

The economic dimension of the digital challenge: a copyright perspective*

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Abstract

The digital revolution has increased the economic importance of copyright, but also made copyright infringement much easier. This paper addresses the most fundamental economic challenge for copyright in the third millennium: to achieve the right level of copyright protection. It is just as dangerous to produce a system with too much protection as one with too little.

1. Introduction

Studies have shown that copyright is of great economic significance.¹ The advent of digital technology has increased the economic importance of copyright in areas such as electronic publishing, CD-ROMS and multimedia, digital broadcasting, computer programs, databases and Internet communication. Simultaneously digital technology has made copyright

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¹ See *inter alia*: M. Hoecke (editor), *The socio-economic role of intellectual property rights* (Story Scientia, 1991); W. Landes and R. Posner, "An economic analysis of copyright law" (1989) 18 *Journal of Legal Studies* 325; E. Mackaay, "Economic incentives in markets for information and innovation (1990) 13 *Harvard Journal Of Law & Public Policy* 867; E. Mackaay, "An Economic View of Information Law" in W. Korthals Altes, E. Dommering, B. Hugenholtz and J. Kabel (editors), *Information law towards the 21st century* (Kluwer, 1992), 43; M. Pendleton "Intellectual property information-based society and a new international economic order - the policy options?" (1985) 2 *E.I.P.R.* 31; A. Quaadvlieg, "The economic analysis of intellectual property law" in W. Korthals Altes, E. Dommering, B. Hugenholtz and J. Kabel (editors), *Information law towards the 21st century* (Kluwer, 1992, 379).

infringement much easier. Given the clear increase in the economic importance of copyright through the advent of digital technology, what challenges does this increased importance represent? The economic analysis of copyright is complex. As a component of the perfect market, information should become costless and instantly available. As a good that must be produced within that market it must give its producers an incentive to produce. In addition, some works require enormous investments of time and money, have a long life span, require no maintenance and can be copied at no cost, therefore requiring high copyright protection. On the other hand, other works require little investment or can be protected by technological means or by advertising, hence requiring a lower level of protection to guarantee an adequate return to encourage future production. The challenge from an economic perspective is to achieve the right level of copyright protection. It is just as dangerous to produce a system with too much protection as one with too little. If the level of protection is too low, authors will probably not create. If copying is cheap and easy, the price that can be charged for the original may decrease to an extent that even something which can be produced at low cost will not be produced in the absence of legal protection. If the level of protection is too high, that will diminish the public domain of freely available material, depriving future creators of the raw materials they need to create new works.

2. The digital revolution

In the past few years the public has been given access to a colossal amount of information and goods on the Internet. The popularity of digital information delivered on-demand has led various companies to set up their own web sites. Goods sold on-line range from clothes and shoes, to food and houses. The purchase of physical goods like CDs, cassettes, videotapes, etc. in the high street is being replaced by the sale of the equivalent digital products without a material carrier over the Internet. Professional advice, such as medical or legal, is given by e-mail or by automatic reply generated on the basis of filling-in a questionnaire. Hotels can be booked on the Internet and air tickets can be bought in the same way. Even lectures can be attended on such medium. New on-line services are emerging, such as ones giving advice on what products to buy in terms of quality and/or price.

The development of digital technology increased the economic relevance of goods which mainly contain information. These goods are immaterial, intangible, and can be called digital goods.² The constant flow of information in the form of digital goods among economic agents is a new reality that raises new issues in the realms of both copyright and economics.

² An extensive discussion of the definition of digital goods, its characteristics, and economic relevance can be found in D. Quah, "Digital Goods and the New Economy" in Derek C. Jones (editor), *New Economy Handbook* (Academic Press Elsevier Science, 2003), 289-321. The author defines digital goods as "*a payoff-relevant bitstring, i. e., a sequence of binary digits, 0s and 1s, that effects the utility of or payoff to some individual in the economy.*" Examples of digital goods are ideas, knowledge, software, images, music, databases, videogames, DNA sequences, codified messages.

3. The copyright perspective

The digital environment brings some dangers to copyright protection.³ Information in digital form is intangible and can be reproduced instantaneously, with total accuracy and little effort. Digital copies are different from printed copies, because there is no difference between original and copy. Analogue technology is not compatible with multi-generation copying, but with digital technology copies can be made indefinitely with no loss of quality. Digital technology also eases the retrieval of existing works across the Internet, by means of mechanisms such as the World Wide Web and search engines. Furthermore, increases in capacity of the Internet and digital compression techniques have made it easier to distribute works at high speed and with little time or cost⁴. In summary, digital technology increases the ability to copy works and related subject matter, the quality of the copies, the potential to manipulate and modify the work and the speed with which copies can be delivered to the public.

The Internet also brings many difficulties to tracing copyright infringement. This is because cyberspace is a place outside boundaries, where information flows globally. On the Internet, illegal acts of reproduction, communication, adaptation and distribution of works can be triggered from anywhere in the world. Servers can be located anywhere and even if the place of illegal storage can be identified, that server can be located in a country where there is no copyright protection or inadequate protection. Therefore, it is often difficult to pinpoint the territory in which transmissions originate and where works are disseminated and cyberspace infringers are virtually unidentifiable.

In addition to this, generally, users feel that private non-commercial copying is not illegal, and that it falls within the realms of fair use. Users with technical skills even circumvent enforcement solutions.

Various technological measures have been developed for copyright protection tending either to control access to content or to control the copying of content. Technical solutions, such as digital watermarking⁵ and encryption⁶,

³ See *inter alia*, N. Highman, "The New Challenges of Digitisation" (1993) 10 EIPR 355-359; E. Samuels, "Copyright Concerns on the Information Superhighway" (1994) Annual Survey of American Law 383-392; F.H. Cate, "Law in Cyberspace" (1996) 39:565 Howard Law Journal 565-57; J.C. Gingsberg, "Putting Cars on the Information Superhighway: Authors, Exploiters and Copyright in Cyberspace" in *The Future of Copyright in a Digital Environment* (Kluwer Law International 1996) 189-219; A. Johnson-Laird, "The anatomy of the Internet meets the body of the law", (1997) 22:3 University of Dayton Law Review 467-509; R.A. Kurz, Jimenez, C.M., "Copyrights On-Line" (1996) 39:2 Howard Law Journal 531-564; A. Mille, "Copyright in the Cyberspace Era" (1997) 10 EIPR 570-577.

⁴ With MP3, for example, copies can be produced which are 8% of the original size and can be transferred down the Internet 12 times faster than the originals.

⁵ Digital watermarks are bits embedded in digital content, usually invisible in the absence of the proper software to detect and decode it. The watermark can contain information such as the author's name and e-mail address, ID number and a URL, information about who owns a work, how to contact the owner and whether a fee must be paid to use the work. A

have been used to develop copyright protection systems to limit use to a single user and to avoid redistribution or reuse of the material.⁷ The basic problem with available technological measures for protection of copyright and other subject matter on the Internet is that most of them have been disregarded or circumvented. In the music field, the SCMS's flags not only require devices where CDs are played to search for such flags, but also can be easily ignored.⁸ In the audio-visual field, the CSS system has been overcome by De Content Scrambling System (DeCSS). This software was developed to allow the playing of DVD films on operating systems other than Windows and Macintosh, such as Linux. The problem is that programs such as DeCSS enable users to overcome technological measures inserted in DVDs.

From a copyright perspective, copying has been made so easy and accessible to any end user, that works and other protected subject matter require more protection from unauthorised copying.

It does not seem that authors will completely stop creating as a result of the difficulties in controlling uses of their works. The problem is that without the ability to control the use of their works, creators will have little incentive to create, because creation usually requires a considerable investment of time and effort. According to Marshall Leaffer⁹, we may be left with great copying

watermark can only be effective if the playback and record devices look for the watermark in that particular piece of content.

⁶ Encryption is a technological method used to obscure the meaning of a message. There are various types of encryption. Asymmetric encryption is the best suited for e-commerce, since it uses two different keys and only public keys need to be distributed (there is no need to distribute any private keys). Each user generates two keys that are different: a private key and a public key. They keep their private key secret but send their public key to other users. The sender encrypts a message with the public key of the intended recipient and then sends it on to the recipient. Only the recipient's private key can be used to decrypt the message.

⁷ See *inter alia* P. Mallam, "Copyright and the Information Superhighway: Some Future Challenges" (1995) 6 Ent.L.R. 234-237; J. Schurtz-Taylor, "The Internet Experience and Author's Rights – An overview of some of the present and future problems in the digital information society" (1996) 24:2 International Journal of Legal Information 119-121; S. Dusollier, "Electrifying the Fence: The Legal Protection of Technological Measures for Protecting Copyright" (1999) 6 E.I.P.R. 285-297; S. Lai, "Digital Copyright and Watermarking" (1999) 4 E.I.P.R. 171-175. L. Jones, "An Artist's Entry into Cyberspace: Intellectual Property on the Internet" (2000) 2 E.I.P.R. 79-92; K.J. Koelman, "A Hard Nut to Crack: the Protection of Technological Measures" (2000) 6 E.I.P.R. 272-288; D.S. Marks and B.H. Turnbull, "Technical Protection Measures: The Intersection of Technology, Law and Commercial Licences" (2000) 5 E.I.P.R. 198-213; K.J. Koelman and N. Helberger, "Protection of Technological Measures" in Hugenholtz, P.B. (editor), *Copyright and Electronic Commerce – Legal Aspects of Electronic Copyright Management* (Kluwer, 2000), 165-227; A.M.E., Kroon, "Protection of Copyright Management Information" in Hugenholtz, P.B. (editor), *Copyright and Electronic Commerce – Legal Aspects of Electronic Copyright Management* (Kluwer, 2000) 229-265; P. Akester, "Survey of technological measures for protection of copyright" (2001) 12:1 Ent.L.R. 36-39.

⁸ When the user attempts to make an unauthorised copy of a work protected by SCMS, a message appears stating that he may not reproduce that work. The user is given the choice to comply with the law or to make an unauthorised copy of the work.

⁹ M. Leaffer, "Protecting Author's Rights in a Digital Age" (Fall, 1995), 27, University of Toledo Law Review, 1-12.

techniques but with very little worth copying. In the absence of assurance of a fair return for authors' creative efforts, the quality of works may decrease.

The immediate effect of the copyright system is to assure a fair return for authors. The ultimate aim of the copyright system is to encourage creation for the benefit of the public. It seems that the balance between the interests of authors and the public has to be somehow kept in the digital world. Only this will assure public access to quality works on the Internet.

4. The economics dilemma

Technology allows digital goods to be copied indefinitely, with no loss of quality and at no additional cost or with no significant cost when compared with the cost of the first unit, in the sense that only the first unit has a cost different from zero and the cost of an additional unit (the marginal cost) is null, or close to it. The problem is that the competitive price becomes zero or close to it in order to be equal to the marginal cost (no one pays the first unit) and hence there is no incentive to produce those goods in the first place.¹⁰ The consequent under-investment in production, means that there is a lower level of innovation since the creation of new digital goods is impaired. Therefore, the capacity to infinitely reproduce and thus to infinitely expand the original digital goods ultimately causes a market failure.

The infinite expansibility of digital goods makes them also non-rival: the use by one agent does not affect use by another agent, that is, the utility or payoff is not affected by use by others.¹¹ Non-rivalry does not impede the functioning of the price system provided that it is possible to prevent use of goods. If digital goods were non-excludable, they would be qualified as public goods and treated as such, but the fact that copyright enables the exclusion of consumers (by denying them use of works and related subject matter protected by copyright unless they are authorised to do so) means that they are not public goods. It is impossible to exclude individuals from consumption of street lighting, military defence, or clean air, but it is possible to exclude them from driving on a motorway: only those who pay are allowed to use it. Because copyright enables exclusion of individuals from consumption, the case of digital goods is similar to the one of motorways, though more complex, given the possibility to make exact copies at no cost, or at a much lower cost than the price of the original, without authorization.

¹⁰ The marginal cost is the cost of producing an additional unit. In order to maximize its profit a firm will continue to sell a good until the price is above or equal to the cost of each additional unit – the marginal cost. The competitive market means that no firm can extract rents from production, in the sense that market power – the power to increase the price above the marginal cost – does not exist, that is, firms are price takers. Any firm that sets a price above the marginal cost loses all of its costumers to any rival firm that sells the same good at a lower price. This competition among firms leads the price to be equal to the marginal cost.

¹¹ Nevertheless, non-rivalry does not imply infinite expansibility: just think of a national system of military defence.

Even if we consider that technological measures for protection of copyright can be circumvented, at least from the moment of creation of the work (a time at which copyright automatically vests upon it) until the act of circumvention, consumers can be excluded from consumption.¹² As public goods by definition are always non-excludable, digital goods are not public goods.¹³ The central role played by copyright and technological protection of copyright works follows from the above reasoning, namely the capacity to effectively exclude individuals from unauthorised use of digital goods.

The possibility of recombining works is another characteristic of digital goods. Portions of several digital goods can be recombined by a consumer, increasing its value, or be used in the production of new digital goods. Thus, the recombination of digital goods can give place to new innovation possibilities.¹⁴ As long as the end product can be deemed original (not copied from another work, originating from the author and involving the necessary investment of skill and labour) and fixed (recorded in some written or any other form), it will be protected by copyright (even though the underlying works will have been infringed if those acts were not authorised).

What are the consequences of these characteristics of digital goods?

Digital copying will increase competition and the price of the product will be zero or close to it where the marginal cost – the cost of an additional unit – is positive but low. The process of copying is beneficial because it facilitates the diffusion of (new) digital goods. But, it is also true that innovation increases the flow of improved (digital) goods. If the returns from the sales of goods are not sufficient to cover the initial cost of the producer, then the optimal solution for the producer is not to sell, that is, not to innovate.¹⁵ Eventually, no one will produce because there will be no incentives to do so.

So far copyright has been the solution to protect authors' works from illegitimate copying of their works, thereby allowing them to set a non-zero

¹² The way to circumvent is itself, from an economics viewpoint, a digital good. It is enough the circumvention by one consumer, who places the illegally obtained copy of the work on the Internet or make available the way to circumvent, to enable all consumers to copy the work.

¹³ D.J. Brennan, "Fair price and public goods: a theory of value applied to retransmission" (2002) 22 International Review of Law and Economics 347-375, provides a useful discussion about excludable public goods in the context of retransmission of copyright subject matter. In particular, the author recognises that excludable public goods, such as copyright, can be provided privately as opposed to non-excludable public goods and the dynamic efficiency considerations to attribute property rights through copyright: to protect the present creations in order to have new creations in the future.

¹⁴ M.L. Weitzman, "Recombinant growth" (1998) 113:2 Quarterly Journal of Economics 331-360.

¹⁵ In fact, it is more than production zero; the decision to incur in the sunk cost is necessary for the initial act of creation. Economic theory submits that production should be positive where the price covers at least the costs that are not sunk. Therefore, the sunk cost – not recoverable due, for example, to the specificity of the investment, which is usually the case of innovation process – if already incurred, does not affect the decision to produce. That is why the potential producer of digital goods will decide to not innovate if he foresees that the stream of rents will not be sufficient to cover the initial investment.

price and thus giving them an incentive to create, which in turn gives the public access to works and other subject matter.

The problem with the new economic reality stemming from the digital revolution is that it may be impossible to enforce copyright. The no-cost copy emerging from this context poses the legislator with new issues to solve.

5. The right level of copyright protection

Copyright protection has to balance the incentives to create new and better goods against the efficient use of those goods. Considering the information content of digital goods and the fact that illegal digital copies may be obtained at cost zero, the socially efficient price should also be zero: no one should be deprived from consumption of digital goods, especially future creators, in the process of producing new goods.

Copyright protection has to balance social welfare benefits against costs.¹⁶ The usual perception is that an increase in the level of copyright protection provides an incentive to invest in the creation of new products, albeit increasing the welfare cost as a result of under-utilization (since some individuals are deprived from consumption).

The effect of the level of copyright protection on the producer's decision to create new goods and on the consumers' decision to use the original goods, or unauthorised copies, or simply not to consume will now be analysed.

The level of copyright protection will determine the cost of unauthorised copying for individuals: a higher level of protection will induce higher costs due to an increased likelihood of detection of copyright infringement and punishment. In this context, the cost of an illegal copy can be seen as the sum of the direct cost of reproduction plus the cost induced by the level of copyright protection.

Where original and copy are not perfect substitutes the consumer will have an additional cost associated with the difference between the quality of the original and the quality of the copy. Where copies are of a lower quality, individuals will derive a lower level of satisfaction from consuming them rather than the originals. The lower the degree of substitution the higher the cost associated with the decrease in satisfaction.

¹⁶ Consider the social welfare function as the sum of the producer and consumer surplus. The producer surplus is simply the profit from its activity. The consumer surplus is measured by the distance between the maximum price that the consumer is willing to pay and the price effectively paid. If the two prices are equal, then the consumer surplus is zero: the consumer pays exactly what is was willing to pay. At the other extreme, if the consumer pays nothing for one good, then the consumer surplus is the maximum: the consumer has all the satisfaction at price zero. The consumer surplus is reduced when the price increases. If the market price is higher than what the consumer is willing to pay then the consumer's optimal decision is not to consume.

Consider now an individual who does not distinguish original from copy. In this case, if the cost of an unauthorised copy is lower than the price charged for the original, the individual will consume the copy; if the cost of the copy is equal to the price of the original, the individual is indifferent; if the cost of an unauthorised copy is higher than the price charged for the original, the individual will consume the original. Where digital goods can be copied at no cost, or are obtained at a much lower cost than the original, and there is no difference between original and copy, the individual only has to consider the cost of reproduction plus the probability of being caught.

What happens to consumers if there is an increase in the level of copyright protection?

Where original and copy are perfect substitutes, an increase in the level of copyright protection will decrease consumer surplus because individuals will stop consuming and/or copying will become more costly, which in turn will lead to a decrease in welfare. Some individuals who previously consumed copies may start consuming originals in view of the new higher costs. For these consumers the total cost of copying will be higher than that of purchasing a legal copy of the work. Since the producer, invested with market power, sets the price above marginal cost, this shift will only be carried out by individuals for whom the cost of copying is higher than the marginal cost incurred by the producer. From a societal point of view, this shift brings a welfare increase because it is more efficient to produce an original than a copy: the cost of the original for the producer is lower than the cost of the copy for the consumer.

When a copy does not perfectly replace the original, the individual bears an additional cost from copying: the decrease in consumer utility given the lower satisfaction derived from the copy.¹⁷ This scenario is more interesting given that the cost of a copy can be higher than the marginal cost of the original, even if we do not consider the cost (from the consumer's perspective) associated with copyright protection, but only the cost associated with lower satisfaction. If the level of copyright protection increases, welfare may too increase (as in the context of perfect substitutability) because the increase in the level of copyright protection may induce the consumption of the original instead of the copy.

The difference between this case and the one of perfect substitutability is that here, the increase of copyright protection coupled with imperfect substitutability mean that there is a higher probability that the cost of copying will be higher than the cost of producing the original. Because the original bears a lower cost, it is then more efficient for consumers (who

¹⁷ The lower utility associated with the copy does not need to be a result of the absence of software manuals, an incomplete music album, or a non fully operating demo; it can also result from a decrease in satisfaction associated with the individual's notion of fairness. See *inter alia* E. Fehr and S. Gächter, "Fairness and Retaliation: The Economics of Reciprocity" (2000) 14:3 Journal of Economic Perspectives 159-181.

experience a greater disutility from substitution) to choose to purchase an original rather than to make an illegal copy, that is, it is more efficient for consumers to shift from illegal copy to original.¹⁸

Therefore, it is not always true that an increase in the level of copyright protection carries a welfare loss associated with under-consumption.¹⁹

What is the effect of an increase in the level of copyright protection on the producer's decision to innovate?

Copyright protection gives market power to the producer, that is, the ability to set a price higher than the marginal cost. In order for the producer to produce, the markup margin of the units sold has to be higher than the sunk cost incurred with the creation of the product, that is, the producer's profit has to be null or positive. Therefore, the level of copyright protection required to induce innovation is a positive function of the innovation sunk cost. For example, when high investments on R&D are necessary to develop a new product, the level of copyright protection will also have to be high. Nevertheless, if the sunk costs are too high, it is possible that no level of protection will induce innovation.

What is the effect of an increase in the level of copyright protection on the producer's decision to innovate when there are several producers?

If the level of copyright protection increases, producers can exercise their rights with a higher marginal profit – the difference between prices and marginal cost increases. Producers can undertake investments in the creation of goods with higher sunk costs if higher profits are extracted and social welfare increases due to the production of new goods.

What is the level of copyright protection that reconciles the producer and consumers decisions?

The right level of copyright protection will be a function of the variables at stake, namely: the cost of the original; the cost of the copy; and the sunk cost of innovation. When the cost of original (and copy) is very low and there is no copyright protection, then the producer cannot obtain enough revenue to cover the sunk cost and therefore will not innovate. If the producer does not innovate and there are no new products, then the individual will not consume and there will follow a decrease in the welfare function. Therefore, it is socially optimum to have a positive level of copyright protection. In an extreme case of no cost for the copy (of reproduction and replacement) and for the original, the right level of copyright protection is one of full protection that does not allow any unauthorised reproduction, otherwise there is no creation of new goods.

¹⁸ Note that those individuals who already have consumed the original – those for whom the substitution is more costly in terms of satisfaction – are not affected by the increase in the level of copyright protection.

¹⁹ See K. Yoon, "The optimal level of copyright protection" (2002) 14 Information Economics and Policy 327-348.

6. Market power

Markets for music, books and films, for example, function with some degree of product differentiation, that is, sufficient heterogeneity, giving each producer market power to set prices above the marginal cost of an additional unit. The perceived quality of each product results from consumer preference for that particular product. The more consumers derive satisfaction from a product, the less sensible they are to prices – lower price elasticity – thus providing more market power to the producer. If the high number of market operators and the absence of significant barriers to entry are also considered, the market can be deemed to function according to a monopolistic competition structure.

With traditional copying methods (such as photocopying machines, tape recorders and video recorders) reproduction took time, cost money (at least the cost of paper, cassettes or videotapes), usually the quality of the copies was inferior to the quality of the original and the number of copies was limited by the need of a physical carrier.²⁰ Therefore, until the advent of the digital revolution, the market power of each copyright owner was reasonably protected by copyright. With digital technology, these disincentives to copying no longer exist. Digitisation increases the ease and speed with which works and related subject matter can be copied, the quality of the copies and the swiftness with which copies can be distributed to the public. Copying can be effected by a few keystrokes. The quality of copies is so high that there is often no discernible difference between original and copy. Copies can be distributed to the public in seconds.

Before digital technology, distributors had a prominent role because users merely consumed products exclusively distributed by intermediaries. The first problem faced by distributors in the digital world is the loss of their predominance: equipped with a personal computer and an Internet connection users can distribute and trigger distribution of any material they either find on-line or they digitise and then release on the Internet. The second problem of traditional distribution is that digital transmission of works is fast and cheap, when compared to distribution by traditional means. Because of the speed and cost factors, traditional distribution, in this respect, cannot compete with digital dissemination of works.

The availability of digital copies at a lower or no cost deprives each producer of direct demand for his tangible goods, thus decreasing his profits and

²⁰ The demand for copies, including illegal copies, exists and behaves as any other demand function. Several studies have analysed this issue. See *inter alia* P.J. Harvey and W.D. Walls, “The revealed demand for pirate goods: Probit analysis of experimental data”, (2003) 20:2 International Journal of Management 194-201. The authors conducted an experiment and showed that an increase in the price of the original good leads to an increase in the probability of buying a counterfeit good, but the increase in the expected penalty decreases it. This latter effect dominates the former, which seems to suggest that individuals are risk averse. Overall, coupled with real evidence, the results from the paper provide support for stronger enforcement of protection laws not only on sellers but also on buyers.

eventually putting him out of business if negative profits are maintained.²¹ Ultimately, if consumer preferences turn solely to intangible digital goods no firm will survive and the number of tangible goods may converge to zero. The question is then whether businesses can survive by just producing intangible digital goods. The main function of these firms is to distribute and promote goods, thus saving on transaction costs.²² If authors, the creators of the information content of digital goods, can operate in the market, delivering digital goods directly to consumers without any intermediaries, and if this is less costly than using a traditional distribution chain, then those firms will no longer be able to justify their existence. In this sense, the advent of digital technology is expected to change the nature of businesses that operate in the digital goods markets.

In the course of these changes, digital intangible copies may create demand for their tangible counterparts and further future sales of digital goods. For example, in the presence of network externalities, producers can gain by allowing the limited spread of unauthorised copies in order to foster demand for the original goods: those individuals with a lower reservation price – the maximum price they are willing to pay – will consume the product and, consequently, increase the demand for individuals with higher reservation prices, due to the existence of network externalities.²³ It is as if the producer is charging different prices for the same product using price discrimination. Producers of computer programs, for instance, charge different prices to specific groups of consumers (e.g., students), with different paying thresholds. This is a standard case of price discrimination that increases the firm payoff even if network externalities are not present.

7. Voluntary contributions?

Is it possible to devise a solution with no enforceable provisions, based on voluntary contributions?²⁴ Prices constitute a decentralised mechanism to transmit information.²⁵ The issue is whether there is an equally decentralised alternative based on voluntary contributions.

²¹ The advent of the demand for intangible digital goods will decrease demand for tangible goods. If at this point, the market is at a long run equilibrium, with free entry, prices will equal the average cost, that is, the firms' profits equal zero. Therefore, the development of intangible digital goods will cause negative profits.

²² The concept of transaction costs was first introduced by R. H. Coase "The Nature of the Firm" (1937) 4 *Economica* 386-405. A transaction can be carried out within a firm or through the market using the price mechanism. The cost of the transaction in each alternative will determine where it is going to take place. The main point is that it is costly to use the price mechanism for some transactions, because it can be costly to coordinate all agents involved in a transaction and to set a separate contract with all of them, for example. Note that within a firm there is no system of prices.

²³ Network externalities arise, for example, when the benefit of a good increases as more individuals use it. For an analysis of the concept see S.J. Liebowitz. and S.E. Margolis, "Are network externalities a new source of market failure?" (1995) 17 *Research In Law And Economics* 1-22.

²⁴ Public provisions include, for example, public lending rights and private copying schemes.

²⁵ Hayek, "The Use of Knowledge in Society" (1945) 35:4 *American Economic Review* 519-530.

Consider a game where we have a producer on one side and consumers on the other side. The problem to solve is how to set a price above zero for a digital good with a lower information content, that is, demanding a lower investment on R&D – a lower sunk cost. Assume a voluntary contribution from consumers to the producer. The game is repeated: in each period the producer can deliver a new product, but it is impossible to sell it due to the nature of the product – a digital good infinitely expansible at no cost. Consumers decide each period whether or not to make a voluntary contribution. For simplicity purposes we will assume that consumers always consume. The producer does not know in advance if consumers are going to contribute or not. If consumers voluntarily contribute, the following period the producer will deliver a new product. Assuming that consumers will always contribute if they like the product – a positive change in their utility – the producer has to decide the following period whether to deliver a new product. If the sum of the contributions is at least equal to the sunk cost of the product, then the answer will be yes.

Is an equilibrium reached in which the producer delivers a new product in every period? Why should consumers contribute? Why not just free ride? This is the major issue. Some consumers will always free ride and, to reach an equilibrium characterised by positive production the number of consumers who do not free ride and their respective contributions must be high enough to cover the cost of the first unit.

8. Conclusion

From the perspective of copyright, a primary conflict can be recognised, one resulting from the fact that new digital technologies provide incentive to the free flow of ideas, knowledge and information, whereas the fundamental design of copyright law is to prevent unauthorised free flow of authors' creations.

Digital goods are pieces of information that can be easily reproduced at low or no cost. The economics dilemma is how to ensure the creation of new knowledge when it is socially desirable that all individuals should be granted access to the information content of a digital good once it has been created. An investment needs to be made in order to obtain innovation. This initial investment is frequently a sunk cost, that is, non-recoverable. If digital goods cannot generate a string of revenues in the market place high enough to cover the initial investment the innovation process has no incentive to continue.

Digital technology raises new issues not only on the functioning of the market, but also on the nature of the firm. The price mechanism, itself a way to convey information, has experienced a general decrease in the cost of obtaining information and an increase in the speed at which the information flows among economic agents. At the same time, the nature of the firm is also likely to change because some transactions can be carried out through the market at a lower cost than within the firm. The distribution and promotion

of information contents like sound recordings is a good example of such changes. To what extent the changes are going to significantly affect the current balance between the market and the firm is yet to be seen.

The problem with the new economic reality stemming from the digital revolution is that it may be impossible to enforce copyright. The no-cost copy emerging in this context poses the legislator with new issues to solve.

Some authors have been overly pessimistic about the ability of copyright law to adapt to the challenges of the digital revolution. The conclusion drawn by many is that the acute changes brought by digital technology will give place to profound transformations in the way in which we protect creators and their creations and copyright will become obsolete.²⁶

But copyright law will adjust to digital technology as it has conformed to other technological challenges, such as photography, motion pictures and sound recordings, throughout its existence.²⁷ Furthermore, technology will provide authors and owners with new methods to assure protection of their works and to enforce their rights. This is significant for the balance of the copyright system as a whole, since it gives authors control over their works, and consequently an incentive to create. The level of protection becomes endogenous, that is, determined to a great extent by the authors themselves. The assurance of a just compensation for authors' creative efforts may mean that the public will be given access to works and related subject matter.

Nevertheless, technology alone cannot provide a viable solution. Technological measures for protection of copyright must be supported by copyright laws that support such measures and prohibit their circumvention, to make sure that they are respected.

The nature of digital goods, mainly intangible and infinitely expansible and the widespread of networks and mechanisms to exchange information mean that these goods are not restricted by national boundaries. So, to assure legal certainty and uniformity these laws should be globally harmonised. In the absence of global harmonisation, digital versions of tax havens will emerge. Because the digital world is a global one, this issue requires the same level of protection worldwide.

²⁶ M. Leaffer, "Protecting Author's Rights in a Digital Age" (Fall 1995), 27, University of Toledo Law Review, 10-12; S. Olswang, "Accessright: an evolutionary path for copyright into the digital era?" (1995) 5 E.I.P.R. 215-218; J. Litman, "Revising Copyright Law" (1996) 75 Oregon Law Review 40-48; J. Litman, "New Copyright Paradigms" (1997) available at <http://www.msen.com/litman/~paradigm.htm>.

²⁷ C. Clark "The answer to the machine is in the machine" in P.B. Hugenholtz (editor), *The future of copyright in a digital environment* (Kluwer, 1996) 139-145.

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