks, or even – as in a recent proposal – by using software agents to sabotage the computers of the users of these networks (Corbett 2003). Given the wealth of information stored on computers and their other uses, the social cost of this interference may be a magnitude greater than the cost to the music industry of copyright infringement.

In parallel, the music industry uses the Internet to develop new distribution systems;

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and that MP3 account for 25% of the decrease in CD sales in the top ten markets between 2000-2001. Hui, Png and Cui (2003) find that CD loss may be 15% higher than the 1999 industry estimate (software and music industry estimated its loss from piracy at $16 billion for 1999). It is not clear how these studies control for substitution effects with other types of entertainment or correct for business cycles.

[8] A 2002 study by Jupiter Media Metrix found that people who download intensively from the Internet has 75% chances to have spent more on CDs that others.

[9] Background information, new legal actions and history of legal cases are available, for instance, on the site of the Recording Industry Association of America, www.riia.com.

[10] For instance, following NAPSTER legal death, the number of P2P networks has multiplied.

the entry of Apple Computer on the online market (iTunes), where songs are sold for 99¢, has been quickly followed by other recording companies like Sony but also non recording companies like Wal-Mart Stores, or firms engaged in delivering media software like RealNetworks and Microsoft.[11] MP3s have given rise to complementary hardware manufactured by some of the very firms – like Sony – fighting copyright infringement.[12] Software solutions, The Digital Rights Management (DRM), limit copying and sharing by users.[13] A literature has developed the idea that illegal copying may increase the demand for complementary software or hardware[14] or that the industry may in fact benefit from copying because of network effects.[15] While suggestive, the effects are probably weak if we refer to a "revealed preference argument": the resources spent by the recording firms in fighting piracy.

Artists are quite divided on the issue of strong copyright. Some artists have organized themselves to fight against copyright infringement (e.g., *Artists coalition against piracy,* `http://welcome.to/acap`, signatories include Elton John). Others embrace

[11] By all accounts, this market is quite small (accounting for less than 2% of all music sales in the U.S.) but is quite competitive; for instance, RealNetworks cut recently the price of its downloads to 49¢ in anticipation of Microsoft's entry (New York Times, August 30, 2004)

[12] This has lead to proposals to tax hardware, like MP3 players or blank CDs and DVDs in order to capture some of the losses from coyright infringement (for instance a tax of the order of 60¢ is levied in France that is put in a fund for artists). Gayer and Shy (2001) offer a model along these lines; they show within their model that such taxation will be ineffective.

[13] Not surprisingly, DRM has become the target of hackers. See for instance, DRM Watch Staff (2004) documenting recent successes in cracking DRM protection in Apple iTunes.

[14] Conner and Rumelt (1991), Shy and Thisse (1999) give theoretical arguments; Givon, Mahajan and Muller (1985) provide an empirical analysis of this effect and find that software piracy may boost demand for the legal software.

The effect may also go in the other direction. For instance, in the January 7, 2005, issue of the *Financial Times*, Peter Jamieson, chairman of the British Phonographic Industry – representing leading labels and music distributors in England – is cited as noting a "strong move in the digital market" coinciding with strong sales of the Apple iPod and other MP3 players.

[15] Takeyama (1994), (1997), Shy and Thisse (1999).

the new technology. Some see an opportunity to become known and eventually sign a contract with one of the majors (examples abound of unknown artists who were able to sign their first major contract after having distributed for free their work[16]). This phenomenon is not limited to new artists, since well established artists, and sometimes stars, also distribute their work on the Internet under weak copyright form.[17]

That established firms and some artists want to use the legal system and the new technologies at their advantage, preserve their rents, is easy to understand. That the legal system should follow their lead is another issue. Proponents of strong copyright laws claim that without them there will be significantly less artistic creation or distribution. Economists are familiar with the precept that strong property rights are needed for inducing innovation : otherwise the innovator is not able to collect enough revenues ex-post to cover his ex-ante investment. There is then a tradeoff between ex-ante and ex-post efficiency (Nordhaus 1969): giving monopoly rights ex-post creates inefficiencies but is needed in order to provide (efficient) ex-ante incentives to invest. This tradeoff is similar to the tradeoff in industries that exhibit increasing returns to scale:[18] firms cannot make positive profits when pricing at marginal cost and therefore pricing above marginal cost is needed. But the usual response to the problem in these industries is to *regulate* – or give subsidies to the industry – rather than to give total and uncontrolled monopoly power to one firm.[19]

[16] In France, the most famous example is the singer Lorie, who signed a contract with Sony Music under the label EGP after having been known through internet downloads. In the US, the pop band Fisher signed a contract with Farmclub and Interscope after having had more than a million downloads of their album on `MP3.com`. The informational role played by the Internet has been analyzed in Peitz and Waelbroeck (2004).

[17] David Bowie may have been the first to distribute the music of a new CD "Hours..." on the Internet *before* it was even made available in stores; see The Economist, September 9, 1999.

[18] The parallel is not quite fair since as noted by Boldrin and Levine (1999) the production of MP3s does not exhibit increasing returns : the cost of creation of the song by the artist is sunk rather than fixed at the time a CD or an MP3 is distributed.

[19] Romer (2002) proposes government direct funding, Shavell and van Ypersele (2001) propose the use of rewards based on realized sales as alternative means for incentive provision.

While it may be difficult to assess the Nordhaus effect for artists, we can turn to recent studies on patents. Lerner (2003) analyses patent protection over 150 years and 177 policy changes. He shows that stronger patent protection has few positive effects on patent applications by applicants from the country in which the change was made (he found in fact a negative relationship after correcting for aggregate effects), which suggests that the Nordhaus effect is not operative. Cross section effects are consistent with the theory, however, since there is a more important effect of shifting to stricter patent policies when starting from weaker patent protection or greater development.[20]

Closer to our topic, two studies analyze the effect of the change in patent protection for software in the 1980's. Bessen and Maskin (2000) present a theoretical argument to show that if innovation is sequential and complementary, patent protection may reduce overall innovation and that the more competitive the market, the more inefficient patenting is.[21] Using as a natural experiment the extension of patent protection to software in the 1980's, Bessen and Maskin show that while the "Nordhaus effect" would suggest that R&D intensity and productivity should have increased among patenting firms, they did not. Bessen and Hunt (2004) argue that the significant increase in software patenting after the 1980's (software patents representing now 15% of all patents) is mainly due to large manufacturing companies since only 5% of these patents belong to software publishers. This suggests a strategic motive for patenting and Bessen and Hunt find evidence that software patents and R&D at the firm level are substitutes. (The methodology and results in Bessen and Hunt (2004) are criticized by Hahn and Wellstein (2003).)

One interpretation of these two studies is that stricter property right laws rather

[20] Lerner notes that he is not able to capture the potential impact of other policy tools used in parallel to patent policy, like offering prizes for discoveries.

[21] A key assumption of the model is that only firms that are active in the market can copy. See Green and Scotchmer (1995) for the question of surplus division when there is sequential innovation. A related issue is the possibility for artists to cooperate in the creation of works of art; the Internet allows the multiplication of such cooperative efforts – as the open source movement has illustrated. Economic issues linked to patenting in cooperative production are analyzed in Scotchmer and Green (1990).

than inducing more innovation may in fact enable firms with market power to substitute patenting for R&D in order to generate rents. By most accounts software is not art,[22] but these studies put into question the claim that strong copyright laws are needed for artistic production. They also suggest that the social problem of providing incentives for innovation should not be confused with the protection of rents of intermediaries, or rents of established artists. And there are reasons to believe that the discussion in the literature and the media on the costs and benefits of piracy contributes to the confusion.

First, there is a focus on the profit losses of record companies or established artists. There are analyses of the potential loss of recording companies due to piracy, but I do not know of studies evaluating the minimum future revenue needed for artists to be induced to create. We have no appreciation of the cost of copyright infringement on artistic creation.

Second, most of the debate about copying and copyright infringement assumes that CDs and MP3s are the only works of art embodying the creative idea of the artist. However, different works of art change the proportion of revenues going to the artist versus the recording company, or outside financiers. It would be interesting to analyze whether MP3 copying has positive effects for attendance at public concerts, or for viewer interest in TV shows, video clips, since these are also significant sources of revenue for the artist.

Third, the possibility for the artist to appropriate the gains from online diffusion, whether legal or not, in a non-monetary way is generally ignored, at least in empirical work. For instance, since attendance at public concerts is a function of the artist's reputation, online distribution, whether controlled or not by the artist, will contribute to this reputation. Hence even if the artist cannot appropriate the monetary gains

[22] However, consider the experiment suggested by Jean-Luc Moulène, a French photographer: use a digital camera to take a picture of a green pad on a red background, and take another picture of the same pad on a background of a different color. The color of the pad will not be the same in the two pictures; this is because the digital process functions on the basis of harmonic equilibrium controlled by the software. This leads Moulène to conclude that the true creative process in digital picture taking is the software.

from the distribution of MP3s he or she may appropriate the reputational gains (that may eventually turn into monetary benefits). The "revealed preference" argument we used earlier that recording companies do not favor weak copyright cannot be applied to dismiss this possibility. Indeed, for public concerts, revenues are often captured directly by the author, while in the case of CD sales, a large proportion of the revenues is captured by the recording company. Hence there is no contradiction in having recording companies oppose weak copyright – to preserve their revenues from CD sales, while artists may favor weak copyright – in order to benefit from reputational effects of online diffusion, and increase their revenues from other works of art. This is an empirical issue.

Non-monetary incentives may matter as much as direct monetary incentives for artistic creation (see chapter 10 by Bryant and Throsby). What is puzzling in a world where only monetary incentives are at stake, becomes relatively clear when other motives, like reputation building and career concerns complement monetary incentives. For instance in their study of the open source software movement Lerner and Tirole (2000) point to career concerns as a motive for cooperation among developers. Their empirical analysis of 40,000 open source projects suggests that those that are consumer oriented have restrictive licences, while those that are developers oriented (or commercial operating systems) have less restrictive licences. These results are consistent with developers trading off the benefits of being recognized for having contributed significantly to a project (the career concern) versus the risk that someone will appropriate the collective work (that they dub "hijacking").

Recent initiatives for distribution of software and artistic or intellectual work weaken the copyright restrictions while also preventing (or trying to prevent) hijacking. The *GNU General Public Licence* allows users to copy, modify, create and sell derivative products on the condition that these derivatives acknowledge their origin – give credit to the previous code writers – and contain the same licensing terms. *The creative commons licence* for intellectual work is in spirit similar but can be made more restrictive, for instance concerning remixing or changes of original songs, or commercialisation of

derivative works.[23] The main restriction in both cases is the obligation to acknowledge the original creator in any derivative work or in any use of the original work. Violations of these licences are not documented yet, which may indicate that the stakes involved by infringing on these licences are for the moment weak.[24] These licences show the possibility for artists to appropriate credit for their work – at least in the non monetary sphere – even if it is made widely available and if the possibilities of replication or modification are not costly.

On `Magnatune.com` it is possible to download MP3s for direct consumption,[25] but also to buy different types of licences: some are for corporate use, some are for remix and derivative works.[26] On Digital Art Auction, (`http://www.digitalartauction.com`), the business model is similar to a subscription system. The artist auctions the master copy of his work of art. Bidders propose in the form of a pledge or bid a retail price they'd be willing to pay, and once the maximum revenue available from these bids meets the artist's requirements, the artist chooses the price, receives the revenue from all successful bidders who then receive a copy of the artwork. Another example of innovative financing is the "Bowie bonds." In 1997, David Bowie issued $55 million worth of bonds that were bought by Prudential Insurance Co.. The bonds were backed

[23] See the description of these licences for "artists" – musicians, writers, filmmakers, photographers and (!) scholars – at `http://creativecommons.org/learn/artistscorners/`.

[24] The technology also allows some protection against infringement. For instance, Commons licenced works have software tags attached to them and these tags will be present in derivative works. If the stakes for infringing are high enough someone will probably find a program to remove the tag. (See Legros and Newman 1999 for related ideas in a contract environment).

[25] Interestingly the price is between $5 and $18 and the consumer chooses how much to pay; the average price paid is around $8. This may confort some economists' view, e.g., de Long and Froomberg (1999), that tomorrow's economy will be based on gift exchange or that business models will be similar to fund raising campaigns.

[26] Example : "This license permits you to use any number of audio samples from a single song by "American Baroque", to create a single song of your own. You can also make remixes or other derivative works. If you make several songs with our samples, you will need a separate license for each song you create (note that alternate versions [i.e. remixes] of your song are considered one song)"

by future royalty payments on the publishing rights and master recordings of some of Bowie's tunes.[27]

Whether these alternative business models will succeed is still unclear, but they suggest that ease of copying and weak copyright may not prevent an artist from collecting revenues. This point has been made in the literature on copying (Besen and Kirby 1989, Liebowitz 1985, Johnson 1985), and sharing (Ordover and Willig 1978, Bakos et al. 1999, Varian 2000).[28] Copying may be beneficial to producers because while it creates more competition, it also increases the willingness to pay of users who anticipate the benefits of copying and sharing. In these models the technologies of production and of distribution are fixed and exhibit increasing returns; it is then cumbersome to capture the market expansion effect of the Internet. A model developed by Boldrin and Levine (2002a) is better fit for capturing the two effects and for analyzing who among the market participants will "bless the curse."

3. A Market for Works of Art

There are two periods and a representative consumer with a subjective discount rate $\delta \in (0,1]$ and a concave and increasing utility $u(c)$ for consumption (assume the Inada condition $u'(0) = +\infty$). If the price of consumption is p, the consumer consumes $p = u'(c)$, and the demand function is given by the solution $c = D(p)$ to this equation ; the elasticity of demand is $\varepsilon = -1/r(c)$, where $r(c) = -c\frac{u''}{u'}$ is the index of relative risk aversion; demand is elastic when $r(c) \leq 1$. I assume that u exhibits increasing relative

[27] The bonds, had an average life of 10 years, and were priced to pay investors 7.9 percent interest (Bloomberg News, March 2, 1997).

[28] For instance, Varian (2000) analyzes the incentives of a producer to rent or to sell information goods when sharing is facilitated by the formation of "clubs," that is groups of agents who agree to share any good purchased or rented by one of the members. Libraries, video clubs are such instances of clubs. He shows that profits can increase with sharing when the transaction cost of sharing is small and when the content is viewed a few times only. Varian focuses on monopoly providers while Ordover and Willig (1978) consider Ramsey prices.

risk aversion, that is

$$r(c) = -c\frac{u''(c)}{u'(c)} \text{is increasing in } c. \tag{3.1}$$

In the first period an artist creates s_1 works of art. These are distributed and sold by firms at zero cost; the asset price of works is q_1 in the first period and therefore the artist has revenue $q_1 s_1$. Consumers choose how much to consume (c_1) in the first period and pay a price p_1 for consumption; the works $s_1 - c_1$ that are unsold are used by firms to create in period 2 other works of art at a rate β. Consumers have access to a "home production" technology that transforms one work into α units; hence home production does not conflict with the act of consumption: if c units are consumed, the consumer has utility $u(c)$ and obtains αc units in period 2. I will make the reasonable assumption that $\beta \geq \alpha \geq 1$.[29] When α increases, consumers have access to a technology that becomes similar to that of firms : at the time of the Daguerreotype, α was small and probably equal to zero, at the time of digital photography, α is large.

A strong copyright regime is one in which the firm can prevent, via legal or technical constraints, consumers to use their home technology. A weak copyright regime is one in which the firm cannot – or does not want to – prevent consumers from using that technology.

[29] Note that there is limited rivalry in the sense that once a firm sells consumption flow c, it cannot use the c units to create copies. See Quah (2002) for a nonrivalry example where he assumes $\alpha > \beta$ in order to capture the idea that reproduction is faster with dissemination.

Note the two main assumptions until now:

(i) The cost of innovation (coming up with the creative idea) is sunk rather than fixed, i.e., there are constant returns to scale rather than increasing returns in the production of works of art.

(ii) Works of art are not divisible and the "creative idea" is embodied into a medium that can be replicated only if the medium is made available; moreover producing additional works of art on the basis of existing ones requires time and the rate of production is finite.[30]

Assumption (i) is a significant departure from the usual assumption of increasing returns made in the literature on innovation (see however, chapter 2 by Baumol in this handbook and Sutton 1999). Assumption (ii) captures the view that the creative ideas, and later their interpretation, have to be embodied into a support before being replicated or used to produce other works of art. Since there must be a productive activity for replicating, this activity comes at a cost, modelled here in terms of time.

Following the discussion leading to conditions HI, I define a work of art by a two dimensional point (x, y).[31] The first component x is never observed and corresponds to the underlying creative idea.[32] The second component y is the observable part and corresponds to the physical or digital properties of the work (e.g., painting, recording on a CD, working paper of an economic model). Interpreting a set of m works of art $\{(x, y_i)\,; i = 1, ..., m\}$ that are known to be based on the same creative idea (e.g., Duchamp's Readymades, or a research question in science) amounts to inferring the non observable component x from the observable components $\{y_i\}$.

Artists are distinguished by the number of creative ideas that they have: an artist with a large (small) number of creative ideas will be able to create only a small (large)

[30] But can be made arbitrary large; finiteness corresponds to the concept of *finite expansibility* in David (1992), Quah (2002).

[31] Our view that consumers value the characteristics of the object and their use for home production is in the spirit of the work of Lancaster (1966) or Becker (1976).

[32] Whether the creative idea is intentional or not is ignored.

number of works of art per creative idea. Hence if John has n creative ideas ($x = 1, ..., n$) and a production capacity of k, he will have $s_1 = k/n$ works of art (x, y_{xi}), $i = 1, ..., k/n$, produced on each of these ideas where I assume that the artist never produces twice the same work of art, that is $y_{xi} \neq y_{\hat{x}j}$ for all $xi \neq \hat{x}j$. Interpretation is facilitated the larger s_1 : observing more works of art that are distinct in their observable components improves interpretation and inference of the underlying idea. In the words of Duchamp (1986), s_1 is an index of the "art coefficient" that can be associated with the production of the artist. Because s_1 is also an index of the number of creative ideas, larger values of s_1 are associated with less creative artists.

For low values of s_1, interpretation is difficult but once obtained, it is easy to create new works; as s_1 increases, interpretation is easier, but it becomes more difficult to create new works. Therefore, the rate $\beta(s_1)$ available to firms for producing new works is an inverted U shaped technology: increasing for low values of s_1 and decreasing for high values of s_1. I assume throughout that $\alpha \leq \beta(s_1)$ and that α is a parameter. Until the last subsection I simply write β instead of $\beta(s_1)$.

Once interpretation is achieved, technology (or craftsmanship) can be used to produce additional works based on the same creative idea x. Each such idea creates its own market, with consumers having utility $u(c)$ for consuming c different works : a new work has value for consumers only in that its observable component is different from existing observable components.[33]

Artists are "driven" in the sense that they always produce initially (that is in period 1) the maximum number of works.[34] The distribution of these works is done by firms

[33] This is obviously an extreme view; it would be the case if aesthetics has no value for consumers who care only about understanding the creative idea. The qualitative results will not change as long as the value that consumers put on new works of art is larger than for exact copies.

[34] While we allow for strategic release to the market by the firm distributing the works of art of the artist, strategic release by the artist himself may be important to model. For instance, Duchamp (1961) writes "I realized very soon the danger of repeating indiscriminately this form of expression and decided to limit the production of "Readymades" to a small number yearly. I was aware at that time, that for the spectator even more for the artist, art is a habit forming drug and I wanted to protect my

which may decide not to distribute all works, to smooth consumption over periods or to keep prices high if they have monopoly power.

Assumptions (i) and (ii) are sufficient for the artist to appropriate positive revenues even if there is competition on the market for works of art, and even if the home technology becomes as good as the firm technology (that is $\beta - \alpha$ gets small), or if the firm technology improves (that is β gets large). The assumption of a competitive market is obviously extreme: having a new idea suggests indeed that there are few immediate substitute ideas and works embodying a similar idea in the market. Since under conditions (i) and (ii) the inventor will not be expropriated, it is fair to wonder why the holder of such innovation would behave competitively.[35] The competitive benchmark is however useful because if the artist can have revenues large enough to induce creative activity under competition, this makes the case for weak copyright laws even stronger when there is market power. But as we show later, considering the monopoly assumption provides additional insights into the reasons for an artist or a firm to favor weak rather than strong copyright.

3.1. Appropriability and Competition

The representative agent's welfare maximization problem is

$$\begin{cases} \max_{c_1} u(c_1) + \delta u(\beta(s_1 - c_1) + \alpha c_1) \\ c_1 \in [0, s_1], \end{cases}$$

where s_1 is the initial asset holding in the economy and $s_2 = \beta(s_1 - c_1) + \alpha c_1$, and

"Readymades" against such a contamination.

Another aspect of the "Readymade" is its lack of uniqueness... the replica of the "Readymade" delivering the same message, in fact nearly every one of the "Readymades" existing today is not an original in the conventional sense."

[35] Boldrin and Levine (2002) consider the case of a monopolist who has full control over all output produced directly or indirectly from his initial holding. Their goal was to show that this kind of monopoly power while increasing the ex-ante value of the asset will depress ex-post incentives to innovate. We abstract from dynamic efficiency considerations.

δ is the subjective discount rate of consumers.

There exists a unique rate of copying for which it is optimal for the consumer to consume all works at $t = 1$. For this value $\hat{\alpha}(s_1)$ the marginal utility from consumption in the first period equals the discounted expected marginal utility in the second period : $u'(s_1) = \delta(\beta - \alpha) u'(\alpha s_1)$, and $\hat{\alpha}(s_1) \in (0, \beta)$.[36] For increasing relative risk aversion utility functions, this cutoff value $\hat{\alpha}(s_1)$ is an increasing function of s_1, that is as the number of works available in the first period increases, the home technology must be good enough for the firm to sell all units in the first period. When $\alpha < \hat{\alpha}(s_1)$ welfare maximization requires $c_1^* < s_1$ solving $u'(c_1) = \delta(\beta - \alpha) u'(\beta s_1 - (\beta - \alpha) c_1)$ while when $\alpha > \hat{\alpha}(s_1)$ the solution is $c_1^* = s_1$. Hence, as α increases, consumers are good substitute for firms for producing the works of art, and the opportunity cost of not consuming today increases.

On a competitive market, the first period asset value q_1 of the works will be equal to the expected revenue from consumption in the two periods, and the artist will have revenue of $q_1 s_1$. Our previous discussion suggests that we may want to distinguish between monetary and non monetary benefits of the artists, but for simplification, we do not. The business model of *Digital Art Auction* we described above fits a monetary interpretation since the artist gets revenues by having agents subscribe (pay the asset price) for obtaining copies from a master.

Asset prices are q_t and consumption prices are p_t. Feasibility conditions are $c_t \leq s_t$ where s_1 is the initial asset holding in the economy and $s_2 = \beta(s_1 - c_1) + \alpha c_1$. Asset prices satisfy $q_1 s_1 = p_1 c_1 + p_2 c_2$ and $q_2 s_2 = p_2 c_2$. Because $t = 2$ is the last period, there is no value of saving assets and $c_2 = s_2$ and $q_2 = p_2$.

The competitive consumer's problem is then under prices p_t, q_t :

$$\begin{cases} \max_{c_1, c_2, s_2} u(c_1) + \delta u(c_2) \\ p_1 c_1 + q_2 s_2 \leq q_1 s_1 \\ p_2 c_2 \leq q_2 s_2. \end{cases} \tag{3.2}$$

[36] Most proofs are given in the Appendix.

for given prices p_t, q_t. For an interior solution we have

$$\frac{u'(c_1)}{\delta u'(c_2)} = \frac{p_1}{p_2}$$

and demand functions are defined implicitly by $u'(c_1) = \mu p_1, \delta u'(c_2) = \mu p_2$, where μ is the Lagrange multiplier of the first period budget constraint.

The firm's problem is

$$\begin{cases} \max_{y_1,y_2,s_2} q_1 s_1 = p_1 y_1 + p_2 y_2 \\ y_t \leq s_t \\ s_2 = \beta(s_1 - y_1) + \alpha y_1, \end{cases}$$

where y_t is supply at t. Equilibrium conditions are that $y_t = c_t$ for $t = 1, 2$. Profit maximization yields

$$c_1 \leq s_1 \text{ if } \frac{p_1}{p_2} = \beta - \alpha$$

The welfare maximizing allocation (c_1^*, c_2^*) is then decentralized by prices p_1, p_2 satisfying[37]

$$\begin{aligned} p_1 &= u'(c_1^*) \\ p_2 &= \delta u'(c_2^*) \end{aligned}$$

If the rate of home production is low enough ($\alpha \leq \hat{\alpha}(s_1)$) the market value of the initial assets is

$$\begin{aligned} q_1 s_1 &= p_1 c_1^* + p_2 c_2^* \\ &= u'(c_1^*) c_1^* + \frac{u'(c_1^*)}{\beta - \alpha}(\beta s_1 - (\beta - \alpha) c_1^*) \\ &= \frac{\beta}{\beta - \alpha} u'(c_1^*) s_1. \end{aligned} \tag{3.3}$$

[37] Indeed when $\alpha \leq \hat{\alpha}(s_1)$, in an interior solution, consumer's optimization yields $u'(c_1)/\delta u'(c_2) = p_1/p_2 = u'(c_1^*)/\delta u'(c_2^*)$ which implies that $c_t = c_t^*$ for $t = 1, 2$. At the price ratio $p_1/p_2 = \beta - \alpha$, the firm is indifferent between all combinations of y_1 and y_2 since its profit is $p_2((\beta - \alpha) y_1 + y_2)$ while the resource constraint can be written $(\beta - \alpha) y_1 + s_2 = \beta s_1$; since $c_2 = s_2$ the result follows.

If $\alpha > \hat{\alpha}(s_1)$, the optimal allocation is $c_1 = s_1$ and by definition $\frac{u'(s_1)}{\delta u'(\alpha s_1)} > \beta - \alpha$. Consumer maximization implies $c_1 = s_1$. Since $u'(s_1) - \delta(\beta - \alpha) u'(\alpha s_1) > 0$, firm's profit function $u'(s_1) c_1 + \delta u'(\alpha s_1)(\beta s_1 - (\beta - \alpha) y_1)$ is increasing in y_1 and therefore $y_1 = s_1$ is optimum for the firm.

While if the rate of home production is high enough ($\alpha > \hat{\alpha}(s_1)$), all initial works are sold in the first period and the market value is

$$q_1 s_1 = \left(u'(s_1) + \delta\alpha u'(\alpha s_1)\right) s_1. \tag{3.4}$$

Therefore, the minimum revenue of the artist is bounded below by $u'(s_1) s_1$, independently of the rates α and β. Moreover, this bound is independent of δ, δ being also an index of appropriability of second period industry profits by the artist. This is the main result in Boldrin and Levine (2002a): as long as there is indivisibility in the provision of ideas, a competitive market will give a positive rent to the fixed factor (the artist). Hence, innovation is compatible with competition.

As α increases, for given first period consumption, tomorrow's price will be lower since there will be more works available on the market; this is the curse or the competitive effect. As α increases however, consumers value more first period consumption since increasing first period consumption does not go against smoothing intertemporal utility. The fact that home production improves means that there are more potential works of art available in the market; this is the blessing or the market expansion effect. The net effect of a small change in α on the asset value is ambiguous and depends on the elasticity of demand. (Details are in the Appendix.)

Consider the special case of constant demand elasticity, that is when the utility function is $u(c) = c^{1-R}/(1-R)$, where $R \geq 0$. Elasticity of demand is $-1/R$ and demand is elastic when $R \in (0,1)$. In this case the cutoff value $\hat{\alpha}(s_1)$ is independent of s_1; $\hat{\alpha}(s_1) = \hat{\alpha}$ solving $\hat{\alpha}^R = \delta(\beta - \hat{\alpha})$. When $\alpha \geq \hat{\alpha}$, $c_1^* = s_1$, $p_1 = s_1^{-R}$ and $q_1 s_1 = s_1^{1-R}\left(1 + \delta\alpha^{1-R}\right)$ which is increasing in α since $R \in (0,1)$; therefore the market value of the assets increases as home production becomes as good as the firm's technology or as β increases. When $\alpha \leq \hat{\alpha}$,

$$\begin{aligned} c_1 &= \frac{\beta s_1}{\beta - \alpha + (\delta(\beta - \alpha))^{1/R}} \\ q_1 s_1 &= \beta^{1-R}\left(\delta^{\frac{1}{R}} + (\beta - \alpha)^{\frac{R-1}{R}}\right)^R s_1 \end{aligned}$$

and is increasing with α (for a fixed β) and increasing in β (for a fixed α).[38] Therefore

[38] It is increasing in α because $R \in (0,1)$ and therefore $(\beta - \alpha)^{\frac{R-1}{R}}$ increases with α. For the variation

when demand has constant elasticity, the market value of the asset increases when home production improves. This is certainly a strong argument against strong copyright. However it turns out that in this case an artist or a firm having the possibility to set monopoly prices *will not* desire to enforce strong copyright. Hence the case of constant elasticity is in many ways not very illuminating because strong copyright will not receive any support from consumers or from the artist.

We now turn to a model in which the artist, or the firm distributing his initial works, has market power.

3.2. A Model of Monopoly Pricing

The static profit function is $\pi(c) = cu'(c)$ and the marginal profit function is $\pi'(c) = u'(c)(1 - r(c))$. Under (3.1) π is single peaked. Let c^M be the unique maximizer of the profit function and write,[39]

$$\pi^M \overset{def}{=} c^M u'\left(c^M\right).$$

I assume to simplify that the monopoly can commit to a production plan (or alternatively to prices).[40]

The market unfolds like in the previous case. The monopoly firm decides to sell c_1 works at time 1. In the strong copyright regime, consumers are prevented from using the works they purchase to make further works. In the weak copyright regime, consumers have access to a home technology and can sell the works they create on the market. They become sellers at time 2 and behave competitively, that is take the price p_2 as given.

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with respect to β, it is enough to differentiate $\log(q_1 s_1)$ with respect to β and to note that the variation is positive only if $\delta(\beta - \alpha) > \alpha^R$. Since $\alpha < \hat{\alpha}$, $\delta(\beta - \alpha) > \delta(\beta - \hat{\alpha}) = \hat{\alpha}^R > \alpha^R$ and the result follows.

[39] Note that when $r(c)$ is less than one, $cu'(c)$ is an increasing function and $c^M = +\infty$.

[40] Under the strong copyright regime, commitment and no-commitment lead the same solution. No commitment introduces the complication in the weak copyright regime that the second period choice of the monopoly is time inconsistent: at time 2 the monopoly solves $\max_{c_2 \geq \alpha c_1}(c_2 - \alpha c_1)\pi(c_2)$ while from the first period point of view, the monopoly wants to solve $\max_{c_2 \geq \alpha c_1} c_2 \pi(c_2)$ in order to maximize the asset value.

3.2.1. Strong Copyright

The monopoly can prevent consumers to use their home technology. This could be because of a legal constraint or technical protection (like DRM); while there is some doubt on the ability to suppress *all* possibility of production by consumers, it seems hard to dispute the fact that this will lead to a lower value of α. We consider here the extreme case where the strong copyright protection can be perfectly enforced and lead to $\alpha = 0$. Consumers solve (3.2) and the monopoly solves

$$\begin{cases} \max_{c_1 c_2, s_2} \pi(c_1) + \delta\pi(c_2) \\ c_2 \leq s_2 \\ s_2 = \beta(s_1 - c_1). \end{cases}$$

There are two regimes corresponding to whether the constraint $c_2 \leq s_2$ binds or not. Let

$$\phi(s_1, \beta) \overset{def}{=} \arg\max_{0 \leq c \leq s_1} \pi(c) + \delta\pi(\beta(s_1 - c)). \tag{3.5}$$

be the first period optimal number of works the monopoly chooses in the strong copyright regime. Two cases are of interest.

In a regime of low initial production of works of art, when $s_1 \leq \frac{\beta+1}{\beta} c^M$, the optimal consumption pattern is $c_1 = \phi(s_1, \beta)$, $c_2 = \beta(s_1 - \phi(s_1, \beta))$. Moreover, $\phi(s_1, \beta) \geq s_1 - c^M/\beta$ and $\phi(s_1, \beta) \leq \beta s_1/(\beta + 1)$ if $\delta\beta > 1$ and $\phi(s_1, \beta) \geq \beta s_1/(\beta + 1)$ if $\delta\beta < 1$.

In a regime of high initial production of works of art, when $s_1 \geq \frac{\beta+1}{\beta} c^M$, the optimal consumption pattern is $c_1 = c_2 = c^M$ and $q_1 s_1 = 2\pi^M$. In this case the monopoly can only lose by weakening copyright laws. Since $\frac{\beta+1}{\beta}$ is decreasing in β, a necessary condition for this second regime is that $s_1 > c^M$ and that β is large enough. Since we interpret s_1 as the number of works of art the artist brings to the market, having $s_1 > c^M$ is somewhat implausible unless the total market size is small. For instance, in the case of constant elasticity of demand, case 2 is not possible since $c^M = +\infty$.

For this reason, it is more likely that the environment is described by the first regime, and this makes the question of whether the monopoly wants to allow consumers to use their home technology non trivial.

3.2.2. Weak Copyright

To capture the idea that home production creates unwanted competition to the monopoly, I assume that consumers behave competitively when selling their copies on the market. Because the production of consumers satisfies constant return to scale, it is convenient to think of a competitive firm having capacity αc_1 on the market in the second period, the monopoly firm having capacity $\beta(s_1 - c_1)$.

As before, the representative consumer receives dividends from the monopoly firm and the competitive firm.[41] At time 1, the monopoly anticipates the behavior of the consumer and the competitive firm, and acts as a monopoly on the residual demand $p_1 = u'(c_1)$, $p_2 = \delta u'(c_2 + \alpha c_1)$.

As before, the consumer takes as given the prices on the market for consumption and for the assets and has a consumption plan (c_1, c_2, s_2)

$$\begin{cases} \max_{c_1,c_2,s_2} u(c_1) + \delta u(c_2) \\ p_1 c_1 + q_2 s_2 \leq q_1 s_1 \\ p_2 c_2 \leq q_2 s_2 \end{cases} \tag{3.6}$$

demand functions are given by $p_1 = u'(c_1)$ and $p_2 = \delta u'(c_2)$. At the optimum both constraints bind and we have $q_1 s_1 = p_1 c_1 + p_2 c_2$.

The competitive firm: is present only at time 2, takes p_2 as given and solves

$$\begin{cases} \max_{\hat{c}_2} p_2 \hat{c}_2 \\ \hat{c}_2 \leq \hat{s}_2 \\ \hat{s}_2 = \alpha c_1 \end{cases} \tag{3.7}$$

and the supply of the competitive firm at time 2 is αc_1.

The monopoly firm anticipates this second period supply by the competitive firm

[41] There is a potential benefit for the monopoly to buy some of the works of the competitive firm at $t = 2$: doing so will increase second period profits since the monopoly would face a larger residual demand. However, the asset price $\hat{q}_2$ should adjust. To simplify I ignore this possibility.

and solves,

$$\begin{cases} \max_{c_1,c_2,s_2} q_1 s_1 = \pi(c_1) + \delta\pi(c_2) \\ c_2 \leq s_2 + \alpha c_1 \\ c_2 \geq \alpha c_1 \\ s_2 = \beta(s_1 - c_1) \end{cases}$$

Note that the second period profit of the monopoly from the sale of consumption good is $\delta(c_2 - \alpha c_1) u'(c_2)$ but that the total industry profit $\delta c_2 u'(c_2)$ is incorporated in the initial asset value. The market internalize the externality that period 1 consumption brings in terms of home production and the price of the assets $q_1 s_1$ is strictly greater than the profit the monopoly firm makes from its sales.

There are two effects of home production from the point of view of the monopoly. There is first the *market capacity expansion* effect illustrated by the constraint $c_2 \leq s_2 + \alpha c_1$: even if the monopoly sells all assets at time 1 ($c_1 = s_1$), consumers can still consume in the second period; this effect is positive since it is a source of extra profit. There is also the *competitive effect,* illustrated by the constraint $c_2 \geq \alpha c_1$, suggesting that the second period capacity may be too large from the point of view of profit maximization, i.e., the monopoly is now limited to choose second period prices greater than $\delta u'(\alpha c_1)$.

Here also there are two regimes, depending on which constraint binds. The optimal choice of the monopoly is then:

(i) If $s_1 \leq c^M/\alpha$ and $\alpha \leq \beta - 1/\delta$ the solution is c_1 solving $\pi'(c_1) = \delta(\beta - \alpha)\pi'(\beta s_1 - (\beta - \alpha) c_1)$. If $\alpha > \beta - 1/\delta$, the solution is $c_1 = s_1$ and $c_2 = \alpha s_1$; moreover for all $c_1 \leq s_1$, $\pi(c_1) + \delta\pi(\beta s_1 - (\beta - \alpha) c_1)$ is increasing in c_1.

(ii) If $s_1 \geq c^M/\alpha$, the solution is $c_1 \in \left[c^M/\alpha, s_1\right]$ solving $\pi'(c_1) = \delta\alpha\pi'(\alpha c_1)$.

Figure 3.1 summarizes the discussion so far and illustrates the market expansion and competition effects generated by the weak copyright regime. With the strong copyright regime, the set of feasible second period industry sales (c_2) is given by the triangle $ab0$, that is the area bounded by the production frontier $\beta(s_1 - c_1)$ and the two axis. With the weak copyright regime the feasible set is given by the triangle $ac0$, that is the area bounded by the new production frontier $\beta(s_1 - c_1) + \alpha c_1$, αc_1 and the two axis.

When, as in case (a) of Figure 3.1, $s_1 < c^M/\alpha$, the market expansion effect dominates. There is no cost from the competitive effect because increasing first period sales is profit maximizing; under the weak regime the monopoly will therefore sell at least the quantity that leads to monopoly supply in the second period – equal to $\left(\beta s_1 - c^M\right)/(\beta - \alpha)$: this dominates the situation under the strong regime if $\phi(s_1, \beta)$ (as defined in (3.5)) is lower than $\left(\beta s_1 - c^M\right)/(\beta - \alpha)$. If $\phi(s_1, \beta)$ is greater than $\left(\beta s_1 - c^M\right)/(\beta - \alpha)$, the monopoly can choose the same first period sales but then benefits from the market expansion effect since c_2 increases while being lower than the monopoly supply.

In cases (b) and (c) of Figure 3.1, when $s_1 > c^M/\alpha$, there is a tension between market expansion and competitive pressure. Here, the competitive effect is the binding constraint since the monopoly does not want to reach the frontier of $ac0$. In case (b), if $\phi(s_1, \beta) < c^M/\alpha$, the weak regime is preferred since choosing c^M/α in the first period yields more profits than in the strong regime in both periods. In case (c), a sufficient condition for the strong regime to be preferred is when the optimal choice under the weak regime is $c_1 \in \left[c^M/\alpha, s_1 - c^M/\beta\right]$ since both first and second period profits are lower than when the monopoly chooses $s_1 - c^M/\beta$ in the weak regime. In the other case, the comparison between the two regimes depends on the elasticity of demand below and above the monopoly supply.

When the static profit function is symmetric[42] around c^M, that is when $\pi(c) = \pi^M - l\left(\left|c - c^M\right|\right)$, with the loss function $l(x)$, $x \geq 0$, convex increasing with a minimum at $x = 0$, there is a simple characterization of the preferred copyright regime in cases (b) and (c) of Figure 1. Since the curse of the Internet is maximum when α gets close to β, I will focus on the limit case; under the assumption of symmetric profit function, the artist prefers the weak regime if and only if $s_1 \leq 2c^M/\beta$.

Hence, when consumers have access to the same production technology $\beta(s_1)$ as firms, artists favor strong copyright only if $s_1 \geq c^M/\beta(s_1)$. Since $\beta(s_1)$ is U shaped, both highly creative artists (s_1 small) and poorly creative artists (s_1 large) favor weak

[42] This is the case when the demand is linear.

copyright laws; only "average" artists favor strong copyright laws. Highly and poorly creative artists are indirectly protected from the competitive effect: for highly creative artists interpretation is difficult while for poorly creative artists interpretation is easier but it is difficult to create new works of art.

This simple model therefore suggests that artists at the two extreme of the creativity scale benefit from market expansion: the most creative because market expansion facilitates interpretation of their work, the least creative because they have already "cornered" the market on their creative idea. This non-convexity resonates well with the variety of opinions of artists on the issue of copyright enforcement.

4. Issues and Conclusion

Like photography and the invention of the printing press a few centuries ago, the new technologies of digitalization and the Internet threaten the market positions of artists and intermediaries. Artists because the technology of production of works may be readily accessible and craftsmanship may no longer be a defining characteristic of art. Intermediaries because their rents were linked to entry barriers in the distribution market. This curse of new technologies may be a blessing in disguise since it also increases the possibilities of production, of distribution and the emergence of new works of art.

Thinking of works of art as multidimensional goods with consumers valuing all dimensions but being able to observe only a subset of these permits a simple answer to Arrow's (1962) problem:[43] how could a creative idea yield revenues on a market if valuation requires disclosure of the idea and if the idea can be appropriated at no cost? As long as interpretation is needed for works of art, and consumers value this dimension, artists can obtain revenues from their creative ideas even if consumers have access to a production technology that makes some of the observable dimensions of the work easy to replicate or produce. Copyright may complement this effect, but the preferences of

[43] There is a small literature on this: Anton and Yao (1994, 2002, 2004), Baccara and Razin (2003), Biais and Perotti (2003), Bhattacharya and Guriev (1983), Gallinin and Wright (1990), Hellman and Perotti (2004).

different participants in the market for strong copyright reflect a basic tradeoff between market expansion and competitive effects and have little to do with social efficiency, including incentive provision for new creative ideas. Appropriability per-se is indeed not enough for market participants to favor weak copyright, that is to allow consumers to use to its full extent the new productive opportunities of the Internet. Intermediaries and artists may want to limit competition in order to increase the rents brought by the indivisibility of creative ideas.

Legal licenses like those proposed by Common Creative Licence facilitate the emergence of new business models that allow artists to bypass current gatekeepers while still providing appropriability, whether monetary or non-monetary. Whether or not the artist will obtain enough revenues to cover the costs of creation is really an empirical issue, but the current support of some artists for weak copyright is an indication that this is the case.

I warned the reader that this chapter will be incomplete. There are other effects of the Internet that deserve further study. Some are already analyzed in chapters of this handbook. Others are less studied and may prove important; one leading question is the relationship between ease of entry and the "quality" of the offerings on the art market.

In a world where information is complete, entry should lead to social gains; but this is not necessarily the case for the art market. For instance, there is a tension between the desire for a "global" presence and the desire to fit local tastes and culture. The media have coined the term "glocal" for expressing this tension. While there is some work on this topic[44] it is still unclear how facility of access to knowledge and need to interpret works from other cultures will affect the offerings on the art market.

If we abandon the fiction of a representative consumer, and if consumers have dif-

[44]For instance, Legros and Stahl (2002) provide a theoretical argument showing how the number of varieties offered locally is affected by global competition and how the local market structure may alleviate this variety loss. There is a large "business economics" literature on these glocal strategies, see for instance Ghemawat (2001).

ferent abilities to interpret works of art or even to identify them, a need for certification arises: either to prevent fraud,[45] or to facilitate the interpretation of the work, e.g., by certifying the origin and therefore the historical context during which the work was created.[46] Who should provide this certification? Certification is often provided after a selection process, a screening process. Traditional gatekeepers (recording studios, galleries) play the role of screening and filter works of art that will be offered to the market; then as in the quote from Duchamp the artist "will have to wait for the verdict of the spectator" – critics, buyers, and historians build his reputation. The Internet by facilitating entry of artists shifts the role of screening to the market; it is not clear at this point whether this shift will improve on the previous system.[47] An indirect consequence of the difficulty to provide certification and screening on the Internet is that there are rents to be gained by offering such services to consumers; this should affect the market for the distribution of works of art, possibly leading to more rather than less concentration.[48]

[45] For instance, during the inaugural auction of Nart.com, an online auction company, a Picasso drawing had to be withdrawn because of fears that it might be a forgery (Economist, January 27, 2000).

[46] Duchamp's fountain would have probably not made an impact on art if Duchamp had not been a certified artist.

[47] For instance, as is known from search theory, a lowering of search cost may lead to less search by consumers because firms adapt their pricing strategy in equilibrium and may incrase the equilibrium opportunity cost of search. The documented search behavior of consumers on the Internet is an indication that this is not merely a theoretical argument, e.g., Brynjolfsson (2002). Search may also become less efficient, for instance if producers adjust their offering and try to manipulate the search of consumers, see Ellison (2003).

[48] The current strategy of Microsoft to purchase the rights of paintings, photographies and other works may be an illustration of this.

5. Bibliography

References

[1] Bakos, Y., Brynjolfsson, E., and Lichtman, D. (1999). "Shared Information Goods." *Journal of Law and Economics*, 42(1), 117-55.

[2] Becker, G. (1976). *The Economic Approach to Human Behavior*. Chicago: U. Chicago Press, pp. 284- 294.

[3] Besen, S. M., and Kirby, S. N. (1989). "Private Copying, Appropriability, and Optimal Copying Royalties." *Journal of Law and Economics*, 32(2), 255-80.

[4] Bessen, J., and Hunt, R. M. (2004). "An empirical look at software patents." WP 03-17, Federal Reserve Bank of Philadelphia.

[5] Bessen, J., and Maskin, E. (2000). "Sequential Innovation, Patents, and Imitation." WP 00-01, MIT.

[6] Boldrin, M., and Levine, D. K. (2002a). "The Case against Intellectual Property." *American Economic Review*, 92(2), 209-12.

[7] Boldrin, M., and Levine, D. K. (2002b). "Perfectly competitive innovation." mimeo, U.C.L.A.

[8] Boldrin, M., and Levine, D. K. (2004). "2003 Lawrence R. Klein Lecture: The Case against Intellectual Monopoly." *International Economic Review*, 45(2), 327-50.

[9] Brynjolfsson, E. (2002). *Understanding The Digital Economy (Data, Tools, And Research).* Cambridge*:* MIT Press.

[10] Conner, K., and Rumelt, R. (1991). "Software Piracy: An Analysis of Protection Strategies." *Management Science*, 37, 125-39.

[11] Corbett, A. R. (2003). "Software Bullet Is Sought to Kill Musical Piracy." New York Times, May 4.

[12] Danto, A. C. (1986). *The Philosophical Disenfranchisement of Art.* New York: Columbia University Press.

[13] De Long, B., and Froomkin, M. (1999). "Speculative Microeconomics for Tomorrow's Economy." http://econ161.berkeley.edu/OpEd/virtual/technet/spmicro.doc.

[14] Dewatripont, M., and Tirole, J. (2003). "Modes of Communication." Brussels and Toulouse.

[15] DRM Watch Staff (2001) . "Apple's iTunes Opens Wider – By Hook or By Hack." http://www.drmwatch.com/drmtech/article.php/3400151.

[16] Duchamp, M. (1959). "The Creative Act." Marcel Duchamp, R. Lebel, ed., Paragraphic Books, New York, 77-78.

[17] Duchamp, M. (1966). "Apropos of 'Readymades'." *Art and Artists*, 1(4).

[18] Duchene, A., and Waelbroeck, P. (2004). "Legal and Technological Battle in Music Industry: Information-Push vs. Information-Pull Technologies." ECARES, Université Libre de Bruxelles.

[19] Ellison, G. (2003). "A Model of Add-On Pricing." NBER Working Paper 9721.

[20] Gayer, A., and Shy, O. (2001a). "Copyright Protection and Hardware Taxation." mimeo, University of Haifa.

[21] Gayer, A., and Shy, O. (2001b). "Freeware, downloading, and piracy in markets for digital media." mimeo, University of Haifa.

[22] Ghemawat, P. (2001), "Global vs. Local Products: A Case Study and A Model." mimeo, Harvard Business School.

[23] Givon, M., Mahajan, V., and Muller, E. (1995). "Software Piracy: Estimation of Lost Sales and the Impact on Software Diffusion." *Journal of Marketing*, 59, 29-37.

[24] Green, J. R., and Scotchmer, S. (1995). "On the Division of Profit in Sequential Innovation." *RAND Journal of Economics*, 26(1), 20-33.

[25] Hahn, R. W, and Wallsten, S. (2003), "A Review of Bessen and Hunt's Analysis of Software Patents," AEI-Brookings Joint Center, mimeo, available at http://www.researchineurope.org/policy/hahn_wallsten.pdf.

[26] Hellwig, M., and Irmen, A. (2001). "Endogenous Technical Change in a Competitive Economy." *Journal of Economic Theory*, 101(1), 1-39.

[27] Hui, K. L., and Png, I. (2003). "Piracy and the Legitimate Demand for Recorded Music." *Contributions to Economic Analysis and Policy*, 2(1).

[28] Hui, K. L., and Png, I. P. L. (2002). "On the Supply of Creative Work: Evidence from the Movies." *American Economic Review*, 92(2), 217-20.

[29] Johnson, W. R. (1985). "The Economics of Copying." *Journal of Political Economy*, 93(1), 158-74.

[30] Kahin, B., and Varian, H. R. eds. (2000). *Internet publishing and beyond: The economics of digital information and intellectual property*, MIT Press, Cambridge and London.

[31] Klein, B., Lerner, A. V., and Murphy, K. M. (2002). "The Economics of Copyright "Fair Use" in a Networked World." *American Economic Review*, 92(2), 205-08.

[32] Lancaster, Kelvin (1966). "A New Approach to Consumer Theory." *Journal of Political Economy*, 76(2), 132.157.

[33] Leggat, R. (1999). "A History of Photography - from its beginnings till the 1920s." http://www.rleggat.com/photohistory/.

[34] Legros, P., and Newman, A. F. (1999). "Interference: Contracts and Authority with Insecure Communication." Brussels and London.

[35] Legros, P., and Newman, A. F. (2002). "Courts, Contracts, and Interference." *European Economic Review*, 46(4-5), 734-44.

[36] Legros, P., and Stahl, K. (2002). "Global vs Local Competition." CEPR DP 3333.

[37] Lerner, J. (2003). "150 Years of Patent Protection." mimeo Harvard University.

[38] Lerner, J., and Tirole, J. (2002a). "The Scope of Open Source Licensing." mimeo, Toulouse and Harvard University.

[39] Lerner, J., and Tirole, J. (2002b). "Some Simple Economics of Open Source." *Journal of Industrial Economics*, 50(2), 197-234.

[40] Lessig, L. (2004). *Free Culture*. The Penguin Press, pdf available under a Creative Commons license on Lessig's site.

[41] Liebowitz, S. J. (1985). "Copying and Indirect Appropriability: Photocopying of Journals." *Journal of Political Economy*, 93(5), 945-57.

[42] Liebowitz, S. J. (2002). "Record Sales, MP3 downloads, and the Annihilation Hypothesis." University of Texas at Dallas.

[43] Nordhaus, W. D. (1969). *Invention, Growth, and Welfare: A Theoretical Treatment of Technological Change*. MIT Press, Cambridge.

[44] Novos, I. E., and Waldman, M. (1984). "The Effects of Increased Copyright Protection: An Analytic Approach." *Journal of Political Economy*, 92(2), 236-46.

[45] Ordover, J. A., and Willig, R. D. (1978), "On the Optimal Provision of Journals qua Sometimes Shared Goods," *American Economic Review,* 68(3), 324-38.

[46] Peitz, M., and Waelbroeck, P. (2003a). "CD sales and Internet Piracy: Cross-section Evidence." mimeo, ECARES and Mannheim.

[47] Peitz, M., and Waelbroeck, P. (2003b). "Piracy of Digital Products: A Critical Review of the Economics Literature." mimeo, ECARES and Mannheim.

[48] Quah, D. (2002a). "24/7 Competitive Innovation," LSE.

[49] Quah, D. (2002b). "Matching Demand and Supply in a Weightless Economy: Market-Driven Creativity With and Without IPRs." mimeo, LSE.

[50] Quah, D. (2003). "Digital Goods and the New Economy." mimeo, LSE..

[51] Romer, P. (2002). "When Should We Use Intellectual Property Rights?" *American Economic Review*, 92(2), 213-16.

[52] Schopenhauer, A. (2004). "The Art of Controversy." eBook@Adelaide, Translated by T. Bailey Saunders, M.A. (1896), available at http://etext.library.adelaide.edu.au/s/schopenhauer/arthur/controversy/complete.html.

[53] Scotchmer, S., and Green, J. (1990). "Novelty and Disclosure in Patent Law." *RAND Journal of Economics*, 21(1), 131-46.

[54] Shavell, S., and van Ypersele, T. (2001). "Rewards versus Intellectual Property Rights." *Journal of Law and Economics*, 44(2), 525-47.

[55] Shy, O., and Thisse, J. F. (1999). "A Strategic Approach to Software Protection." *Journal of Economics and Management Strategy*, 8(2), 163-90.

[56] Sutton, J. (1991). *Sunk Costs and Market Structure – Price Competition, Advertising, and the Evolution of Concentration.* MIT Press.

[57] Takeyama, L. N. (1994). "The Welfare Implications of Unauthorized Reproduction of Intellectual Property in the Presence of Demand Network Externalities." *Journal of Industrial Economics*, 42(2), 155-66.

[58] Takeyama, L. N. (1997). "The Intertemporal Consequences of Unauthorized Reproduction of Intellectual Property." *Journal of Law and Economics*, 40(2), 511-22.

[59] Varian, H. R. (2000). "Buying, Sharing and Renting Information Goods." *Journal of Industrial Economics*, 48(4), 473-88.

6. Appendix

While single peakness of the profit function π is enough for most of the results, I will sometimes make the assumption that π is concave.

Competition

Lemma 1. *(i) There exists a unique value* $\hat{\alpha}(s_1)$ *solving* $u'(s_1) = \delta(\beta - \alpha) u'(\alpha s_1)$; $\hat{\alpha}(s_1) \in (0, \beta)$. *Under Assumption A,* $\hat{\alpha}(s_1)$ *is an increasing function of* s_1.

(ii) For all $\alpha < \hat{\alpha}(s_1)$ *the second best involves* $c_1^* < s_1$ *solving* $u'(c_1) = \delta(\beta - \alpha) u'(\beta s_1 - (\beta - \alpha) c_1)$; c_1^* *is increasing in* α. *For all* $\alpha > \hat{\alpha}(s_1)$ *the second best involves* $c_1^* = s_1$.

Proof. (i) Consider the equation $u'(s_1) = \delta(\beta - \alpha) u'(\alpha s_1)$. By concavity of u, the right hand side is strictly decreasing in α. At $\alpha = 0$, $u'(s_1) < \delta\beta u'(0)$, at $\alpha = \beta$, $u'(s_1) > 0$. Therefore there exists indeed a unique solution $\hat{\alpha}(s_1)$ solving the equation; moreover this solution is in $(0, \beta)$. Using the implicit function theorem, we have

$$\frac{d\hat{\alpha}(s_1)}{ds_1} = -\frac{u''(s_1) - \delta\alpha(\beta - \alpha) u''(\alpha s_1)}{\delta u'(\alpha s_1) - \delta\alpha(\beta - \alpha) u''(\alpha s_1)};$$

the denominator is positive, therefore $\frac{d\hat{\alpha}(s_1)}{ds_1} \propto \delta\alpha(\beta - \alpha) u''(\alpha s_1) - u''(s_1)$. At $\hat{\alpha}(s_1)$, $u'(s_1)/u'(\alpha s_1) = \delta(\beta - \alpha)$, therefore $\frac{d\hat{\alpha}(s_1)}{ds_1} \propto \alpha \frac{u'(s_1)}{u'(\alpha s_1)} u''(\alpha s_1) - u''(s_1)$ and we obtain $\frac{d\hat{\alpha}(s_1)}{ds_1} \geq 0 \Leftrightarrow r(\alpha s_1) \geq r(s_1)$ at $\alpha = \hat{\alpha}(s_1)$, which holds by (3.1) and $\alpha \geq 1$.

(ii) Obviously $c_2 = s_2$ at the optimum. For c_1, Inada condition insures that $c_1 > 0$ but it is possible that there is a corner solution at $c_1 = s_1$. Consider the restricted problem $\max_{c_1 \leq s_1} u(c_1) + \delta u(s_1 - (\beta - \alpha) c_1)$, we can have $c_1 < s_1$ only if the first order condition $u'(c_1) = \delta(\beta - \alpha) u'(\beta s_1 - (\beta - \alpha) c_1)$ has a solution $c_1 < s_1$. The left hand side is decreasing in c_1 and the right hand side is increasing in c_1, therefore if $\alpha \leq \hat{\alpha}(s_1)$ an interior solution exists while if $\alpha > \hat{\alpha}(s_1)$ the solution is at the corner $c_1 = s_1$. Using the implicit function theorem $\frac{dc_1^*}{d\alpha} \propto \delta u'(c_2) - \delta\alpha(\beta - \alpha) u''(c_2) > 0$; intuitively as α increase the opportunity cost of consuming at $t = 1$ is lower since "home production" becomes more efficient. ■

Corollary 1. *Let* ε_x *be the elasticity of first period consumption with respect to* x $(x = s_1, \alpha, \beta)$.

(i) In the low copying regime ($\alpha < \hat{\alpha}(s_1)$), a small increase in α yields a higher initial value for the asset only if $r(c_1)\varepsilon_\alpha < \frac{\alpha}{\beta-\alpha}$. A small increase in β yields a higher initial value for the asset only if $\varepsilon_\beta r(c_1) \leq -\frac{\alpha}{\beta-\alpha}$.The market value of the assets decreases when s_1 increases if and only if $\varepsilon_{s_1} r(c_1) < -1$.

(ii) In the high copying regime – $\alpha > \hat{\alpha}(s_1)$ – a small increase in α yields an increase in the asset price and in profits if and only if $r(\alpha s_1) \leq 1$; if $r(\alpha s_1) \leq 1$, a small increase in s_1 yields also a higher profit.

Proof. (i) When $\alpha < \hat{\alpha}(s_1)$, first period consumption solves

$$u'(c_1) - \delta(\beta-\alpha)u'(\beta s_1 - (\beta-\alpha)c_1) = 0.$$

using local concavity at the optimum, the implicit function theorem yields

$$\begin{aligned}
\frac{dc_1}{d\alpha} &\propto u'(c_2) - (\beta-\alpha)c_1 u''(c_2) > 0 \\
\frac{dc_1}{d\beta} &\propto -u'(c_2) - (\beta-\alpha)(s_1-c_1)u''(c_2),
\end{aligned}$$

hence while c_1 increases with α, its variation with respect to β is ambiguous; therefore while $\varepsilon_\alpha > 0$, ε_β could be positive or negative. Totally differentiating (3.3), we also have

$$\begin{aligned}
\frac{dq_1}{d\beta} &\propto -\frac{\alpha}{\beta-\alpha}u'(c_1) + \beta\frac{dc_1}{d\beta}u''(c_1) \\
&\propto -\frac{\alpha}{\beta-\alpha} - \varepsilon_\beta r(c_1) \\
\frac{dq_1}{d\alpha} &\propto \frac{1}{\beta-\alpha}u'(c_1) + \frac{dc_1}{d\alpha}u''(c_1) \\
&\propto \frac{1}{\beta-\alpha} - \frac{1}{\alpha}\varepsilon_\alpha r(c_1)
\end{aligned}$$

the result is then immediate.\ ■

Monopoly

Proposition 1. *Let $\phi(s_1,\beta)$ defined in (3.5). (i) [Low asset holdings] If $s_1 \leq \frac{\beta+1}{\beta}c^M$, $c_1 = \phi(s_1,\beta)$, $c_2 = \beta(s_1 - \phi(s_1,\beta))$. Moreover, $\phi(s_1,\beta) \geq s_1 - c^M/\beta$ and $\phi(s_1,\beta) \leq \beta s_1/(\beta+1)$ if $\delta\beta > 1$ and $\phi(s_1,\beta) \geq \beta s_1/(\beta+1)$ if $\delta\beta < 1$; that is even if $\beta s_1 > c^M$, the monopoly may choose in the first period not to supply the monopoly quantity in*

the second period. (ii) [Large asset holdings] If $s_1 \geq \frac{\beta+1}{\beta} c^M$, *then* $c_1 = c_2 = c^M$ *and* $q_1 s_1 = 2\pi^M$.

Proof. Consider the Lagrangian

$$L(c_1, c_2) = \pi(c_1) + \delta\pi(c_2) + \lambda(\beta(s_1 - c_1) - c_2).$$

If $\lambda > 0$, $\beta(s_1 - c_1) - c_2$ and maximization requires $\pi'(c_1) = \lambda\beta$ and $\delta\pi'(c_2) = \lambda$, hence $\pi'(c_1) = \delta\beta\pi'(\beta(s_1 - c_1))$. Since $\pi'(c_1)$ and $\pi'(\beta(s_1 - c_1))$ must have the same sign, if $c_1 \leq c^M$, we must also have $\beta(s_1 - c_1) \leq c^M$, and therefore $s_1 - c^M/\beta \leq c_1 \leq c^M$, or $s_1 \leq (\beta + 1) c^M/\beta$. If $c_1 > c^M$, we also need $\beta(s_1 - c_1) > c^M$, however this cannot be optimal because the monopoly could sell c^M each period rather than $c_t > c^M$. If $\delta\beta > 1$, we have by concavity of π that $\beta(s_1 - c_1) > c_1$, or $c_1 < \beta s_1/(\beta + 1)$; if $\delta\beta < 1$ we have $c_1 > \beta(s_1 - c_1)$, or $c_1 > \beta s_1/(\beta + 1)$.
If $\lambda = 0$, we need $\pi'(c_1) = \delta\pi'(c_2) = 0$, that is $c_1 = c_2 = c^M$. This is possible only if $s_1 \geq c^M$ and moreover $\beta(s_1 - c_1) \geq c^M$, that is $s_1 - c^M/\beta \geq c_1 \geq c^M$, or $s_1 \geq (\beta + 1) c^M/\beta$. ■

Proposition 2. *(i) If* $s_1 \leq c^M/\alpha$ *and* $\alpha \leq \beta - 1/\delta$ *the solution is* c_1 *solving* $\pi'(c_1) = \delta(\beta - \alpha)\pi'(\beta s_1 - (\beta - \alpha) c_1)$. *(ii) If* $s_1 \leq c^M/\alpha$ *and* $\alpha > \beta - 1/\delta$, *the solution is* $c_1 = s_1$ *and* $c_2 = \alpha s_1$; *moreover for all* $c_1 \leq s_1$, $\pi(c_1) + \delta\pi(\beta s_1 - (\beta - \alpha) c_1)$ *is increasing in* c_1. *(iii) If* $s_1 \geq c^M/\alpha$, *the solution is* $c_1 \in \left[c^M/\alpha, s_1\right]$ *solving* $\pi'(c_1) = \delta\alpha\pi'(\alpha c_1)$.

Proof. We assume that $s_1 \leq (\beta + 1)/\beta c^M$. The Lagrangian of this problem is

$$L(c_1, c_2) = \pi(c_1) + \delta\pi(c_2) + \lambda(\beta(s_1 - c_1) + \alpha c_1 - c_2) + \mu(c_2 - \alpha c_1)$$

where we ignore the constraint $c_1 \leq s_1$.
If $\lambda = \mu = 0$, maximization requires that $\pi'(c_1) = \delta\pi'(c_2) = 0$, or that $c_1 = c_2 = c^M$; this is not possible since $c_1 = c^M$ implies that $c_2 \geq \alpha c_1 > c^M$.
Therefore either $\lambda > 0$ (and $\mu = 0$) or $\mu > 0$ (and $\lambda = 0$) or $\lambda > 0, \mu > 0$.
If $\lambda > 0$, $\mu > 0$, we have $\beta s_1 - (\beta - \alpha) c_1 = \alpha c_1$, or $c_1 = \beta s_1/(\beta - \alpha + 1) > s_1$ which is

impossible.

If $\lambda > 0$, $c_2 = \beta s_1 - (\beta - \alpha) c_1$ and maximization requires $\pi'(c_1) = \lambda\beta$, $\delta\pi'(c_2) = \lambda$; therefore $\pi'(c_1) = \delta(\beta - \alpha)\pi'(\beta s_1 - (\beta - \alpha) c_1)$: $\pi'(c_1)$ and $\pi'(\beta s_1 - (\beta - \alpha) c_1)$ have same sign. Choosing $c_1 > c^M$ is strictly dominated by choosing $c_1 = c^M$ while keeping the same value of c_2; choosing $c_1 = c^M$ yields a contradiction since $c_2 \geq \alpha c^M$. When $\delta(\beta - \alpha) < 1$, concavity of π implies that $\beta s_1 - (\beta - \alpha) c_1 < c_1$, that is $c_1 > \beta s_1 / (\beta - \alpha + 1)$ which is impossible when $c_1 \leq s_1$ since $\alpha > 1$; therefore for all $c_1 \leq s_1$, $\pi'(c_1) - \delta(\beta - \alpha)\pi'(\beta s_1 - (\beta - \alpha) c_1) > 0$ and the solution is $c_1 = s_1$; this proves (iii) When $\delta(\beta - \alpha) \geq 1$; in this case $c_1 \leq s_1$ implies that indeed $\beta s_1 - (\beta - \alpha) c_1 > c_1$ as required by the first order conditions.

We need $c_1 \leq \min(s_1, c^M)$ and $\beta s_1 - (\beta - \alpha) c_1 \leq c^M$ or $(\beta s_1 - c^M) / (\beta - \alpha) \leq c_1 \leq \min(s_1, c^M)$. If $s_1 > c^M$, the condition requires that $s_1 < (\beta - \alpha + 1) c^M / \beta$ but the right hand side is strictly less than c^M which is a contradiction. Therefore, we need $s_1 < c^M$, and the condition requires

$$s_1 \leq \frac{c^M}{\alpha}.$$

Therefore, $\lambda > 0$,$\mu = 0$ is possible when $s_1 \leq c^M/\alpha$ and $\delta(\beta - \alpha) > 1$; in this case the solution is c_1 solving $\pi'(c_1) = \delta(\beta - \alpha)\pi'(\beta s_1 - (\beta - \alpha) c_1)$; this proves (ii)

If $\mu > 0$, $c_2 = \alpha c_1$ and profit maximization requires $\pi'(c_1) = \mu\alpha$, $\delta\pi'(c_2) = -\mu$, that is $\pi'(c_1) = -\delta\alpha\pi'(\alpha c_1)$ and $\pi'(c_1)$ and $\pi'(\alpha c_1)$ have opposite signs. As above, choosing $c_1 > c^M$, $c_2 = \alpha c_1$ is dominated by $c_1 = c^M$, $c_2 = \alpha c^M$.; the case $c_1 = c^M$ is not possible since then $\pi'(c_1) = 0 > \delta\beta\pi'(\alpha c^M)$. Therefore we need $c_1 < c^M < \alpha c_1$ and a necessary condition is that $s_1 \geq c^M/\alpha$. Clearly choosing $c_1 < c^M/\alpha$ is dominated by choosing $c_1 \geq c^M/\alpha$. Therefore the solution is $c_1 \in [c^M/\alpha, s_1]$ solving $\pi'(c_1) = -\delta\alpha\pi'(\alpha c_1)$. This proves (iii). ■

Proposition 3. *(i) The monopoly prefers the weak copyright regime when* $s_1 \leq c^M/\alpha$. *(ii) When* $s_1 \in [c^M/\alpha, (\beta + \alpha) c^M/(\alpha\beta)]$ *the monopoly prefers the weak copyright regime when* $\phi(s_1, \beta) \leq c^M/\alpha$, *or* $\pi'(c^M/\alpha) - \delta\beta\pi'(\beta(s_1 - c^M/\alpha)) < 0$. *(iii) When* $s_1 \geq (\beta + \alpha) c^M/(\alpha\beta)$, *the monopoly prefers the strong copyright regime if* $\pi'(s_1 - c^M/\beta) +$

$\delta\alpha\pi'\left(\alpha\left(s_1 - c^M/\beta\right)\right) < 0.$

Proof. Let V^k be the asset value at time 1 in regime k $(k = w, s)$.Since we assume $s_1 \leq (\beta + 1)\, c^M/\beta$, the market value in the strong copyright regime is

$$V^s = \pi(\phi) + \delta\pi(\beta(s_1 - \phi))$$

where ϕ stands for $\phi(s_1, \beta)$ as defined in (3.5).

(a) $s_1 \leq c^M/\alpha$, $\alpha > \beta - 1/\delta$.

In the weak copyright regime, $V^w = \pi(s_1) + \delta\pi(\alpha s_1)$; moreover, we know that $\pi(c) + \delta\pi(\beta s_1 - (\beta - \alpha)\, c)$ is increasing on $c \in [0, s_1]$.

We have

$$V^w - V^s = \pi(s_1) - \pi(\phi) + \delta\left\{\pi(\alpha s_1) - \pi(\beta s_1 - \beta\phi)\right\}.$$

The monopoly gains in the first period since $\pi(s_1) > \pi(\phi)$. In the second period, if $\alpha s > \beta s - \beta\phi$, the monopoly also gains in the second period since $\alpha s_1 < c^M$. Therefore if $\phi \geq (\beta - \alpha)\, s_1/\beta$, $V^w > V^s$.

Suppose now that $\phi < (\beta - \alpha)\, s_1/\beta$, that is the monopoly loses in the second period. We show that this second period loss is more than compensated by the first period gain: the market expansion effect in the weak regime enables the monopoly to increase its first period sales without suffering too much from the extra competition in the second period. We know from Proposition 1 that $\phi > s_1 - c^M/\beta$; and since $\alpha s_1 \leq c^M$ we can indeed have $\phi \in \left(s_1 - c^M/\beta, (\beta - \alpha)\, s_1/\beta\right)$. Let $\hat{c}$ be defined by $\beta s_1 - (\beta - \alpha)\,\hat{c} = \beta s_1 - \beta\phi$, that is $\hat{c} = \frac{\beta}{\beta - \alpha}\phi$; since we assume that $\phi < (\beta - \alpha)\, s_1/\beta$., we have $\hat{c} \leq s_1$, and $\hat{c} \geq \phi$ when $\alpha \leq \beta$. Therefore it is feasible to use $\hat{c}$ in the weak regime, and we have

$$\begin{aligned} V^w &\geq \pi(c) + \delta\pi(\beta s_1 - (\beta - \alpha)\, c) \\ &= \pi(c) + \delta\pi(\beta s_1 - \beta\phi) \\ &> \pi(\phi) + \delta\pi(\beta s_1 - \beta\phi) \\ &= V^s, \end{aligned}$$

the first inequality is by revealed preferences, the first equality is by definition of c, the second inequality is by $\hat{c} \in \left(\phi, c^M\right)$.

(b) $s_1 \leq c^M/\alpha$, $\alpha \leq \beta - 1/\delta$.

$$\begin{aligned} V^w &= \max_{c_1} \pi\left(c_1\right) + \delta\pi\left(\beta s_1 - \left(\beta - \alpha\right) c_1\right) \\ &\geq \pi\left(s_1\right) + \delta\pi\left(\alpha s_1\right). \end{aligned}$$

We can now use the same arguments in (i) above to show that $V^w > V^s$. This proves (i).

(c) $s_1 \geq c^M/\alpha$. From Proposition 1, the optimal choice in the strong regime satisfies $\phi \geq s_1 - c^M/\beta$. From Proposition 2, the optimal in the weak regime satisfies $c_1 \geq c^M/\alpha$. Suppose first that $s_1 \in \left[c^M/\alpha, \left(\alpha + \beta\right) c^M/\alpha\beta\right]$. If $\phi \in \left[s_1 - c^M/\beta, c^M/\alpha\right]$,

$$\begin{aligned} V^w &\geq \pi\left(c^M/\alpha\right) + \delta\pi\left(c^M\right) \\ &> \pi\left(\phi\right) + \delta\pi\left(\beta\left(s_1 - \phi\right) + \alpha\phi\right) \end{aligned}$$

since $\beta\left(s_1 - \phi\right) + \alpha\phi < c^M$. A necessary and sufficient condition for this case is, by concavity of $\pi\left(c\right) + \delta\pi\left(\beta\left(s - c\right)\right)$, that $\pi'\left(c^M/\alpha\right) - \delta\beta\pi'\left(\beta\left(s_1 - c^M/\alpha\right)\right) < 0$. This proves (ii).

Suppose now that $s_1 > \left(\alpha + \beta\right) c^M/\alpha\beta$ (this is the case illustrated in Figure 1 case (b)). If $c^M/\alpha < c_1 < s_1 - c^M/\beta$, $\alpha c_1 > c^M$ then,

$$\begin{aligned} V^s &= \pi\left(\phi\right) + \delta\pi\left(\beta\left(s_1 - \phi\right)\right) \\ &\geq \pi\left(s_1 - c^M/\beta\right) + \delta\pi\left(c^M\right) \\ &> \pi\left(c_1\right) + \pi\left(\alpha c_1\right) \\ &= V^w. \end{aligned}$$

A necessary and sufficient condition for $c_1 \in \left(c^M/\alpha, s_1 - c^M/\beta\right)$ is, by concavity of $\pi\left(c\right) + \delta\pi\left(\alpha c\right)$, that $\pi'\left(s_1 - c^M/\beta\right) + \delta\alpha\pi'\left(\alpha\left(s_1 - c^M/\beta\right)\right) < 0$. This proves (iii) ■

Proposition 4. *Suppose that the profit function is symmetric around c^M. (i) If $s_1 \leq \left(\beta + \alpha\right) c^M/\left(\alpha\beta\right)$ the monopoly prefers the weak regime. (ii)If $s_1 \in \left(\left(\beta + \alpha\right) c^M/\left(\alpha\beta\right), 2c^M/\alpha\right)$,*

the monopoly prefers the weak regime if $\phi(s_1,\beta) \geq \left(\beta s_1 - 2c^M\right)/(\beta-\alpha)$. *(iii) If* $s_1 \geq 2c^M/\alpha$, *the monopoly prefers the strong regime. (iv) In the limit case* $\alpha = \beta$ *the weak regime is preferred if and only if* $s_1 \leq 2c^M/\beta$.

Proof. (i) At $\hat{c} = \beta s_1/(\beta+\alpha)$ we have $\beta(s_1 - \hat{c}) = \alpha\hat{c}$; $c^M > \alpha\hat{c}$ is equivalent to

$$s_1 \leq (\beta+\alpha)\, c^M/(\alpha\beta), \tag{6.1}$$

that is we are in (i) or (ii) of Proposition 3. In case (ii), we have already argued that if $\phi \leq c^M/\alpha, s_1 V^w > V^s$. Suppose therefore that $\phi > c^M/\alpha$. The loss in period 2 from this choice in the strong regime is $l\left(c^M - \beta(s_1-\phi)\right)$ while the loss in the weak regime would be $l\left(\alpha\phi - c^M\right)$. We have

$$\begin{aligned} c^M - \beta(s_1-\phi) &> \beta\phi - \beta c^M/\alpha\text{: by (6.1)} \\ &> \alpha\phi - c^M \text{ : since } \phi \geq c^M/\alpha. \end{aligned}$$

Therefore $V^w \geq \pi(\phi) + \delta\pi(\alpha\phi) > V^s$ as claimed.

(ii) Suppose now that

$$s_1 \in \left((\beta+\alpha)\, c^M/(\alpha\beta), 2c^M/\alpha\right). \tag{6.2}$$

We are in case (iii) of Proposition 3. A sufficient condition for the weak regime to be preferred to the strong regime is that at the optimum choice in the first period of the strong regime, total profit is greater in the weak regime, that is when second period loss is lower under the weak regime, or when $\alpha\phi - c^M \leq c^M - \beta(s_1-\phi)$, that is when $\phi \geq \left(\beta s_1 - 2c^M\right)/(\beta-\alpha)$ – that condition is non vacuous since by (6.2), $s_1 \geq (\beta+\alpha)\, c^M/(\alpha\beta)$ and the right hand side is decreasing in α and is bounded below by $2c^M/\beta$ at $\alpha = \beta$.

(iii) Finally, suppose

$$s_1 \geq 2c^M/\alpha. \tag{6.3}$$

Then, $\frac{\beta s_1 - 2c^M}{\beta-\alpha} \geq s_1$, and therefore for all $c_1 \leq s_1$, $c_1 \leq \frac{\beta s_1 - 2c^M}{\beta-\alpha}$. Now the loss in the strong regime is smaller when we use as first period sales the optimum of the weak regime when $\alpha c_1 - c^M > c^M - \beta(s_1 - c_1)$ which is equivalent to $c_1 < \left(\beta s_1 - 2c^M\right)/(\beta-\alpha)$.

(iv) Note that when $\alpha = \beta$ condition (6.2) is vacuous. ■

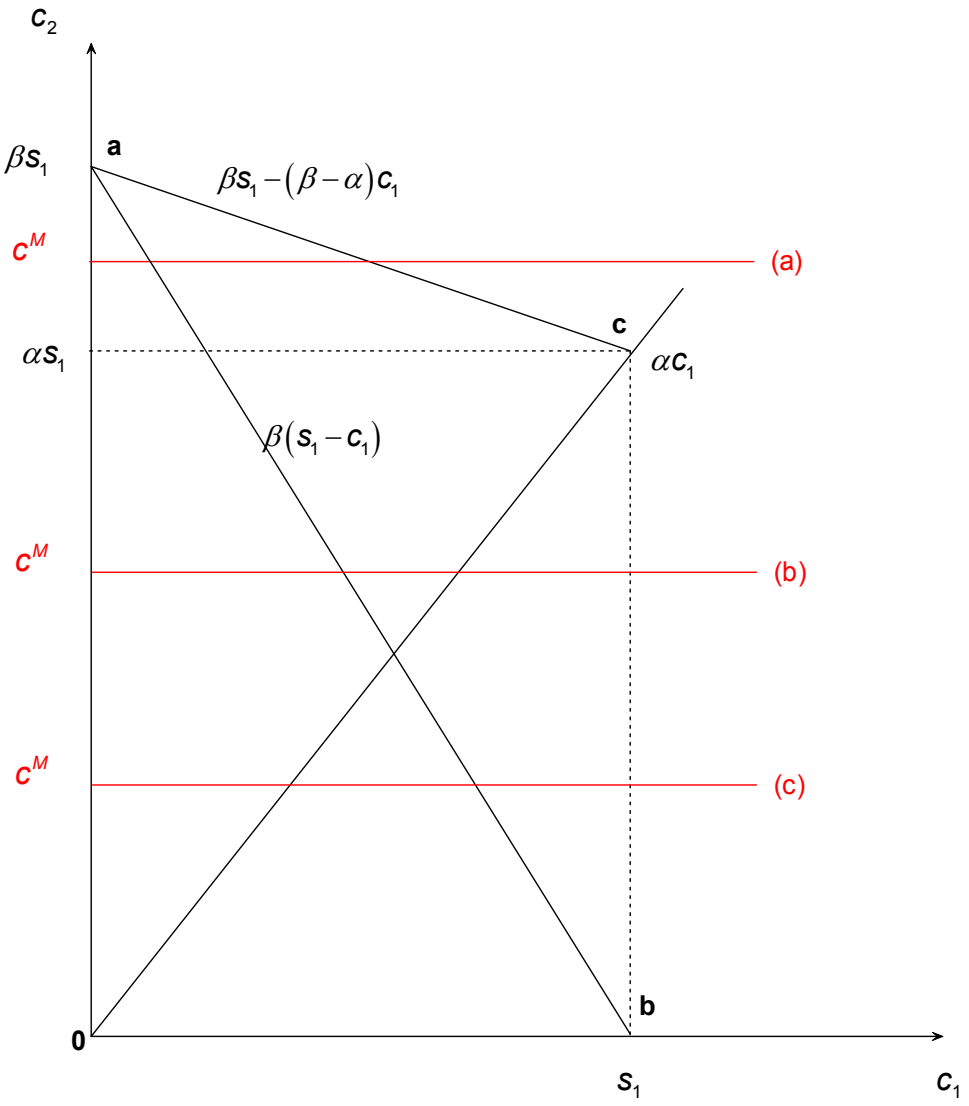

Figure 3.1: Market Expansion versus Competitive Effects